Does Fair Value Accounting Contribute to Procylical Leverage?

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Abstract

We model commercial bank behavior focusing on actions banks take in response to economic gains and losses on their assets to meet regulatory leverage requirements. Our model shows that absent differences in regulatory risk weights across assets, accounting leverage cannot be procyclical. We test the model’s predictions using a sample of US commercial banks, during economic upturns and downturns, including the recent financial crisis. Although we find a significantly positive relation between change in accounting leverage and change in assets, this procyclical relation evaporates when change in each bank’s weighted average regulatory risk weight is included in the estimating equation. We also find that all changes in equity, including those arising from fair value accounting, are significantly negatively related to change in accounting leverage, which is inconsistent with fair value accounting contributing to procyclical leverage. In addition, we find no evidence of a relation between change in accounting leverage and the interaction between change in assets arising from fair value accounting and other changes in assets. Taken together, the empirical evidence indicates that fair value accounting is not a source of procyclical accounting leverage. The key conclusion we draw is that bank regulatory requirements, particularly regulatory leverage determined using regulatory risk weighted assets, explain why banks’ accounting leverage can be procyclical, and that fair value accounting does not.
1. Introduction

Many academic researchers, policy-makers, and other practitioners have concluded that fair value accounting can lead to suboptimal real decisions by firms, particularly financial institutions, and result in negative consequences for the financial system. This conclusion is sustained by the belief that fair value accounting was a major factor contributing to the 2008-2009 financial crisis by causing financial institutions to recognize excessive losses, which in turn caused excessive sales of assets and repayment of debt, thereby leading to procyclical accounting leverage. Leverage is procyclical when it decreases during economic downturns and increases during economic upturns. The question we address is whether there exists any link between fair value accounting and procyclical accounting leverage. To address this question, we develop a model of commercial bank actions taken in response to economic gains and losses on their assets throughout the economic cycle to meet regulatory leverage requirements. We focus on commercial banks because of the central role they play in the financial system and the allegation that their actions in response to fair value losses contributed to the financial crisis. Our model and empirical tests based on the model establish that procyclical accounting leverage for commercial banks only arises because of differences between regulatory and accounting leverage, and not because of fair value accounting.

Studying whether commercial banks exhibit procyclical accounting leverage and, if they do, whether bank regulation or fair value accounting is its source is important to helping policy-makers determine how best to minimize the effects of exogenous shocks to financial asset prices on the macro economy. Although many claim that fair value accounting caused banks to take actions that resulted in procyclical decreases in bank leverage during the financial crisis, there is
no direct evidence that this is the case. Moreover, we are unaware of any research regarding the role of bank regulation as a cause of these actions.

Our model of bank behavior in response to changes in asset prices assumes the objective of a bank is to maximize return on equity. To achieve this objective, a bank uses debt financing whenever possible to acquire risky assets, thereby maximizing accounting leverage. However, bank regulatory leverage constraints limit both the amount of assets a bank can purchase using debt financing and the riskiness of the assets in its investment portfolio. In particular, a bank’s regulatory leverage—the ratio of risk-weighted assets (where weights are set by a regulator) to regulatory capital—cannot exceed an amount set by the regulator. Thus, our model assumes that banks maximize accounting leverage subject to a regulatory leverage constraint. The model shows that procyclical accounting leverage results only when the average regulatory risk weight of assets purchased (sold) in response to increases (decreases) in asset values is less than the average asset risk weight of the assets in its investment portfolio prior to the purchase (sale). That is, absent differences in regulatory risk weights across assets, accounting leverage cannot be procyclical. Thus, procyclical accounting leverage is attributable to bank regulatory requirements and not fair value accounting. Regulatory risk weights likely change counter-cyclically, i.e., risk weights increase (decrease) during economic downturns (upturns). The model shows that counter-cyclical regulatory risk weights only serve to exacerbate any accounting leverage procyclicality.

We empirically test predictions of the model using quarterly financial statement and regulatory data for a sample of US commercial banks from 2001 to 2010. Following prior research, we begin by estimating the relation between change in accounting leverage and change in assets and find that the relation is significantly positive, which indicates that accounting
leverage is procyclical. However, consistent with the predictions of our model, this procyclical relation evaporates when change in each bank’s weighted average regulatory risk weight is included in the estimating equation. We next estimate the relation between change in accounting leverage and change in assets disaggregated into comprehensive income, other changes in equity, and change in debt. We find that comprehensive income and other changes in equity are significantly negatively related to change in accounting leverage, and change in debt is significantly positively related. These are the expected relations between change in leverage and change in debt and equity. When we estimate this relation disaggregating comprehensive income into net income, fair value components of other comprehensive income, and the remaining components of other comprehensive income, all three components of comprehensive income are significantly negatively related to change in accounting leverage. Thus, we find no evidence that fair value accounting—whether reflected in net income or other comprehensive income—is a source of procyclical accounting leverage.

Because of the asymmetry in accounting for gains and losses and that the concerns about fair value accounting and procyclicality arose during the economic downturn that followed the financial crisis, we estimate the relations described above separately for quarters of up and down economic markets. Inferences based on these separate estimations are the same as those for the full sample, except that there is no evidence of procyclical accounting leverage in down markets. To test more directly whether there is a link between fair value accounting and procyclical accounting leverage, we estimate the relation between change in accounting leverage and change in assets arising from fair value comprehensive income, other changes in assets, and their interaction. We find no evidence of a relation between the interaction and change in accounting leverage.
The paper proceeds as follows. The next section provides a discussion of the institutional background and research relating fair value accounting to the financial crisis, including research linking fair value accounting and procyclical leverage. Section 3 presents the model we use to develop our theoretical insights and empirical predictions. Section 4 describes the data and sample selection, and section 5 presents the empirical results. Section 6 provides summary and concluding remarks.

2. Institutional Background and Related Research

Many academic researchers, policy-makers, and other practitioners have concluded that fair value accounting can lead to suboptimal real decisions by firms, particularly financial institutions, and result in negative consequences for the financial system.¹ This conclusion is sustained by the belief that fair value accounting was a major factor contributing to the 2008-2009 financial crisis by causing financial institutions to recognize excessive losses, which in turn caused excessive sales of assets and repayment of debt, thereby leading to procyclical accounting leverage. The exogenous shock to prices of financial assets—particularly asset-backed securities—caused by the bursting of the US housing market bubble resulted in financial institutions, particularly banks, having to recognize losses in their financial statements. Recognizing such losses increased bank leverage. Presumably to avoid violating regulatory leverage requirements, banks were then forced to sell assets and repurchase debt. These asset sales depressed financial asset prices further. The alleged role of fair value accounting is that fair value accounting requires asset write-downs to be based on exit prices, which were artificially low because of illiquidity and therefore poor indicators of many financial assets’

fundamental values. Thus, fair value-based write-downs resulted in excessive asset sales and an even greater decline in the prices of financial assets.\(^2\)

This alleged link between fair value accounting and the financial crisis exerted strong political pressure on accounting standard setters and regulators. In the US, political pressure brought by the American Bankers Association and others resulted in Congress including a provision in the Emergency Economic Stabilization Act of 2008 requiring the Securities and Exchange Commission (SEC), in consultation with the Federal Reserve and the Treasury, to conduct a study on the potential role that fair value accounting standards, particularly Statement of Financial Accounting Standards (SFAS) No. 157 *Fair Value Measurements* (FASB, 2006), played in the financial crisis, including effects on financial institutions’ statements of financial position. Although the SEC’s report (SEC, 2008) endorsed private-sector standard setting and fair value accounting, including SFAS 157, the report recommended that the Financial Accounting Standards Board (FASB) develop implementation guidelines and readdress accounting for financial asset impairment. In response to political pressure and the SEC’s report, the FASB issued three FASB Staff Positions, two of which made it easier for firms effectively to minimize the effects of economic losses on income and equity.\(^3\)

In the European Union, European officials exerted political pressure on the International Accounting Standards Board (IASB) to amend existing accounting rules to increase reported bank equity (Bischof, Brüggemann, and Daske, 2013). In response, the IASB issued amendments to International Accounting Standard 39 *Financial Instruments: Recognition and*

\(^2\) See the American Bankers Association letter to the Financial Accounting Standards Board (ABA, 2010) for a discussion of this argument linking fair value accounting to the financial crisis. See also Plantin, Adrian, and Shin (2008) for a theoretical model that predicts excessive asset sales result from fair value accounting in response to exogenous negative shocks to asset prices.

\(^3\) See, e.g., Ronald Orol’s April 2, 2009 article in MarketWatch, “FASB Approves More Mark-to-Market Flexibility.”
Measurement (IASB, 2008a) and International Financial Reporting Standard 7 Financial Instruments: Disclosures (IASB, 2008b). The amendments included a provision permitting entities, including banks, to reclassify investments out of categories requiring fair value measurement, and in some cases to do so retroactively to June 30, 2008, which predates the precipitous decrease in financial asset prices during the third quarter of 2008.

