Does Fair Value Accounting Contribute to Procyclical Leverage?

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Abstract

We describe analytically commercial bank behavior focusing on actions banks take in response to economic gains and losses on their assets to meet regulatory leverage requirements. Our analysis shows that absent differences in regulatory risk weights across assets, leverage cannot be procyclical. We test the analytical description’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 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 leverage, which is inconsistent with fair value accounting contributing to procyclical leverage. In addition, we find no evidence of a relation between change in 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 leverage. The key conclusion we draw is that bank regulatory requirements, particularly regulatory leverage determined using regulatory risk-weighted assets, explain why banks’ 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 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. Excess asset sales, which result in procyclical decreases in leverage, 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). Because procyclical leverage is evidence of a link between fair value accounting and the financial crisis, the question we address is whether there exists a link between fair value accounting and procyclical leverage.

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. A key factor affecting actions taken by commercial banks is 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 establish that procyclical leverage for commercial banks only arises because of differences between regulatory and accounting leverage, and not because of fair value accounting.¹

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

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.
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 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 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 assumes that banks maximize leverage subject to a regulatory leverage constraint. The analysis shows that procyclical leverage results only when the average regulatory risk weight of assets bought (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, leverage cannot be 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 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

Many academic researchers, policy-makers, and other practitioners have concluded 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.\(^2\) This
conclusion is sustained by the belief that fair value accounting was a major factor contributing to
the 2008-2009 financial crisis. The line of reasoning supporting this conclusion has three steps.

The first step is that 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. Other
things equal, recognizing such losses increased bank leverage. Presumably to avoid violating
regulatory leverage requirements, banks were then forced to sell assets and repurchase debt,
thereby decreasing leverage. If asset sales are excessive, i.e., exceed the amount necessary to
restore leverage to the level before an exogenous shock, then leverage will be lower than it was
before the shock, i.e., leverage will be procyclical. Thus, procyclical leverage is evidence of
excessive asset sales by banks.

The second step is that asset sales by one bank can have adverse 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. This

\(^2\) See, for example, “The Crisis and Fair Value Accounting,” The Economist, September 18, 2008; “The Market is
not the Best Place to Set a Fair Price for Assets,” Financial Times, July 16, 2013; Allen and Carletti (2008); Adrian
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. 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 availability of credit, which leads to a downturn throughout the economy.

The third step is that excessive assets sales by banks, which result in procyclical decreases in leverage, amplify the asset price declines and subsequent contagion. The basis for concluding fair value accounting was a major factor contributing to the 2008-2009 financial crisis is that fair value accounting requires asset write-downs to be based on exit prices, which purportedly were artificially low because of illiquidity and therefore poor indicators of financial assets’ fundamental values. As a result, fair value-based write-downs resulted in excessive asset sales by banks, which were the source of the amplified asset price declines and subsequent contagion (Allen and Carletti, 2008; Plantin, Sapra, and Shin, 2008). Because procyclical leverage is evidence of excessive asset sales, the question we address is whether there exists any link between fair value accounting and procyclical leverage.

This potential link between fair value accounting and the financial crisis exerted 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),

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3 Conversely, contagion can cause asset bubbles to occur in economic upturns.
4 See also 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.
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.\(^5\)

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 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 claims linking fair value accounting and the financial crisis, several academic studies provide evidence that impairments 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.

\(^5\) See, e.g., Ronald Orol’s April 2, 2009 article in MarketWatch, “FASB Approves More Mark-to-Market Flexibility.”
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 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.\(^6\)

Other studies, notably Adrian and Shin (2008, 2010), reach a different conclusion regarding a link between fair value accounting and declines in asset prices that could have contributed to the financial crisis. In particular, Adrian and Shin (2008, 2010) explain that the actions financial institutions typically take to offset counter-cyclical increases (decreases) in leverage arising from recognition of decreases (increases) in values of all their assets—including investments in securities and loans—during economic downturns (upturns) can cause procyclical decreases (increases) in leverage.\(^7\) Adrian and Shin (2008, 2010) assume that fair value accounting is the cause of 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. However, the studies provide no direct evidence that fair value accounting \textit{per se} caused procyclical leverage for the investment banks. Moreover, although it is conceivable that the actions of investment banks and other broker-dealer financial firms contributed to the financial crisis, most of the debate regarding fair value accounting and the

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

\(^7\) 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.
financial crisis revolved around commercial banks, in large part because of the central role they play in the economy.

