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Panacea, Pandora's box, or placebo: Feedback in bank mortgage-backed security holdings and fair value accounting ☆

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ABSTRACT

We examine the relation between bank holdings of mortgage-backed securities (MBS) and MBS prices. Theory suggests feedback between MBS holdings and underlying asset markets can be aggravated by mark-to-market accounting. We measure feedback by the relation between asset returns and the changes in bank MBS holdings. Consistent with the existence of feedback effects related to mark-to-market, we find that for banks with high MBS, more nonperforming loans, and lower total capital ratio, changes in bank MBS positions are positively associated with changes in MBS prices and that this relation is reduced after the April 2009 mark-to-market rule clarification. To assess the effect of feedback on shareholder value, we test whether the stock-price response of banks to the announcement of the mark-to-market accounting rule clarification is associated with the intensity of feedback behavior. We find that the stock market reaction to the rule change is more positive for banks with more MBS, higher nonperforming loans and higher pre-rule-change feedback. We also find positive bond-price reactions to the rule change. Overall, our results suggest feedback related to mark-to-market accounting had a measurable effect on shareholder value.

1. Introduction

We examine how changes in commercial bank mortgage-backed-securities (hereafter MBS) holdings relate to changes in MBS prices and how the easing of mark-to-market accounting affects this relation during the Financial Crises of 2007.[3] The purpose of this study is to understand how mark-to-market accounting influences the ability and incentives of banks to provide liquidity in debt securities markets during crises. We define feedback as an increased tendency of banks to liquidate asset holdings when they confront liquidity driven asset-price declines. We provide evidence of feedback effect in that banks are more likely to sell MBS when market prices decline. Our results also indicate that the easing of mark-to-market accounting

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[3] The period we study is characterized by market-price declines. In this context, fair-value accounting is similar to impairment accounting. Ryan (2008) notes that "…even amortized cost accounting is subject to asset impairment write-downs, and so these feedback effects likely would have been similar in the absence of FAS No. 157 and other fair value accounting standards." We use the term "mark-to-market" rather than "impairment" or "fair value" because the emphasis on fair-value accounting by standard setters has lead to controversy and a key issue in the debate surrounding fair-value accounting is the role that should be played by market prices in the determination of book values.

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rules was associated with a reduction in banks' feedback trading. However, the magnitude of these effects makes it unlikely that such feedback leads to significant economy-wide consequences.

Theory suggests that banks can be forced to sell securities when prices fall in an illiquid market (Shleifer and Vishny, 2009; Allen and Carletti, 2008; Brunnermeier and Pedersen, 2009) and that mark-to-market accounting can accentuate this "feedback" effect (Plantin et al., 2008; Allen and Carletti, 2008). When liquidity shocks depress prices, mark-to-market accounting can force banks to recognize other-than-temporary impairments on securities holdings, leading to reduced earnings and regulatory capital. Because of the possibility of regulatory intervention or because they focus on accounting performance, managers are concerned about these effects. Such concerns can prompt managers to sell securities into liquidity shocks to avoid these consequences. For example, in the Plantin et al. (2008) managers benefit by selling before feedback effects are fully priced. By doing so, they maximize earnings-based compensation. In the case of banks, easing mark-to-market accounting rules allows banks to reduce the amount of unrealized losses recognized in their income statements alleviating managers' incentives to sell.

Using banks' data between 2006 and 2009 and ABX.HE index to measure the market price of MBS, we run three categories of tests that focus on bank holdings of non-agency MBS[4]: (1) We correlate changes in banks' MBS positions with MBS returns to understand whether price declines are associated with MBS sales and examine cross-sectional variation in this correlation. The purpose of these tests is to identify whether feedback effects are related to the importance of MBS to the bank's balance sheet and bank performance. (2) We investigate whether the correlation between changes in MBS holdings of banks and MBS returns differs before and after April 2009 to understand whether the accounting-rule change was associated with diminished pressure to reduce these positions. (3) We examine cross-sectional variation in bank stock returns around four events leading up to and including the announcement of the Financial Accounting Standards Board's (FASB) April 2, 2009 decision to clarify mark-to-market requirements. Our goal in these tests is to isolate the effect of feedback on shareholder value, by relating market reactions to variables associated with the intensity of feedback prior to the rule change. We also test bank bond returns around the four events to determine if bondholders benefit from the rule change.

Three key findings are documented. First, we find a positive and significant relation between quarterly changes in banks' non-agency-MBS holdings and the liquidity component of the ABX.HE return. This result suggests that for the average bank, MBS holdings exhibit a feedback effect. Further investigation finds that certain types of banks drive the relation. It is significant for banks that have above median non-agency-MBS holdings but not for those with below median non-agency-MBS holdings. Similarly, it is significant for banks that have lower total capital ratio or higher nonperforming loans. These results suggest feedback is more pronounced when a bank exhibits weak performance and when non-agency MBS holdings are economically significant.

Second, we find that feedback trading associated with the liquidity component of the ABX.HE return is significantly reduced after 2009. Thus, the evidence indicates that the April 2009 accounting-rule clarification reduced feedback-related trading of non-agency MBS by banks.

Third, we find higher abnormal bank-stock returns on event dates related to the rule change for banks with more non-agency MBS holdings and more non-performing loans during events leading up to and including April 2, 2009, when the FASB announced the mark-to-market accounting rule change. These results suggest that shareholders of subsamples of banks associated with feedback trading benefit from the rule change. We also find positive bond-price reactions to the rule change albeit the statistical significance is moderate. These results imply that banks' bondholders benefit from the accounting rule change and we are unable to reject the null that no significant wealth transfer from bondholders to shareholders (net of any government subsidy) occurred as a result of the relaxation of the accounting rules. Furthermore, we find that banks' stock-price reaction is positively associated with feedback trading prior to the rule changes. In sum, we find evidence that the change in mark-to-market accounting rules alleviates feedback effects and these effects have measurable impact on bank shareholder wealth for banks previously exhibiting feedback effects. We conclude that regulatory forbearance and efficiency effects can jointly explain these results.[5]

We conduct a series of robustness tests. Our results are robust to the exclusion of banks receiving TARP assistance, to alternative deflator, and to the adjustments of the change in non-agency MBS holdings by OTTI. Overall, this study lends credibility to the belief that financial reporting rules have real effects. The pressure placed on the FASB to alter the valuation of distressed assets and change the accounting treatment of unrealized losses is indicative of these effects. Our tests suggest a specific consequence for a bank's trading activities.

[4] Agency MBS are those issued by Fannie Mae and Freddie Mac, or guaranteed by a government-sponsored entity (e.g., Ginnie Mae). Non-agency or "private label" MBS are not guaranteed and were subject to significantly greater uncertainty with regard to default risk during the financial crises leading to greater price variability. For example, Wells Fargo's September 30, 2008 10K shows that fair value and historical cost are similar for agency-backed MBS ($43,904M vs. $43,074M) but differ significantly for non-agency MBS ($21,033M vs. $24,582M). On July 13, 2008, the government made its tacit guarantee of agency MBS explicit when the Treasury Department announced it would seek an unlimited credit line for Fannie and Freddie. On November 25, 2008, the Federal Reserve announced a program to purchase agency MBS. As of June 30, 2010 the Federal Reserve held in excess of $1T of Fannie Mae, Freddie Mac, and Ginnie Mae securities.

[5] We define 'regulatory forbearance' as an action by regulators reducing the probability of regulatory intervention. Forbearance has two effects. First, it results in a wealth transfer from taxpayers to bank owners and creditors by permitting continued bank access to short-term credit and other government subsidies (e.g., discount window borrowing and TARP). Second, it increases the likelihood of asset substitution by the bank (e.g., Lu et al., 2011). Given these effects, regulatory forbearance should induce increased bank share prices, but its effect on bank bond prices is uncertain.

The paper is organized as follows. Section 2 develops testable hypotheses. Sample selection and research method are discussed in Section 3. Empirical results are presented in Section 4 and Section 5 provides sensitivity tests. We conclude in Section 6.