Although regulators and accounting standard setters reacted to critics’ claims linking fair value accounting and the financial crisis, several academic studies provide evidence that fair value accounting had little impact on the banks’ regulatory capital and bank behavior during the crisis. For example, Shaffer (2010) provides evidence that the decline in Tier 1 regulatory capital arising from impairment to fair value of available-for-sale and held-to-maturity securities averaged only 2.1% for the 14 largest US banks during the financial crisis. Similarly, Badertscher, Burks, and Easton (2012) finds that impairments that reduce the carrying amounts of non-Treasury available-for-sale and held-to-maturity securities to fair value had minimal effect on regulatory capital during the financial crisis for 150 bank holding companies. Badertscher, Burks, and Easton (2012) finds mixed evidence that banks sold securities in response to asset impairments and concludes the sales were economically insignificant because there is no evidence of an industry- or firm-level increase in sales of securities during the crisis.4

Other studies, notably Adrian and Shin (2008, 2010), reach a different conclusion regarding the potential for a link between fair value accounting and procyclical asset prices that could have contributed to the financial crisis. In particular, Adrian and Shin (2008, 2010) assert that the actions financial institutions typically take to offset counter-cyclical changes in leverage arising from recognition of decreases in asset values during economic downturns ultimately

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4 See Barth and Landsman (2010) for a broader discussion of the link between financial reporting—including fair value accounting—and the financial crisis.
cause procyclical changes in accounting leverage.\textsuperscript{5} The assertion is based on the belief that procyclical accounting leverage results from fair value accounting causing financial institutions to recognize excessive losses, which in turn causes excessive sales of assets and repayment of debt. Thus, Adrian and Shin (2008, 2010) interpret procyclical accounting leverage as evidence of excessive actions caused by fair value accounting.\textsuperscript{6} Adrian and Shin (2008, 2010) provide empirical evidence of procyclical accounting leverage by documenting a positive relation between quarterly changes in assets and accounting leverage for five investment banks from the third quarter of 1992 through the first quarter of 2008.

We make several observations about Adrian and Shin (2008, 2010). First, the studies provide no direct evidence that fair value accounting \textit{per se} caused procyclical accounting leverage for the investment banks. Rather, the studies assert that because such firms use fair value accounting for most of their assets, any procyclical accounting leverage they exhibit stems from fair value accounting. Second, the studies offer no evidence that the aggregate effect of fair value accounting that allegedly results in procyclical leverage at the individual investment bank level caused or contributed to the financial crisis. Third, it is conceivable that the actions of investment banks and other broker-dealer financial firms contributed to the financial crisis. We focus on commercial banks because most of the debate regarding fair value accounting and the financial crisis revolved around commercial banks, in large part because of the central role they play in the economy.

\textsuperscript{5} Adrian and Shin (2008, 2010) make no distinction between accounting and regulatory leverage. Because the studies’ empirical work is based on commercial banks and investment banks, which are unregulated, we assume when Adrian and Shin (2008, 2010) refer to leverage, they mean accounting leverage.

\textsuperscript{6} Adrian and Shin (2008, 2010) note that the aggregate effect of procyclical accounting leverage at the individual bank level is a “contagion” or feedback mechanism in which, during an economic downturn, asset sales by each financial institution cause asset prices to decline further.
A key factor affecting actions taken by commercial banks is that banks must meet regulatory leverage requirements. In the next section, we develop a model of bank actions taken to meet regulatory leverage requirements in response to economic gains and losses on their assets resulting from upturns and downturns in the economy. The model assumes that banks maximize return on equity by maximizing accounting leverage subject to a regulatory leverage constraint. Our model and empirical tests based on the model establish that procyclical accounting leverage for commercial banks only arises because of differences between regulatory and accounting leverage, and not because of fair value accounting.

3. Model

This section develops a model of how bank actions taken in response to economic gains and losses on their assets resulting from upturns and downturns in the economy can result in procyclical accounting leverage. Consistent with Adrian and Shin (2010), we assume the bank’s objective, as with all entities, is to maximize return on equity. To achieve this objective, entities use debt financing whenever possible to acquire risky assets, thereby maximizing accounting leverage. Although entities would want to purchase an unlimited amount of risky assets funded by debt, debt capital providers charge increasingly higher prices as debt increases, which ultimately limits the amount of risky assets entities can purchase (Kraus and Litzenberger, 1973). Thus, they cannot increase leverage indefinitely. In the case of commercial banks, the constraint on leverage is externally imposed by the regulator, which presumably is more binding than the debt market constraint. Thus, our model assumes banks maximize accounting leverage subject to a regulatory leverage ratio, i.e., the reciprocal of the regulatory capital ratio.7

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7 Analogously, Adrian and Shin (2008, 2010) assume that investment banks maximize return on equity by maximizing accounting leverage subject to maintaining capital to meet an internally imposed value-at-risk criterion.
Although there is no consensus in the finance literature whether there is an optimal capital structure (e.g., Modigliani and Miller, 1958; Kraus and Litzenberger, 1973; Myers, 1984; Myers and Majluf, 1984), if banks have a target accounting leverage, then the actions they take would be limited to achieving this goal. That is, in the face of increasing (decreasing) asset values, banks would buy (sell) assets and issue (repay) debt in amounts sufficient to restore accounting leverage to the level it was before the increase (decrease) in asset values. However, if banks take actions to maintain a target accounting leverage, there would be no observed change in accounting leverage and hence no reason to expect a relation between change in accounting leverage and change in assets. Thus, observing a procyclical relation between accounting leverage and assets is evidence that banks do not manage accounting leverage to a targeted amount.

Regulatory leverage differs from accounting leverage because risk weights are applied to assets in determining the former but not the latter. In particular, regulatory leverage can be smaller than accounting leverage if a bank invests in assets with risk weights less than one. Because regulatory leverage depends on the risk weights assigned to a bank’s assets, in striving to maximize return on equity, banks need to take into account the tradeoff between purchasing (selling) assets with lower risk weights—and thus lower expected return per dollar of assets purchased (sold)—and fewer assets with higher risk weights—and thus higher expected return per dollar of assets purchased (sold).

We model the actions of a representative bank for a single period, where \( t_0 \) marks the beginning of the period and \( t_1 \) the end. At \( t_0 \) the bank has assets \( A_0 > 0 \), equity capital \( K_0 > 0 \), and debt \( D_0 > 0 \), with \( A_0 = K_0 + D_0 \). The bank’s accounting leverage ratio is \( L_0 = \frac{A_0}{K_0} \). For
risk-based capital regulation, bank assets are assigned risk weights from a vector, $V$. We denote the bank’s weighted average risk-weight at $t_0$ as $V_0 \geq 0$, which results in a regulatory leverage ratio of $R_0 = \frac{V_0 \times A_0}{K_0}$. For simplicity, but without loss of generality, the model does not distinguish between accounting and regulatory equity capital because we assume the bank’s capital comprises only shareholders’ equity. Thus, if risk weights equal one for all assets, then accounting and regulatory leverage are the same.

Between $t_0$ and $t_1$ the economy can expand, contract, or remain unchanged. We denote positive (negative, zero) economic growth by a growth factor, $g > 1$ ($g < 1$, $g = 1$). The bank earns income during the period, $I_t$, that depends on the state of the economy, where $I = (g - 1)A_0$. Because our focus is on the potential relation between fair value accounting and procyclical accounting leverage, we assume the bank’s only income comprises fair value gains or losses. $I_t$ is positive if the economy expands and negative if the economy contracts. At $t_1$ the bank has assets of $A_1 = gA_0$ and capital of $K_1 = K_0 + I_1$.

To assess the role of regulatory risk weights in affecting bank actions, we consider two cases. In the first case, we assume regulatory risk weights remain constant throughout the economic cycle, i.e., they are independent of $g$. This case establishes a benchmark for assessing the incremental role of the more descriptive counter-cyclical risk weights, which we assume in the second case. Appendix A provides proofs of the propositions that appear below.

8 During our sample period, regulatory risk weights range from zero to one, with cash assigned a risk weight of zero, and increasingly riskier assets assigned increasingly higher risk weights. 9 Conceptually, an asset’s regulatory risk weight can be viewed as equivalent to the value-at-risk the asset creates for the bank. Risk weights tend to be counter-cyclical because bank regulators increase risk weights during economic downturns to ensure banks have adequate capital. Counter-cyclical risk weights is the mechanism regulators use to ensure a bank’s capital reflects the bank’s asset value-at-risk.
3.1 **Regulatory risk weights are independent of the economic cycle**

To assess the effects on leverage of banks striving to achieve their assumed objective—i.e., buying or selling assets to maximize accounting leverage subject to a regulatory leverage constraint—we proceed in two steps. First, we derive how accounting and regulatory leverage change during the period assuming the bank does not buy or sell assets in response to the income it earns. We next derive how regulatory and accounting leverage change if the bank buys or sells assets to meet its objective.

Assuming the bank does not buy or sell assets in response to the income it earns, its regulatory and accounting leverage change depending on the state of the economy, that is, depending on whether the bank has fair value gains or losses. Equations (1) and (2) specify regulatory and accounting leverage at $t_1$, $R_1$ and $L_1$.

$$R_1 = \frac{V_0 \times A_1}{K_1} = \frac{V_0 \times gA_0}{K_0 + I_1}$$

$$L_1 = \frac{A_1}{K_1} = \frac{gA_0}{K_0 + I_1}$$

**Proposition 1**: At $t_1$, regulatory and accounting leverage do not change if the economy exhibits no growth, i.e., $g = 1$. If the economy expands, i.e., $g > 1$, regulatory and accounting leverage decrease. If the economy contracts, i.e., $g < 1$, accounting and regulatory leverage increase.