A key factor affecting actions taken by commercial banks is that banks must meet regulatory leverage requirements. We establish analytically and empirically that procyclical leverage for commercial banks only arises because of differences between regulatory and accounting leverage, and not because of fair value accounting.

3. 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. 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 leverage. 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, which ultimately limits the amount of risky assets entities can buy (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 analytical description assumes banks maximize leverage subject to a regulatory leverage ratio, i.e., the reciprocal of the regulatory capital ratio.  

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8 Although using equity financing typically does not maximize return on equity, some banks issue and repurchase equity for reasons outside of our analytical description. Nonetheless, in our empirical tests we include changes in equity other than the change attributable to comprehensive income as an explanatory variable.

9 We assume the bank operates at its optimal regulatory leverage. This optimum 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 regulatory leverage, which during our sample period is relatively constant, ranging between seven and eight for our sample banks.

10 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.
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 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 leverage to the level it was before the increase (decrease) in asset values. However, if banks take actions 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 procyclical relation between leverage and assets is evidence that banks do not manage 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 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, \( V \).\(^{11}\) 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, our analysis 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, \( I_1 \), 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 procyclical leverage, we assume the bank’s only income comprises fair value gains or losses. \( I_1 \) 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 \( K_1 = K_0 + I_1 \). 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 we assume 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

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\(^{11}\) 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.
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. Appendix A provides the details supporting our algebraic observations that appear below.

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 $L_1$.

$$R_1 = \frac{V_0 \times A_1}{K_1} = \frac{V_0 \times gA_0}{K_0 + I_1} \quad (1)$$

$$L_1 = \frac{A_1}{K_1} = \frac{gA_0}{K_0 + I_1} \quad (2)$$

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 assuming 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, $A_t = gA_0 + d$ 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 $V^\ast$.

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

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

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, $V^\ast$.

Furthermore, because leverage at $t_1$, $L_t = \frac{A_t}{K_1}$, equals $\frac{gA_0 + d}{K_0 + I_1}$, purchasing 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: Assuming 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 purchasing or selling assets.

That is, procyclical leverage as the result of asset purchases or sales is only possible if $V^* < V_0$.\(^\text{12}\)

Regardless of how a bank decides which assets to buy or sell, the analysis shows that procyclical leverage can only result 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

\(^{12}\) 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 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, $V^* = 0.67 = [(10 \times 0) + (20 \times 1)] / 30$, 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 $V_0 = 0.83$. 


sales. Thus, procyclical leverage cannot 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 (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{13}

Thus far we have assumed that regulatory risk weights remain constant throughout the economic cycle, i.e., they are independent of $g$. Regulatory risk weights likely change countercyclically, i.e., risk weights increase (decrease) during economic downturns (upturns).\textsuperscript{14} Permitting risk weights to change countercyclically 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 cannot occur in the absence of risk-based bank capital regulation.\textsuperscript{15}

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.

\textsuperscript{13} 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{14} 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). Risk weights for other assets tend to be constant throughout the economic cycle, although regulators have the discretion to change them.

\textsuperscript{15} To permit risk weights to be counter-cyclical, we assume $V_t = V_0 / g$, which has a direct effect on regulatory leverage at $t$. 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 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 $t_t$ exceeds a predetermined amount. Thus, whether leverage is procyclical does not depend on the magnitude of fair value gains and losses.
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 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 of buying or selling activities between banks. Thus, the bank’s fair value income at $t_1$ is $I_1 = (g^{t+\gamma} - 1)A_0$. Assume there is contagion, i.e., $\gamma > 0$. In economic upturns, i.e., when $g > 1$, then $g^{t+\gamma} > g$; in economic downturns, i.e., when $g < 1$, then $g^{t+\gamma} < g$. 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 cannot occur in the absence of risk-based bank capital regulation and does not depend on the magnitude of fair value gains and losses.\textsuperscript{16}

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 cannot be 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.

4. Empirical Predictions and Estimating Equations

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 can only be achieved if banks take actions to offset the mechanical relation between change in 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) 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:

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

\textsuperscript{16} 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. We refer the reader to Plantin, Sapra, and Shin (2008) for a comparison of the resource allocation effects of fair value accounting and historical cost accounting.
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. 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):

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

where $\Delta V$ is the quarterly change in the bank’s weighted average regulatory risk weight. $\Delta V$ 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 is only possible if the weighted average risk weight of the assets purchased 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 (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:

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

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.
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, \( CI \) 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 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 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 by fair value accounting, \( FVOCI \), and the remaining components of other comprehensive income, \( OTHOCI \).

