ARE ACQUISITIONS AN OPERATIONAL HEDGE?

THE INTERACTION OF FINANCIAL AND OPERATIONAL HEDGING

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ABSTRACT

This paper investigates the substitution of financial and operational hedging choices. Modern risk management can enhance firm value when volatility is costly due to capital market imperfections. Both financial hedging with derivatives and operational hedging can reduce income volatility and, in turn, the potential costs of such volatility. I present a simple model of the tradeoffs between such hedging choices to motivate an empirical investigation into firm behavior. Using a large sample of bank holding companies, I document that acquisitions can provide operational hedging and that this is a substitute for financial hedging. Not only do the majority of acquisitions reduce volatility, the subsequent decrease in financial hedging corresponds to an acquisition's contribution to operational hedging. Those acquisitions that provide the most operational hedging are followed by the largest declines in financial hedging.

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1. INTRODUCTION

In the world of Modigliani and Miller, risk management is not a tool for value maximization. However, capital market imperfections such as financial distress, tax convexity, and external financing create a cost to cash flow volatility (Smith and Stulz (1985), Tufano (1996)). Empirical evidence confirms the importance of these costs: 71% of the large[1] bank holding companies (BHC) utilize derivative hedges against interest rate, foreign exchange, equity, or commodity risks. Yet income volatility also can be reduced with operational hedging, such as adjusting operating leverage, sourcing parts in different countries, or diversifying cash flows through project choice or acquisitions. Using a large sample of BHCs, I find that acquisitions can reduce income volatility and that managers substitute this operational hedging for financial hedging. In spite of this, acquisitions and other firm organization decisions are frequently considered orthogonal to derivatives use.

If operational hedges are a risk management tool, appreciating their relationship to financial hedging is essential to the capital budgeting, hedging, and diversification literatures. This paper investigates this relationship both by introducing a simple model of optimal hedging when multiple avenues for risk management exist and empirically analyzing the relationship between financial and operational hedging. In the model, management aims to maximize firm value by limiting costly volatility while taking into account the expense of hedging. Optimal risk management balances the relative costs of each hedging choice with its contribution to reducing volatility. Any increased use of one hedge should result in an offsetting decline in the alternative hedging tool. That is, if total firm risk matters, then operational decisions which reduce idiosyncratic risk will impact the use of derivatives for hedging.

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[1] Large BHCs are defined as those with at least $1 billion in total assets.

Dramatic changes in operational hedging should provide the easiest observation of risk management tradeoffs. Amihud and Lev (1981) and Aggarwal and Samwick (2003) argue that diversifying idiosyncratic risk is a key motivation for mergers and acquisitions (M&A). Thus, I focus on how this firm organization decision affects hedging with derivatives using a dataset of bank holding companies. I concentrate on interest rate hedging because this exposure comprises the overwhelming majority of BHC derivatives hedging. Consistent with my hypothesis, I document a substitution between hedging with derivatives and acquisition activity. Not only is an acquisition more likely if risk exposures are not actively hedged with derivatives, but financial hedging decreases after most acquisitions.

It should be noted that acquisitions could influence financial hedging even in the absence of operational hedging. If the acquirer's intrinsic risk exposure shifts with an acquisition, derivatives use should adjust. This provides some information about risk management (e.g., that managers respond to changing exposures), but it does not address whether some acquisitions serve as an operational hedge and how that influences derivatives use. As aforementioned, the reliance on financial hedging decreases following acquisitions. Evidence of this substitution exists even after controlling for changing risk exposure. For example, assume a firm hedges a certain percentage of its risk exposure. If the firm hedges a significantly smaller percent after an acquisition, controlling for the change in exposure due to the acquisition, operational hedging may have increased.

I also test whether an acquisition's impact on financial hedging varies with its contribution to operational hedging. Acquisitions which increase the scale of the firm, but do not affect cash flow volatility in any material manner, offer little in the way of operational hedging. Conversely, acquisitions which alter volatility should be factored into the total risk management.

The empirical evidence presented in this paper suggests that those acquisitions offering the most operational hedging lead to the largest reductions in hedging with derivatives.

If acquisition activity provides operational hedging, then this research pertains to not only the hedging literature but also basic theory of the firm issues. Coase (1937) established the discussion on what determines the boundaries of a firm and whether those boundaries affect resource allocation. More recently, Berger *et al*. (2005) provided empirical support for the notion that organizational form influences the choice of business activities. This implies that if risk management impacts firm organization, the core business activities of a firm may change. Hedging choices could influence firm value not just by minimizing the costs of volatility but also by changing project selection or business practices.

This research also may contribute to understanding some of the unexplained cross-sectional variation in diversification discount literature (Stein (2003)). Benston, Hunter, and Wall (1995) conclude that banks value more highly those acquisitions which diversify earnings. This could be explained by the reduction in volatility and, possibly, financial hedging costs.

The remainder of the paper is organized as follows. Section 2 reviews the existing literature. In Section 3, a basic model of hedging alternatives is described. Section 4 presents the data and Section 5 discusses the methodology and results. Section 6 concludes.

2. FINANCIAL VERSUS OPERATIONAL HEDGING

No comprehensive survey exists of the multiple avenues for corporate hedging. Prior research focuses primarily on the relationship of derivatives to either firm value or leverage but overlooks the risk management aspects of corporate decisions such as capital budgeting and diversification. Hedging decisions have been found to affect debt ratios (Graham and Rogers,

2002; Purananandam, 2004a), but it is less clear whether hedging affects firm value. Allayannis and Weston (2003) document a positive correlation between firm value and foreign exchange hedging while Jin and Jorion (2004) find no such relationship with commodity hedging in the oil and gas industry. The industry effect on hedging decisions also is ambiguous. Nain (2004) finds within-industry practices are important influences on risk management decisions while Carter, Rogers, and Simkins (2002) and Haushalter (2000) document great variation in within-industry hedging practices.

The relationship between firm size and hedging is equally murky. Most small firms do not employ financial hedging – an observation frequently attributed to the fixed costs of establishing a hedging program. However, Haushalter (2000) finds some evidence that fraction of production hedged is negatively associated with size amongst actively hedging oil and gas producers. This is somewhat surprising given the assumption that hedging with derivatives has a low marginal cost. This paper offers a potential explanation of this phenomenon. It is feasible that firm size is positively correlated with operational hedging if firms increase their total assets through acquisitions, geographic expansion, or any other project selection that diversifies cash flow. Larger firms may substitute this increased operational hedging for alternative risk management, such as derivatives use, leading to the observed relationship between financial hedging and firm size.