(i) $\Delta R = 0$ and $\Delta L = 0$ iff $g = 1$

(ii) $\Delta R < 0$ and $\Delta L < 0$ iff $g > 1$

(iii) $\Delta R > 0$ and $\Delta L > 0$ iff $g < 1$

$\Delta R$ ($\Delta L$) is the change in regulatory (accounting) leverage from $t_0$ to $t_1$, i.e., $R_1 - R_0$ ($L_1 - L_0$).

We refer to the relation implied by equation (3) as the mechanical relation between fair value gains or losses and leverage. This relation is consistent with the Adrian and Shin (2010)
observation that in the absence of bank action there is an inverse relation between the size of firm’s balance sheet and leverage.

We next derive changes in regulatory and accounting leverage assuming the bank buys or sells assets to achieve its objective. In particular, the bank takes steps to counteract the mechanical relation between fair value gains or losses and leverage. Because the bank seeks to maximize accounting leverage, the bank finances its asset purchases with debt or uses proceeds from asset sales to repay debt. Let $d > 0$ ($d < 0$) represent the amount of assets the bank needs to purchase (sell) to maintain its regulatory leverage ratio, $R_0$. As a result, $A_i = gA_0 + d$ and $d = \Delta D = D_i - D_0$. We denote the weighted average regulatory risk weight of assets purchased or sold as $V^*$.

**Proposition 2:** For the bank to maintain a constant regulatory leverage ratio, i.e., $\Delta R = 0$, $d$ must satisfy the following equation:

$$d = \frac{V_0A_0}{V^*} \left[ 1 + (g - 1) \frac{A_0}{K_0} - g \right], \quad (4)$$

which implies that

(i) $d = 0$ iff $g = 1$;
(ii) $d > 0$ iff $g > 1$;
(iii) $d < 0$ iff $g < 1$. \quad (5)

Proposition 2 indicates that the bank purchases assets by increasing debt during economic expansions and by selling assets to repay debt during economic contractions to maintain its regulatory leverage ratio. Equation (5) implies that $d$ increases as $g$ increases. Equation (4) indicates that $d$ is larger the higher the bank’s initial accounting leverage, $L_0$, and the higher is
the ratio of the weighted average risk weight of its initial assets, \( V_0 \), to that of assets purchased or sold, \( V^* \).

Furthermore, because accounting leverage at \( t_1 \), 

\[ L_1 = \frac{A_1}{K_1} = \frac{gA_0 + d}{K_0 + I_1}, \]

purchasing assets by increasing debt increases accounting leverage during economic expansions, and selling assets to repay debt decreases accounting leverage during economic contractions. That is, accounting leverage is procyclical. However, Proposition 3 establishes that this procyclical accounting leverage is independent of the magnitude of fair value gains or losses.

**Proposition 3:** *Assuming the bank buys or sells assets to maximize accounting leverage subject to its regulatory leverage constraint, whether accounting leverage is procyclical, i.e., \( \Delta L > 0 \) during economic expansions and \( \Delta L < 0 \) during economic contractions, does not depend on the magnitude of fair value gains or losses.*

\[
\begin{align*}
\text{If } g > 1 & \Rightarrow \Delta L > 0 \text{ iff } \frac{gA_0 + d}{K_1} > \frac{A_0}{K_0} \\
\text{If } g < 1 & \Rightarrow \Delta L < 0 \text{ iff } \frac{gA_0 + d}{K_1} < \frac{A_0}{K_0} 
\end{align*}
\]

(6)

Procyclical accounting leverage is possible only if the weighted average regulatory risk weight of assets purchased or sold is less than the bank’s initial weighted average regulatory risk weight, i.e., if \( V^* < V_0 \).

\[
\begin{align*}
\text{If } g > 1 & \Rightarrow \Delta L > 0 \text{ iff } \frac{V_0}{V} > 1 \\
\text{If } g < 1 & \Rightarrow \Delta L < 0 \text{ iff } \frac{V_0}{V^*} > 1 
\end{align*}
\]

(7)

Equation (7) follows from equation (6) by substituting in equation (6) the expression for \( d \) in equation (4), and simplifying the resulting expression. Proposition 3 establishes that regardless
of the sign or magnitude of fair value income, accounting leverage does not change procyclically unless the weighted average risk weight of assets the bank purchases or sells is less than that of the assets in its portfolio before purchasing or selling assets. That is, procyclical accounting leverage as the result of asset purchases or sales is only possible if \( V^* < V_0 \).\(^{10}\) Regardless of how banks decide which assets to purchase or sell, the model shows that procyclical accounting leverage can only result if the weighted average risk weight of assets they purchase or sell is less than the weighted average risk weight of assets in their portfolios prior to asset purchases or sales. Thus, procyclical accounting leverage cannot occur in the absence of bank regulation based on a risk-weighted measure of leverage.

3.2 Regulatory risk weights change counter-cyclically during the economic cycle

We next analyze the extent to which the conclusions we draw from the model change when regulatory risk weights are counter-cyclical. That is, for each given asset type, e.g., US Treasury securities or mortgage-backed securities, the regulator decreases the assigned regulatory risk weight during economic expansions, and increases it during economic

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\(^{10}\) As an illustration relating to asset purchases, consider a bank that has 100 in assets with a risk weight of one, 80 in debt, and 20 in equity, implying that its accounting and regulatory leverage are both five, and \( V_0 = 1 \). Assume that the bank’s assets increase in value by five to 105, and assume risk weights of the assets do not change. Absent taking any action, the bank’s accounting and regulatory leverage both decrease to 4.2 (= 105 / 25). However, in its quest to maximize accounting leverage, the bank buys 30 in assets by issuing 30 in debt. Because its regulatory leverage constraint is five, the mix of assets the bank purchases is 10 with a risk weight of zero and 20 with a risk weight of one. Thus, \( V^* = 0.67 = \left(\frac{10 \times 0 + 20 \times 1}{30}\right) \), which is less than \( V_0 = 1 \). This action results in regulatory leverage of 5 (= \( \left(\frac{125 \times 1 + 10 \times 0}{25}\right) \)) and accounting leverage of 5.4 (=135 / 25), which is procyclical. Other asset purchase combinations can achieve this goal.

As an illustration relating to asset sales, consider a bank that has 120 in assets, 100 (20) of which have a risk weight of one (zero), 100 in debt, and 20 in equity, implying that its accounting leverage is six, regulatory leverage is five, and \( V_0 = 0.83 = \left(\frac{100 \times 1 + 20 \times 0}{120}\right) \). Assume that the bank’s risky assets, i.e., those with a risk weight of one, decrease in value by 10 to 90. Absent taking any action, the bank’s accounting and regulatory leverage increase to 11 (= 110 / 10) and 9 (= \( \left(\frac{90 \times 1 + 20 \times 0}{10}\right) \)). To achieve procyclical accounting leverage while restoring regulatory leverage to five, the bank needs to sell 40 of its risky assets and more than 10 of its riskless assets. For example, if the bank sells 12 of its riskless assets in addition to the 40 risky assets, accounting leverage decreases to 5.8 (= \( \left(\frac{90 - 40 + 20 - 12}{10}\right) \)). Thus, \( V^* = 0.77 = \left(\frac{40 \times 1 + 12 \times 0}{52}\right) \), which is less than \( V_0 = 0.83 \).
contractions. We model this counter-cyclical change in risk weights by assuming $V_i = \frac{V_0}{g}$, which

has a direct effect on regulatory leverage at $t_1$. In particular, $R_i^{CC} = \frac{g}{K_1} = \frac{V_0 \times A_0}{K_1}$, where

$R_i^{CC}$ is regulatory leverage at $t_1$ when regulatory risk weights are counter-cyclical.

Assuming the bank does not buy or sell assets in response to the income it earns, Proposition 4 establishes that the mechanical relation between fair value gains or losses and leverage is amplified in the presence of counter-cyclical risk weights.

**Proposition 4:** Compared with the case where regulatory weights are independent of the economic cycle, the presence of counter-cyclical regulatory risk weights causes regulatory leverage to decrease more when the economy expands and to increase more when the economy contracts. That is:

$$R_i - R_i^{CC} \begin{cases} = 0 & \text{iff } g = 1 \\ > 0 & \text{iff } g > 1 \\ < 0 & \text{iff } g < 1 \end{cases}, \quad (8)$$

where $R_i$ is regulatory leverage at $t_1$ when regulatory risk weights are unaffected by the economic cycle.

Corollary 1 follows directly from Proposition 4.

**Corollary 1:** The mechanical relation between accounting leverage and fair value gains and losses during economic expansions and contractions is unaffected by counter-cyclical regulatory risk weights. That is:

$$L_i - L_i^{CC} = 0 \ \forall g,$$  

(9)
where $L_{1}^{cc}$ ($L_{1}$) represents accounting leverage at $t_1$ when regulatory risk weights are (are not) counter-cyclical.

We next derive how accounting leverage changes in the presence of counter-cyclical risk weights assuming the bank maximizes accounting leverage subject to its regulatory leverage constraint. In this case, Proposition 5 establishes how counter-cyclical regulatory risk weights affect the amount of assets the bank purchases (sells) during economic expansions (contractions).

**Proposition 5:** In the presence of counter-cyclical risk weights, for the bank to maintain its target regulatory leverage ratio such that $\Delta R = 0$, asset purchases (sales), $d^{cc}$, must satisfy the following equation.

$$d^{cc} = \frac{V_{0}A_{0}}{V^{*}}(g - 1)\frac{A_{0}}{K_{0}}$$ (10)

Corollary 2 follows directly from Proposition 5.

