Procyclical Leverage: Bank Regulation or Fair Value Accounting?

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Abstract

We analyze how banks’ responses to asset gains and losses can result in procyclical leverage. The analysis reveals that absent differences in regulatory risk weights across assets, leverage is not procyclical. We test predictions from the analysis using a sample of US commercial banks and find that the procyclical relation between leverage changes and asset changes evaporates in the presence of regulatory risk weight changes. Also, all equity changes are negatively related to leverage changes, which is inconsistent with fair value accounting contributing to procyclical leverage. We conclude that risk-based regulatory requirements explain banks’ procyclical leverage, not fair value accounting.
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1. Introduction

Many academic researchers, policy-makers, and other practitioners conclude that fair value accounting can lead to suboptimal real decisions by financial institutions, particularly commercial banks, 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 because it was the source of excess asset sales by banks. Such excess asset sales, which result in procyclical decreases in leverage, allegedly amplified asset price declines that began with the shock to financial asset prices when the housing market bubble burst. Leverage is procyclical when it decreases (increases) during economic downturns (upturns). However, this line of reasoning fails to incorporate a key factor affecting actions taken by commercial banks, namely that banks must meet regulatory leverage requirements. The question we address is whether procyclical leverage arises from bank regulation or fair value accounting.

To address our research question, we describe analytically 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 leverage. Our analytical description incorporates the fact that banks must meet regulatory leverage requirements. Regulatory leverage differs from accounting leverage because risk weights are applied to assets in determining the former but not the latter. Our analytical description and related empirical tests show that procyclical leverage for commercial banks arises because of differences between accounting and regulatory leverage, i.e., bank regulation, and not because of fair value accounting.\(^1\)

\(^1\) Henceforth, for ease of exposition, we use the term “leverage” to refer to accounting leverage, i.e., the ratio of total assets to equity book value, and “regulatory leverage” to refer to regulatory leverage, i.e., the ratio of risk-weighted assets to regulatory capital.
Studying whether commercial banks exhibit procyclical 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 analytical description of bank behavior in response to changes in asset prices, which we use to develop insights that provide the basis for our empirical predictions, assumes the objective of a bank is to maximize its economic return on equity. To achieve this objective, a bank uses debt financing to acquire risky assets, which increases leverage. However, bank regulatory leverage constraints limit both the amount of assets a bank can buy 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 analytical description characterizes banks as maximizing leverage subject to a regulatory leverage constraint. The analysis shows that procyclical leverage only results when the weighted average regulatory risk weight of assets bought (sold) in response to increases (decreases) in asset values is less than the average risk weight of the assets in its investment portfolio prior to the purchase (sale). That is, absent differences in regulatory risk weights across assets, leverage is not procyclical. Thus, procyclical leverage is attributable to bank regulatory requirements and not fair value accounting.
We empirically test predictions of the analytical description 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 leverage and change in assets and find that the relation is significantly positive, which indicates that leverage is procyclical. However, consistent with predictions, this procyclical relation evaporates when the change in each bank’s weighted average regulatory risk weight is included in the estimating equation. We next estimate the relation between change in 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 leverage, and change in debt is significantly positively related. These are the expected relations between change in leverage and changes 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 leverage. Thus, we find no evidence that fair value accounting—whether reflected in net income or other comprehensive income—is a source of procyclical leverage.

Because of the asymmetry in accounting for gains and losses under modified historical cost accounting 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. To test more directly whether there is a link between fair value accounting and procyclical leverage, we estimate the relation between change in 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 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 analytical description we use to develop insights that are the basis for our 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

2.1 Procyclical leverage

Exogenous shocks to financial asset prices cause changes in bank leverage. Other things equal, when asset prices increase (decrease) leverage decreases (increases). If banks have a target leverage ratio, then in the face of increasing (decreasing) asset prices, banks buy (sell) assets and issue (repay) debt in amounts sufficient to restore leverage to the level it was before the increase (decrease) in asset prices. If asset purchases (sales) are excessive, i.e., exceed the amount necessary to restore leverage to the level before an exogenous shock, then leverage will be higher (lower) than it was before the shock, i.e., leverage will be procyclical. Thus, procyclical leverage is evidence of excessive asset purchases or sales by banks.

Although such excessive purchases or sales may be apposite for an individual bank, they can have negative consequences to the financial system. In the case of a negative exogenous shock, the asset sales by one bank can cause a drop in asset prices arising from an increase in supply, which in turn can cause other banks to sell assets. This contagion, or feedback, effect (Kiyotaki and Moore, 1997; Cifuentes, Ferrucci, and Shin, 2005) on asset prices can lead to a
downward spiral in asset prices, as was alleged to be the case in the 2008-2009 financial crisis. Shleifer and Vishny (2010) shows that banks transmit asset price fluctuations into the real economy. In the case of a negative shock to financial asset prices, the shrinkage of financial institutions results in a reduction of available credit, which leads to a downturn throughout the economy. The converse is true in the case of a positive exogenous shock to asset prices. To the extent that asset purchases or sales are excessive, the effects on the financial sector and real economy are magnified.

2.2 Fair value accounting and procyclical leverage

Many academic researchers, policy-makers, and other practitioners believe that fair value accounting was a major factor contributing to the 2008-2009 financial crisis. One way in which fair value accounting could have contributed to the financial crisis is its link to procyclical leverage. Adrian and Shin (2008; 2010) provide empirical evidence of procyclical leverage by documenting a positive relation between quarterly changes in total assets and leverage for five investment banks from the third quarter of 1992 through the first quarter of 2008. Although Adrian and Shin (2008; 2010) interpret this as evidence that fair value accounting is the cause of procyclical leverage, the studies provide no direct evidence that fair value accounting per se caused the procyclical leverage.

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2 The 2008-2009 financial crisis started with an exogenous negative shock to financial asset prices caused by the bursting of the US housing market bubble. Bank leverage increased substantially in response to decreased asset prices. Banks then reduced leverage by selling assets and repurchasing debt.


4 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.

5 There are other ways in which fair value accounting allegedly contributed to the financial crisis. One way is that fair value accounting requires asset write-downs to be based on exit prices, which purportedly were artificially low
However, most of the debate regarding fair value accounting and the financial crisis revolves around commercial banks, in large part because of the central role they play in the economy. A key factor affecting commercial banks is that they must meet regulatory leverage requirements. As section 3 explains, regulatory leverage, i.e., the reciprocal of the regulatory capital ratio, differs from accounting leverage because risk weights are applied to assets in determining the former but not the latter. We investigate analytically and empirically the extent to which procyclical leverage for commercial banks arises because of differences between regulatory and accounting leverage or because of fair value accounting.