The banking literature provides additional evidence that corporate decisions are related to risk management. Both Diamond (1984) and Brewer *et al.* (2000) find that bank lending is related to hedging. Hughes *et al.* (1999) argue that bank expansion which diversifies risk will reduce risk management costs. And Cebenoyan and Strahan (2004) note that active credit risk hedgers hold less capital.

Numerous papers consider the relative importance of financial versus operational hedging. Guay & Kothari (2003) contend that derivatives appear to cover only a small part of a firm's risk profile. They conclude most risk stems from sources that cannot be financially hedged. This finding, coupled with the Froot and Stein (1998) conclusion that unhedgable risks will alter both capital structure and investment policy, highlights the potential importance of operational hedging. The prior evidence on whether operational and financial hedging are substitutes or complements is ambiguous. Nance, Smith, and Smithson (1993) briefly note that other financial policies, such as adjustments to leverage or dividends, may substitute for derivatives, while operational and financial hedging are found to be complements in the theoretical work of Lim and Wang (2003) and the empirical study of exchange rate exposures by Allayannis, Ihrig, and Weston (2001). Geczy, Minton and Schrand (1999) examine risk management choices in the natural gas industry and find mixed evidence on whether hedging alternatives are complements or substitutes. In contrast, my investigation documents evidence of operational hedging (through acquisitions) substituting for derivatives use.

This paper is not the first to suggest that acquisitions may provide an operational hedge. The *Wall Street Journal* often highlights an acquisition's effect on risk exposures and volatility (Editors (2004), Samor (2004)). Moreover, the academic literature has recognized the potential risk management benefits of M&A activity since Lewellen (1971). Stulz (1990) asserts that costless acquisitions which reduced cash flow volatility would benefit shareholders and Santomero (1997) notes that credit risk is diversifiable through acquisitions. Amihud and Lev (1981) conclude that managerial risk aversion is a significant determinant of acquisition activity; although this paper's empirical results are not consistent with this agency motivation. I document a decline in derivatives use after an increase in operational hedging. Risk aversion

would lead the manager to seek an overall decrease in volatility not maintain the current level by substituting operational for financial hedging. Also, Esty, Narasimhan, and Tufano (1999) examine how the interest rate environment affects bank acquisitions. They find the competitive dynamics of bank mergers change with interest rates movements and acquisition prices are a function of the current interest rate. Unlike Esty *et al.*, I examine acquisitions as a risk management tool, rather than a byproduct of risk exposure. Most relevant to this inquiry is the finding of Benston, Hunter, and Wall (1995) that banks bid more for targets that diversify earnings. This lends indirect support to my hypothesis that acquisitions can provide operational hedging. *Ceteris paribus*, acquisitions which reduce volatility should command a premium.

Still, there is little consensus in the literature on acquisitions and firm value. Recent work on the diversification discount indicates that the discount may disappear or possibly become a premium after accounting for selection bias (Graham, Lemmon, and Wolf (2002), Villalonga (2004)). To the extent that acquisitions vary in their contribution to risk management (some reduce volatility greatly while others have no effect), differences in operational hedging benefits may explain some of the cross-sectional variation in the value of diversification. I now present a brief model of risk management choices. This model demonstrates how increased operational hedging will reduce the expenditure on financial hedging which, in turn, could affect firm value.

3. MODEL OF HEDGING ALTERNATIVES

Cash flow volatility is costly for a firm due to capital market imperfections such as tax convexity and costly external financing. Froot, Scharfstein, and Stein (1993) model optimal hedging in response to these costs. I use their model as a foundation but focus on optimal

hedging when multiple risk management choices are available. Furthermore, I incorporate the cost of hedging which must (logically) affect a manager's risk management decisions. For simplicity, assume there are two risk management choices, which may be thought of as financial hedging and operational hedging. Each hedging choice (h_1, h_2) has a positive cost and we assume hedging increases firm value only by means of reducing costly volatility. The manager wishes to select the optimal hedging portfolio that maximizes firm value.

$$\underset{h_i}{Max} \quad VRM = -\gamma(\sigma(h_1, h_2)) - C_1(h_1) - C_2(h_2) \tag{1}$$

where ***VRM*** is the value of risk management,

γ is a parameter representing the cost of volatility,

σ is firm volatility, a function of the hedging choices,

$\boldsymbol{h_i}$ is the level of hedging choice i,

$\boldsymbol{C_i}$ is the cost of hedging choice i.

Existing evidence on the costs of hedging suggests that initiating a derivatives program has a high fixed cost (Mian (1996)). Acquisitions also have a high fixed cost. Therefore, I assume a basic linear cost function for both h_1 and h_2.

$$C_i(h_i) = F_i + c_i h_i \tag{2}$$

where $\boldsymbol{F_i}$ is the fixed cost of hedging choice i,

$\boldsymbol{c_i}$ is the marginal cost of hedging choice i.

In making hedging choices, managers are constrained in their hedging expenditure. This constraint is assumed to be a function of how costly volatility is for the firm. I therefore maximize (1) such that:

$$c_1 h_1 + F_1 + c_2 h_2 + F_2 \leq K(\gamma) \tag{3}$$

where ***K*** is the hedging budget which is a function of γ.

The first order conditions of this constrained maximization problem are:

$$\frac{\partial VRM}{\partial h_1} = -\gamma(\frac{\partial \sigma}{\partial h_1}) - c_1 - \lambda(c_1) = 0 \tag{4a}$$

$$\frac{\partial VRM}{\partial h_2} = -\gamma(\frac{\partial \sigma}{\partial h_2}) - c_2 - \lambda(c_2) = 0 \tag{4b}$$

$$\frac{\partial VRM}{\partial \lambda} = c_1 h_1 + F_1 + c_2 h_2 + F_2 - K(\gamma) = 0 \tag{5}$$

Solving (4a, 4b) for λ and equating the first order conditions with respect to h_1 and h_2:

$$\frac{\partial \sigma / \partial h_1}{c_1} = \frac{\partial \sigma / \partial h_2}{c_2} \tag{6}$$

Optimal risk management balances each hedging choice's contribution to reducing volatility against its marginal cost. This holds even without the budget constraint. Next, I solve (5) for h_1 and substitute (6) to find the impact of the budget constraint:

$$h_1^* = \frac{K(\gamma) - F_1 - F_2}{c_1} - \frac{\partial \sigma / \partial h_2}{\partial \sigma / \partial h_1} h_2 \tag{7}$$

That is, the optimal choice of h_1 is a function of the maximum amount of h_1 (the amount available to spend on hedging divided by the cost of h_1) minus the relative effectiveness of the other hedging choice (h_2).