**Corollary 2:** Compared with the case where regulatory weights are independent of the economic cycle, the presence of counter-cyclical regulatory risk weights causes the bank to make larger asset purchases (sales) during economic expansions (contractions). That is,

$$d - d^{cc} \begin{cases} = 0 & \text{iff } g = 1 \\ < 0 & \text{iff } g > 1 \\ > 0 & \text{iff } g < 1. \end{cases}$$ (11)

Finally, although there is a magnifying effect on any accounting leverage procyclicality from counter-cyclical regulatory risk weights, as in the case with regulatory risk weights that are independent of the economic cycle, accounting leverage is independent of the magnitude of fair value gains or losses. This is formally stated in Proposition 6.
**Proposition 6:** In the presence of counter-cyclical regulatory risk weights, assuming the bank buys or sells assets to maximize accounting leverage subject to its regulatory leverage constraint, whether accounting leverage is procyclical, i.e., $\Delta L > 0$ during economic expansions and $\Delta L < 0$ during economic contractions, does not depend on the magnitude of fair value gains or losses.

\[
\text{If } g > 1 \Rightarrow \Delta L > 0 \text{ iff } \frac{V_0}{V} > 1 - \frac{K_0}{A_0}
\]

\[
\text{If } g < 1 \Rightarrow \Delta L < 0 \text{ iff } \frac{V_0}{V} > 1 - \frac{K_0}{A_0}
\]

(12)

Procyclical accounting leverage is possible only if the ratio of the weighted average regulatory risk weight of assets purchased or sold to the weighted average regulatory risk weight of the bank’s assets at $t_0$ exceeds a predetermined amount, \(1 - \frac{K_0}{A_0}\).

Thus, Propositions 3 and 6 establish that regardless of whether regulatory risk weights are counter-cyclical or independent of the economic cycle, procyclical accounting leverage cannot occur in the absence of risk-based bank capital regulation.

### 3.3 Summary of model insights

The model yields three key insights. First, absent differences in regulatory risk weights across assets, regardless of the action the bank takes in response to fair value gains and losses, accounting leverage cannot be procyclical. Second, the extent of any accounting leverage procyclicality is independent of the magnitude of fair value gains and losses. Third, counter-cyclical regulatory risk weights only serve to magnify any accounting leverage procyclicality. Thus, any procyclical accounting leverage is attributable to bank regulatory requirements and not fair value accounting.
4. Empirical Predictions and Estimating Equations

Based on the findings in Adrian and Shin (2008, 2010), we predict a positive relation between change in accounting leverage and change in assets. Our model predicts that this procyclical relation can only be achieved if banks take actions to offset the mechanical relation between change in accounting leverage and change in assets that arises from recognizing gains and losses. This mechanical relation occurs because asset gains (losses) increase (decrease) assets and equity by the same amount, thereby decreasing (increasing) accounting leverage. To attain a positive relation between change in accounting leverage and change in assets banks must issue debt and purchase assets in the presence of gains and sell assets and repay debt in the presence of losses.

To test our model’s predictions, following Adrian and Shin (2008, 2010), we begin by estimating the following regression of change in leverage on change in assets:

\[
\Delta L_{iq} = \beta_0 + \beta_1 \Delta A_{iq} + \epsilon_{iq},
\]

(13)

where \( \Delta L \) is quarterly percentage change in accounting leverage, \( \Delta A \) is quarterly percentage change in assets, and \( i \) and \( q \) refer to bank \( i \) and quarter \( q \). Equation (13) and those that follow also include fixed effects for each firm, year, and fiscal quarter, which we do not tabulate. If accounting leverage is, on average, procyclical, then we predict \( \beta_1 \) is positive.

To test whether any accounting leverage procyclicality observed in equation (13) is attributable to change in a bank’s weighted average risk weight, we estimate equation (14):

\[
\Delta L_{iq} = \beta_0 + \beta_1 \Delta A_{iq} + \beta_2 \Delta V_{iq} + \epsilon_{iq},
\]

(14)

where \( \Delta V \) is the quarterly change in the bank’s weighted average regulatory risk weight. \( \Delta V \) reflects changes in the bank’s weighted average risk weight arising from changes in the bank’s
portfolio of assets as well as from changes in economic conditions. Because our model predicts that any procyclicality results from $\Delta V$, we predict $\beta_2$ is negative and $\beta_1$ is zero.

To test whether any procyclicality observed in equation (13) is associated with fair value accounting, we first estimate equation (15a), which disaggregates change in assets into components that are affected by fair value accounting and components that are not:

$$
\Delta L_{iq} = \beta_0 + \beta_1 CI_{iq} + \beta_2 \Delta K_{iq} + \beta_3 \Delta D_{iq} + \epsilon_{iq},
$$

(15a)

where $CI, \Delta K$, and $\Delta D$ are quarterly comprehensive income, change in equity other than comprehensive income, and change in debt, each divided by lagged assets. That is, the sum of $CI, \Delta K$, and $\Delta D$ equals $\Delta A$. Comprehensive income comprises amounts based on historical cost and fair value accounting. Thus, $C$ is affected by fair value accounting in quarter $q$, but $\Delta K$ and $\Delta D$ are not. In the absence of procyclicality, we predict $\beta_1$ and $\beta_2$ are negative, and $\beta_3$ is positive. We also predict that $\beta_1$ and $\beta_2$ are equal to each other because in the absence of procyclicality the source of a change in equity should have no effect on change in accounting leverage. These are the mechanical relations between change in leverage and change in debt and equity. If accounting leverage is procyclical and the procyclicality is associated with fair value accounting, we predict $\beta_1$ is positive or less negative than $\beta_2$. This is because the procyclical effect of fair value accounting would bias positively the relation between leverage and the component of equity affected by fair value accounting, i.e., $CI$.

To test more directly whether any procyclicality observed in equation (13) is associated with fair value accounting, we next estimate equation (15b), in which $CI$ is disaggregated into three components, net income, $NI$, the components of other comprehensive income determined by fair value accounting, $FVOCI$, and the remaining components of other comprehensive income, $OTHOCI$. 
\[
\Delta L_{iq} = \beta_0 + \beta_1 NI_{iq} + \beta_2 FVOCI_{iq} + \beta_3 OTHOCI_{iq} + \beta_4 \Delta K_{iq} + \beta_5 \Delta D_{iq} + \epsilon_{iq}.
\] (15b)

In the absence of procyclicality, we predict \(\beta_1, \beta_2, \beta_3,\) and \(\beta_4\) are negative and equal to each other, and \(\beta_5\) is positive. If accounting leverage is procyclical and the procyclicality is associated with fair value accounting, we predict \(\beta_1\) and \(\beta_2\) are positive or less negative than \(\beta_3\). Because net income comprises amounts based on historical and fair value accounting, we predict \(\beta_1\) is less positively biased than \(\beta_2\).

We next estimate equations (13) through (15) separately for up and down markets to allow for the possibility that the extent of accounting leverage procyclicality is greater during downturns than upturns. This could result because accounting standards in place during our sample period permitted recognition of fair value gains—which are expected to be observed during upturns—only for a subset of investment securities, but required banks (and other entities) to recognize impairment losses—which are expected to be observed during downturns—for all assets.\(^{11}\) As a result, to the extent that there is procyclical accounting leverage and it stems from fair value accounting, we predict the following in economic downturns relative to economic upturns: in equation (1) \(\beta_1\) is more positive; in equations (15a) and (15b) the coefficients on the equity amounts affected by fair value accounting, \(CI, NI,\) and \(FVOCI,\) are less negative.

Finally, to test the Adrian and Shin (2008, 2010) hypothesis that accounting leverage procyclicality arises from the interaction of asset purchases (sales) and fair value gains (losses), i.e., fair value gains cause banks to issue more debt and purchase more assets (repurchase more debt and sell more assets) than would be the case under historical cost accounting, we estimate equation (16):

\(^{11}\) Impairments do not reduce carrying amounts to fair value for all assets, most notably loans. However, impairments are designed to recognize economic losses.
\[
\Delta L_{iq} = \beta_0 + \beta_1 \Delta OTHA_{iq} + \beta_2 FVDECILE_{iq} + \beta_3 \Delta OTHA_{iq} \times FVDECILE_{iq} + \beta_4 \Delta V_{iq} + \epsilon_{iq},
\]

where \( \Delta OTHA \) is change in assets other than those resulting from fair value gains and losses, i.e., \( \Delta A \) less the sum of unrealized fair value gains and losses from trading securities recognized in net income and other unrealized fair value gains and losses recognized in other comprehensive income, deflated by lagged assets, \( FVCI \). \( FVDECILE \) is the quarterly cross-sectional decile rank of \( FVCI \), and as such ranges from zero to one. We estimate two versions of equation (16)—one that includes change in weighted average regulatory risk weight, \( \Delta V \), and one that does not.