2. Background and hypothesis development

2.1. Chronology of events related to the mark-to-market accounting rule changes

Positive accounting theory suggests that accounting procedures affect costs faced by the firm that arise through contracting or political processes (Watts and Zimmerman, 1986, pp. 200–243). In the case of banks, regulators, such as the Federal Deposit Insurance Corporation (FDIC), the board of Governors of the Federal Reserve System (Board), and the Office of the Comptroller of the Currency (OCC), rely on accounting numbers to evaluate bank capital adequacy.[6] During the financial Panic of 2007 and in subsequent periods, regulators, banks and investors pressured accounting standard setters to ease fair-value requirements based on the notion that quoted market values understated intrinsic values (Bank of England, 2008). In response, on January 12, the FASB issued FSP EITF 99-20-1, amending impairment guidance of EITF no. 99-20. This guidance applies to other-than-temporary impairment (OTTI) of risky, asset-backed securities—including MBS held by banks. FSP EITF 99-20-1 allows for more managerial judgment in determining OTTI.

The timeline leading up to the FASB's issuance of fair-value-accounting guidelines in April 2009 is as follows: On March 10, 2009, in remarks made to the Council on Foreign Relations in Washington, Federal Reserve Chairman Ben Bernanke said, "We should review regulatory policies and accounting rules to ensure that they do not induce excessive (swings in the financial system and economy)."[7] Although Bernanke does not call for the suspension of fair value principles, his statement indicates a willingness to consider ways to reduce potential pro-cyclical effects of fair value accounting. On March 11, 2009, in testimony to the House Financial Services subcommittee, Mary Schapiro, SEC Chairwoman, supported changes to mark-to-market rules. On March 12, 2009, in a House Financial Services subcommittee hearing standard setters and regulators were pressed to alter existing fair value accounting rules immediately. On March 17, 2009, the FASB proposed guidance on how to determine whether an asset's market can be considered inactive and whether a transaction qualifies as a distressed transaction. The FASB issued two FASB Staff Positions (FSP) giving guidance on when markets are illiquid and on the determination of other-than-temporary impairments. On April 1, 2009, the Financial Times reported that FASB was expected to approve change in fair value rules. On April 2, 2009, the FASB affirmed the change in fair value rules after a 15-day public comment period.

On April 9, 2009, the FASB issued three final Staff Positions (157-4, 107-1/28-1, and 115-2/124-2).[8] FAS 157-4 updates FAS 157 and emphasizes fair value measurements reflect values from orderly transactions. As a result FAS 157-4 eases mark-to-market rules when the market is unsteady or inactive such as during the 2007–2009 financial crisis. FAS 115-2 and FAS 124-2 update FAS 115 and FAS 124, respectively. They require a permanent write-down of debt securities and income-statement recognition of an OTTI loss if an entity intends to sell a security prior to recovery of price to the security's amortized cost (i.e., its recorded value). However, if the firm intends to hold the security, it need only recognize the portion of the loss related to credit impairment on its income statement. The remaining loss goes to other comprehensive income.[9] The rule change can help banks report higher earnings as long as they do not sell securities with unrealized losses. Consequently the newly amended mark-to-market rule could discourage banks from selling the distressed securities.[10]

Other events during 2008 or 2009 likely affect investors' perceptions of the probability that fair value accounting rules will be eased. However, the four events described above (i.e., 12 January, 10–12 March, 17 March, and 1–2 April) are most closely related to the revision of this expectation. Therefore we focus on these events in conducting the event-study analysis.

2.2. Bank holdings of MBS

Mortgage-related products have been increasingly more popular among commercial banks in the decade prior to 2007. Bank executives believed that such securities offered favorable returns given their risk (Bank investment report, 1989). Moreover, risk-based regulatory capital guidelines assign a much lower risk rating to agency MBS and highly rated

[6] Our discussion with bank managers suggests that the determination of regulatory capital conforms to the financial information provided in accordance with U.S. GAAP. An example of the OCC's desire to avoid "two sets of accounting standards" can be seen in the way it changed its definition of Goodwill in its regulatory capital rules to conform to SFAS 141 and 142.

[7] http://www.federalreserve.gov/newsevents/speech/bernanke20090310a.htm.

[8] FSB 107-1/APB 28-1 requires disclosure of the fair value of financial instruments in interim reports.

[9] Prior rules required "other than temporary impairments" enduring beyond the security owner's intent and ability to hold to be charged against income. Prior rules also required that losses on debt securities be recognized in income if it is probable that the holder will not be able to collect amounts due.

[10] Early adopters with December fiscal-year ends can elect to apply the Staff Positions as of the first quarter of 2009. Remaining firms are required to apply this guidance beginning in the second quarter of 2009. The net financial statement effect of the rule with regard to marking-to-market securities is unclear. While the new interpretation allowed Wells Fargo to reduce unrealized losses on available-for-sale securities by $4.4B in the first quarter of 2009, JP Morgan Chase & Co and Citigroup say the interpretation had little effect (Landry, 2009). For further discussion of the effect of the rule change on the incentive for banks to hold securities with unrealized losses see comments from Katz and Westbrook on Bloomberg (March 29, 2009).

non-agency MBS than that to loans.[11] Consequently holdings of MBS enabled banks to increase their leverage. Berger and Udell (1994) echo this point by noting that standards in Basel Accord I (1988) place a higher capital requirement on commercial loans than securities, thereby creating an incentive for banks to tilt their asset allocations toward securities.

2.3. Hypothesis development

Theoretical results suggest a relation between asset prices and selling by asset holders. Some models do not require fair-value accounting as a necessary condition for feedback. For example, Adrian and Shin (2008) demonstrate pro-cyclical selling by banks, because increases in risk reduce banks' debt capacity and amplify de-leveraging causing banks to sell assets. The argument in Benmelech and Bergman (2009) is based on the feedback loop between lending, liquidity, and collateral. Under certain conditions, the feedback reinforces itself until the process reaches a low collateral value and low lending equilibrium. Brunnermeier and Pedersen (2009) provide a model that links an asset's market liquidity with banks' funding liquidity. They find that under certain conditions, funding ability is destabilizing and market liquidity and funding liquidity are mutually reinforcing, leading to liquidity spirals. Shleifer and Vishny (2009) focus on the allocation of scarce bank capital among competing activities over time. They demonstrate banks borrow short-term using collateral to fund security trading in good times, because they attempt to profit from investor sentiment. This leveraging increases the risk of selling collateralized assets at fire-sale prices in bad times. Thus, banks' cyclical proprietary trading activities create systemic risk.

Various stories link mark-to-market accounting with incentives to sell securities and therefore mark-to-market accounting can intensify the feedback effect. FAS 115 requires companies to recognize unrealized losses in MBS classified as available-for-sale securities or held-to-maturity if losses are other than temporary (OTTI). Specifically, MBS must be written-down to the fair value and the loss must be recognized in the income statement. Therefore in this context, fair-value accounting is similar to impairment accounting. Anecdotally OTTI led to massive losses for banks holding illiquid assets during the credit crisis that started in 2007.

Regulatory capital requirements, debt and compensation contracts can play a role in motivating bank managers to sell distressed assets during the negative liquidity shocks to avoid the negative consequence of OTTI recognition on the income statement. For example, Plantin et al. (2008) use compensation contract tied to accounting to show that a downward-spiral in illiquid asset prices can arise when management is focused on (short term) accounting numbers because such numbers affect compensation. Specifically in their model, traders queue for order execution in anticipation of further drop in prices. Therefore, they have an incentive to submit orders early expecting their orders to execute before the full effect of all trades is impounded in price. In this case, management could be inclined to sell relatively illiquid assets at a price below the fundamental value to pre-empt the anticipated sales of other market participants. Doing so allows them to avoid potentially larger OTTI recognition for holding these assets.

Regulation can be another force leading to bank feedback trading. In Allen and Carletti (2008), bank regulators rely on accounting numbers to assess capital adequacy. When liquidity pricing occurs, banks have incentives to sell assets below the fundamental value to avoid OTTI recognition that can reduce bank regulatory capital and lead regulators to liquidate their assets. In this way, mark-to-market accounting results in feedback trading.[12]

H1. Banks' MBS holdings are positively associated with changes in underlying asset prices.