Equation (7) illustrates that hedging decisions are a function of the other risk management tools available and that the relative costs affect the optimal hedging strategy. If M&A activity increases operational hedging (h_2) and there is a budget constraint, then it is optimal for management to reduce their use of financial hedging (h_1). As financial hedging becomes more expensive (or less useful), operational hedging may be substituted. This model also indicates that hedging is increasing with the cost of volatility (γ).

This basic model motivates three empirically testable hypotheses concerning the risk management tradeoffs between operational and financial hedging.

1) **Acquisitions can be an operational hedge**. Whether an acquisition is an operational hedge depends on its potential to reduce volatility. To test this, I estimate how an acquisition will impact an acquirer's income volatility. For acquisitions where income data is available for the twelve quarters preceding the acquisition for both the target and acquirer, I compare the income volatility of acquirer alone with that of the target and acquirer's income if it were combined on a quarterly basis over the same twelve quarters.

2) **Financial hedging is related to acquisition activity**. If BHCs utilize acquisitions to manage risk, acquisitions and derivatives will not be independent. I investigate whether current risk management predicts future acquisition activity by estimating a probit model of the propensity to acquire. In addition, if acquisitions are an alternative tool to reduce volatility, a trade-off should exist and derivatives usage should decline. I test this by measuring the change in derivatives following an acquisition using both a Heckman selection model and panel analysis.

3) **Operational hedging and financial hedging are substitutes**. The degree to which an acquisition reduces volatility determines the change in financial hedging. To test this, I model the post-acquisition change in derivatives use as a function of the acquisition's impact on volatility.

4. DATA

Measuring the hedging activity for most types of firms requires laborious data collection from 10-K filings. However, BHCs report their derivatives use in the quarterly Federal Reserve Y-9C filings. Beginning in 1995, derivatives used for trading purposes and non-trading purposes were reported separately. Therefore, this paper will use data from BHCs to examine how firms adjust financial hedging following acquisitions. The dataset constructed from 1995 - 2003 Federal Reserve quarterly filings includes the entire universe of bank holding companies with total consolidated assets of $150 million or more. Only top-tier BHCs are examined since risk may be managed across subsidiaries. The Y-9C filings categorize the derivatives into interest rate, foreign exchange, equity derivative, and commodity/other contracts, and identify non-trading (hedging) versus trading positions. The empirical analysis of this paper is limited to hedging with interest rate derivatives as such contracts comprise 97% of BHC hedging. Detailed deal information for BHCs involved in business combinations valued at $50 million or more is obtained from the SDC Platinum Mergers database.[2]

From the SDC Platinum database, there are 487 M&A deals identified involving a bank holding company. This deal information is combined with the panel of BHC quarterly filings.

[2] A minimum deal value of $50 million limits possible data errors (such as deal values of zero) and inconsequential acquisitions. At the time of an acquisition, the median total assets for a BHC are $5,309,524,000. The conclusions are robust to a minimum deal value of $20 million.

To be included in the sample, both parties must be bank holding companies. This excludes the acquisitions of non-banks or partial acquisitions (such as the acquisition of bank branches or business segments). Of the 487 deals, BHC information was available and matched for 448 acquirers. Quarterly bank information, including derivatives usage, is matched to acquirers. All of these variables are winsorized at the 1st and 99th percentiles to remove potential outliers.

Historically, bank regulation has varied by state. Restrictions on bank merger activity were no exception. Some states began to permit M&A before 1970 while others resisted deregulation until the early 1990s (Strahan (2003)). To control for differences in state legislation which might affect acquisition activity, the time since deregulation (Strahan (2003)) is matched to each BHC by state.

In addition, I control for the composition of the balance sheet as business composition may shape hedging decisions. BHC control variables are generated by dividing the BHC asset categories by the total assets (Schedule HC of the FR-Y9C). However, Allen and Saunders (1992) show that these quarter end numbers are susceptible to 'window-dressing' adjustments. They note that the most active window-dressing on the asset side is in securities, Federal funds, and loans. Therefore, the quarterly average is substituted for each of these three asset groups as well as the total assets throughout the dataset (Schedule HC-K of the FR-Y9C).

4.1 Measures of Interest Rate Exposure and Hedging

Interest rate exposure is expected to influence the level of interest rate hedging. Following the methodology of Flannery and James (1984), a measure of interest rate sensitivity – the one year maturity gap – is constructed by subtracting the reported liability exposure subject to repricing within a year from the asset exposures subject to the same repricing time period

(Schedule HC-H of the FR-Y9C). This net sensitivity is measured relative to the average quarterly total assets. Flannery and James note that this metric assumes that unexpected changes to the interest rate sensitivity affect the bank in a manner proportional to the short term net sensitivity. Similar one year gap measures of the mismatch between the asset and liabilities exposures are used by Brewer, Jackson, and Moser (2001) and Purnanandam (2004a).

$$IR\ Sensitivity_t = \frac{ST\ Assets_t - ST\ Liabilities_t}{TA_t} \tag{8}$$

where ***ST Assets*** are those assets which mature or reprice within one year,

ST Liabilities are those liabilities which mature or reprice within one year,

TA is the quarterly average of consolidated assets.

The measure of financial hedging is the BHC's end-of-quarter gross notional amount of interest rate derivatives used for hedging divided by total assets. To detect the substitution of operational hedging for financial hedging, I measure the changing use of derivatives for hedging purposes over one and two year horizons:

$$\Delta\ IR\ Hedging = \frac{IRG_{t+4\ (or\ t+8)}}{TA_{t+4\ (or\ t+8)}} - \frac{IRG_t}{TA_t} \tag{9}$$

where ***IRG*** is the gross notional amount of derivatives used to hedge interest rate risk.

The gross notional amount of derivatives does not capture the true hedging position if some of the contracts offset one another (Graham and Rogers (2002)). This introduces an upward bias into this measurement. While the net derivatives would be preferable, empirical

examinations indicate that the difference between net and gross positions is minor.[3] Furthermore, gross notional amounts bias against finding any decline in financial hedging. Controlling for the change in interest rate sensitivity, a BHC's gross notional volume of derivatives would be expected to increase or remain constant following an acquisition. First, acquiring a target without a derivatives program provides economies of scale with respect to the fixed costs of a hedging program. The target could hedge without incurring the initial fixed costs of establishing its own program. Therefore, derivatives use would increase for the combined firm. Second, combining two firms with derivatives programs would result in a constant use of derivatives. And, lastly, derivative contracts are not normally cancelled; new ones are just written.[4] Therefore, the reorganization of any existing contracts with the combination of two firms would increase derivatives use. All of these issues bias the empirical analysis against finding a decrease in financial hedging.