Equation (16) includes \( \Delta OTHA \) rather than \( \Delta A \) because \( \Delta OTHA \) reflects purchases and sales of assets, i.e., not changes in assets attributable directly to fair value accounting. Our focus is on the interaction coefficient, \( \beta_3 \), because it reflects any association between fair value accounting and purchases and sales of assets that result in procyclical leverage. We use \( FVDECILE \) rather than the sum of fair value gains and losses to facilitate interpretation of the interaction coefficient, \( \beta_3 \). In particular, the sum of \( \beta_2 \) and \( \beta_3 \) is the coefficient on \( \Delta OTHA \) for banks with the highest fair value income. If procyclicality arises from the interaction of asset purchases (sales) and fair value gains (losses), then \( \beta_3 \) is positive.

5. Sample and Data

We obtain quarterly financial statement data from the COMPUSTAT Bank files (three-digit SIC 602) and the WRDS Bank Regulatory Database, which includes accounting and regulatory data from regulatory forms filed with the Federal Reserve System, Federal Deposit Insurance Corporation, and the Comptroller of the Currency, from the first quarter of 2001 to the fourth quarter of 2010.\(^{12}\) The sample comprises US commercial banks that file Call Reports and

\(^{12}\) Our sample period begins in 2001 because that is when data are available on other comprehensive income, which we require for estimating equation (15b). All other data are available beginning in 1996. Inferences based on
Federal Reserve Y-9C reports. We require all sample firms to have non-negative values for total assets and equity in all quarters of the sample period. We winsorize all continuous regression variables at the 1% and 99% levels. The final sample consists of 12,486 firm-quarter observations of 623 commercial banks. Appendix B provides definitions for all variables.

Tables 1 and 2 present sample descriptive statistics and correlations for the regression variables. Table 1 reveals that the mean and median percentage changes in leverage, $\Delta L$, are less than one percent, 0.60% and 0.05%. The mean and median percentage changes in assets, $\Delta A$, 2.43% and 1.51%, are largely attributable to change in debt (mean and median $\Delta D = 2.51$ and 1.59).

Table 2 reveals that $\Delta L$ is positively correlated with $\Delta A$ (Spearman and Pearson correlations = 0.41 and 0.05), which is consistent with procyclical accounting leverage. However, $\Delta L$ is negatively correlated with changes in all equity components, including those relating to fair value accounting, except for changes in comprehensive income unrelated to fair value accounting. For example, the Spearman (Pearson) correlation between $\Delta L$ and fair value gains and losses in other comprehensive income, $FVOCI$, is $-0.32$ ($-0.18$). These correlations are inconsistent with fair value accounting being a source of procyclical accounting leverage. In addition, consistent with model predictions, the correlation between $\Delta L$ and change in average regulatory risk weight, $\Delta V$, is negative (Spearman and Pearson correlations = $-0.24$ and $-0.13$). All of these correlations are significantly different from zero.

---

13 Untabulated findings from estimation of equations (13), (14), (15a), and (16) using data from 1996 to 2010 are the same as those based on the tabulated findings for these four equations.

13 Inferences based on untabulated findings from estimation of all equations using continuous variables winsorized at the 5% and 95% levels and after eliminating outliers identified using studentized residuals and the Cooke’s D-statistic are the same as those based on tabulated findings.
6. Empirical Results

6.1 Tests of empirical predictions

Table 3 presents regression summary statistics from estimations of equations (13) and (14). The findings in the first column provide evidence of procyclical accounting leverage and confirm the findings of Adrian and Shin (2008, 2010) that are based on five investment banks. In particular, there is significant positive relation between change in accounting leverage, \( \Delta L \), and change in assets, \( \Delta A \). The coefficient on \( \Delta A \) is 0.10 with a t-statistic of 2.16.\(^{14}\)

The findings in the second column confirm the predictions of our model that procyclical accounting leverage can only result when the average regulatory risk weight of assets acquired (sold) in response to increases (decreases) in asset values is less than the average risk weight prior to the purchase (sale). In particular, as predicted there is a significantly negative relation between \( \Delta L \) and change in weighted average risk weight, \( \Delta V \) (coefficient = \(-0.29\), t-statistic = \(-6.15\)), and there is no significant relation between \( \Delta L \) and \( \Delta A \) (coefficient = \(0.02\), t-statistic = \(0.53\)). That is, after controlling for change in bank regulatory risk weights, accounting leverage is not procyclical.

Table 4 presents regression summary statistics from estimations of equations (15a) and (15b). The findings in table 4 are consistent with the expected relations between change in leverage and change in debt and equity, and inconsistent with accounting leverage procyclicality being associated with fair value accounting. In particular, relating to equation (15a), the coefficients on comprehensive income, \( CI \), and other changes in equity, \( \Delta K \), are significantly negative (coefficients = \(-13.66\) and \(-7.61\); t-statistics = \(-23.13\) and \(-34.16\)), and the coefficient on change in debt, \( \Delta D \), is significantly positive (coefficient = \(1.03\), t-statistic = 53.99). More

\(^{14}\) Reported t-statistics relating to all estimating equations are based on standard errors clustered by firm and quarter.
importantly, the \( CI \) coefficient is significantly more negative than the \( \Delta K \) coefficient (untabulated F-statistic = 124.32, \( p \)-value < 0.001). This is inconsistent with fair value accounting being a source of accounting leverage procyclicality. More broadly, the findings relating to equation (15a) are consistent with the expected relations between change in leverage and change in debt and equity, rather than procyclicality being associated with fair value accounting.

Relating to equation (15b), which disaggregates comprehensive income, the coefficients on net income, \( NI \), the fair value components of other comprehensive income determined by fair value accounting, \( FVOCI \), and the remaining components of other comprehensive income, \( OTHOCI \), are significantly negative. The coefficients are \(-13.58\), \(-13.34\), and \(-4.87\) (\( t \)-statistics = \(-21.04\), \(-10.80\), and \(-5.50\)). The coefficients on other changes in equity, \( \Delta K \), and change in debt, \( \Delta D \), are essentially the same as those in equation (15a). More importantly, the \( NI \) and \( FVOCI \) coefficients are not significantly different (untabulated F-statistic = 0.05, \( p \)-value = 0.8237), and each is significantly more negative than the \( \Delta K \) coefficient (untabulated F-statistics = 100.42 and 43.36; \( p \)-values < 0.001). As with equation (15a), these findings are inconsistent with fair value accounting being a source of accounting leverage procyclicality.

Table 5, panel A (B), presents regression summary statistics from estimations of equations (13) and (14) (equations (15a) and (15b)) separately for economic upturns and downturns. The findings in panel A reveal that whereas inferences based on the upturn findings in first set of columns are identical to those from table 3, the inferences based on the downturn findings in the second set of columns are not. In particular, in economic upturns, the coefficient on change in assets, \( \Delta A \), is marginally significantly positive (coefficient = 0.11, \( t \)-statistic = 1.85) when change in weighted average regulatory risk weight, \( \Delta V \), is not included in the estimating
equation, and insignificantly different from zero when $\Delta V$ is included (coefficient = 0.03, t-statistic = 0.39). In contrast, in economic downturns, the coefficient on $\Delta A$ is insignificantly different from zero regardless of whether $\Delta V$ is included in the estimating equation (coefficients = 0.08 and 0.02; t-statistics = 1.24 and 0.33). Untabulated statistics reveal that the coefficient on $\Delta A$ in economic downturns is not significantly larger than that in economic upturns (p-values = 0.37 and 0.50). In addition, the coefficient on $\Delta V$ is not significantly different in economic downturns and upturns (p-value = 0.35).

Finding evidence of accounting leverage procyclicality during upturns but not downturns provides additional evidence that fair value accounting does not contribute to procyclicality. This is because if fair value accounting contributes to accounting leverage procyclicality, its effect should be more pronounced during economic downturns because of the asymmetry in accounting recognition of economic gains and losses. Regardless, as in table 3, the findings relating to economic upturns and downturns in table 5, panel A, provide no evidence of procyclical accounting leverage when change in regulatory risk weight is included in the estimating equation.

Inferences based on the findings in table 5, panel B, are essentially the same as those in table 4—there is no evidence of accounting leverage procyclicality in either upturns or downturns. For example coefficients on $NI$, $FVOCI$ and $OTHOCI$ are −14.37, −12.59, and −4.48 (t-statistics = −14.18, −13.92, and −5.97) during upturns, and −12.87, −13.87, and −4.75 (t-statistics = −19.59, −6.57, and −3.03) during downturns. Also, as in table 4, the $NI$ and $FVOCI$ coefficients are not significantly different in either upturns or downturns (untabulated F-statistics = 2.27 and 0.51, p-values = 0.1327 and 0.4734), and each is significantly more negative than the
ΔK coefficient (untabulated F-statistics = 51.66 and 42.18 during upturns and 52.10 and 19.60; all p-values < 0.001).

Relating to differences in coefficients in economic upturns and downturns, untabulated statistics reveal that the coefficient on CI and NI in economic downturns are not significantly less negative than those in economic upturns (p-values = 0.21 and 0.11, one sided tests), and that the coefficient on FVOCI is not significantly different in economic downturns and upturns (p-value = 0.54, one sided test). These findings provide additional evidence that fair value accounting is not associated with accounting leverage procyclicality in either economic downturns or upturns.

Table 6 presents regression summary statistics from estimations of equation (16) that include and exclude ΔV. Neither estimation reveals any association between fair value accounting and the procyclical purchase and sale of assets. In particular, the coefficients on the interaction of ΔOTA and FVDECILE are insignificantly different from zero (coefficients = 0.040; t-statistics = 0.39). In addition, the coefficients on FVDECILE are significantly negative in both estimations (coefficients = −0.05; t-statistics = −6.06 and −6.07), which is consistent with the findings in tables 4 and 5 showing that fair value income is negatively associated with change in accounting leverage.