Some prior studies also recognize the importance of considering regulatory capital when examining whether fair value accounting contributed to the financial crisis. These studies provide evidence that impairment of investments in securities to fair value had little impact on 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 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 because of illiquidity. As a result, fair value-based write-downs resulted in potentially unwarranted asset sales by banks, which contributed to the amplified asset price declines and subsequent contagion (Allen and Carletti, 2008; Plantin, Sapra, and Shin, 2008; Sapra, 2008). These asset sales did not necessarily result in procyclical leverage; only those sales in excess of what a bank needs to restore leverage to its target result in procyclical leverage. Another way is that because fair value accounting amounts often are based on estimates, particularly in illiquid markets, managerial incentives can play a role in determining fair value accounting amounts. In the lead up to the financial crisis, bank asset fair values allegedly were overstated, which contributed to the housing bubble. To the extent that these overstated asset values were written down with the bursting of the housing bubble, the increase in leverage was greater than if the asset values had not been overstated. Because our interest is in determining whether there is a link between procyclical leverage and fair value accounting, we do not consider these alternative potential links between fair value accounting and the financial crisis.
response to these 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 financial crisis.\textsuperscript{6}

Taken together, these studies show that fair value accounting had little impact on bank regulatory capital and bank behavior during the crisis. The absence of an impact is indirect evidence that fair value accounting did not contribute to procyclical leverage. Because securities are only one type of bank asset, impairments of other assets, particularly loans, could have affected regulatory capital and bank behavior.\textsuperscript{7} However, establishing such an effect does not establish the extent to which procyclical leverage is attributable to bank regulation or fair value accounting, which is the question we address.

3. \textit{Analytical Description and Basis for Predictions}

This section develops an analytical description 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 leverage. The purpose of the analytical description is to develop insights that provide the basis for our empirical predictions. Consistent with Adrian and Shin (2010), we assume the bank’s objective, as with all entities, is to maximize economic return on equity. To achieve this objective, entities use debt financing to acquire risky assets, which increases leverage.\textsuperscript{8} Although entities would want to buy an unlimited amount of risky assets funded by debt, debt capital providers charge increasingly higher prices as debt increases because higher levels of debt are associated with a higher likelihood of financial distress. As a

\textsuperscript{6} See Barth and Landsman (2010) for a broader discussion of the link between financial reporting—including fair value accounting—and the financial crisis.

\textsuperscript{7} Impairments do not reduce carrying amounts to fair value for all assets, most notably loans. However, impairments are designed to recognize economic losses.

\textsuperscript{8} Although using equity financing typically does not maximize return on equity, some banks issue and repurchase equity for reasons we do not incorporate into our analytical description. Nonetheless, in our empirical tests we include as an explanatory variable changes in equity other than the change attributable to comprehensive income.
result, entities are limited in the amount of risky assets they can buy (Kraus and Litzenberger, 1973). Thus, entities cannot increase leverage indefinitely. In the case of commercial banks, a constraint on leverage is externally imposed by the regulator, which presumably is more binding than the debt market constraint. Thus, our analytical description characterizes banks as maximizing leverage subject to a regulatory leverage ratio, i.e., the reciprocal of the regulatory capital ratio.\textsuperscript{10,11}

Although there is no consensus in the finance literature as to 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 leverage, then the actions they take would be aimed at maintaining this target leverage. That is, in the face of increasing (decreasing) asset values, banks would buy (sell) assets and issue (repay) debt in amounts sufficient to restore leverage to the level it was before the increase (decrease) in asset values. However, if banks buy or sell assets to maintain a target leverage, there would be no observed change in leverage and hence no reason to expect a relation between change in leverage and change in assets. Thus, observing a positive relation between change in leverage and change in assets is evidence that banks do not manage leverage to a targeted amount, or do so with a lag.

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

\textsuperscript{9} The literature dealing with capital structure choice typically assumes debt capital providers assess a firm’s leverage based on the market values of debt and equity. We make the same assumption in our analytical description. In our empirical tests, we use leverage based on accounting amounts, which is consistent with other empirical studies examining leverage procyclicality, e.g., Adrian and Shin (2008; 2010).

\textsuperscript{10} We characterize the bank as operating at its target regulatory leverage. This target could be the maximum leverage allowed by the regulator or include a buffer that results in regulatory leverage being below that maximum. In either case, the bank’s target is based on required regulatory leverage limit, which during our sample period is constant at 12.5. Untabulated statistics reveal that our sample banks’ quarterly mean regulatory leverage ranges between seven and eight, which implies that the buffer is relatively constant during our sample period.

\textsuperscript{11} Analogously, Adrian and Shin (2008; 2010) assume that investment banks maximize return on equity by maximizing leverage subject to maintaining capital to meet an internally imposed value-at-risk criterion. See also Adrian and Shin (2014).
smaller than accounting leverage if a bank invests in assets with risk weights less than one. Because regulatory leverage depends on the risk weights regulators assign to a bank’s assets, in striving to maximize return on equity, banks need to take into account the tradeoff between buying (selling) assets with lower risk weights—and thus lower expected return per dollar of assets bought (sold)—and fewer assets with higher risk weights—and thus higher expected return per dollar of assets bought (sold).

We analyze 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 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 $R_0 = V_0 \times A_0$. For simplicity, our analysis does not distinguish between accounting and regulatory equity capital because in the analysis the bank’s capital comprises only shareholders’ equity. Thus, in the analysis, 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, $I_1$, that depends on the state of the economy, where

$I_1 = (g - 1)A_0$. Because our focus is on the potential relation between fair value accounting and

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12 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.

13 There are other aspects of bank regulation that we do not include in our analysis. For example, some assets, e.g., goodwill, are deducted from capital rather being assigned a risk weight. Assuming a regulatory leverage limit of 12.5, such a deduction is equivalent to assigning a risk weight of 1250%. 

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procyclical leverage, in the analysis 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 $A_t = gA_0$ and capital of $K_t = K_0 + I_t$. Because leverage at $t_1$ and $t_0$ differ, we assume the bank will buy or sell assets if the return on equity it achieves from taking such actions is higher than from not taking such actions. As is shown below, subject to its regulatory leverage constraint, when the economy expands (contracts), i.e., $g > 1$ ($g < 1$), the bank has an incentive to buy (sell) assets. Without loss of generality, in the analysis regulatory risk weights remain constant throughout the economic cycle, i.e., they are independent of $g$.

To assess the effects on leverage of banks striving to achieve their assumed objective—i.e., buying or selling assets to maximize leverage subject to a regulatory leverage constraint—we proceed in two steps. First, we analyze how regulatory and accounting leverage change during the period if 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. Appendix A provides the details supporting our algebraic observations that appear below.

If 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 $t_1$, $R_t$ and $L_t$.

$$R_t = \frac{V_0 \times A_t}{K_t} = \frac{V_0 \times gA_0}{K_0 + I_t}$$

(1)

$$L_t = \frac{A_t}{K_t} = \frac{gA_0}{K_0 + I_t}$$

(2)
Observation 1: At $t_1$, regulatory and accounting leverage do not change if the economy exhibits no growth, i.e., $\Delta R = 0$ and $\Delta L = 0$ iff $g = 1$. If the economy expands, regulatory and accounting leverage decrease, i.e., $\Delta R < 0$ and $\Delta L < 0$ iff $g > 1$. If the economy contracts, accounting and regulatory leverage increase, i.e., $\Delta R > 0$ 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 Observation 1 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 action there is an inverse relation between the size of firm’s balance sheet and leverage.

We next analyze changes in regulatory and accounting leverage if the bank buys or sells assets to achieve its objective of maximizing leverage to maximize return on equity. 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 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 buy (sell) to maintain its regulatory leverage ratio, $R_0$.