Given the measure of financial hedging is relative to the quarterly average assets, changes to the asset size could impact the empirical findings. If the gross notional amount of hedging is constant in the year following the acquisition ($IRG_{t+4} = IRG_t$), the Δ *IR Hedging* could decline simply due to the acquisition's impact on the size of assets. To control for this, a new dependent variable (Δ*IR Hedging_Size*) is generated.

$$\Delta IR\,Hedging\_Size = \frac{IRG_{t+4(or\,t+8)} - IRG_t}{TA_t} \tag{10}$$

This variable removes the potential size effect. The empirical analysis is conducted using both measures for the change in hedging with qualitatively similar results.

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[3] Graham and Rogers (2002) state, "We conclude, however, that using net, as opposed to total, positions is only marginally important in helping identify factors that affect corporate hedging decisions." "Our important findings with respect to the tax incentives to hedge are unchanged [between gross notional and net positions.]"

[4] Stulz (2004) discusses that closing derivatives positions often involves purchasing an offsetting contract.

4.2 Measures of Volatility

To address the mechanism by which acquisitions provide operational hedging, this paper evaluates the target's impact on the acquirer's volatility. Volatility calculations based on the BHC net income would include the effect of current hedging. Therefore, a new variable *OI* is created:

$$OI_t = NI_t - Deriv_t \tag{11}$$

where ***OI*** is operational income,

NI is net income,

Deriv is the impact on income of derivatives held for hedging.

The net change in interest income and expense due to hedging is provided on Schedule HI of the FR-Y9C and is subtracted from the net income on a quarterly basis. From *OI*, volatility is calculated without the influence of derivatives.

Next, I measure the level of operational hedging introduced by an acquisition by examining the volatility of the acquirer and target had they been a combined entity for the three years preceding the acquisition. This captures how management expected the target to impact the acquirer's operational income volatility. The volatility of these twelve combined quarterly observations is compared to the volatility of the twelve quarterly observations of the acquirer alone.

$$OV_{Acquirer} = St.\ Dev.\ (\frac{OI_{t-12,A}}{TA_{t-12,A}},\ldots\frac{OI_{t-1,A}}{TA_{t-1,A}}) \tag{12a}$$

$$OV_{Combined} = St.\ Dev.\ (\frac{OI_{t-12,A}+OI_{t-12,T}}{TA_{t-12,A}+TA_{t-12,T}},\ldots\frac{OI_{t-1,A}+OI_{t-1,T}}{TA_{t-1,A}+TA_{t-1,T}})) \tag{12b}$$

$$Impact\% = \frac{OV_{Acquirer} - OV_{Combined}}{OV_{Acquirer}} \quad (13)$$

where ***Impact%*** is the percentage change in operational volatility due to the acquisition,

$\boldsymbol{OI_{t,A}}$ is the operational income of the acquirer at time t,

$\boldsymbol{OI_{t,T}}$ is the operational income of the target at time t.

5. METHODOLOGY & RESULTS

Managing interest rate risk is a priority for BHCs' risk management. Table 1 shows that interest rate derivatives are employed more than other derivative contracts. The sample is divided into two groups; observations where an acquisition is made and observations where no acquisition is made. The median and mean derivatives levels relative to the quarterly average of total assets are presented for both sub-samples. While interest rate hedging and trading dominate derivatives use, other derivatives use informs the likelihood of an interior solution. Panel A indicates that BHCs, on average, exhibit a higher level of hedging, as well as trading, when an acquisition is made. However, Panel B reveals that the reverse holds when the sample is limited to BHCs that use each derivative contract. For active hedgers, the mean amount of interest rate hedging at the time of an acquisition is 3.9% of average quarterly total assets versus 7.8% when no acquisition is made. Table 2 shows that target BHCs exhibit a similar pattern but – perhaps due to the small sample size - the difference is not statistically significant.

While the statistics documented in Table 1 support the hypothesis that acquirers have different risk management practices, these BHCs simply may have a lower level of interest rate exposure – leading to a lower need for hedging. Therefore, Table 3 presents the average *IR Sensitivity* (equation 8) by target and acquirer status. Acquisitions and targets both have

significantly more interest rate exposure than non-merging institutions,[5] but the larger exposure does not explain the difference in financial hedging. Merging BHCs have more exposure to interest rate movements but hedge less than other institutions.

Yet, acquisitions do not significantly change the average BHC's interest rate sensitivity, as seen in Table 4. There is no statistically significant change in interest rate exposure between the year before and the year after the acquisition. This implies that while acquirers appear to manage risk differently, acquisitions aren't being used to directly reduce interest rate exposure.

5.1 Do Acquisitions Affect Income Volatility?

To investigate why acquirers hedge less of their interest rate exposure than other BHCs, I explore whether acquisitions can provide operational hedging. *Impact%* (equation 13) is generated for a sample of 208 matched pairs of acquirers and targets where both are bank holding companies and have at least three years of data before the acquisition. A deal's *Impact%* is, relative to the acquirer's volatility, the difference between the acquirer's volatility for the three years preceding the deal versus the volatility of the acquirer and the target if they were combined during that period. Volatility is measured as the standard deviation of the quarterly operational income divided by total assets. If the combined net income volatility is smaller than that of the acquirer alone, *Impact%* is positive. A positive impact implies the acquisition would reduce income volatility *ceteris paribus*. Reductions in income volatility indicate the target has potential operational hedging benefits or potential savings associated with lower costs of convex taxation, potential financial distress, and external capital.

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[5] *IR Sensitivity* is significantly higher for acquirers and targets than BHCs not involved in M&A activity. This is true whether it is measured at the time of M&A or one year prior to the event.

Panel A of Table 5 shows that, on average, BHC acquisitions increase operational hedging by reducing income volatility. The *Impact%* coefficient indicates that, on average, volatility decreases 5.9%. Furthermore, this average increase is not driven by outliers as 86% of acquisitions create operational hedging (Panel B).

5.2 Do Managers Use Acquisitions to Manage Risk?

A probit analysis is used to examine the likelihood of making an acquisition or being a target given current exposures and risk management over the short-term horizon. Using the methodology of Billett (1996), the data set is split into four sub-samples: 1996-1997, 1998-1999, 2000-2001, and 2002-2003. A two year horizon period balances the predictive power of current risk management with the need for an adequate sample size. The likelihood of an acquisition during each period is predicted using the prior year's first quarter BHC information. For example, the binary dependent variable equals unity if an acquisition is made during 1996 or 1997 and is modeled as a function of 1995 Q1 data. This also is done using 1997 Q1 with 1998-1999 data, etc. (Using the first quarter of the prior year reduces correlation with adjacent quarters and minimizes the impact of any adjustments due to the expected merger.) The four non-overlapping sub samples are pooled and a probit model, with year dummies and clustering at the individual BHC level, is estimated.[6]

$$M\&A\_dum = IR\ Sensitivity_t + IR\ Hedging_t + IR\ Trading_t + Private_t + Dereg_t + BHC\ Controls_t + \varepsilon_t \quad (14)$$

[6] This analysis also was conducted using seven overlapping periods (1996-1997, 1997-1998, 1998-1999, 1999-2000, 2000-2001, 2001-2002, 2002-2003) and the results are qualitatively similar and retain similar levels of significance.

$$M\&A\_dum = High\ Sensitivity_t + Less\ Hedging_t + (High\ Sensitivity_t * Less\ Hedging_t) + Private_t + Dereg_t + BHC\ Controls_t + \varepsilon_t \quad (15)$$

where ***M&A_dum*** is a binary variable equaling unity if the observation is an acquirer in columns 1-2, and equaling unity if the observation is a target in columns 3-4 in Table 6.