6.2 Estimations using broker-dealers

Adrian and Shin (2008, 2010) base their empirical analyses on a sample of five investment banks, whereas our study’s findings are based on a sample of over 600 commercial banks. A key distinction between investment banks and commercial banks during the studies’ sample periods is that investment banks were not subject regulatory requirements. Because most investment banks either became or were acquired by commercial banks or ceased operations, we are unable to replicate our study on a sample of investment banks. To assess whether our
inferences regarding the lack of an association between fair value accounting and procyclical accounting leverage extend to financial institutions that are not subject to regulation, we estimate equations (13), (15a), and (16) for a sample of broker-dealers. We do not estimate equation (14) because broker-dealers are not subject to regulatory risk weights; we do not estimate equation (15b) because virtually all of broker-dealer fair value gains and losses are recognized in net income, not other comprehensive income.

Untabulated findings reveal that our inferences apply to broker-dealers. Although there is a significant positive relation between change in leverage and change in assets ($\Delta A$ coefficient and t-statistic = 0.85 and 2.87), there is no evidence that fair value accounting contributes to this relation. In particular, the coefficients (t-statistics) for $CI$, $\Delta K$, and $\Delta D$ from the equation (15a) estimation are $-3.65$, $-2.39$, and $1.52$ ($-2.92$, $-3.32$, and $5.49$), and the coefficient (t-statistic) for the interaction of $FVDECI$ and $\Delta OTHA$ from the equation (16) estimation is $-0.70$ ($-0.91$). Thus, as with the commercial banks, there is no evidence that fair value accounting biases the coefficient on comprehensive income towards zero, and there is no evidence that fair value gains (losses) cause banks to purchase (sell) more assets than would be the case under historical cost accounting.

7. Summary and Concluding Remarks

We develop a model of commercial bank behavior and test predictions from the model based on a sample of US commercial banks, with data that span economic upturns and downturns, including the recent financial crisis-related downturn. We focus on commercial banks because of the central role they play in the financial system and the alleged claim that their actions in response to fair value losses contributed to the financial crisis. Studying whether commercial banks exhibit procyclical accounting leverage as well as its potential sources—bank
regulation or fair value accounting—is important to helping policy-makers determine how best to minimize the effects of exogenous shocks to financial asset prices on the macro economy.

Our model of commercial bank behavior focuses on actions banks take in response to economic gains and losses on their assets throughout the economic cycle to meet regulatory leverage requirements. Our model shows that absent differences in regulatory risk weights across assets, accounting leverage cannot be procyclical. We then test the model’s predictions empirically and although we find a significantly positive relation between change in accounting leverage and change in assets—indicating that accounting leverage is procyclical, this procyclical relation evaporates when change in each bank’s weighted average regulatory risk weight is included in the estimating equation. When we disaggregate change in assets into change in equity affected by fair value accounting, other changes in equity, and change in debt, we find that all changes in equity are significantly negatively related to change in accounting leverage, and change in debt is significantly positively related. We also find no evidence of a relation between change in accounting leverage and the interaction between change in assets related to fair value comprehensive income and other changes in assets. Thus, we find no evidence that fair value accounting is a source of procyclical accounting leverage.

The key conclusion we draw from the model and supporting empirical evidence is that bank regulatory requirements, particularly regulatory leverage that is determined using regulatory risk weighted assets, explain why banks’ accounting leverage can be procyclical, and that fair value accounting does not.
Appendix A
Proofs of Propositions

Proof of Proposition 1:

At $t_1$, regulatory leverage is

$$R_l = \frac{V_0 \times A_1}{K_1} = \frac{V_0 \times gA_0}{K_0 + I_1}.$$  

Hence, the change in regulatory leverage from $t_0$ to $t_1$ is

$$\Delta R = R_l - R_0 = \frac{V_0 \times gA_0}{K_1} - \frac{V_0 \times A_0}{K_0}.$$  

Regulatory leverage is constant during the period if

$$\frac{V_0 \times gA_0}{K_1} = \frac{V_0 \times A_0}{K_0}$$

which implies

$$\frac{V_0 \times gA_0}{K_0 + (g-1)A_0} = \frac{V_0 \times A_0}{K_0}$$

and

$$gK_0 = K_0 + (g-1)A_0 \Rightarrow g(K_0 - A_0) - (K_0 - A_0) = 0.$$  

Because $A_0$ is always larger than $K_0$ if the bank is levered, it follows that

(i) $\Delta R = 0$ iff $g = 1$;
(ii) $\Delta R < 0$ iff $g > 1$;
(iii) $\Delta R > 0$ iff $g < 1$.

Similarly, accounting leverage at $t_1$ is

$$L_l = A_1 = \frac{gA_0}{K_1} = \frac{A_0}{K_0 + I_1}.$$  

Hence the change in accounting leverage from $t_0$ to $t_1$ is

$$\Delta L = L_l - L_0 = \frac{gA_0}{K_0 + I_1} - \frac{A_0}{K_0},$$  

and, as with regulatory leverage,
\[ \Delta L = L_1 - L_0 = 0 \iff gK_0 = K_0 + (g-1)A_0. \]

Thus, it follows that

(i) \( \Delta L = 0 \iff g = 1; \)

(ii) \( \Delta L < 0 \iff g > 1; \)

(iii) \( \Delta L > 0 \iff g < 1. \)

**Proof of Proposition 2:**

After the purchase (sale) of assets, regulatory leverage at \( t_1 \) is

\[ R_1 = \frac{V_0 \times gA_0 + V^*d}{K_1}. \]

For regulatory leverage at \( t_1 \) to equal regulatory leverage at \( t_0 \), the following must hold:

\[ \frac{V_0 \times gA_0 + V^*d}{K_1} = \frac{V_0 \times A_0}{K_0}. \]

Solving this equation for \( d \):

\[ d = \frac{V_0A_0K_0 - V_0gA_0}{V^*K_0} = \frac{V_0A_0K_1 - V_0gA_0K_0}{V^*K_0}, \]

\[ d = \frac{V_0A_0 + V_0A_0(g-1)A_0 - V_0gA_0K_0}{V^*K_0}, \]

\[ d = \frac{V_0A_0}{V^*} \left[ 1 + (g-1) \frac{A_0}{K_0} - g \right]. \]

Because \( \frac{V_0A_0}{V^*} \) is always larger than zero, it follows that

\[ d = 0 \iff \left[ 1 + (g-1) \frac{A_0}{K_0} - g \right] = 0 \Rightarrow 1 + \frac{A_0}{K_0} g - \frac{A_0}{K_0} g = 0. \]

Thus, it follows that

(i) \( d = 0 \iff g = 1; \)

(ii) \( d > 0 \iff g > 1; \)

(iii) \( d < 0 \iff g < 1. \)
Proof of Proposition 3:

Because \( d > 0 \) (\( d < 0 \)) when \( g > 1 \) (\( g < 1 \)), \( d \) has a positive (negative) effect on accounting leverage during economic expansions, i.e., \( g > 1 \) (contractions, i.e., \( g < 1 \)), such that

\[
\begin{align*}
\text{if } g > 1 & \Rightarrow \Delta L > 0 \iff \frac{gA_0 + d}{K_1} > \frac{A_0}{K_0}; \\
\text{if } g < 1 & \Rightarrow \Delta L < 0 \iff \frac{gA_0 - d}{K_1} < \frac{A_0}{K_0}.
\end{align*}
\]

During expansions accounting leverage is procyclical if and only if asset purchases \( d \) are large enough such that \( \frac{gA_0 + d}{K_1} > \frac{A_0}{K_0} \).

Solving for \( d \) and substituting for \( d \) from Proposition 2, yields

\[
d > \frac{A_0K_1}{K_0} - gA_0
\]

\[
\Rightarrow d > \frac{A_0}{K_0} \left[ K_0 + (g - 1)A_0 \right] - gA_0
\]

\[
\Rightarrow \frac{V_0A_0}{v^*} \left[ 1 + (g - 1) \frac{A_0}{K_0} - g \right] > \frac{A_0}{K_0} \left[ K_0 + (g - 1)A_0 \right] - gA_0
\]

\[
\Rightarrow \frac{V_0}{v^*} > \frac{1 + (g - 1) \frac{A_0}{K_0} - g}{1 + (g - 1) \frac{A_0}{K_0} - g}
\]

\[
\Rightarrow \frac{V_0}{v^*} > 1.
\]

Using the same analysis, during economic contractions:

\[
\frac{gA_0 - d}{K_1} < \frac{A_0}{K_0} \Rightarrow d > \frac{A_0K_1}{K_0} - gA_0 \Rightarrow \frac{V_0}{v^*} > 1.
\]

Proof of Proposition 4:

Regulatory leverage at \( t_1 \) is
\[
R_t = \frac{V_0 \times A_t}{g} \frac{K_1}{K_1} = \frac{V_0 \times A_0}{K_1}.
\]

Hence, the difference in the change in regulatory leverage in the presence of counter-cyclical risk weights compared to change in regulatory leverage in the presence of constant regulatory risk weights is given by

\[
R_t - R_t^{CC} = \frac{V_0 g \times A_0}{K_1} - \frac{V_0 A_0}{K_1} = \frac{V_0 A_0 (g - 1)}{K_1}.
\]

Hence,

\[
R_t - R_t^{CC} = \begin{cases} 
0 \text{ iff } g = 1 \\
> 0 \text{ iff } g > 1 \\
< 0 \text{ iff } g < 1.
\end{cases}
\]

**Proof of Corollary 1:**

There is no change in accounting leverage because accounting leverage is independent of \( V \).