As a result, $A_1 = gA_0 + d$ and $d = \Delta D = D_1 - D_0$. Observation 2 describes how the bank determines $d$. We denote the weighted average regulatory risk weight of assets bought or sold as $V^*$.

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

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

(3)
Observation 2 indicates that the magnitude of the bank’s asset purchases (sales) during economic upturns (downturns) depends on $g$, the bank’s initial leverage, and the relative risk weights of the assets. Recall that the bank’s objective implies that $d$ increases as $g$ increases. Equation (3) indicates that $d$ is larger the higher the bank’s initial 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 bought or sold, $V^*$. Furthermore, because leverage at $t_1$, $L_1 = \frac{A_1}{K_1}$, equals $\frac{gA_0 + d}{K_0 + L_1}$, buying assets by increasing debt increases leverage during economic upturns, and selling assets to repay debt decreases leverage during economic downturns. That is, leverage is procyclical. However, Observation 3 demonstrates that this procyclical leverage is independent of the magnitude of fair value gains or losses.

Observation 3: If the bank buys or sells assets to maximize return on equity subject to its regulatory leverage constraint, whether leverage is procyclical, i.e., $\Delta L > 0$ during economic upturns and $\Delta L < 0$ during economic downturns, does not depend on the magnitude of fair value gains or losses. Procyclical leverage is possible only if the weighted average regulatory risk weight of assets bought or sold is less than the bank’s initial weighted average regulatory risk weight, i.e., if $V^* < V_0$.

If $g > 1$ ($g < 1$) $\Rightarrow \Delta L > 0$ ($\Delta L < 0$) iff $\frac{V_0}{V^*} > 1$ (4)

Observation 3 demonstrates that regardless of the sign or magnitude of fair value income, leverage does not change procyclically unless the weighted average risk weight of assets the
bank buys or sells is less than that of the assets in its portfolio before buying or selling assets.\(^\text{14}\)

That is, procyclical leverage as the result of asset purchases or sales is only possible if \(V^* < V_0\).\(^\text{15}\)

Regardless of how a bank decides which assets to buy or sell, the analysis shows that procyclical leverage results only if the weighted average risk weight of assets it buys or sells is less than the weighted average risk weight of assets in its portfolio prior to asset purchases or sales.\(^\text{16}\) Thus, procyclical leverage does not occur in the absence of bank regulation based on a risk-weighted measure of leverage. Buying (selling) assets with risk weights lower than the bank’s initial weighted average risk weight implies that the expected income from buying

\(^\text{14}\) More generally, it can be shown that even if banks were to apply pure historical cost accounting, i.e., no recognition of fair value gains and losses or impairment, Observation 3 still holds. Although recognition of fair value gains and losses can result in banks buying or selling assets sooner than if they applied pure historical cost accounting, procyclical leverage occurs only if the weighted average regulatory risk weight of assets bought or sold is less than the bank’s initial weighted average regulatory risk weight.

\(^\text{15}\) 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, which implies 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 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 buys is 10 with a risk weight of zero and 20 with a risk weight of one. Thus, \(V^* = [(10 \times 0) + (20 \times 1)] / 30\), which is less than \(V_0 = 1\). This action results in regulatory leverage of 5 (= [(125 \times 1) + (10 \times 0)] / 25) and 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 leverage is six, regulatory leverage is five, and \(V_0 = 0.83 = [(100 \times 1) + (20 \times 0)] / 120\). 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 (= [(90 \times 1) + (20 \times 0)] / 10). To achieve procyclical 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, leverage decreases to 5.8 (= [(90 – 40) + (20 – 12)] / 10). Thus, \(V^* = 0.77 = [(40 \times 1) + (12 \times 0)] / 52\), which is less than \(V_0 = 0.83\).

\(^\text{16}\) Although Observation 3 establishes the condition for how banks’ responses to gains and losses on their assets can result in procyclical leverage, which is the purpose of the analytical description, a natural question to ask is why banks would respond in such a manner. To gain insight into this question, without loss of generality, assume a bank can buy and sell a risky asset with a risk weight of one and a riskless asset with a risk weight of zero. When the bank experiences a gain and buys assets in response, it will buy as much of the risky asset as the regulator will allow. In addition, the bank will buy as much of the riskless asset as possible, conditional on the marginal cost of debt, because even riskless assets have a positive return, which increases the bank’s return on equity. When the bank experiences a loss and sells assets in response, it will sell as little of the risky asset as the regulator will allow. In addition, the bank will sell as much of the riskless asset as necessary to lower the marginal cost of debt to an acceptable level. For leverage to be procyclical, the bank needs to buy or sell enough riskless assets such that \(V^*\) is less than \(V\).
(selling) these assets is higher relative to their risk weight than assets with risk weights greater
than or equal to the bank’s initial weighted average risk weight. This difference in relative
income could be attributable to mispricing of assets with lower risk weights or risk weights that
underestimate the assets’ risk.\textsuperscript{17}

Thus far the analysis assumes that regulatory risk weights remain constant throughout the
economic cycle, i.e., they are independent of \( g \). Regulatory risk weights likely change counter-
cyclically, i.e., risk weights increase (decrease) during economic downturns (upturns).\textsuperscript{18}
Permitting risk weights to change counter-cyclically in our analysis only serves to exacerbate
any leverage procyclicality that obtains in the absence of counter-cyclical risk weights. Thus,
regardless of whether regulatory risk weights are counter-cyclical or independent of the
economic cycle, procyclical leverage does not occur in the absence of risk-based bank capital
regulation.\textsuperscript{19}

Our analysis leads to the conclusion that recognition of fair value gains or losses does not
cause a bank to make excessive asset purchases or sales that result in procyclical leverage.
However, a key step in establishing a link between fair value accounting and the financial crisis
includes that there is a contagion effect, whereby asset sales by one bank can have adverse

\textsuperscript{17} Prior research suggests both attributes played a role during the credit boom that led to the 2008-2009 financial
crisis (e.g., Coval, Jurek, and Stafford, 2009; Shleifer and Vishny, 2010; Erel, Nadauld, and Stulz, 2012).
\textsuperscript{18} Risk weights tend to be counter-cyclical because risk weights for trading assets are based on the bank’s
assessment of value-at-risk for such assets (BIS, 1996). However, trading assets comprise, on average, a small
percentage of bank assets, 0.03%. Although regulators have the discretion to change risk weights for other assets,
they tend to be constant throughout the economic cycle and were constant during our sample period.
\textsuperscript{19} To permit risk weights to be counter-cyclical, we assume \( V_i = V_0 / g \), which has a direct effect on regulatory
leverage at \( t_i \). It can be shown that this assumption results in regulatory leverage decreasing (increasing) more
when the economy expands (contracts). However, the mechanical relation between leverage and fair value gains
and losses during economic upturns and downturns is unaffected by counter-cyclical regulatory risk weights. In
addition, the presence of counter-cyclical regulatory risk weights causes the bank to make larger asset purchases
(sales) during economic upturns (downturns). Procyclical leverage occurs only if the ratio of the weighted average
regulatory risk weight of assets bought or sold to the weighted average regulatory risk weight of the bank’s assets at
\( t_i \) exceeds a predetermined amount. Thus, whether leverage is procyclical does not depend on the magnitude of fair
value gains and losses.
effects on other banks because the asset sales occasioned by the loss suffered by one bank cause a drop in asset prices arising from an increase in supply, which in turn causes other banks to sell assets. Plantin, Sapra, and Shin (2008) shows that such contagion can result when there is illiquidity in financial asset markets, whereby the price of a financial asset is sensitive to the decisions of other financial institutions. During economic downturns, fundamental values decrease, but there are negative externalities generated by other banks selling assets. When other banks sell a financial asset, its price is lower than its fundamental value, thereby exerting a negative effect on other banks, especially those that hold the asset. Anticipating this negative effect, the bank may attempt to preempt the price decrease by selling the asset it holds. However, such preemptive action amplifies the price decline. Thus, during an economic downturn, fair value accounting amplifies asset price declines relative to changes in fundamental value.