The accounting rule changes that passed in April 2009 can ease banks' selling pressure in an illiquid market for two reasons. First, by partially delinking mark-to-market accounting from earnings, the accounting rule change (FAS 115-2) permits banks more freedom to avoid income statement recognition of OTTI in the face of unrealized losses, which in turn make it less likely that an unrealized loss would reduce earnings and regulatory capital. For example, the new accounting rule allowed Federal Home Loan Banks to recognize approximately $1.9B more retained earnings as March 31, 2009, by classifying OTTI as non credit. Second, the accounting rule change (FAS 157-4) makes it easier for firms to account for illiquid MSB as Level 3 securities. The result of this change is a potential boost in MBS fair values, which in turn reduces the magnitude of OTTI recognition, and thus the negative impact on earnings and regulatory capital.[13] As such we predict:

H2. The relation between banks' holdings of MBS and the change in underlying asset prices decreases after the mark-to-market accounting rule change.

[11] For example, the risk weight for Fannie Mae or Ginnie Mae backed agency MBS is between 10% and 20%. For the AAA rated non-agency MBS the risk weight is 20%. In contrast, for commercial and industrial loans, the risk weight is about 50–100%.

[12] Under the instructions for preparing the Consolidated Reports of Condition and Income (Call Reports), banks are required to follow FASB 115 for regulatory reporting purposes. For regulatory capital purposes, the final rule which became effective on January 27, 1995, states that net-unrealized-holding gains and losses on available-for-sale securities other than equity securities are excluded from the definition of Tier 1 capital.

[13] Laux and Leuz (2009) note that FASB/SEC guidance issued on September 30, 2008 and the FASB Staff Position (FSP FAS 157-3) already state that adjustments to observable inputs and market prices may be necessary and should be considered, and the financial statements of US banks for fiscal 2008 show that banks have been able to move assets into the Level 3 category. However, they acknowledge that it is possible that banks did not move enough assets into the Level 3 category to prevent contagion effects.

If the relaxation of mark-to-market alleviates the pressure on banks to sell MBS thereby reducing economic losses arising from sales at distressed prices, then we predict a positive market reaction for bank stocks. Our third hypothesis is formally stated as follows:

H3. Bank stocks will exhibit positive returns around events that suggest the easing of mark-to-market accounting.

Though easing mark-to-market may benefit banks' shareholders, it can reduce bondholder wealth if the rule changes allow banks to continue operation and engage in assets substitution (Lu et al., 2011). This implies a negative market reaction by bank bonds to the rule changes. However, by increasing the likelihood of solvency, the accounting rule changes permit continued bank access to short-term credit and other government subsidies (e.g., discount window borrowing and TARP). Thus the rule changes can transfer wealth from tax payers to banks' shareholders and bondholders. This implies a positive market reaction by bank bonds. Given these offsetting effects, the market reaction for bank bonds is uncertain a priori. Therefore, we state Hypothesis 4 in the null form:

H4. Bank bonds will exhibit zero returns around events that suggest the easing of mark-to-market accounting.

3. Measurements, sample selection, and research method

3.1. ABX.HE indices, Case–Shiller indices, residential REIT index, and treasury bond yield

We use the ABX index as one measure of the "market" in mark-to-market. The ABX indices are equally weighted indices of 20 subprime residential-MBS transactions that started trading in 2006, providing the primary way to gauge the market value of subprime MBS (Gorton, 2008). A new index is started every six months to track new securitizations settled during the time period. We use the AAA second-quarter-2006-vintage index for our tests to maximize length of the time-series and because our review of bank financial statement footnotes suggests that bank non-agency-MBS holdings were primarily AAA. Another advantage of using this specific index is that this index provides quotes during the crisis period, which is critical for our empirical analysis.

By providing a transparent market for securities with no secondary market, Gorton (2008) argues that the initiation of trading in the ABX index revealed information about the default risk of mortgage-backed securities that, in part, fed the Panic of 2007.[14] Using the ABX index as the measure of the "market" in mark-to-market, we assume that auditors and Repo counterparties used the ABX index as a market reference when determining the fair value of securities held by banks.[15] According to Gorton (2008), "Once the ABX indices started to drift downwards, accountants required market participants to use these indices for mark-to-market purposes, which may have led to a feedback effect…" (p. 61). We do not assume that the ABX index was a precise measure of the spreads realized by the holders of MBS. In fact, the spreads implied by ABX indices could differ from those of the cash instruments when increases in repo rates raise the cost of funding the position in cash instruments and thus increase the cost of arbitraging the difference between these spreads. We designate this portion of the ABX price the liquidity component.

Longstaff (2010) finds that ABX index returns have significant predictive ability for subsequent stock market returns, Treasury yield changes, corporate bond-spread changes, and changes in the Chicago Board Options Exchange Volatility Index as far as three weeks ahead. He also finds that shocks in the ABX market have predictive power for trading activity in financial stocks, trading disruptions in the fixed-income markets, and the availability of short-term asset-backed financing during the crisis. This evidence reinforces the view that market- and funding-liquidity effects were the major factors in the transmission of contagion during the subprime crisis. These results also imply that the ABX index is a timely indicator of liquidity in the MBS market.

To gauge the discounted cash flow component of ABX index, we use the S&P/Case–Shiller U.S. National Home Price Index. The value of MBS is linked to underlying real estate prices. In the case of subprime MBS, in particular, increases in the price of real estate were necessary to maintain collateral and permit repayment or refinancing of the underlying mortgages (Gorton, 2008). The Case–Shiller National index is a composite of constant-quality house prices calculated from data on repeat sales of single-family homes in nine regions that span the United States. Options and futures based on the Case–Shiller index are traded on the Chicago Mercantile Exchange. The index is updated monthly and the national index is normalized to have a value of 100 in January 2000. We obtain US S&P/Case–Shiller 20-city-composite home-price index from Datastream.

An alternative measure of the discounted cash flow component of ABX index is residential real estate investment trust index. We obtain monthly returns from the U.S. Datastream residential REITS index (Mnemonic: RITRSUS). This index is composed of seven residential REITS that focus on leasing residential apartments.

To measure the effect of discount-rate changes on MBS value, we include the monthly change in the yield of constant-maturity, 30-year US Treasury bonds obtained from the St. Louis Federal Reserve website.[16] However, the change in

[14] Gorton (2009) provides a more detailed discussion of the ABX indices. See also Markit (2006).

[15] Repos are short-term loans secured by the underlying financial instrument (e.g., MBS). Footnotes in the 2008 and 2009 10K reports of Citibank indicate that the ABX index is used in their valuation method.

[16] http://research.stlouisfed.org/fred2/categories/115. As an alternative measure of the underlying discount rate, we apply the return on the BBB-rated corporate bond index for non-financial corporations (BBB). All our results are qualitatively similar to those tabulated based on the estimation of including the change of US Treasury bond yield.

Treasury bond yield can also reflect liquidity constraints, and by controlling for it, we remove a portion of the liquidity effect we seek to isolate. During the financial crises, the investors sought safety, driving down yields of Treasury bonds.

To extract the liquidity component of the ABX index, we regress the monthly ABX index return on the monthly Case/Shiller index return, the residential REIT index return and the yield change in Treasury bonds, and use the residual of the regression as a measure of the liquidity component of ABX index return. Results of this estimation are provided in Panel A of Appendix A. As expected, the coefficients on Case/Shiller index return and the residential REIT index return are positive, though only the REIT index returns is marginally significant. The positive coefficient on the Treasury bond yield change suggests that the fluctuation of Treasury yield reflects funding liquidity. The three variables explain about 39% of the variation of ABX index return. In Panel B, we present summary statistics for ABX index return and the residual and the predicted ABX index return. These returns are cumulated over each quarter based on the monthly data estimated from Panel A. ABX index return is negative on average over the sample period and the residual return has a mean of zero.

3.2. Sample selection

We retrieve bank quarterly financial statements from the Federal Reserve Bank of Chicago website over the period between 2006Q4 and 2010Q1. MBS daily/weekly returns (or monthly residual ABX index return) are cumulated over each fiscal quarter and matched with bank quarterly financial statement data. Our initial sample contains 12,927 bank-quarter observations for 1120 unique banks. For our feedback tests, we delete bank-quarter observations with a zero beginning non-agency MBS balance. This sample contains 5068 bank-quarter observations for 560 unique banks. Our returns tests use a subsample of 178 public banks.