**Proof of Proposition 5:**

After the purchase (sale) of assets, regulatory leverage at \( t_1 \) is

\[
R_t = \frac{g}{K_1} V_0 \times g A_0 + V^* d.
\]

For regulatory leverage at \( t_1 \) to equal regulatory leverage at \( t_0 \), the following must hold:

\[
\Delta R = R_t - R_0 = 0 \Rightarrow \frac{V_0 \times A_0 + V^* d}{K_1} = \frac{V_0 A_0}{K_0}.
\]

Solving for \( d \), yields

\[
d = \frac{V_0 A_0 K_1 - V_0 A_0 K_0}{V^* K_0} = \frac{V_0 A_0 K_0 + V^* d (g - 1) A_0 - V_0 A_0 K_0}{V^* K_0}
\]

\[
d = \frac{V_0 A_0 (g - 1)}{V^* K_0}.
\]
Proof of Corollary 2:

The difference in asset purchases (sales), \( d \), in the presence of counter-cyclical risk weights compared to asset purchases (sales) in the presence of constant regulatory risk weights is given by

\[
d - d^{cc} = \frac{V_0 A_0}{V^*} \left[ 1 + (g - 1) \frac{A_0}{K_0} - g \right] - \frac{V_0 A_0}{V^*} (g - 1) \frac{A_0}{K_0} = \frac{V_0 A_0}{V^*} (1 - g)
\]

\[
\Rightarrow d - d^{cc} \begin{cases} 0 & \text{iff } g = 1 \\ < 0 & \text{iff } g > 1 \\ > 0 & \text{iff } g < 1. \end{cases}
\]

Proof of Proposition 6:

Because \( d > 0 \) (\( d < 0 \)) when \( g > 1 \) (\( g < 1 \)), \( d \) has a positive (negative) effect on accounting leverage during economic expansions, i.e., \( g > 1 \) (contractions, i.e., \( g < 1 \)), such that

\[
\text{if } g > 1 \Rightarrow \Delta L > 0 \iff \frac{g A_0 + d}{K_1} > \frac{A_0}{K_0}
\]

\[
\text{if } g < 1 \Rightarrow \Delta L < 0 \iff \frac{g A_0 - d}{K_1} < \frac{A_0}{K_0}.
\]

During expansions (contractions) accounting leverage is procyclical if and only if asset purchases (sales) \( d \) are large enough such that

\[
\frac{g A_0 + d}{K_1} > \frac{A_0}{K_0} \quad \text{or} \quad \frac{g A_0 - d}{K_1} < \frac{A_0}{K_0}.
\]

Solving for \( d \) and substituting for \( d \) from Proposition 5, yields
\[ d > \frac{A_0 K_1}{K_0} - g A_0 \]

\[ \Rightarrow d > \frac{A_0}{K_0} [K_0 + (g - 1) A_0] - g A_0 \]

\[ \Rightarrow \frac{V_0 A_0}{V^*} (g - 1) \frac{A_0}{K_0} > \frac{A_0}{K_0} [K_0 + (g - 1) A_0] - g A_0 \]

\[ \Rightarrow \frac{V_0 A_0}{V^*} (g - 1) > K_0 + (g - 1) A_0 - g K_0 \]

\[ \Rightarrow \frac{V_0}{V^*} (g - 1) \frac{A_0}{K_0} > 1 + (g - 1) A_0 - g \]

\[ \Rightarrow \frac{V_0}{V^*} > \frac{(1 - g) K_0}{(g - 1) A_0} + 1. \]

Hence, it follows that

\[ \text{if } g = 1 \Rightarrow \frac{V_0}{V^*} > 1 \text{ for any } d \text{ that satisfies } \Delta R = 0 \]

\[ \text{if } g \neq 1 \Rightarrow \frac{V_0}{V^*} > 1 - \frac{K_0}{A_0}. \]
Appendix B
Variable Definitions

CI  Comprehensive income divided by lagged assets, \( NI + FVOCI + OTHOCI \)

FVDECILE  Sum of unrealized fair value gains and losses from trading securities recognized in net income and other unrealized fair value gains and losses recognized in other comprehensive income, divided by lagged assets, \( FVCI \), calculated as decile rank between zero and one

FVOCI  Components of other comprehensive income determined by fair value accounting, divided by lagged assets

NI  Net income, divided by lagged assets

OTHOCI  Other comprehensive income divided by lagged assets, less \( FVOCI \)

\( \Delta D \)  Quarterly change in debt, divided by lagged assets

\( \Delta K \)  Quarterly change in equity less net income and other comprehensive income, divided by lagged assets

\( \Delta L \)  Quarterly percentage change in leverage, \( \frac{(leverage_t - leverage_{t-1})}{leverage_{t-1}} \), where leverage is assets divided by shareholders’ equity

\( \Delta OTHA \)  Change in assets other than amounts attributable to \( FVCI \)

\( \Delta A \)  Quarterly percentage change in assets, \( \frac{(assets_t - assets_{t-1})}{assets_{t-1}} \)

\( \Delta V \)  Quarterly change in average regulatory risk weight, i.e., regulatory risk-weighted assets divided by assets
References


International Accounting Standards Board. 2008b. Reclassification of Financial Assets – Effective Date and Transition – Amendments to IAS 39 Financial Instruments:


Table 1
Descriptive Statistics

This table presents descriptive statistics for quarterly observations for US commercial banks from 2001 to 2010 (N = 12,486). For ease of exposition, all amounts except those relating to \( FVDECEILE \) are multiplied by 100. See Appendix B for variable definitions.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Std Dev</th>
</tr>
</thead>
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<tr>
<td>( \Delta L )</td>
<td>0.60</td>
<td>0.05</td>
<td>9.86</td>
</tr>
<tr>
<td>( \Delta V )</td>
<td>−0.05</td>
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<td>3.98</td>
</tr>
<tr>
<td>( \Delta A )</td>
<td>2.43</td>
<td>1.51</td>
<td>6.39</td>
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<tr>
<td>( CI )</td>
<td>0.17</td>
<td>0.23</td>
<td>0.49</td>
</tr>
<tr>
<td>( NI )</td>
<td>0.15</td>
<td>0.23</td>
<td>0.47</td>
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<tr>
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<td>0.01</td>
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<tr>
<td>( OTHOCI )</td>
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<td>0.00</td>
<td>0.14</td>
</tr>
<tr>
<td>( \Delta K )</td>
<td>0.06</td>
<td>−0.07</td>
<td>0.93</td>
</tr>
<tr>
<td>( \Delta D )</td>
<td>2.21</td>
<td>1.38</td>
<td>5.86</td>
</tr>
<tr>
<td>( \Delta OTHA )</td>
<td>2.27</td>
<td>1.44</td>
<td>5.55</td>
</tr>
<tr>
<td>( FVDECEILE )</td>
<td>4.50</td>
<td>5.00</td>
<td>2.81</td>
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</tbody>
</table>
Table 2
Correlations

This table presents Pearson (below the diagonal) and Spearman (above the diagonal) correlations for quarterly observations for US commercial banks from 2001 to 2010 (N = 12,486). See Appendix B for variable definitions. * denotes significance at the p < 0.01 level.

<table>
<thead>
<tr>
<th></th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
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<th>(6)</th>
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<th>(8)</th>
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<td>0.41*</td>
<td>-0.34*</td>
<td>-0.15*</td>
<td>-0.32*</td>
<td>0.09*</td>
<td>-0.24*</td>
<td>0.51*</td>
<td>0.43*</td>
<td>-0.25*</td>
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<tr>
<td>(2) ΔV</td>
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<td></td>
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<td>-0.02</td>
<td>0.06*</td>
<td>-0.10*</td>
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<td>-0.07*</td>
<td>-0.39*</td>
<td>-0.39*</td>
<td>-0.10*</td>
</tr>
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<td>0.19*</td>
<td>0.18*</td>
<td>0.04*</td>
<td>0.02</td>
<td>0.16*</td>
<td>0.98*</td>
<td>1.00*</td>
<td>0.06*</td>
</tr>
<tr>
<td>(4) CI</td>
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<td>-0.03*</td>
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<td>0.50*</td>
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<tr>
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<td>0.16*</td>
<td>0.91*</td>
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<td>-0.30*</td>
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<td>0.18*</td>
<td>0.07*</td>
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<tr>
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<td></td>
<td>-0.16*</td>
<td>0.07*</td>
<td>0.00</td>
<td>0.00</td>
<td>0.62*</td>
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<tr>
<td>(7) OTHOCI</td>
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<td>0.01</td>
<td>0.00</td>
<td>0.08*</td>
<td>0.00</td>
<td>-0.19*</td>
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<td>0.06*</td>
<td>0.03*</td>
<td>0.02</td>
<td>-0.01</td>
</tr>
<tr>
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<td>-0.09*</td>
<td>-0.06*</td>
<td>0.01</td>
<td>-0.10*</td>
<td></td>
<td>0.11*</td>
<td>0.17*</td>
<td>-0.08*</td>
</tr>
<tr>
<td>(9) ΔD</td>
<td>0.16*</td>
<td>-0.38*</td>
<td>0.99*</td>
<td>0.10*</td>
<td>0.10*</td>
<td>-0.01</td>
<td>0.01</td>
<td>0.56*</td>
<td></td>
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<td>0.02</td>
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<tr>
<td>(10) ΔOTHA</td>
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<td>-0.37*</td>
<td>0.98*</td>
<td>0.16*</td>
<td>0.17*</td>
<td>0.00</td>
<td>0.01</td>
<td>0.53*</td>
<td>0.98*</td>
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<tr>
<td>(11) FVDECILE</td>
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<td>0.03*</td>
<td>0.27*</td>
<td>0.05*</td>
<td>0.56*</td>
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<td>-0.02</td>
<td>0.01</td>
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Table 3  
Leverage Changes and Regulatory Risk Weights