To incorporate into our analysis the possibility of contagion in either economic downturns or upturns and regardless of its source—including asset market illiquidity, we let \( \gamma \in [0,1] \) be the correlation between banks of their buying or selling activities. Thus, the bank’s fair value income at \( t_1 \) is \( I_1 = (g^{1+\gamma} - 1)A_0 \). Assume there is contagion, i.e., \( \gamma > 0 \). In economic upturns, i.e., when \( g > 1 \), \( g^{1+\gamma} > g \); in economic downturns, i.e., when \( g < 1 \), \( g^{1+\gamma} < g \). Thus, a bank’s fair value gain (loss) during economic upturns (downturns) is larger than when there is no contagion. As a result, the bank will buy (sell) more assets to achieve its regulatory leverage target. That is, relative to the case in which there is no contagion, contagion serves to exacerbate excessive asset purchases (sales), and thus procyclical leverage. However, regardless of whether
there is contagion, procyclical leverage does not occur in the absence of risk-based bank capital regulation and does not depend on the magnitude of fair value gains and losses.\footnote{We do not consider whether accounting amounts determined based on fair value accounting or modified historical cost lead to more or less efficient resource allocation arising from real decisions by bank managers. See Plantin, Sapra, and Shin (2008) for a comparison of the resource allocation effects of fair value accounting and historical cost accounting.}

Taken together, the analytical description 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, leverage is not procyclical. Second, the extent of any leverage procyclicality is independent of the magnitude of fair value gains and losses. Third, counter-cyclical regulatory risk weights and contagion only serve to magnify any leverage procyclicality. Thus, any procyclical leverage is attributable to bank regulatory requirements and not fair value accounting.


Based on the findings in Adrian and Shin (2008; 2010), we predict a positive relation between change in leverage and change in assets. Our analysis in section 3 predicts that this procyclical relation only occurs if banks take actions to more than offset the mechanical relation between change in leverage and change in assets that arises from recognizing gains and losses. This mechanical relation results because asset gains (losses) increase (decrease) assets and equity by the same amount, thereby decreasing (increasing) leverage. To attain a positive relation between change in leverage and change in assets banks must issue debt and buy assets in the presence of gains and sell assets and repay debt in the presence of losses.

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

\begin{align}
\Delta L_{iq} &= \beta_0 + \beta_1 \Delta A_{iq} + \epsilon_{iq}, \tag{5}
\end{align}

\begin{align}
\Delta L_{iq} &= \beta_0 + \beta_1 \Delta A_{iq} + \epsilon_{iq}, \tag{5}
\end{align}
where $\Delta L$ is quarterly percentage change in leverage, $\Delta A$ is quarterly percentage change in assets, and $i$ and $q$ refer to bank $i$ and quarter $q$. Equation (5) and those that follow also include fixed effects for each firm, year, and fiscal quarter, which we do not tabulate.\(^{21}\) If leverage is, on average, procyclical, then we predict $\beta_1$ is positive.

To test whether any leverage procyclicality observed in equation (5) is attributable to change in a bank’s weighted average risk weight, we estimate equation (6):

\[
(2) \quad \Delta L_{iq} = \beta_0 + \beta_1 \Delta A_{iq} + \beta_2 \Delta V_{iq} + \epsilon_{iq}
\]

where $\Delta V$ is the quarterly change in the bank’s weighted average regulatory risk weight, i.e., regulatory risk-weighted assets divided by total assets.\(^{22}\) $\Delta V$ 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 analysis in section 3 predicts that any procyclicality results from $\Delta V$, we predict $\beta_1$ is zero in equation (6). We predict $\beta_2$ is negative because procyclical leverage resulting from asset purchases or sales only occurs if the weighted average risk weight of the assets bought or sold is less than the weighted average risk weight of the assets in the investment portfolio prior to the purchase or sale. Thus, because asset purchases

\(^{21}\) Fiscal quarter fixed effects are four indicator variables that equal one if an observation is from the bank’s fiscal quarter, and zero otherwise. For example, for a March quarter observation from a bank with a December fiscal year end, the quarter one fixed effect equals one and the remaining three fixed effects equal zero. Also, for expositional convenience, we use the same notation for coefficients and error terms in equations (5) through (8). In all likelihood they differ. Use of firm and time fixed effects assumes that the unobserved effects are time and firm invariant, respectively. Although research shows leverage ratios to be fairly stable, leverage adjustments also occur over longer time horizons (Lemmon et al., 2008; Huang and Ritter, 2009). Because we cannot use lagged dependent variables with fixed effects (Nickel, 1981), we estimated all equations using lagged dependent variables with up to four lags as explanatory variables instead of a fixed effects model. Untabulated findings reveal negligible differences in estimated $\Delta A$ and $\Delta V$ coefficients and standard errors from those we tabulate.

\(^{22}\) Our measure of $\Delta V$ does not include implied changes in regulatory risk weights arising from changes in regulatory deductions described in footnote 13. To the extent that such deductions are large relative to our measure of $\Delta V$, this will bias against finding a significantly negative coefficient for $\Delta V$. 

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(sales) are associated with increases (decreases) in leverage, increases (decreases) in leverage are associated with decreases (increases) in \( V \).  

To test whether any procyclicality observed in equation (5) is associated with fair value accounting, we first estimate equation (7a), which disaggregates change in assets into components that are affected by fair value accounting and components that are not:

\[
\Delta L_{iq} = \beta_0 + \beta_1 CI_{iq} + \beta_2 (\Delta K - CI)_{iq} + \beta_3 \Delta D_{iq} + \epsilon_{iq}, \tag{7a}
\]

where \( CI, \Delta K, \) and \( \Delta D \) are quarterly comprehensive income, change in equity, and change in debt, each divided by lagged assets. Comprehensive income comprises amounts based on modified historical cost and fair value accounting. Thus, \( CI \) is affected by fair value accounting in quarter \( q \), but \( \Delta K - CI \) and \( \Delta D \) are not. In the absence of procyclical, 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 procyclical the source of a change in equity should have no effect on change in leverage. These are the mechanical relations between change in leverage and change in debt and equity. If 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 change in leverage and the component of equity affected by fair value accounting, i.e., \( CI \).