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

(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.\(^\text{18}\) 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; in equations (7a) and (7b) 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) 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):

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

(8)

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

\(^{18}\) Impairments do not reduce carrying amounts to fair value for all assets, most notably loans. However, impairments are designed to recognize economic losses.
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.\footnote{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 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.} The sample comprises US commercial banks 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.

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.

---

20 Inferences based on untabulated findings from estimation of all equations using continuous variables that are not winsorized, that are 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 (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.\footnote{Reported t-statistics relating to all estimating equations are based on standard errors clustered by firm and calendar quarter.}

The findings in the second column confirm the predictions of our analysis in section 3 that procyclical 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 = −0.27, 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.

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, $\Delta K$, 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). More importantly,
the CI coefficient is significantly more negative than the ΔK coefficient (untabulated F-statistic = 82.97, p-value < 0.001). This is inconsistent with fair value accounting being a source 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, ΔK, and change in debt, ΔD, are essentially the same as those in equation (7a). More importantly, the NI and FVOCI coefficients are each significantly more negative than the ΔK 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 from table 3. In particular, in economic upturns, the coefficient on change in assets, ΔA, is significantly positive (coefficient = 0.12, t-statistic = 3.10) when change in weighted average regulatory risk weight, ΔV, is not included in the estimating equation, and insignificantly different from zero when ΔV is included (coefficient = 0.04, t-statistic = 0.85). Similarly, in economic downturns, the coefficient on ΔA is significantly positive (coefficient = 0.11, t-statistic = 2.41) when change in weighted average regulatory risk weight, ΔV, 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 in 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-value = 0.671 and p-value <0.001), and each is significantly more negative than the $\Delta K$ coefficient (untabulated F-statistics = 101.12 and 108.95 during upturns and 14.92 and 66.96; 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 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.

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

The Adrian and Shin (2008, 2010) studies 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 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 estimate equation (6) because broker-dealers are not subject to regulatory risk weights; 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 $CI$, $\Delta K$, 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.

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 cannot 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 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 commercial bank behavior and test predictions from the analysis 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 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 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. The analysis shows that absent differences in regulatory risk weights across assets, leverage cannot be procyclical. We then test empirically predictions based on the analysis and although we find a significantly 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 algebraic analysis 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.
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 \( d \):

\[ \Rightarrow d = \frac{V_0A_0K_1 - V_0gA_0}{V^*K_1} = \frac{V_0A_0K_1 - V_0gA_0K_0}{V^*K_0} \]
\[ \Rightarrow d = \frac{V_0A_0K_0 + V_0A_0(g - 1)A_0 - V_0gA_0K_0}{V^*K_0} \]
\[ \Rightarrow d = \frac{V_0A_0}{V^*} \left[ 1 + (g - 1)\frac{A_0}{K_0} - g \right]. \]

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

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

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

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

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

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

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

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

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

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>CI</td>
<td>Comprehensive income divided by lagged assets, $NI + FVOCI + OTHOCI$</td>
</tr>
<tr>
<td>FVDECILE</td>
<td>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</td>
</tr>
<tr>
<td>FVOCI</td>
<td>Components of other comprehensive income determined by fair value accounting, divided by lagged assets</td>
</tr>
<tr>
<td>NI</td>
<td>Net income, divided by lagged assets</td>
</tr>
<tr>
<td>OTHOCI</td>
<td>Other comprehensive income divided by lagged assets, less $FVOCI$</td>
</tr>
<tr>
<td>ΔD</td>
<td>Quarterly change in debt, divided by lagged assets</td>
</tr>
<tr>
<td>ΔK</td>
<td>Quarterly change in equity less net income and other comprehensive income, divided by lagged assets</td>
</tr>
<tr>
<td>ΔL</td>
<td>Quarterly percentage change in leverage, $(\text{leverage}<em>t - \text{leverage}</em>{t-1})/\text{leverage}_{t-1}$, where leverage is assets divided by shareholders’ equity</td>
</tr>
<tr>
<td>ΔOTHA</td>
<td>Change in assets other than amounts attributable to $FVCI$</td>
</tr>
<tr>
<td>ΔA</td>
<td>Quarterly percentage change in assets, $(\text{assets}<em>t - \text{assets}</em>{t-1})/\text{assets}_{t-1}$</td>
</tr>
<tr>
<td>ΔV</td>
<td>Quarterly change in average regulatory risk weight, i.e., regulatory risk-weighted assets divided by assets</td>
</tr>
</tbody>
</table>
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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 \textit{FVDECILE} are multiplied by 100. See Appendix B for variable definitions.