IR Sensitivity is the net interest rate exposure over the next year.

IR Hedging is the gross notional amount of interest rate derivatives used for hedging divided by the quarterly average of total assets.

IR Trading is the gross notional amount of interest rate derivatives used for trading divided by the quarterly average of total assets.

Private is a binary variable equaling unity if the BHC is not registered with the SEC.

Dereg is the time since the BHC's state deregulated interstate M&A activity.

BHC Controls are the log of the quarterly average of total assets and the BHC asset categories (Securities, Federal funds sold and securities repurchase under agreements to resell, Loans and lease financing receivables, Trading assets, Premises and fixed assets, Other real estate owned, Investments in unconsolidated subsidiaries and associated companies, Intangible assets, Other assets) divided by the quarterly average of total assets

High Sensitivity is a binary variable equaling unity if *IR Sensitivity* is above the median.

Less Hedging is a binary variable equaling unity if the use of interest rate derivatives for hedging is zero or below the *IR Hedging* median of BHCs that hedge.

Table 6 presents the results of this analysis. Columns (1) and (3) indicate that the *IR Sensitivity* and *IR Hedging* do not appear to predict merger activity. Yet, column (2) shows that BHCs with higher sensitivity to interest rate movements (*High Sensitivity*) but who are less active hedgers (*Less Hedging*) have a higher propensity to merge. That is, the absolute level of sensitivity to short-term interest rate movements does not appear to be important for future

acquisitions. What is important is whether a BHC with a large risk exposure is actively hedging with derivatives. This finding is consistent with the hypothesis that both derivatives and M&A are hedging choices and supports Proposition #2 that financial hedging is related to acquisition activity.

Private firms also are less likely to be involved with M&A. Given the unconditional probability of a BHC making an acquisition in any quarter is 1.6%, this is a substantial decrease in the likelihood of M&A. Private firms may find idiosyncratic risk less costly, as argued by Xu and Malkiel (2003), or external capital for financing acquisitions may be more difficult to access. Private firms also may be less visible targets or may reap fewer benefits from joining an established hedging program.

The increased propensity to acquire documented in Table 6 should not immediately be attributed to risk management preferences. It is conceivable that *High Sensitivity, Less Hedging* firms – due to their lower use of financial derivatives – experience more volatile cash flows. If these firms survive, they may have more cash relative to active hedgers and be more able to make acquisitions. I attempt to distinguish between the risk management preferences and the cash-on-hand hypotheses by investigating the type of acquisitions made.[7] If acquisitions were driven by risk management preferences, and not simply cash-on-hand, I would expect *High Sensitivity, Less Hedging* firms to prefer volatility-reducing acquisitions. In Table 7, I estimate whether this preference exists using a probit model.

$$OpHedge\_dum_t = (High\ Sensitivity_t \times Less\ Hedging_t) + BHC\ Controls_t + \varepsilon_t \qquad (16)$$

[7] I wish to thank Bob Jennings for this suggestion.

where ***OpHedge_dum*** is a binary variable equaling unity if the acquisition reduces volatility. In column (1), any acquisition which reduces volatility counts as an operational hedge. In column (2), only acquisitions reducing volatility at least 2% are counted as an operational hedge. In column (3), the threshold increases to 4%, etc.

There is modest support for the risk management hypothesis. Firms not actively hedging a large exposure to interest rate movements exhibit some preference for acquisitions which provide operational hedging. These firms are more likely to acquire targets which reduce their volatility. The weak empirical results indicate that while risk management is not the only motivation for acquisitions, there is some evidence of endogeneity.

5.3 Is Derivatives Use Responsive to Operational Hedging?

The results presented in Tables 6 and 7 indicate acquisition activity may be correlated with risk exposures and risk management. If managers actually recognize the potential hedging benefits of acquisitions and believe they can substitute for financial hedging, they should adjust the use of other risk management activities. To test this, I estimate a Heckman selection model using the following regressions:

$$\Delta\, IR\ Hedging_{\,t,\,t+4\,(t,\,t+8)} = Acquirer_{\,t} + \Delta\, IR\ Sensitivity_{\,t,\,t+4\,(t,\,t+8)} + BHC\ Controls_{\,t} + \Delta BHC\ Controls_{\,t\,,t+4\,(t\,,t+8)} + \varepsilon_t \quad (17)$$

$$\Delta\, IR\ Hedging,\ Size_{\,t,\,t+4\,(t,\,t+8)} = Acquirer_{\,t} + \Delta\, IR\ Sensitivity_{\,t,\,t+4\,(t,\,t+8)} + BHC\ Controls_{\,t} + \Delta BHC\ Controls_{\,t,\,t+4\,(t,\,t+8)} + \varepsilon_t \quad (18)$$

where Δ ***IR Hedging*** is the change in hedging relative to total assets over the next year (or two).

Δ ***IR Hedging, Size*** is the change in hedging over the next year (or two), controlling for size.

Acquirer is a binary variable equaling unity if an acquisition is made that quarter.

Δ ***BHC Controls*** are the change in the quarterly assets and BHC categories over the same period as the dependent variable.

Obviously, addressing the endogenous relationship between acquisitions and derivatives – as both appear to be risk management choice variables – is important for unbiased and consistent estimates of how firms manage risk. The average impact of making an acquisition on financial hedging is estimated using the Heckman two-stage selection model which attempts to minimize the selection bias as an explanation for the treatment outcomes. The selection lambda, commonly referred to as the inverse Mill's ratio, is included in the second stage estimation to correct for the potential selection bias. This approach estimates the acquisition decision with a probit model based on the results of Table 6. The selection criteria are *Total Assets, Private,* and *IR Sensitivity*. It should be noted that the specific Heckman selection criteria choice does not materially affect the coefficient estimates presented in this paper.