To test more directly whether any procyclicality observed in equation (5) is associated with fair value accounting, we next estimate equation (7b), in which \( CI \) is disaggregated into three components, net income, \( NI \), the components of other comprehensive income determined

\[\overline{\text{Note:}}\] Our estimating equations assume that banks take actions in response to gains and losses in the same quarter as the gains and losses occur. This is because banks must meet regulatory leverage requirements at the end of the quarter. Nonetheless, we estimated equations (5) through (7) also including lagged values of the explanatory variables. Untabulated results reveal inferences identical to those revealed by tables 3 and 4.
by fair value accounting, \( FVOCI \), and the remaining components of other comprehensive income, \( OTHOCI \).

\[
\Delta L_{iq} = \beta_0 + \beta_1 NI_{iq} + \beta_2 FVOCI_{iq} + \beta_3 OTHOCI_{iq} + \beta_4 (\Delta K - CI)_{iq} + \beta_5 \Delta D_{iq} + \epsilon_{iq}.
\]  

(7b)

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 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 modified historical cost and fair value accounting, we predict \( \beta_1 \) is less positively biased than \( \beta_2 \).

We next estimate equations (5) through (7) separately for up and down markets to allow for the possibility that the extent of 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. As a result, to the extent that there is procyclical 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, and in equations (7a) and (7b) the coefficients on the equity amounts affected by fair value accounting, \( CI, NI, \) and \( FVOCI \), are less negative. We define up (down) markets as those quarters with positive (negative) S&P 500 index returns.

Finally, to test the Adrian and Shin (2008; 2010) proposition that 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 buy more assets (repurchase more debt and sell more
assets) than would be the case under modified historical cost accounting, we estimate equation (8):

\[ \Delta L_{iq} = \beta_0 + \beta_1 \Delta OTHA_{iq} + \beta_2 FVDECILE_{iq} + \beta_3 \Delta OTHA_{iq} \times FVDECILE_{iq} + \beta_4 \Delta V_{iq} + \epsilon_{iq}, \]  

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 (8)—one that includes change in weighted average regulatory risk weight, \( \Delta V \), and one that does not.

Equation (8) 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. The sample comprises US commercial banks and bank holding companies that file Call Reports and 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, 0.45% 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 $\Delta D = 2.21\%$ and 1.38%). Untabulated statistics reveal that, on average, assets measured at fair value comprise 18% of total assets and 220% of equity, and fair value gains and losses comprise 17% of revenue. Additional untabulated statistics reveal that change in average regulatory risk weight, $\Delta V$, arises from changes in loans, and held-to-maturity, available-for-sale, and trading securities. In particular, increases in loans (held-to-maturity, available-for-sale, and trading securities) are significantly associated with increases (decreases) in $V$. In addition, $\Delta V$ arises from changes in risk weights within each asset class. For example, the net increase in $V$ for loans arises largely from an increase in the 100% risk-weight category and a decrease in the 20% risk-weight category.

24 To merge COMPSTAT with the Call Reports and Y-9Cs we use the CRSP-FRB link provided by the New York Federal Reserve between regulatory entity codes and CRSP PERMCOs. Our sample period begins in 2001 because that is when data are available on other comprehensive income, which we require for estimating equation (7b). All other data are available beginning in 1996. Inferences based on untabulated findings from estimation of equations (5), (6), (7a), and (8) using data from 1996 to 2010 are the same as those based on the tabulated findings for these four equations.

25 Inferences based on untabulated findings from estimation of all equations using variables that are not winsorized, that are winsorized at the 5% and 95% levels, and after eliminating outliers identified using studentized residuals and Cooke’s D-statistic are the same as those based on tabulated findings.
Table 2 reveals that $\Delta L$ is positively correlated with $\Delta A$ (Spearman and Pearson correlations = 0.41 and 0.08), which is consistent with procyclical 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 $-0.32$ ($-0.21$). These correlations are inconsistent with fair value accounting being a source of procyclical leverage. In addition, consistent with predictions, the correlation between $\Delta L$ and change in average regulatory risk weight, $\Delta V$, is negative (Spearman and Pearson correlations = $-0.24$ and $-0.16$). All of these correlations are significantly different from zero.

6. **Empirical Results**

6.1 *Tests of empirical predictions*

Table 3 presents regression summary statistics from estimations of equations (5) and (6). The findings in the first column provide evidence of procyclical leverage and confirm the findings of Adrian and Shin (2008; 2010) that are based on five investment banks. In particular, there is a significant positive relation between change in leverage, $\Delta L$, and change in assets, $\Delta A$. The coefficient on $\Delta A$ is 0.12 with a t-statistic of 3.95.\(^{26}\)

The findings in the second column confirm the predictions of our analysis in section 3 that procyclical leverage results only when the weighted average regulatory risk weight of assets bought (sold) in response to increases (decreases) in asset values is less than the weighted average risk weight prior to the purchase (sale). In particular, as predicted there is a significant

\(^{26}\) Reported t-statistics relating to all estimating equations are based on standard errors clustered by firm and calendar quarter. We thank Dan Taylor for making his STATA code available on his website for fixed-effects models with two-way clustered standard errors (see Gow, Ormazabal, and Taylor, 2010).
negative relation between $\Delta L$ and change in weighted average risk weight, $\Delta V$, (coefficient = −0.27, t-statistic = −6.57), and there is no significant relation between $\Delta L$ and $\Delta A$ (coefficient = 0.05, t-statistic = 1.52). That is, after controlling for change in bank regulatory risk weights, leverage is not procyclical.\textsuperscript{27, 28}

Table 4 presents regression summary statistics from estimations of equations (7a) and (7b). The findings in table 4 are consistent with the expected relations between change in leverage and changes in debt and equity, and inconsistent with leverage procyclicality being associated with fair value accounting. In particular, relating to equation (7a), the coefficients on comprehensive income, $CI$, and other changes in equity, $\Delta K − CI$, are significantly negative (coefficients = −10.94 and −7.27, t-statistics = −28.06 and −44.89), and the coefficient on change in debt, $\Delta D$, is significantly positive (coefficient = 0.98, t-statistic = 61.54).\textsuperscript{29} More importantly, the $CI$ coefficient is significantly more negative than the $\Delta K − CI$ coefficient (untabulated F-statistic = 82.97, p-value < 0.001). This is inconsistent with fair value accounting being a source

\textsuperscript{27}To ensure that our inferences obtained from table 3 apply to the largest banks, we re-estimated equations (5) and (6) using the banks in the largest size quintile based on total assets. Untabulated findings reveal inferences identical to those relating to the full sample. In addition, to ensure that our inferences regarding the role of $\Delta V$ are not influenced by extreme values of $\Delta V$, we re-estimated equation (6) for the subsample of observations in the middle three $\Delta V$ quintiles. Untabulated findings reveal inferences relating to this subsample that are identical to those based on the full sample.

\textsuperscript{28}Although, as noted above, there is no consensus regarding optimal capital structure, there is a literature that identifies determinants of the level of leverage. For example, Gropp and Heider (2010) finds that the equity market-to-book ratio, profits, assets, and an indicator for whether a firm pays dividends are determinants. Accordingly, we estimated versions of equations (5) and (6) that include change in the equity market-to-book ratio, change in comprehensive income, and change in the indicator variable for whether a firm pays dividends. Untabulated findings reveal that although some of the additional variables have significant incremental explanatory power, inferences regarding the coefficients on $\Delta A$ and $\Delta V$ are identical to those relating to the findings in table 3.