3.3. Research method

3.3.1. Test of Hypothesis 1

To test Hypothesis 1, we estimate Eqs. (1) and (2), by regressing the change in bank MBS holdings on index returns and on the two components of index returns using 3384 quarterly bank observations with positive non-agency MBS prior to the announcement of April 2009. The standard errors are two-way clustered by time and firm to derive p-values:

$$\Delta\text{NA\_MBS\_HC}_{i,q} = \beta_0 + \beta_1 * \text{ABX\_RET}_q + \beta_2 \Delta\text{LOAN}_{i,q} + \beta_3 \Delta\text{TA}_{i,q} + \beta_4 \Delta\text{AG\_MBS\_HC}_{i,q} + \varepsilon_{i,q}, \quad (1)$$

$$\Delta\text{NA\_MBS\_HC}_{i,q} = \beta_0 + \beta_1 * \text{RES\_RET}_q + \beta_2 * \text{PRED\_RET}_q + \beta_3 \Delta\text{LOAN}_{i,q} + \beta_4 \Delta\text{TA}_{i,q} + \beta_5 \Delta\text{AG\_MBS\_HC}_{i,q} + \varepsilon_{i,q}, \quad (2)$$

where ΔNA_MBS_HC is the change in historical cost in a bank's holdings of available-for-sale and held-to-maturity non-agency MBS over quarter q as a percentage of total assets. Note that MBS can be classified on a bank's balance sheet as trading assets, available for sale, or held to maturity. ABX_RET is return on the ABX.HE index; RES_RET and PRED_RET are the two components of return on the ABX.HE index: the residual and the predicted ABX.HE index return as discussed in Appendix A. Change in loan portfolio (ΔLOAN), change in total assets (ΔTA), and change in historical cost in agency MBS (ΔAG_MBS_HC) are variables designed to control for changes in bank investment policies in quarter q. Changes in investment policy can lead to changes in MBS that are not due to feedback. For example, banks might reduce loan activity or contract in size leading to a change in the relative proportion of MBS securities unrelated to MBS trading.

Hypothesis 1 predicts that the change in MBS prices is positively associated with the change in bank holdings of MBS. Theory does not provide detailed guidance with regard to the time-lag between asset price changes and selling behavior, but Plantin et al. (2008) suggest close time proximity between returns and trading. In their model, traders queue for order execution and have an incentive to submit orders immediately. By queuing, they expect their orders to execute before the full effect of all trades is impounded in price. However, use of contemporaneous prices risks reverse causality. Bank sales could lead to price drops. Available data on the total value of the non-agency MBS outstanding relative to the value of bank holdings indicates that banks own approximately 11% of non-agency MBS during our sample period.[17] This suggests that concerted trading by banks has a limited effect on non-agency MBS prices. Thus, reverse causality is likely to be a second-order effect. Therefore, we measure ABX_RET and its two components contemporaneously with the change in non-agency MBS holdings.[18] We expect feedback to lead to a positive coefficient on β_1.

3.3.2. Test of Hypothesis 2

To examine Hypothesis 2, we create an indicator variable (POST) coded as 1 if a quarter falls in the period after the first quarter of 2009, subsequent to the mark-to-market rule change, and 0 otherwise. While firms were permitted to apply the rule clarification to the first quarter of 2009, MBS trading for the first quarter was already completed by the announcement

[17] Our measure of the value of the non-agency MBS market comes from Securities Industry and Financial Markets Association (2009), which provides measures of non-agency MBS outstanding between 2004 and 2009. We determine total bank holdings by summing across the holdings of banks in our sample. At the end of Q4 2007 (Q4 2008, Q3 2009) banks held 11.2 (9.8, 12)% of non-agency MBS outstanding.

[18] To capture time lags between price changes and bank trading, we also include a lagged ABX_RET, and lagged RES_RET and lagged PRED_RET in the model as a robustness check in Section 5.2.

date. This indicator variable is then interacted with the RES_RET$_q$, PRED_RET$_q$, and other control variables in Eq. (2). If the rule change reduces feedback trading, we expect the coefficient on the interaction with RES_RET$_q$ to be negative.

3.3.3. Tests of Hypotheses 3 and 4

Hypotheses 3 and 4 predict a positive return for bank stocks and uncertain returns for bank bonds around the events associated with the relaxation of mark-to-market rule. To test these two hypotheses, we use return window cumulating all events leading up to the passage of the mark-to-market rule changes. The window encompasses 15 trading days, 01/09/2009–01/13/2009, 03/09/2009–03/13/2009, 03/16/2009–03/18/2009, and 03/31/2009–04/03/2009. We calculate abnormal returns for banks' stock during the cumulative event windows, where abnormal stock return is adjusted for firm size and book-to-market using Fama-French 25 size and book-to-market portfolio stock returns. Similarly, abnormal bond returns are calculated using Barclays Capital U.S. credit bond index (ABRET_BOND) and Barclays aggregate bond index (ABRET_AGG_BOND).[19] We conduct *t*-tests based on the standard deviation of 15-day banks' stock or bond return over the period 1 January 2008–31 March 2010.

4. Empirical results

4.1. Summary statistics

Fig. 1 plots bank holdings of agency and non-agency MBS measured at historical cost as a percentage of total assets using the full sample of 12,927 observations over the period beginning in the first quarter of 2005 and ending in the first quarter of 2010. We also plot the ABX.HE index, and US S&P/Case–Shiller 20-city-composite home-price (hereafter "Case–Shiller index") in Fig. 1. Non-agency MBS holdings are rescaled by multiplying by 10 and Case–Shiller index is rescaled by dividing by 2 to facilitate visual comparisons of the trend lines. Because the latest available financial statements of bank holding companies are March 31, 2010, the series of bank holdings of MBS stops at the end of March 31, 2010. As discussed earlier, we use the ABX.HE second-quarter-of-2006-vintage index to measure mortgage backed security market performance and quotes for this series begin in the third quarter of 2006.

Both the ABX.HE index and the Case–Shiller index slope downward and are almost parallel to each other over the period between the third quarter of 2006 and the second quarter of 2007, reflecting that these two indices capture similar housing market characteristics before financial crisis. However, in the third quarter of 2007, ABX.HE index drops more significantly than the Case–Shiller index, potentially indicating intensified problems in subprime and/or divergence of the ABX.HE index from cash-based fundamentals as institutions paid a premium for insurance. The sample period encompasses the fall of Bear Sterns, which announced its sale to JP Morgan on March 16, 2008. This episode might have increased liquidity concerns. The two indices almost simultaneously reached the bottom in the first and second quarter of 2009, coinciding with the announcement of the mark-to-market accounting rule change and/or other Federal Reserve rescue programs of agency and non-agency MBS.[20] The ABX.HE index dropped from 100 in 2007 to less than 50 in 2009. Thus, it lost over half of its value during the financial crisis. The drop of the Case–Shiller index was smaller (from 190 at the end of 2006 to 137 in the third quarter of 2009). Both indices rose in the fourth quarter of 2009 though this trend is more pronounced for ABX.HE index. The divergence of the rising pattern in ABX.HE index from Case–Shiller index after the first quarter of 2009 seems to suggest that the liquidity pressure on the MBS market is relaxed to a greater extent than the change in the underlying cash flows. Note that as housing prices fall and default risk rises, the securities underlying the ABX.HE index, take on the characteristics of a levered equity stake in the mortgage portfolio. Therefore, the index magnifies changes in underlying cash flows and the wedge between the ABX.HE index and Case–Shiller index could reflect this leverage effect.

In contrast to the dramatic fall in the MBS market and the housing market during the financial crisis, bank holdings of both agency and non-agency MBS relative to total assets remain fairly stable over 2007, followed by an increase in 2008 and stability in 2009. Starting from the first quarter of 2010, banks' holdings of non-agency MBS decrease seeming to revert to the pre-crisis level (i.e., the level of 2005). Fig. 1 suggests no evidence of bank fire sales in the midst of the decline in the asset market.

Table 1 Panel A reports the summary statistics for the full sample of banks (i.e., including those with zero non-agency MBS holdings). Agency MBS constitutes the majority of banks' MBS holdings. For both agency and non-agency MBS, MBS classified as "available-for-sale" dominate MBS classified as both "trading" and "held-to-maturity." Because the proportion of MBS classified as "trading" is relatively small and banks do not report the historical cost for these assets, we used bank holdings of "available-for-sale" and "held-to-maturity" MBS for the empirical tests. Loans are the major assets on banks'

[19] This benchmark removes some of the effect we seek to measure because economy is likely to be affected by the financial sector.