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
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<tr>
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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.

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<td>0.24*</td>
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<td>0.10*</td>
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<td>0.07*</td>
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<td>0.19*</td>
<td></td>
<td>0.18*</td>
<td>0.04*</td>
<td>0.16*</td>
<td>0.98*</td>
<td>1.00*</td>
<td>0.06*</td>
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<td>-0.16*</td>
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<tr>
<td>(7) OTHOCl</td>
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<td>0.08*</td>
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<td>0.19*</td>
<td></td>
<td>0.06*</td>
<td>0.03*</td>
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<tr>
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<td>-0.06*</td>
<td>0.01</td>
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<td>0.17*</td>
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<td>0.00</td>
<td>0.53*</td>
<td>0.98*</td>
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<tr>
<td>(10) ΔOTHA</td>
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<td>0.00</td>
<td>0.56*</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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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.

\[
(1) \quad \Delta L_{iq} = \beta_0 + \beta_1 \Delta A_{iq} + \varepsilon_{iq}
\]

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

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<tr>
<td></td>
<td>(3.95)***</td>
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<tr>
<td>( \Delta V )</td>
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<td>-0.27</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(−6.57)***</td>
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<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>
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</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.

\[
\begin{align*}
(1) \quad \Delta L_{iq} &= \beta_0 + \beta_1 CI_{iq} + \beta_2 \Delta K_{iq} + \beta_3 \Delta D_{iq} + \varepsilon_{iq} \\
(2) \quad \Delta L_{iq} &= \beta_0 + \beta_1 NI_{iq} + \beta_2 FVOCI_{iq} + \beta_3 OTHOCI_{iq} + \beta_4 \Delta K_{iq} + \beta_5 \Delta D_{iq} + \varepsilon_{iq}
\end{align*}
\]

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<tr>
<td></td>
<td>(-28.06)**</td>
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<tr>
<td>NI</td>
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</tr>
<tr>
<td></td>
<td>(-24.88)**</td>
<td></td>
</tr>
<tr>
<td>FVOCI</td>
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</tr>
<tr>
<td></td>
<td>(-43.68)**</td>
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</tr>
<tr>
<td>OTHOCI</td>
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</tr>
<tr>
<td></td>
<td>(-16.08)**</td>
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</tr>
<tr>
<td>(\Delta K)</td>
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<td>-7.11</td>
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<tr>
<td></td>
<td>(-44.89)**</td>
<td>(-44.74)**</td>
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<tr>
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<td>0.97</td>
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<tr>
<td></td>
<td>(61.54)**</td>
<td>(60.32)**</td>
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<tr>
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<td>12,486</td>
</tr>
<tr>
<td>R-squared</td>
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<td>0.84</td>
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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.

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

Panel A: Leverage changes and regulatory risk weights

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<td>0.04</td>
<td>0.11</td>
<td>0.06</td>
</tr>
<tr>
<td></td>
<td>(3.10)***</td>
<td>(0.85)</td>
<td>(2.41)**</td>
<td>(1.27)</td>
</tr>
<tr>
<td>( \Delta V )</td>
<td>–0.32</td>
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<td>–0.20</td>
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</tr>
<tr>
<td></td>
<td>(–6.00)***</td>
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<td>(–3.29)***</td>
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<td>5,360</td>
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<tr>
<td>R-squared</td>
<td>0.15</td>
<td>0.17</td>
<td>0.16</td>
<td>0.17</td>
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(3) \[ \Delta L_{iq} = \beta_0 + \beta_1 CI_{iq} + \beta_2 \Delta K_{iq} + \beta_3 \Delta D_{iq} + \epsilon_{iq} \]
(4) \[ \Delta L_{iq} = \beta_0 + \beta_1 NI_{iq} + \beta_2 FVOCI_{iq} + \beta_3 OTHOCI_{iq} + \beta_4 \Delta K_{iq} + \beta_5 \Delta D_{iq} + \epsilon_{iq} \]

Panel B: Leverage changes and fair value gains and losses

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<td>(3)</td>
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<td>–9.91</td>
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<td>( OTHOCI )</td>
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Table 6
Leverage Changes and Fair Value Income Interactions

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 $p < 0.01$, $p < 0.05$, $p < 0.10$ levels.

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

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