\textsuperscript{29}The coefficient magnitudes are consistent with banks being highly levered. For a highly levered bank, change in debt has an almost one-to-one correspondence with change in leverage. To see this, consider, e.g., a bank with $A = 120$, $D = 110$, and $K = 10$, the relative magnitudes of which are representative of the average of our sample banks. If the bank issues debt of 1 and buys assets of 1, the implied coefficient on $\Delta D$ would equal 1 ($= \Delta L / \Delta D = 0.00833 / 0.00833$). All else equal, change in equity has a larger effect on change in leverage. In this example, if the increase of 1 in assets instead is financed by equity, the implied coefficient on $\Delta K$ would equal −10 ($= \Delta L / \Delta K = −0.0833 / 0.00833$). That the coefficient on $\Delta K − CI$ in table 4 is less negative than −10 suggests that, on average, banks are not simply issuing (repurchasing) equity and buying (selling) an equal amount of assets, but rather at the same time they are buying (selling) more assets using debt.
of procyclical leverage. More broadly, the findings relating to equation (7a) are consistent with the expected relations between change in leverage and changes in debt and equity, rather than procyclical leverage being associated with fair value accounting.

Relating to equation (7b), 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 $-10.71$, $-11.86$, and $-4.24$ (t-statistics $= -24.88$, $-43.68$, and $-16.08$). The coefficients on other changes in equity, $\Delta K - CI$, and change in debt, $\Delta D$, are essentially the same as those in equation (7a). More importantly, the $NI$ and $FVOCI$ coefficients are each significantly more negative than the $\Delta K - CI$ coefficient (untabulated F-statistics $= 66.01$ and $207.09$, p-values $< 0.001$). As with equation (7a), these findings are inconsistent with fair value accounting being a source of procyclical leverage.

Table 5, panel A (B), presents regression summary statistics from estimations of equations (5) and (6) (equations (7a) and (7b)) separately for economic upturns and downturns. Panel A reveals that inferences based on the upturn and downturn findings in the two sets of columns are identical to those based on table 3. In particular, in economic upturns, the coefficient on change in assets, $\Delta A$, is significantly positive (coefficient $= 0.12$, t-statistic $= 3.10$) 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 $= 0.04$, t-statistic $= 0.85$). Similarly, in economic downturns, the coefficient on $\Delta A$ is significantly positive (coefficient $= 0.11$, t-statistic $= 2.41$) 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 $= 0.06$, t-statistic $= 1.27$). Untabulated statistics reveal that the
coefficient on \( \Delta A \) in economic downturns is not significantly larger than that in economic upturns (p-values = 0.92 and 0.69). In addition, the coefficient on \( \Delta V \) is not significantly different in economic downturns and upturns (p-value = 0.17). As in table 3, the findings relating to economic upturns and downturns in table 5, panel A, provide no evidence of procyclical 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 based on table 4—there is no evidence of procyclical leverage in either upturns or downturns. For example, coefficients on \( NI, FVOCI, \) and \( OTHOCI \) are \(-12.01, -11.75, \) and \(-4.03 \) (t-statistics \(-25.69, -28.68, \) and \(-11.44 \)) during upturns, and \(-9.49, -11.61, \) and \(-4.37 \) (t-statistics \(-17.29, -26.81, \) and \(-10.57 \)) during downturns. Also, the \( NI \) and \( FVOCI \) coefficients are not significantly different in upturns, but they are in downturns (untabulated F-statistics = 0.18 and 11.55, p-values = 0.671 and <0.001), and each is significantly more negative than the \( \Delta K - CI \) coefficient (untabulated F-statistics = 101.12 and 108.95 during upturns and 14.92 and 66.96 during downturns; all p-values < 0.001).

Relating to differences in coefficients in economic upturns and downturns, untabulated statistics reveal that the coefficients on \( CI \) and \( NI \) in economic downturns are significantly less negative than those in economic upturns (p-values < 0.01, one sided tests), and that the coefficient on \( FVOCI \) is not significantly different in economic downturns and upturns (p-value = 0.82, one sided test). Although finding that the \( CI \) and \( NI \) coefficients are less negative in economic downturns than upturns is consistent with fair value accounting potentially being associated with procyclical leverage more in economic downturns, each of the \( CI, NI, \) and \( FVOCI \) coefficients is significantly negative in both downturns and upturns. That is, taken
together, the findings table 5, panel B, are consistent with fair value accounting playing little or no role in contributing to procyclical leverage.\textsuperscript{30}

Table 6 presents regression summary statistics from estimations of equation (8) that include and exclude $\Delta V$. Neither estimation reveals any association between fair value accounting and the excessive purchase and sale of assets. In particular, the coefficients on the interaction of $\Delta OTHA$ and $FVDECILE$ are insignificantly different from zero (coefficients $= -0.03$, t-statistics $= -0.38$). In addition, the coefficients on $FVDECILE$ are significantly negative in both estimations (coefficients $= -0.04$, t-statistics $= -14.02$ and $-14.11$), which is consistent with the findings in tables 4 and 5 showing that fair value income is negatively associated with change in 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 findings are based on a sample of over 600 commercial banks. A key distinction between investment banks and commercial banks during the three studies’ sample periods is that investment banks were not subject to risk-weighted regulatory capital 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 leverage extend to financial institutions that are not subject to regulation, we estimate equations (5), (7a), and (8) for a sample of broker-dealers. We do not

\textsuperscript{30} We also estimated equations (7a) and (7b) for the subset of downturn quarters that comprise the 2008 financial crisis, i.e., the seven quarters beginning with the last quarter of 2007. Untabulated findings reveal inferences identical to those relating to down markets in table 5, panel B.
estimate equation (6) because broker-dealers are not subject to regulatory risk weights;\textsuperscript{31} we do not estimate equation (7b) 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 $= 0.47$, t-statistic $= 3.99$), there is no evidence that fair value accounting contributes to this relation. In particular, the coefficients (t-statistics) for $CI$, $\Delta K - CI$, and $\Delta D$ from the equation (7a) estimation are $-1.80$, $-1.76$, and $0.90$ ($-5.27$, $-5.17$, and $11.90$), and the coefficient (t-statistic) for the interaction of $FVDECILE$ and $\Delta OTHA$ from the equation (8) estimation is $0.28$ ($0.99$). 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 broker-dealers to buy (sell) more assets than would be the case under modified historical cost accounting.

\textit{6.3 Estimations using non-financial firms}

The key finding from our analytical description of bank behavior and related empirical tests is that procyclical leverage does not occur in the absence of bank regulation based on a risk-weighted measure of leverage. The findings in section 6.2 indicate broker-dealers exhibit some evidence of procyclical leverage, which is consistent the Adrian and Shin (2008; 2010) observation that such firms maximize return on equity by maximizing leverage subject to maintaining capital to meet an internally imposed value-at-risk criterion. In contrast, non-financial firms are neither subject to regulation nor likely to face particularly strong incentives to impose a value-at-risk criterion. As a result, one would expect non-financial firms to exhibit no

\textsuperscript{31} Although broker-dealers are subject to net capital requirements, their assets are not risk weighted in determining net capital.
evidence of procyclical leverage. Untabulated findings based on estimation of equation (5) for a sample of 127,002 firm-quarter observations relating to 9,272 US non-financial firms with available data during our sample period reveal that, as expected, non-financial firms exhibit no evidence of procyclical leverage.