[20] For example, the Federal Reserve created the Term Asset-Backed Securities Loan Facility in November 2008. Under the program, the Federal Reserve Bank of New York proposed lending up to $200 billion on a non-recourse basis to investors to purchase AAA-rated ABS. The idea is that banks would be more willing to extend credit knowing that investors stand ready to purchase the loans. At the time, the Federal Reserve Board also indicated that funds may be expanded to include commercial mortgages, non-agency residential mortgages and/or other asset classes. We find significantly positive ABX.HE returns during the week when this facility was announced (November 25, 2008).

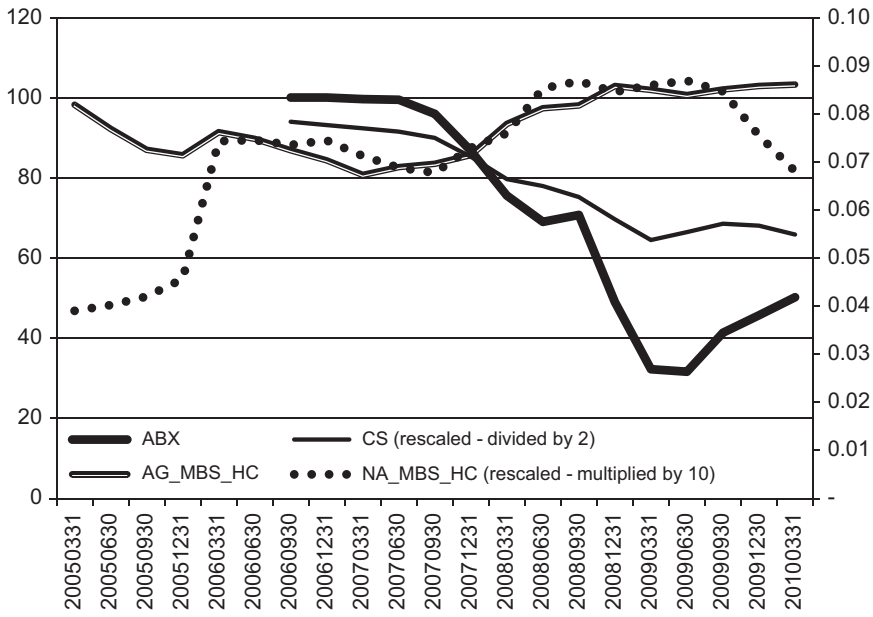

Fig. 1. Average bank holdings of agency and non-agency MBS and other state variables. This figure shows bank holdings of mortgage-backed securities, the ABX index (ABX) and the Case–Shiller U.S. Home Price Index (CS) overtime. The left axis measures the value of the ABX index and the Case–Shiller U.S. Home Price Index, and the right axis measures agency and non-agency MBS (AG_MBS_HC and NA_MBS_HC, respectively) as a percentage of total assets. The lines depict the average AG_MBS_HC and the average NA_MBS_HC for 1120 banks in our sample. See Appendix B for variable descriptions.

balance sheet ranging from 65% for the first quartile to 78% for the third quartile. Banks assets are highly right skewed with a mean of $15 billion and a median of less than $1 billion.

Panel B shows summary statistics for the subsample of 5068 observations containing 560 unique banks with positive non-agency MBS in the prior quarter. As expected, these banks hold higher proportion of both agency and non-agency MBS compared to other banks. This increase is offset by holding a lower proportion of loan assets. In addition, the positive-non-agency-MBS banks are larger in size. It is noteworthy that the fair value of agency MBS is higher than its corresponding historical cost while the fair value of non-agency MBS is lower than its corresponding historical cost at both mean and median. This result provides initial evidence that the market decline in MBS prices negatively affects the fair value of non-agency MBS rather than agency MBS reported by banks on their balance sheet, which supports our focus on non-agency MBS.

Panel C reports cross-sectional means over time in the proportion of both fair value and historical cost of agency MBS relative to bank total assets in the first two columns, the ratio of fair value to historical cost in the third column, and the change in this ratio in the fourth column. Columns 5–8 provide the same information for non-agency MBS. The fair value of agency MBS is slightly lower than its corresponding historical cost from the last quarter of 2006 to the third quarter of 2008. However, from the last quarter of 2008 up to one year later, the fair value surpassed the historical cost of agency MBS possibly due to reduced interest rates. The change in the ratio of fair value to historical cost of agency MBS is fairly stable over the sample period.

In contrast, the fair value is lower than the historical cost for non-agency MBS throughout the sample period and this ratio decreases from the second quarter of 2007 until the first quarter of 2009, and then starts to pick up during the last two quarters of the sample period. Given the significant MBS market price decline during the sample period, it is not surprising that the change in the FV/HC ratio is negative for almost all sample periods with the biggest drop occurring in the last quarter of 2008. In the last two columns of panel C, we show the quarterly return for ABX index. A simple Spearman correlation between the mean of quarterly change in FV/HC across all banks in this sample and ABX index return is positive and statistically significant at the 0.01 level for non-agency MBS but the correlation is not statistically significant for agency MBS. Therefore, Panel C suggests that banks adjustments of non-agency MBS fair value track the ABX index. These results indicate that banks are marking-to-market and that the ABX index returns are correlated with this behavior. This result provides support for our use of the ABX index as a proxy for the market—a necessary condition for the ability of our tests to detect feedback.

Table 2 shows Pearson (Spearman) correlations among variables in the main regression for the subsample during the period prior to the first quarter of 2009, the passage of the mark-to-market accounting rule change. Three insights emerge from this table. First, change in non-agency MBS is positive and significantly related with the residual but not the predicted ABX index return, suggesting that banks change MBS holdings in response to liquidity shocks. Second, the proportion of loans to total assets is positively related with the predicted ABX index return, suggesting

Table 1
Summary statistics.

Variable	N	Mean	Std. Dev.	Q1	Median	Q3
Panel A: Summary statistics for 1120 banks for the period 2006Q4–2010Q1						
ag_mbs_tr_fv	12,927	0.04	0.46	0.00	0.00	0.00
ag_mbs_afs_fv	12,927	7.29	6.57	2.12	5.88	10.59
ag_mbs_htm_fv	12,927	0.64	2.54	0.00	0.00	0.01
NA_mbs_tr_fv	12,927	0.01	0.17	0.00	0.00	0.00
NA_mbs_afs_fv	12,927	0.63	1.84	0.00	0.00	0.33
NA_mbs_htm_fv	12,927	0.08	0.67	0.00	0.00	0.00
loans	12,927	69.73	12.53	64.06	71.67	77.83
TA	12,927	15.16	121.86	0.64	0.96	2.12
NPL	12,927	2.42	3.36	0.56	1.30	2.89
TOTALCAP	12,927	13.54	17.71	11.18	12.51	14.48
Panel B: Summary statistics for sub-sample of 560 banks and 5068 bank quarters with non-agency MBS holdings for the period 2006Q4–2010Q1						
ag_mbs_afs_fv	5068	9.06	6.54	4.56	7.99	12.18
ag_mbs_afs_HC	5068	9.00	6.48	4.52	7.94	12.09
ag_mbs_HTM_fv	5068	0.93	3.27	0.00	0.00	0.03
ag_mbs_HTM_HC	5068	0.92	3.26	0.00	0.00	0.03
NA_mbs_afs_fv	5068	1.58	2.65	0.13	0.58	1.88
NA_mbs_afs_HC	5068	1.69	2.81	0.15	0.62	2.04
NA_mbs_HTM_fv	5068	0.21	1.05	0.00	0.00	0.00
NA_mbs_HTM_HC	5068	0.23	1.16	0.00	0.00	0.00
loans	5068	67.12	12.84	62.11	69.26	75.31
TA	5068	34.06	191.10	0.76	1.38	5.17
NPL	5068	2.66	3.17	0.67	1.52	3.44
TOTALCAP	5068	13.43	10.86	11.22	12.49	14.49
ΔAG_MBS_HC	5068	0.09	1.54	(0.53)	(0.07)	0.57
ΔNA_MBS_HC	5068	(0.02)	0.36	(0.10)	(0.02)	(0.00)
ΔLOANS	5068	(0.23)	2.34	(1.40)	(0.05)	1.09
ΔTA	5068	1.60	5.88	(1.02)	0.94	2.98