This table presents regression summary statistics based on quarterly observations for US commercial banks from 2001 to 2010. See Appendix B for variable definitions. The regressions include firm, year, and quarter fixed effects; standard errors are clustered by firm and quarter. \( t \)-statistics are in parenthesis. *** and ** denote significance at the \( p < 0.01 \) and \( p < 0.05 \) levels.

\[
\begin{align*}
(1) \quad \Delta L_{iq} &= \beta_0 + \beta_1 \Delta A_{iq} + \epsilon_{iq} \\
(2) \quad \Delta L_{iq} &= \beta_0 + \beta_1 \Delta A_{iq} + \beta_2 \Delta V_{iq} + \epsilon_{iq}
\end{align*}
\]

<table>
<thead>
<tr>
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<tr>
<td>( \Delta A )</td>
<td>0.10</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>(2.16)**</td>
<td>(0.53)</td>
</tr>
<tr>
<td>( \Delta V )</td>
<td>-0.29</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-6.15)**</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>12,486</td>
<td>12,486</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.09</td>
<td>0.10</td>
</tr>
</tbody>
</table>
Table 4
Leverage Changes and Fair Value Gains and Losses

This table presents regression summary statistics based on quarterly observations for US commercial banks from 2001 to 2010. See Appendix B for variable definitions. The regressions include firm, year, and quarter fixed effects; standard errors are clustered by firm and quarter. t-statistics are in parenthesis. *** denotes significance at the p < 0.01 level.

(1) \[ \Delta L_{iq} = \beta_0 + \beta_1 CI_{iq} + \beta_2 \Delta K_{iq} + \beta_3 \Delta D_{iq} + \epsilon_{iq} \]

(2) \[ \Delta L_{iq} = \beta_0 + \beta_1 NI_{iq} + \beta_2 FVOCI_{iq} + \beta_3 OTHOCI_{iq} + \beta_4 \Delta K_{iq} + \beta_5 \Delta D_{iq} + \epsilon_{iq} \]

<table>
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<td>CI</td>
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<td>–13.58</td>
</tr>
<tr>
<td></td>
<td>(–23.13)***</td>
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<tr>
<td>NI</td>
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<td></td>
<td>(–10.80)***</td>
<td>(–5.50)***</td>
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<tr>
<td>FVOCI</td>
<td>–7.61</td>
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<td>(–34.16)***</td>
<td>(–33.79)***</td>
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<td>OTHOCI</td>
<td>1.03</td>
<td>1.01</td>
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<tr>
<td></td>
<td>(53.99)***</td>
<td>(53.30)***</td>
</tr>
<tr>
<td>ΔK</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ΔD</td>
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</tr>
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<td>R-squared</td>
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<td>0.73</td>
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</table>
Table 5
Leverage Changes in Up and Down Markets

This table presents regression summary statistics based on quarterly observations for US commercial banks from 2001 to 2010. Up (Down) Markets are quarters with positive (negative) S&P 500 index returns. See Appendix B for variable definitions. The regressions include firm, year, and quarter fixed effects; standard errors are clustered by firm and quarter. *-statistics are in parenthesis. *** and * denote significance at the p < 0.01 and p < 0.1 levels.

(1) $\Delta L_{iq} = \beta_0 + \beta_1 \Delta A_{iq} + \varepsilon_{iq}$
(2) $\Delta L_{iq} = \beta_0 + \beta_1 \Delta A_{iq} + \beta_2 \Delta V_{iq} + \varepsilon_{iq}$

<table>
<thead>
<tr>
<th></th>
<th>Up Markets</th>
<th>Down Markets</th>
<th>Up Markets</th>
<th>Down Markets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>$\Delta A$</td>
<td>0.11</td>
<td>0.03</td>
<td>0.08</td>
<td>0.02</td>
</tr>
<tr>
<td></td>
<td>(1.85)*</td>
<td>(0.39)</td>
<td>(1.24)</td>
<td>(0.33)</td>
</tr>
<tr>
<td>$\Delta V$</td>
<td>–0.33</td>
<td>–0.23</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(–5.21)***</td>
<td></td>
<td>(–2.85)***</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>7,126</td>
<td>7,126</td>
<td>5,360</td>
<td>5,360</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.15</td>
<td>0.16</td>
<td>0.14</td>
<td>0.15</td>
</tr>
</tbody>
</table>

(3) $\Delta L_{iq} = \beta_0 + \beta_1 CI_{iq} + \beta_2 \Delta K_{iq} + \beta_3 \Delta D_{iq} + \varepsilon_{iq}$
(4) $\Delta L_{iq} = \beta_0 + \beta_1 NI_{iq} + \beta_2 FVOCI_{iq} + \beta_3 OTHOCI_{iq} + \beta_4 \Delta K_{iq} + \beta_5 \Delta D_{iq} + \varepsilon_{iq}$

<table>
<thead>
<tr>
<th></th>
<th>Up Markets</th>
<th>Down Markets</th>
<th>Up Markets</th>
<th>Down Markets</th>
</tr>
</thead>
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<td></td>
<td>(3)</td>
<td>(4)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td></td>
<td>(–15.06)***</td>
<td></td>
<td>(–14.18)***</td>
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<tr>
<td></td>
<td>(–13.92)***</td>
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<td>(–6.57)***</td>
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<tr>
<td>FVOCI</td>
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<td>–4.75</td>
<td>–5.97***</td>
<td>–3.03***</td>
</tr>
<tr>
<td></td>
<td>(–5.97)***</td>
<td></td>
<td>(–3.03)***</td>
<td></td>
</tr>
<tr>
<td>OTHOCI</td>
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<td>–7.35</td>
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<tr>
<td></td>
<td>(–30.36)***</td>
<td></td>
<td>(–17.46)***</td>
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<tr>
<td>$\Delta K$</td>
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<td>1.03</td>
<td>1.01</td>
<td>0.99</td>
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<tr>
<td></td>
<td>(38.01)***</td>
<td></td>
<td>(29.52)***</td>
<td></td>
</tr>
<tr>
<td>$\Delta D$</td>
<td>1.03</td>
<td>1.01</td>
<td>0.99</td>
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<tr>
<td></td>
<td>(37.50)***</td>
<td></td>
<td>(29.49)***</td>
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<tr>
<td>Observations</td>
<td>7,126</td>
<td>7,126</td>
<td>5,360</td>
<td>5,360</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.82</td>
<td>0.82</td>
<td>0.68</td>
<td>0.67</td>
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</table>
This table presents regression summary statistics based on quarterly observations for US commercial banks from 2001 to 2010. See Appendix B for variable definitions. The regressions include firm, year, and quarter fixed effects; standard errors are clustered by firm and quarter. \( t \)-statistics are in parenthesis. ***, **, * denote significance at the \( p < 0.01 \), \( p < 0.05 \), \( p < 0.1 \) levels.

\[
\begin{align*}
(1) \; \Delta L_{iq} &= \beta_0 + \beta_1 \Delta OTHA_{iq} + \beta_2 FVDECILE_{iq} + \beta_3 \Delta OTHA_{iq} \times FVDECILE_{iq} + \epsilon_{iq} \\
(2) \; \Delta L_{iq} &= \beta_0 + \beta_1 \Delta OTHA_{iq} + \beta_2 FVDECILE_{iq} + \beta_3 \Delta OTHA_{iq} \times FVDECILE_{iq} + \beta_4 \Delta V_{iq} + \epsilon_{iq}
\end{align*}
\]

<table>
<thead>
<tr>
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</thead>
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<tr>
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<td>0.13</td>
<td>0.12</td>
</tr>
<tr>
<td></td>
<td>(1.89)**</td>
<td>(1.71)*</td>
</tr>
<tr>
<td>( \Delta V )</td>
<td>–0.04</td>
<td>–0.05</td>
</tr>
<tr>
<td></td>
<td>(–3.08)**</td>
<td>(–6.07)**</td>
</tr>
<tr>
<td>( FVDECILE )</td>
<td>–0.05</td>
<td>–0.05</td>
</tr>
<tr>
<td></td>
<td>(–6.06)**</td>
<td>(–6.07)**</td>
</tr>
<tr>
<td>( \Delta OTHA \times FVDECILE )</td>
<td>0.04</td>
<td>0.04</td>
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<tr>
<td></td>
<td>(0.39)</td>
<td>(0.39)</td>
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<tr>
<td>Observations</td>
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<tr>
<td>R-squared</td>
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