7. Summary and Concluding Remarks

We develop an analytical description of how commercial 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 leverage. We test predictions from the analysis on a sample of US commercial banks, with data that span economic upturns and downturns, including the 2008-2009 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 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 analysis focuses on actions banks take in response to economic gains and losses on their assets throughout the economic cycle to meet regulatory leverage requirements. The analysis shows that absent differences in regulatory risk weights across assets, leverage is not procyclical. We then test empirically predictions based on the analysis and although we find a significant positive relation between change in leverage and change in assets—indicating that 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 leverage, and change in debt is significantly positively related. We also find no evidence of a relation between change in 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 leverage.

The key conclusion we draw from the analytical description and supporting empirical evidence is that bank regulatory requirements, particularly regulatory leverage that is determined using regulatory risk-weighted assets, explain why banks’ leverage can be procyclical, and that fair value accounting does not. This does not imply that bank regulatory leverage requirements are inappropriate—bank regulators likely impose such requirements to achieve multiple objectives. Regardless, to the extent that during the financial crisis there were excessive asset sales by banks that resulted in procyclical leverage and amplified asset price declines, bank regulation rather than fair value accounting was the culprit.
Appendix A
Support for Observations

Observation 1:

At $t_1$, regulatory leverage is

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

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

$$\Delta R = R_1 - R_0 = \frac{V_0 \times gA_0}{K_1} - \frac{V_0 \times A_0}{K_0}.$$  

Regulatory leverage is constant during the period if

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

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

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

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, leverage at $t_1$ is

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

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

$$\Delta L = L_1 - L_0 = \frac{gA_0}{K_0 + I_1} - \frac{A_0}{K_0},$$
and, as with regulatory leverage,

$$\Delta L = L_t - L_0 = 0 \iff gK_0 = K_0 + (g - 1)A_0.$$

Thus, it follows that

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

**Observation 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 $$d$$:

$$\Rightarrow d = \frac{V_0 A_0 K_1}{V^* K_0} - \frac{V_0 gA_0}{V^*} = \frac{V_0 A_0 K_1 - V_0 gA_0 K_0}{V^* K_0}$$

$$\Rightarrow d = \frac{V_0 A_0 K_0 + V_0 A_0 (g - 1)A_0 - V_0 gA_0 K_0}{V^* K_0}$$

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

Because $$\frac{V_0 A_0}{V^*}$$ is always larger than zero, it follows that

$$d = 0 \iff 1 + (g - 1)\frac{A_0}{K_0} - g = 0 \Rightarrow 1 + \frac{A_0}{K_0} g - \frac{A_0}{K_0} - g = 0.$$

Thus, it follows that
(i) \( d = 0 \) iff \( g = 1 \);
(ii) \( d > 0 \) iff \( g > 1 \);
(iii) \( d < 0 \) iff \( g < 1 \).

**Observation 3:**

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

\[
\text{if } g > 1 \Rightarrow \Delta L > 0 \text{ iff } \frac{gA_0 + d}{K_1} > \frac{A_0}{K_0};
\]

\[
\text{if } g < 1 \Rightarrow \Delta L < 0 \text{ iff } \frac{gA_0 - d}{K_1} < \frac{A_0}{K_0}.
\]

During economic upturns 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 Observation 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 downturns:

\[
\frac{gA_0 - d}{K_1} < \frac{A_0}{K_0} \Rightarrow d > \frac{A_0K_1}{K_0} - gA_0 \Rightarrow \frac{V_0}{V^*} > 1.
\]
Appendix B
Variable Definitions
(item identifiers from COMPUSTAT and Y-9C reports in brackets)

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 (ciderglq + cisecglq), divided by lagged assets (atq)

FVOCI
Components of comprehensive income determined by fair value (ciderglq + cisecglq + bhck4077)

NI
Net income (niq), divided by lagged assets

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

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

\( \Delta K - CI \)
Quarterly change in shareholders’ equity (seqq) less 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 (bhcka223 or rcfda223) divided by assets
References


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 FVDECILE 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>0.45</td>
<td>0.05</td>
<td>8.09</td>
</tr>
<tr>
<td>$\Delta V$</td>
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<td>0.09</td>
<td>3.98</td>
</tr>
<tr>
<td>$\Delta A$</td>
<td>2.43</td>
<td>1.51</td>
<td>6.39</td>
</tr>
<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>
</tr>
<tr>
<td>FVOCI</td>
<td>0.01</td>
<td>0.01</td>
<td>0.19</td>
</tr>
<tr>
<td>OTHOCI</td>
<td>0.00</td>
<td>0.00</td>
<td>0.14</td>
</tr>
<tr>
<td>$\Delta K - CI$</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>FVDECILE</td>
<td>0.50</td>
<td>0.56</td>
<td>0.31</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) $\Delta L$</th>
<th>(2) $\Delta V$</th>
<th>(3) $\Delta A$</th>
<th>(4) $CI$</th>
<th>(5) $NI$</th>
<th>(6) $FVOCI$</th>
<th>(7) $OTHOCl$</th>
<th>(8) $\Delta K - CI$</th>
<th>(9) $\Delta D$</th>
<th>(10) $\Delta OTHA$</th>
<th>(11) $FVDEcile$</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) $\Delta L$</td>
<td>-0.24*</td>
<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>
<td></td>
</tr>
<tr>
<td>(2) $\Delta V$</td>
<td>-0.16*</td>
<td>-0.39*</td>
<td>-0.02</td>
<td>0.06*</td>
<td>-0.10*</td>
<td>0.03*</td>
<td>-0.07*</td>
<td>-0.39*</td>
<td>-0.39*</td>
<td>-0.10*</td>
<td></td>
</tr>
<tr>
<td>(3) $\Delta A$</td>
<td>0.08*</td>
<td>-0.36*</td>
<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>
<td></td>
</tr>
<tr>
<td>(4) $CI$</td>
<td>-0.52*</td>
<td>-0.03*</td>
<td>0.16*</td>
<td>0.63*</td>
<td>0.45*</td>
<td>0.09*</td>
<td>-0.34*</td>
<td>0.14*</td>
<td>0.16*</td>
<td>0.50*</td>
<td></td>
</tr>
<tr>
<td>(5) $NI$</td>
<td>-0.48*</td>
<td>-0.01</td>
<td>0.16*</td>
<td>0.91*</td>
<td>-0.17*</td>
<td>0.01</td>
<td>-0.30*</td>
<td>0.15*</td>
<td>0.18*</td>
<td>0.07*</td>
<td></td>
</tr>
<tr>
<td>(6) $FVOCI$</td>
<td>-0.21*</td>
<td>-0.07*</td>
<td>0.02</td>
<td>0.25*</td>
<td>-0.10*</td>
<td>-0.16*</td>
<td>0.07*</td>
<td>0.00</td>
<td>0.00</td>
<td>0.62*</td>
<td></td>
</tr>
<tr>
<td>(7) $OTHOCl$</td>
<td>0.06*</td>
<td>0.01</td>
<td>0.00</td>
<td>0.08*</td>
<td>0.00</td>
<td>-0.19*</td>
<td>0.06*</td>
<td>0.03*</td>
<td>0.02</td>
<td>-0.01</td>
<td></td>
</tr>
<tr>
<td>(8) $\Delta K - CI$</td>
<td>-0.41*</td>
<td>-0.11*</td>
<td>0.60*</td>
<td>-0.09*</td>
<td>-0.06*</td>
<td>0.01</td>
<td>-0.10*</td>
<td>0.11*</td>
<td>0.17*</td>
<td>-0.08*</td>
<td></td>
</tr>
<tr>
<td>(9) $\Delta D$</td>
<td>0.19*</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>0.98*</td>
<td>0.02</td>
<td></td>
</tr>
<tr>
<td>(10) $\Delta OTHA$</td>
<td>0.10*</td>
<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>
<td>0.00</td>
<td></td>
</tr>
<tr>
<td>(11) $FVDEcile$</td>
<td>-0.15*</td>
<td>-0.08*</td>
<td>0.03*</td>
<td>0.27*</td>
<td>0.05*</td>
<td>0.56*</td>
<td>0.00</td>
<td>-0.02</td>
<td>0.01</td>
<td>0.00</td>
<td></td>
</tr>
</tbody>
</table>
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 fiscal quarter fixed effects; standard errors are clustered by firm and calendar 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>
<th></th>
<th>(1)</th>
<th>(2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \Delta A )</td>
<td>0.12</td>
<td>0.05</td>
</tr>
<tr>
<td></td>
<td>(3.95)***</td>
<td>(1.52)</td>
</tr>
<tr>
<td>( \Delta V )</td>
<td>–0.27</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(–6.57)***</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>12,486</td>
<td>12,486</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.10</td>
<td>0.11</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 calendar quarter. *t*-statistics are in parenthesis. *** denotes significance at the p < 0.01 level.