Date	N	Agency MBS				Non-agency MBS				Index
		AG_MBS_FV (% of TA)	AG_MBS_HC (% of TA)	AG_MBSDIFF (FV as % of HC)	ΔAG_MBSDIFF (FV as % of HC)	NA_MBS_FV (% of TA)	NA_MBS_HC (% of TA)	NA_MBSDIFF (FV as % of HC)	ΔNA_MBSDIFF (FV as % of HC)	ABX_RET (%)
		1	2	3	4	5	6	7	8	9
Panel C: Mean statistics for the fair value and the historical cost of bank holdings of agency and non-agency MBS and the contemporaneous ABX index returns.										
31 Dec 06	331	9.63	9.78	98.46	0.27	1.98	2.01	99.39	0.03	0.00
31 Mar 07	315	9.32	9.43	98.96	0.42	2.06	2.07	99.75	0.34	−0.55

Table 1 (*continued*)

Date	*N*	Agency MBS				Non-agency MBS				Index
		AG_MBS_FV (% of TA)	AG_MBS_HC (% of TA)	AG_MBSDIFF (FV as % of HC)	ΔAG_MBSDIFF (FV as % of HC)	NA_MBS_FV (% of TA)	NA_MBS_HC (% of TA)	NA_MBSDIFF (FV as % of HC)	ΔNA_MBSDIFF (FV as % of HC)	ABX_RET (%)
		1	2	3	4	5	6	7	8	9
30 Jun 07	317	9.27	9.50	97.71	−1.21	1.95	1.98	98.87	−0.90	−0.01
30 Sep 07	324	9.36	9.47	98.94	1.19	1.85	1.88	98.77	0.09	−3.48
31 Dec 07	331	9.35	9.36	99.86	1.00	1.96	1.99	98.69	−0.07	−9.83
31 Mar 08	328	9.74	9.63	101.27	1.28	1.94	2.03	96.54	−2.34	−13.18
30 Jun 08	346	9.83	9.91	99.38	−1.86	1.99	2.12	94.79	−1.92	−6.20
30 Sep 08	360	9.82	9.83	99.93	0.59	1.88	2.08	91.54	−3.33	−0.61
31 Dec 08	364	10.35	10.20	101.57	1.61	1.66	1.97	86.50	−5.08	−29.62
31 Mar 09	368	10.32	10.09	102.42	0.83	1.69	2.02	85.86	−0.65	−44.84
30 Jun 09	386	10.17	9.98	102.03	−0.30	1.75	2.03	87.91	1.61	9.81
30 Sep 09	433	10.57	10.30	102.78	0.79	1.65	1.83	91.93	2.74	26.52
31 Dec 09	438	10.60	10.38	102.23	−0.54	1.48	1.63	93.18	0.57	10.49
31 Mar 10	427	10.71	10.47	102.53	0.29	1.37	1.49	95.49	1.10	9.66
All qtrs	5068	9.98	9.91	100.73	0.30	1.78	1.92	93.95	−0.44	−3.70

Panel A reports bank characteristics for the full sample of 1120 banks and 12,927 bank quarters for the period 2006Q4–2010Q1 including agency and non-agency MBS holdings by type (Trading, AFS or HTM), loan portfolio as percentage of total assets, securities sold under agreements to repurchase as a % of total assets, total assets, and total regulatory capital ratio. Panel B reports all the aforementioned descriptive statistics for a sub-sample of 560 banks for the period 2006Q4–2010Q1 that have non-zero non-agency MBS holdings including changes in Agency MBS holdings, changes in non-agency MBS holdings, changes in loan portfolio and changes in total assets. Panel C presents mean statistics for the fair value, the historical cost, the difference between the fair value and the historical cost, and the change in the difference between the fair value and the historical cost of the agency and non-agency MBS portfolios for the sub-sample of banks that have non-zero non-agency MBS holdings. It also shows the contemporaneous ABX index return by quarter. Variable definitions are included in Appendix B.

Table 2
Correlations.

Pearson\Spearman	ABX_RET	RES_RET	PRED_RET	Δag_mbs_HC	Δna_mbs_HC	Δloans	Δta	NA_MBS_HC	NPL	TOTALCAP
ABX_RET		−0.0228	0.8726	−0.1341	−0.0001	0.1751	0.0042	−0.0157	−0.4171	0.0367
		(0.185)	(<0.001)	(<0.001)	(0.995)	(<0.001)	(0.807)	(0.360)	(<0.001)	(0.033)
RES_RET	0.6419		−0.4670	0.0395	0.0312	−0.0049	0.0412	0.0056	−0.0037	−0.0593
	(<0.001)		(<0.001)	(0.021)	(0.070)	(0.775)	(0.017)	(0.743	(0.829)	(0.001)
PRED_RET	0.6753	−0.1321		−0.1127	−0.0028	0.1747	−0.0134	−0.0137	−0.3760	0.0456
	(<0.001)	(<0.001)		(<0.001)	(0.870)	(<0.001)	(0.437)	(0.426)	(<0.001)	(0.008)
Δag_mbs_HC	−0.0509	0.0419	−0.1061		0.0691	−0.1862	−0.0637	−0.0449	0.0914	0.0187
	(0.003)	(0.015)	(<0.001)		(<0.001)	(<0.001)	(<0.001)	(0.009)	(<0.001)	(0.278)
Δna_mbs_HC	0.0246	0.0296	0.0033	0.0120		0.0344	−0.2014	−0.2607	0.0524	−0.0356
	(0.153)	(0.085)	(0.848)	(0.484)		(0.046)	(<0.001)	(<0.001)	(0.002)	(0.039)
Δloans	0.2064	0.0899	0.1804	−0.1868	−0.0417		−0.4387	0.0115	−0.1017	−0.0297
	(<0.001)	(<0.001)	(<0.001)	(<0.001)	(0.015)		(<0.001)	(0.503)	(<0.001)	(0.084)
Δta	0.0086	0.0400	−0.0274	−0.0628	−0.0920	−0.3955		−0.0416	−0.1530	−0.0814
	(0.619)	(0.020)	(0.111)	(<0.001)	(<0.001)	(<0.001)		(0.016)	(<0.001)	(<0.001)
NA_MBS_HC	0.0029	−0.0013	0.0050	−0.0172	0.0233	−0.0307	0.0385		−0.0172	0.0723
	(0.867)	(0.940)	(0.773)	(0.319)	(0.176)	(0.074)	(0.025)		(0.318)	(<0.001)
NPL	−0.3476	−0.1815	−0.2747	0.0650	−0.0048	−0.1118	−0.1087	0.0071		−0.0743
	(<0.001)	(<0.001)	(<0.001)	(0.000)	(0.781)	(<0.001)	(<0.001)	(0.679)		(<0.001)
TOTALCAP	−0.0025	−0.0218	0.0177	0.0090	0.0024	−0.0048	−0.0350	0.0111	−0.0773	
	(0.884)	(0.206)	(0.303)	(0.601)	(0.887)	(0.780)	(0.042)	(0.519)	(<0.001)	

This table reports the Pearson (below the diagonal) and Spearman correlations for 3384 firm-year observations for the period prior to the accounting rule change, i.e., 2006Q4–2009Q1. Variable definitions are included in Appendix B. *P* values are in parentheses.

reduced banks lending in response to the cash flow shocks. Third, we find a significantly negative correlation between change in non-agency MBS and change in loans. Therefore, banks' lending activities substitute their non-agency MBS holdings, which is consistent with Shleifer and Vishny's (2009) model of a substitute relation between these activities.

4.2. Multivariate analysis of bank MBS holdings and MBS index returns

Table 3 Panel A presents results of testing Hypothesis 1 based on Eq. (1) using both ABX index return and its predicted and residual components for the positive non-agency MBS subsample. The number of observations drops slightly from 5068 to 3384 due to the exclusion of observations after the accounting rule change. ABX index return is included for the first two columns, and the residual and the predicted components are included in the last two columns. The first column estimates Eq. (1) without the control variables, and the coefficient on ABX_RET_q is positive and statistically not significant at the 0.10 level. The second column estimates Eq. (1) with the three additional controls and the coefficient on ABX_RET_q is positive and becomes statistically significant at the 0.10 level.