Table 8 presents the Heckman two-stage coefficient estimates. Regardless of the time horizon and dependent variable specification, and controlling for interest rate sensitivity changes, financial hedging declines following an acquisition (as seen in the first row). The selection lambda is positive and, for the two year horizon measures, significant. Since the acquisition decision is modeled as a function of risk exposure, BHC size, and private status, acquisitions considered unexpected by this model may not be motivated by risk management. The positive lambda implies that such unexpected acquisitions decrease their financial hedging less following an acquisition as might be expected with acquisitions driven by concerns other than risk management.

A shortcoming of the Heckman approach is that it neglects the data's panel attributes. Therefore, in Table 9, the change in financial hedging following an acquisition is examined using

both random and fixed effect models (again, estimating equations 17 and 18). Once again, derivatives hedging decreases significantly over both the one and two year horizons even after controlling for the change in interest rate exposure and the composition of the BHC.

If the post-acquisition decline in derivatives is due to the increase in operational hedging, then acquisitions which create the most operational hedging should lead to the largest declines in financial hedging. Therefore, I regress *Impact%* against the change in derivatives use.

$$\Delta\, IR\ Hedging_{\,t,t+4\,(t,t+8)} = Impact\%_{t} + BHC\ Controls_{\,t} + \Delta BHC\ Controls_{\,t,t+4\,(t,t+8)} + \varepsilon_{\,t} \quad (19)$$

Table 10 indicates that acquisitions which reduce volatility are followed by reduced financial hedging. Since *Impact%*, the measure of operational hedging, is positive when the acquisition contributes to operational hedging, negative coefficients indicate the post-acquisition hedging is negatively related to the volatility impact. That is, the more operational hedging created, the more financial hedging will decline. This supports Proposition #3 that operational and financial hedging are substitutes.

6. CONCLUSION

This paper provides empirical evidence on risk management tradeoffs between M&A activity and derivatives use for bank holding companies. After providing a simple model of optimal risk management, I present three main findings. First, acquisitions can provide operational hedging. Second, managers recognize the risk management potential of acquisition activity. And, lastly, operational hedging is substituted for derivatives use. The results imply that risk management is not exogenous to firm organization. This has vast implications for the analysis, specifically the econometric specification, of hedging and firm value.

Furthermore, the implications of this paper extend beyond the hedging literature. Variations in the diversification discount may relate to an acquisition's contribution to hedging. Also, the documented trade off between financial and operational hedging implies that managerial risk aversion may not be a primary motivation for M&A activity. And, most significantly, risk management may affect firm value not only by minimizing the cost of volatility, but also by influencing firm organization.

It must be restated that this dataset only examines bank holding companies. Whether non-financial firms recognize acquisitions as an operational hedge is unknown. Clearly, there is much more work to be done at this intersection of risk management and corporate finance. That being said, this paper highlights some of the possible issues for future researchers to consider.

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Table 1. Summary of Derivatives Use for Acquirers

The sample is split into observations where an acquisition was made and observations where one was not made. This table summarizes the level of derivatives use for hedging and trading purposes over the four derivatives categories of interest rate (IR), foreign exchange (FX), equity, and commodity. Derivatives use is measured as the gross notional amount relative to total assets. (Derivatives = Gross Notional Amount of Derivatives / Total Quarterly Average Consolidated Assets) A positive level of hedging exists if the BHC uses the derivatives of interest in quarter t.

	An Acquirer in Qtr t				**Not an Acquirer in Qtr t**				**Difference between Means**	
	# Obs	Median	Mean	St.Dev.	# Obs	Median	Mean	St.Dev.	Diff.	Signif.
	Panel A: All Observations									
Hedging										
IR	448	0.000	0.016	0.034	54165	0.000	0.007	0.050	0.009	***
FX	448	0.000	0.001	0.002	54109	0.000	0.000	0.003	0.001	***
Equity	448	0.000	0.000	0.000	54097	0.000	0.000	0.000	0.000	***
Commodity	448	0.000	0.000	0.000	54093	0.000	0.000	0.000	0.000	
Trading										
IR	448	0.000	0.046	0.122	54102	0.000	0.007	0.088	0.039	***
FX	448	0.000	0.012	0.039	54093	0.000	0.002	0.022	0.010	***
Equity	448	0.000	0.000	0.000	54078	0.000	0.000	0.001	0.000	***
Commodity	448	0.000	0.000	0.000	54079	0.000	0.000	0.000	0.000	***
	Panel B: Positive Level of Hedging									
Hedging										
IR	186	0.020	0.039	0.044	4665	0.036	0.078	0.154	-0.040	***
FX	101	0.003	0.003	0.004	1111	0.004	0.008	0.019	-0.004	***
Equity	9	0.000	0.000	0.000	527	0.001	0.002	0.003	-0.002	***
Commodity	0				0					
Trading										
IR	158	0.025	0.131	0.176	2001	0.068	0.197	0.415	-0.066	***
FX	109	0.030	0.050	0.066	1666	0.025	0.066	0.106	-0.016	***
Equity	18	0.002	0.002	0.001	539	0.002	0.003	0.004	-0.001	***
Commodity	31	0.000	0.000	0.000	363	0.000	0.000	0.000	0.000	***

Table 2. Summary of Derivatives Use for Targets

The sample is split into observations where the BHC was a target and observations where it was not a target. This table summarizes the level of derivatives use for hedging and trading purposes over the four derivatives categories of interest rate (IR), foreign exchange (FX), equity, and commodity. Derivatives use is measured as the gross notional amount relative to total assets. (Derivatives = Gross Notional Amount of Derivatives / Total Quarterly Average Consolidated Assets) A positive level of hedging exists if the BHC uses the derivatives of interest in quarter t.

	A Target in Qtr t				**Not a Target in Qtr t**				**Difference between Means**	
	# Obs	Median	Mean	St.Dev.	# Obs	Median	Mean	St.Dev.	Diff.	Signif.
	Panel A: All Observations									
Hedging										
IR	448	0.000	0.009	0.061	54165	0.000	0.007	0.050	0.002	
FX	448	0.000	0.000	0.001	54109	0.000	0.000	0.003	0.000	***
Equity	448	0.000	0.000	0.000	54097	0.000	0.000	0.000	0.000	
Commodity	448	0.000	0.000	0.000	54093	0.000	0.000	0.000	0.000	
Trading										
IR	448	0.000	0.012	0.066	54102	0.000	0.008	0.089	0.004	
FX	448	0.000	0.004	0.026	54093	0.000	0.002	0.022	0.002	*
Equity	448	0.000	0.000	0.000	54078	0.000	0.000	0.001	0.000	
Commodity	448	0.000	0.000	0.000	54079	0.000	0.000	0.000	0.000	
	Panel B: Positive Level of Hedging									
Hedging										
IR	64	0.027	0.068	0.158	4787	0.035	0.077	0.152	-0.009	
FX	15	0.004	0.003	0.002	1197	0.004	0.007	0.019	-0.004	***
Equity	4	0.001	0.002	0.002	532	0.001	0.002	0.003	0.000	
Commodity	0				0					
Trading										
IR	38	0.034	0.148	0.193	2121	0.065	0.193	0.405	-0.044	
FX	33	0.022	0.066	0.079	1742	0.026	0.065	0.104	0.001	
Equity	11	0.002	0.002	0.001	546	0.002	0.003	0.004	-0.001	***
Commodity	10	0.000	0.000	0.000	384	0.000	0.000	0.000	0.000	