\[
\begin{align*}
\text{(1) } \Delta L_{iq} &= \beta_0 + \beta_1 CI_{iq} + \beta_2 (\Delta K - CI)_{iq} + \beta_3 \Delta D_{iq} + \epsilon_{iq} \\
\text{(2) } \Delta L_{iq} &= \beta_0 + \beta_1 NI_{iq} + \beta_2 FVOCI_{iq} + \beta_3 OTHOCI_{iq} + \beta_4 (\Delta K - CI)_{iq} + \beta_5 \Delta D_{iq} + \epsilon_{iq}
\end{align*}
\]

<table>
<thead>
<tr>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>CI</td>
<td>−10.94</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(−28.06)***</td>
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</tr>
<tr>
<td>NI</td>
<td>−10.71</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(−24.88)***</td>
<td></td>
</tr>
<tr>
<td>FVOCI</td>
<td>−11.86</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(−43.68)***</td>
<td></td>
</tr>
<tr>
<td>OTHOCI</td>
<td>−4.24</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(−16.08)***</td>
<td></td>
</tr>
<tr>
<td>$\Delta K - CI$</td>
<td>−7.27</td>
<td>−7.11</td>
</tr>
<tr>
<td></td>
<td>(−44.89)***</td>
<td>(−44.74)***</td>
</tr>
<tr>
<td>$\Delta D$</td>
<td>0.98</td>
<td>0.97</td>
</tr>
<tr>
<td></td>
<td>(61.54)***</td>
<td>(60.32)***</td>
</tr>
</tbody>
</table>

Observations 12,486 12,486
R-squared 0.85 0.84
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 fiscal quarter fixed effects; standard errors are clustered by firm and calendar quarter. \( t \)-statistics are in parenthesis. *** and * denote significance at the p < 0.01 and p < 0.10 levels.

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

Panel A: Leverage changes and regulatory risk weights

<table>
<thead>
<tr>
<th></th>
<th>Up Markets</th>
<th>Down Markets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
</tr>
<tr>
<td>( \Delta A )</td>
<td>0.12</td>
<td>0.04</td>
</tr>
<tr>
<td>( \Delta A )</td>
<td>(3.10)***</td>
<td>(0.85)</td>
</tr>
<tr>
<td>( \Delta V )</td>
<td>–0.32</td>
<td>–0.20</td>
</tr>
<tr>
<td></td>
<td>(–6.00)***</td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>7,126</td>
<td>7,126</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.15</td>
<td>0.17</td>
</tr>
</tbody>
</table>

\[
(3) \quad \Delta L_{iq} = \beta_0 + \beta_1 CI_{iq} + \beta_2 (\Delta K – CI)_{iq} + \beta_3 \Delta D_{iq} + \epsilon_{iq}
\]

\[
(4) \quad \Delta L_{iq} = \beta_0 + \beta_1 NI_{iq} + \beta_2 FVOCI_{iq} + \beta_3 OTHOCI_{iq} + \beta_4 (\Delta K – CI)_{iq} + \beta_5 \Delta D_{iq} + \epsilon_{iq}
\]

Panel B: Leverage changes and fair value gains and losses

<table>
<thead>
<tr>
<th></th>
<th>Up Markets</th>
<th>Down Markets</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>( CI )</td>
<td>–12.01</td>
<td>–9.91</td>
</tr>
<tr>
<td></td>
<td>(–28.67)***</td>
<td></td>
</tr>
<tr>
<td>( NI )</td>
<td>–12.01</td>
<td>–25.69***</td>
</tr>
<tr>
<td>( FVOCI )</td>
<td>–11.75</td>
<td>(–28.68)***</td>
</tr>
<tr>
<td>( OTHOCI )</td>
<td>–4.03</td>
<td>(–11.44)***</td>
</tr>
<tr>
<td>( \Delta K – CI )</td>
<td>–7.13</td>
<td>–7.00</td>
</tr>
<tr>
<td></td>
<td>(–38.87)***</td>
<td>(–38.71)***</td>
</tr>
<tr>
<td>( \Delta D )</td>
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<td>0.98</td>
</tr>
<tr>
<td></td>
<td>(48.67)***</td>
<td>(47.71)***</td>
</tr>
<tr>
<td>Observations</td>
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<td>7,126</td>
</tr>
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<td>R-squared</td>
<td>0.87</td>
<td>0.86</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 fiscal quarter fixed effects; standard errors are clustered by firm and calendar quarter. \( t \)-statistics are in parenthesis. ***, **, * denote significance at the p < 0.01, p < 0.05, and p < 0.10 levels.

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

<table>
<thead>
<tr>
<th>Variable</th>
<th>(1) ( \beta )</th>
<th>(2) ( \beta )</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
<td>(3.47)***</td>
<td>(3.28)***</td>
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<tr>
<td>( \Delta V )</td>
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<td>-0.04</td>
</tr>
<tr>
<td></td>
<td>(-3.69)***</td>
<td>(-3.69)***</td>
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<tr>
<td>( FVDECILE )</td>
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<td>-0.04</td>
</tr>
<tr>
<td></td>
<td>(-14.02)***</td>
<td>(-14.11)***</td>
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<tr>
<td>( \Delta OTHA \times FVDECILE )</td>
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<td>-0.03</td>
</tr>
<tr>
<td></td>
<td>(-0.38)</td>
<td>(-0.38)</td>
</tr>
<tr>
<td>Observations</td>
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<td>12,486</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.12</td>
<td>0.13</td>
</tr>
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</table>