When we move to the columns 3 and 4, which employ the residual and the predicted ABX return in the regression, the coefficient on RES_RET_q is positive and statistically significant at the 0.05 level (two-tailed test) in column 4. In contrast, the coefficient on $PRED\_RET_q$ is positive but statistically not significant at the 0.10 level in either column 3 or 4. A one-tailed *t*-test that the coefficient on RES_RET is less than or equal to that on PRED_RET rejects the null at the 0.05 level, suggesting that the liquidity shocks in the MBS market drive bank selling of MBS.

The evidence suggests that banks tend to sell non-agency MBS in response to liquidity portion of the price decline. The coefficient on change in loans is negative and statistically significant at the 0.05 level suggesting that banks substituted lending for MBS holdings. Thus, the feedback effect does not appear to constrain banks' supply of liquidity in lending markets. The coefficient on the change in agency MBS is negative but statistically insignificant at the 0.10 level suggesting that the substitute relation between the two types of MBS holdings is weaker than the substitute relation between non-agency MBS holdings and loans.

The effect of liquidity shock in MBS market on bank holdings of non-agency MBS is of moderate economical significance. Based on results reported in column (4), a one standard deviation decrease in the ABX residual return (0.102) is associated with a decrease in non-agency MBS holdings of 0.00016, which is equivalent of 0.8% of non-agency MBS holdings. The effect is small in proportion to total non-agency MBS holdings. However, average quarterly turnover of bank non-agency MBS portfolios is 10% mean (7% median).[21] Viewed relative to normal turnover, the trading prompted by liquidity effects becomes more economically significant. In comparison, we also assess the effect of fundamental shock in

[21] On an annual basis a quarterly turnover of 10% is equivalent to an annual turnover of 40%. For comparison, the annual portfolio turnover ratio for the Vanguard Index 500 fund is approximately 12%, while the actively managed Windsor fund has a turnover of 60%.

Table 3
Multivariate regression of change in bank holdings of non-agency MBS and other state variables.

Panel A: ABX index returns, predicted ABX return, residual ABX index return and change in bank holdings of non-agency MBS

Variable	Estimate			
	1	2	3	4
Intercept	0.0001	0.0004	0.0001	0.0003
	(0.495)	(0.080)	(0.628)	(0.123)
ABX_RET_q	0.0006	0.0012		
	(0.321)	(0.079)		
RES_RET_q			0.0010	0.0016
			(0.101)	(0.039)
$PRED\_RET_q$			0.0002	0.0008
			(0.871)	(0.613)
$\Delta LOANS_{i,q}$		−0.0178		−0.0177
		(0.013)		(0.013)
$\Delta TA_{i,q}$		−0.0085		−0.0086
		(0.001)		(0.001)
$\Delta AG\_MBS\_HC_{i,q}$		−0.0037		−0.0042
		(0.666)		(0.628)
Adj. R^2	0.00	0.02	0.00	0.02
N	3384	3384	3384	3384

Panel B: Change in bank holdings of non-agency MBS for banks with high non-agency MBS holdings, high REPO borrowings and low total capital ratio

Variable	Estimate					
	HIGH NA_MBS_HC	**LOW NA_MBS_HC**	**HIGH NPL**	**LOW NPL**	**HIGH TOTALCAP**	**LOW TOTALCAP**
	1	2	3	4	5	6
Intercept	0.0003	0.0003	0.0003	0.0003	0.0003	0.0004
	(0.376)	(0.010)	(0.122)	(0.237)	(0.092)	(0.194)
RES_RET_q	0.0031	0.0000	0.0023	0.0007	0.0006	0.0027
	(0.007)	(0.976)	(0.030)	(0.303)	(0.352)	(0.015)
$PRED\_RET_q$	0.0068	0.0007	0.0010	0.0002	0.0005	0.0010
	(0.784)	(0.285)	(0.485)	(0.915)	(0.709)	(0.589)
$\Delta LOANS_{i,q}$	−0.0275	−0.0037	−0.0124	−0.0190	−0.0169	−0.0188
	(0.010)	(0.484)	(0.020)	(0.048)	(0.009)	(0.066)
$\Delta TA_{i,q}$	−0.0159	0.0007	−0.0035	−0.0126	−0.0099	−0.0062
	(<0.001)	(0.731)	(0.248)	(<0.001)	(0.004)	(0.040)
$\Delta AG\_MBS\_HC_{i,q}$	−0.005	−0.0038	−0.0061	−0.0028	−0.0014	−0.0099
	(0.609)	(0.620)	(0.615)	(0.809)	(0.853)	(0.419)
Adj. R^2	0.04	0.04	0.01	0.04	0.02	0.02
N	1694	1690	1694	1690	1694	1690

This table reports regression results. Panel A reports results on the relation between the changes in non-agency MBS security holdings and the ABX index returns as specified in Eq. (1), and the relation between the changes in non-agency MBS security holdings and the predicted ABX index returns and the residual of ABX index returns as specified in Eq. (2), for the period prior to the rule change i.e., 2006Q4–2009Q1. Panel B reports the results on the relation between the changes in non-agency MBS security holdings and the predicted ABX index returns and the residual of ABX index returns for banks with non-agency MBS security holdings above (below) median, banks with non-performing loans above (below) median and banks with a total capital ratio above (below). The computation of the residual ABX returns is shown in Appendix A and the variable definitions are provided in Appendix B. Standard errors are corrected for two-way clustering by time and firm. *P* values are in parentheses.

$$\Delta NA\_MBS\_HC_{i,q} = \beta_0 + \beta_1 * ABX\_RET_q + CONTROLS + \varepsilon_q \quad (1)$$

$$\Delta NA\_MBS\_HC_{i,q} = \beta_0 + \beta_1 * RES\_RET_q + \beta_2 * PRED\_RET_q + CONTROLS + \varepsilon_q \quad (2)$$

MBS market. A one standard deviation decrease in the ABX predicted return (0.147) is associated with a decrease in non-agency MBS holdings of 0.00011, which is equivalent of 0.5% of non-agency MBS holdings.

Next, we investigate whether banks' feedback trading is related with their holdings of non-agency MBS, financial health and regulatory pressure. The feedback effect is expected to be more pronounced if banks hold economically significant amounts of non-agency MBS assets, show poor financial performance, and are close to the minimum regulatory capital requirement. If MBS holdings are larger, price change will have a more significant effect on the performance measures assumed to induce feedback (Plantin et al., 2008; Allen and Carletti, 2008), and as bank performance deteriorates regulatory and creditor oversight intensifies, adding weight to short-term performance measures. Panel B shows the

results of estimating Eq. (2) for the six subsamples partitioned based on the sample median non-agency MBS holdings, non-performing loans, and total regulatory capital ratio. We find that only banks with high non-agency MBS, high non-performing loans, and low total capital ratio sell MBS in response to MBS market liquidity shocks. In contrast, banks with low non-agency MBS, low non-performing loans and high total capital ratio do not show any sign of feedback trading. To help put the results into economic perspective, a one standard deviation decrease in the residual return is associated with a decrease of 1.58% non-agency MBS holdings for banks with high non-agency MBS compared to an almost zero decrease in non-agency MBS holdings for banks with low non-agency MBS. Similarly, a one standard deviation decrease in the residual return is associated with a decrease of 1.15% (1.35%) non-agency MBS holdings for banks with high non-performing loans (low total capital ratio) compared to a decrease of 0.34% (0.29%) non-agency MBS holdings for banks with low non-performing loans (high total capital ratio). In sum, Table 3 suggests that the existence of banks' feedback trading is related with the level of MBS holdings, financial health, and regulatory pressure.

4.3. Post-event changes in feedback-related trading

Hypothesis 2 predicts that if the change of mark-to-market accounting requirements alleviates pressure on banks to unload MBS at fire sale prices, feedback should be reduced after the change. Table 4 reports results of testing this hypothesis by expanding Eq. (2) as discussed in Section 3.3.1. Consistent with the results in Table 3, the coefficient on RES_RET_q is positive and statistically significant at the 0.05 level. More importantly, the interaction between RES_RET_q and POST is negative and statistically significant at the 0.01 level suggesting that the change in mark-to-market rule reduces banks' feedback trading in MBS. In fact, the magnitude of the interaction coefficient suggests banks exhibit the opposite behavior, selling on price increases and buying on price declines after the accounting rule change. In contrast, the interaction between $PRED\_RET_q$ and POST is positive and statistically not distinguishable from 0 suggesting that the change in mark-to-market rule does not influence the cash-flow effect on banks' trading in MBS. A one-tailed *t*-test that the coefficient on RES_RET_q*POST is less than or equal to that on $PRED\_RET_q$*POST rejects the null at the 0.01 level, suggesting that the effect of liquidity shocks rather than cash flow shocks is reduced following the accounting rule change. Therefore, after the mark-to-market accounting rule changes, banks seem to resume their role of providing liquidity.