Table 3. Pre-Acquisition Interest Rate Sensitivity

The sample is split into observations where M&A occurred and those where it did not occur, both for acquirers and targets. This table presents the average *IR Sensitivity* for each of these groups from one year before the observation. This measure is the difference between the short term asset and liability exposure to interest rate movements relative to the quarterly average of total assets.

	An Acquirer in Qtr t			**Not an Acquirer in Qtr t**			**Difference between Means**	
	# Obs	Mean	St Dev	# Obs	Mean	St Dev	Diff.	Signif.
IR Sensitivity$_{t-4}$	446	0.146	0.137	49680	0.068	0.191	0.078	***
	A Target in Qtr t			**Not a Target in Qtr t**				
	# Obs	Mean	St Dev	# Obs	Mean	St Dev		
IR Sensitivity$_{t-4}$	447	0.118	0.193	49679	0.068	0.191	0.050	***

Table 4. Acquisitions' Impact on Interest Rate Sensitivity

This table summarizes the acquisitions' average impact on interest rate sensitivity for the acquirer. There are 439 acquisitions where the interest sensitivity can be calculated both one year before and one year after the acquisition. Δ *IR Sensitivity* is the difference in between *IR Sensitivity* at the two times.

	# Obs	Mean	St Dev	Significance
Δ IR Sensitivity	439	-0.010	0.128	-

Table 5. Acquisitions' Impact on Volatility

To evaluate potential operational hedging provided, the acquisitions' impact on volatility is measured. There are 208 acquisitions where income data is available for both the target and acquirer for the twelve quarters preceding the acquisition. Panel A presents the mean percent change in volatility, *Impact%*. It measures the difference between the prior 12 quarters income (relative to total assets) volatility of the acquirer alone (*Vol_Acquirer*) versus the prior 12 quarters if the target and acquirer were a combined entity over that period (*Vol_Combined*) and divides this by the volatility of the acquirer alone. A positive mean indicates that volatility decreased with the acquisition and that operational hedging increased. Panel B shows the percentage of the 208 acquisitions which decreased volatility for the acquirer.

Panel A: Average Impact on Volatility

	# Obs	Mean	St Dev	Significance
Impact %	208	0.059	0.116	***

Panel B: Percent of Acquisitions Decreasing Volatility

	# Obs.	Percentage
Decrease Volatility	179	86%
Increase Volatility	29	14%
	208	

Table 6. Risk Management & the Propensity to Merge

The data set is split into four sub-samples; 1996-1997, 1998-1999, 2000-2001, 2002-2003. The likelihood of being an acquirer or target during each period is predicted using the prior year's first quarter BHC information. For example, 1995 Q1 data are the independent variables and there is a binary dependent variable equaling unity if an acquisition is made during 1996 or 1997. The four sub-samples are pooled and the probit, with year dummies, is conducted. Errors are clustered at the BHC level. This table presents the marginal effects. *IR Sensitivity* is measured by the difference in short term asset and liability exposure to interest rate movements divided by the quarterly average of total assets. *Private* is a binary indicator of whether the BHC is not registered with the SEC at time t. *IR Hedging* and *IR Trading* variables measure the gross notional amount of derivatives use divided by the quarterly average of total assets. *High Sensitivity* is a binary variable equaling unity if *IR Sensitivity* is above the median. *Less Hedging* is a binary variable equaling unity if the BHC has less than the median amount of *IR Hedging* of those with hedging programs or the BHC does not hedge. *BHC Controls* are included. P values are in parentheses.

$$M\&A\_dum = IR\ Sensitivity_t + IR\ Hedging_t + IR\ Trading_t + Private_t + Dereg_t + Total\ Assets_t + BHC\ Controls_t + \varepsilon_t$$

$$M\&A\_dum = High\ Sensitivity_t + Less\ Hedging_t + (High\ Sensitivity_t \times Less\ Hedging_t) + Private_t + Dereg_t + BHC\ Controls_t + \varepsilon_t.$$

Marginal Effects

	Acquirer		Target	
	(1)	(2)	(3)	(4)
IR Sensitivity	-0.001		0.016	
	(0.918)		(0.372)	
IR Hedging	-0.025		-0.019	
	(0.610)		(0.848)	
IR Trading	0.019		0.129	
	(0.356)		(0.002)	
Private	-0.023	-0.021	-0.037	-0.033
	(0.000)	(0.000)	(0.000)	(0.000)
Dereg	0.001	0.001	0.001	0.001
	(0.003)	(0.002)	(0.166)	(0.068)
High Sensitivity		-0.017		-0.036
		(0.070)		(0.088)
Less Hedging		-0.009		-0.010
		(0.300)		(0.487)
High Sensitivity & Less Hedging		0.021		0.032
		(0.036)		(0.137)
BHC Controls	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes
# Obs	5403	5403	5403	5403

Table 7. Propensity to Merge & Acquisition Preference

This table shows the preference of acquisitions that provide some operational hedging using a probit analysis, presenting the marginal effects. The dependent variable (*OpHedge_dum*) is an indicator equaling unity if the acquisition reduced volatility. Each column presents a more restrictive definition of operational hedging. In column (1), all acquisitions which reduce volatility are considered operational hedges. By column (5), the acquisition must reduce volatility by at least 8% to be counted as an operational hedge. The # *Operational Hedges* indicates the number of observations that reduce volatility for each definition. *High Sensitivity* & *Less Hedging Dummy* is a binary variable equaling unity if the BHC exhibits both *High Sensitivity* (*IR Sensitivity* is above the median) and *Less Hedging* (the BHC has less than the median amount of *IR Hedging* of those with hedging programs or the BHC does not hedge). A positive marginal effect on the dummy indicates that BHCs with *High Sensitivity* & *Less Hedging* demonstrate some preference for volatility reducing acquisitions by BHCs that do not actively manage their exposure with derivatives. *BHC Controls* are included. Robust p values are in parentheses.

$$OpHedge\_dum_t = (High\ Sensitivity_t \times Less\ Hedging_t) + BHC\ Controls_t + \varepsilon_t$$

Marginal Effects

	Acquisitions which Reduce Volatility				
	Any Reduction	At least 2%	At least 4%	At least 6%	At least 8%
	(1)	(2)	(3)	(4)	(5)
High Sensitivity & Less Hedging Dummy	0.101	0.160	0.150	0.187	0.199
	(0.109)	(0.050)	(0.101)	(0.085)	(0.100)
BHC Controls	Yes	Yes	Yes	Yes	Yes
# Operational Hedges	179	120	94	72	59
# Obs	208	161	136	115	102

Table 8. Derivatives Use Following Acquisitions – Controlling for Selection

This table examines the change in financial hedging following an acquisition. A Heckman selection model is used with the selection criteria of quarterly assets, interest rate sensitivity, and a private firm indicator. The dependent variable is the change in the ratio of interest rate hedging to total assets (Δ*IR Hedging*) in the year (or two years) following the observation. To prevent the acquisition's impact on the total assets from changing the hedging ratio, a size controlled change which divides the change in the gross notional amount of hedging over the year (or two years) following the observation by the beginning period quarterly total assets also is presented (Δ*IR Hedging, Size*). *Acquirer* is an indicator variable equaling unity if the BHC makes an acquisition during quarter t. Δ *IR Sensitivity* is the change in interest rate exposure during the period over which the change in interest rate hedging is measured. *BHC Controls* and Δ*BHC Controls* also are included. P values are in parentheses.

$$\Delta\ IR\ Hedging_{\ t,\ t+4\ (or\ t,\ t+8)} = Acquirer_{\ t} + \Delta\ IR\ Sensitivity_{\ t,\ t+4\ (or\ t,\ t+8)} + BHC\ Controls_{\ t} + \Delta BHC\ Controls_{\ t,\ t+4\ (t,t+8)} + \varepsilon_t$$

$$\Delta\ IR\ Hedging,\ Size_{\ t,\ t+4\ (or\ t,\ t+8)} = Acquirer_{\ t} + \Delta\ IR\ Sensitivity_{\ t,\ t+4\ (or\ t,\ t+8)} + BHC\ Controls_{\ t} + \Delta BHC\ Controls_{\ t,\ t+4\ (t,\ t+8)} + \varepsilon_t$$

	1 Year Horizon		2 Year Horizon	
	Δ IR Hedging	Δ IR Hedging, Size	Δ IR Hedging	Δ IR Hedging, Size
	(1)	(2)	(3)	(4)
Acquirer $_t$	-0.003	-0.027	-0.031	-0.072
	(0.799)	(0.091)	(0.047)	(0.005)
Δ IR Sensitivity	0.007	0.008	0.010	0.018
	(0.002)	(0.006)	(0.000)	(0.000)
Constant	-0.010	-0.017	-0.010	-0.007
	(0.187)	(0.086)	(0.340)	(0.706)
BHC Controls	Yes	Yes	Yes	Yes
Δ BHC Controls	Yes	Yes	Yes	Yes
hazard: lambda	0.000	0.009	0.012	0.026
	(0.980)	(0.189)	(0.078)	(0.021)
# Obs	26206	24909	21107	19968

Table 9. Derivatives Use Following Acquisitions – Controlling for Panel Attributes

This table examines the change in financial hedging following an acquisition using random and fixed effects models. The dependent variable is the size controlled change which divides the change in the gross notional amount of hedging over the year (or two years) following the observation by the beginning period quarterly total assets (Δ*IR Hedging, Size*). *Acquirer* is an indicator variable equaling unity if the BHC makes an acquisition during quarter t. Δ *IR Sensitivity* is the change in interest rate exposure during the period over which the change in interest rate hedging is measured. *BHC Controls* and Δ*BHC Controls* also are included. P values are in parentheses.

$$\Delta\ IR\ Hedging,\ Size_{\ t,\ t+4\ (or\ t,\ t+8)} = Acquirer_{\ t} + \Delta\ IR\ Sensitivity_{\ t,\ t+4\ (or\ t,\ t+8)} + BHC\ Controls_{\ t} + \Delta BHC\ Controls_{\ t,\ t+4\ (t,\ t+8)} + \varepsilon_t$$

	ΔIR Hedging, Size			
	1 Year Horizon		2 Year Horizon	
	Random Effects	Fixed Effects	Random Effects	Fixed Effects
	(1)	(2)	(3)	(4)
Acquirer	-0.007	-0.006	-0.011	-0.010
	(0.035)	(0.073)	(0.012)	(0.032)
Δ IR Sensitivity	0.009	0.010	0.013	0.012
	(0.002)	(0.002)	(0.001)	(0.004)
Constant	-0.006	-0.005	-0.021	-0.057
	(0.513)	(0.818)	(0.164)	(0.123)
BHC Controls	Yes	Yes	Yes	Yes
Δ BHC Controls	Yes	Yes	Yes	Yes
# Obs	27054	27054	21791	21791
# Groups	1871	1871	1644	1644
R^2		0.033		0.052

Table 10. Volatility and the Change in Financial Hedging

This table shows how changes in operational hedging affect hedging with derivatives using an OLS regression with standard errors clustered at the BHC level. The dependent variable is the one year change in interest rate hedging following the acquisition adjusted for size (Δ*IR Hedging, Size*) over both a one and two year horizon. *Impact%* measures the change in volatility due to the acquisition – based on the difference of the acquirer's prior twelve quarters income (divided by the quarterly average of total assets) volatility and the combined firms' volatility over the same period – relative to the volatility of the acquirer alone. A positive *Impact%* implies that operational hedging increased as the volatility of the combined target and acquirer is smaller than that of the acquirer alone. Therefore, the negative coefficient on *Impact%* indicates that the deal's contribution to reducing volatility is followed by a similar decrease in financial hedging. Δ *IR Sensitivity* is the change in interest rate exposure during the period over which the change in interest rate hedging is measured.

$$\Delta IR\ Hedging,\ Size_{\,t,\,t+4\,(t,\,t+8)} = Impact\%_{\,t} + BHC\ Controls_{\,t} + \Delta BHC\ Controls_{\,t,\,t+4\,(t,\,t+8)} + \varepsilon_{\,t}$$

	ΔIR Hedging, Size	
	1 Year Horizon	2 Year Horizon
Impact%	-0.022	-0.050
	(0.072)	(0.000)
Constant	-0.191	-0.393
	(0.000)	(0.000)
BHC Controls	Yes	Yes
Δ BHC Controls	Yes	Yes
# Obs	189	171
R^2	0.111	0.348