Table 4
Post April 2009 non-agency MBS selling behavior.

Variable	Estimate
Intercept	0.0003
	(0.119)
RES_RET_q	0.0016
	(0.036)
RES_RET_q*POST	−0.0068
	(<0.001)
$PRED\_RET_q$	0.0008
	(0.608)
$PRED\_RET_q$*POST	0.0015
	(0.404)
$\Delta LOANS_{i,q}$	−0.0177
	(0.011)
$\Delta LOANS_{i,q}$*POST	0.0157
	(0.040)
$\Delta TA_{i,q}$	−0.0086
	(0.001)
$\Delta TA_{i,q}$*POST	0.0064
	(0.045)
$\Delta AG\_MBS\_HC_{i,q}$	−0.0042
	(0.623)
$\Delta AG\_MBS\_HC_{i,q}$*POST	−0.0199
	(0.030)
POST	−0.0012
	(<0.001)
Adj. R^2	0.03
N	5068

This table reports results on the relation between the changes in non-agency MBS security holdings and the residual ABX index returns over the period 2006Q4–2010Q1 as specified in Eq. (3). POST is an indicator variable equal to 1 for the quarters after 2009Q1. The computation of the residual ABX returns is provided in Appendix A and the variable definitions are shown in Appendix B. Standard errors are corrected for two-way clustering by time and firm. *P* values are in parentheses.

$$\Delta NA\_MBS\_HC_{i,q} = \beta_0 + \beta_1 * RES\_RET_q + \beta_2 * RES\_RET_q * POST + \beta_3 * PRED\_RET_q + \beta_4 * PRED\_RET_q * POST + \beta_5 * POST + CONTROLS + CONTROLS * POST + \varepsilon_q \quad (3)$$

Table 5
Abnormal bank stock returns around events surrounding the changes of mark-to-market accounting requirements.

	ABRET		
	HIGH	**LOW**	**DIFF**
NA_MBS_HC	0.2932 (<0.001), 65 banks	0.1385 (<0.001), 70 banks	0.1546 (0.021)
NON_PERFORMING	0.3003 (<0.001), 70 banks	0.1191 (<0.001), 65 banks	0.1812 (0.005)
TOTALCAP	0.2162 (<0.001), 67 banks	0.2099 (<0.001), 68 banks	0.0063 (0.925)

This table presents the mean cumulative abnormal daily stock returns (adjusted for Fama-French factors) for the public banks in our sample with non-zero non-agency MBS security holdings, on four event dates relevant to the change of mark-to-market accounting requirements, viz., 12 Jan 2009, 10 March 2009–12 March 2009, 17 March and 1 April–2 April 2009, and a day prior and after each of these sub-periods. The HIGH (LOW) groups are coded for banks with non-agency MBS holdings above (below) median, banks with non-performing loans above (below) median and banks with a total capital ratio above (below), where all these variables as coded as dummy variables equal to 1 for above median values and 0 for below median values and measured for the quarter 2008Q4 before the rule change. *P*-values under the mean are based on *Z*-statistics computed using the standard deviation of daily abnormal returns (cumulative over 15 days, using non-overlapping windows), excluding event days, for the period January 2008–March 2010. *P* values are in parentheses derived from robust standard errors. The variable definitions are provided in Appendix B.

In contrast to a decrease of 0.8% in non-agency MBS holdings in the pre-rule-change period, a one standard deviation decrease in the residual return is associated with a 2.6% increase in non-agency MBS holdings in the post-rule change period.

The interaction between POST and change in loan portfolio is positive and statistically significant at the 0.05 level, suggesting that the substitution effect between lending activities and non-agency MBS holdings is reduced after the accounting rule change. This would be expected if liquidity constraints were reduced by events surrounding the rule changes, allowing banks to expand their balance sheets to accommodate positive net-present-value investments. We investigate the potential for this effect by examining the impact of TARP on feedback in Section 5.1.

4.4. Event-day announcement return of bank stocks

To test Hypothesis 3, we examine cumulative bank-stock returns over days associated with the events leading up to the announcement of the mark-to-market accounting rule change. We correlate the cumulative returns with the level of banks' non-agency MBS holdings, nonperforming loans and total-capital ratio. The results are reported in Table 5 for the 135 public banks with positive non-agency MBS holdings in our sample.[22] The abnormal return of bank stocks is significantly higher for banks holding more non-agency MBS and with more non-performing loans. The difference in shareholder wealth between high and low non-agency MBS (non-performing loans) groups is about $330M ($399M) at the mean and $24M ($29M) at the median. We do not find any difference in the abnormal return between high and low total regulatory capital groups.[23] Thus, viewed with the results in Table 3 panel B, the results in Table 5 suggest that the positive reaction of banks stocks with more non-agency MBS and non-performing loans reflects the anticipated benefits accruing to banks via reduced pressure to sell non-agency MBS at distressed prices. The insignificant relation of bank stock return with total capital ratio, on the other hand, suggests that regulatory pressure that induces banks' feedback trading has limited effect on shareholders' wealth.

4.5. Relation between event-day returns and feedback

To further explore whether the reduction of the feedback effect/regulatory forbearance explains the positive market reaction to bank stocks around the accounting rule change, we examine whether bank stock returns are positively related with the severity of feedback-related changes in bank MBS positions prior to the mark-to-market rule change. Specifically, we expand Eq. (2) by interacting bank cumulative-event-day returns (ABRET) with the residual and predicted ABX index return, and other control variables.

[22] There are 178 public banks with event-day returns in our sample, and 135 of these banks have regulatory filing data as of December 31, 2008. Our results still hold if all 178 banks are included in the sample by averaging firm-specific measures in regulatory filing data (e.g., nonperforming loans) over our sample period.

[23] All results hold if we regress the cumulative abnormal return on three dummy variables to capture banks with above sample median non-agency MBS holdings, non-performing loans, and below sample median total capital ratio, and bank size as measured by the natural logarithm of total market value.

Table 6 reports results of this analysis. The coefficient on RES_RET_q is positive and statistically indistinguishable from 0 suggesting that banks with zero cumulative event-day returns show no significant feedback trading. More importantly, the coefficient on RES_RET_q*ABRET is positive and statistically significant at the 0.05 level. This result is consistent with our expectation that bank stocks react more positively if they exhibit more feedback trading before the accounting rule change. Economically, for a bank with a zero abnormal return, a one standard deviation decrease in the residual ABX return is associated with a decrease of 0.45% in non-agency MBS holdings. In contrast, for a bank with 0.383 event abnormal return (the standard deviation of the event abnormal return is 0.383), a one standard deviation decrease in the residual ABX return is associated with a decrease of 1.22% in non-agency MBS holdings.

The combined results from Tables 4 and 6 suggest the reduction in feedback trading has a measurable effect on shareholder wealth. Joint forbearance/efficiency stories can be used to interpret these results. As discussed earlier, feedback trading can arise from both contracting and regulatory reasons. The accounting-rule change improves banks' bottom line earnings/regulatory capital, helping banks resist liquidity pressure leading to more efficient trading decisions. In addition, a simultaneous forbearance effect can result, because increased regulatory capital forestalls liquidation by bank regulators (i.e., Allen and Carletti, 2008). Furthermore, the higher regulatory capital allows banks avoid raising additional, expensive capital from the market to meet capital requirements and facilitates access to various government funding programs (e.g., discount window borrowing, TARP, FDIC guaranteed debt outstanding under the Temporary Liquidity Guarantee Program, etc.).

4.6. Event-day announcement return of bank bonds

To test Hypothesis 4, we examine the reaction of bank bondholders to the mark-to-market accounting rule change. Twenty-eight banks have publicly traded bonds available for the calculation and the results are presented in Table 7. The results show that bond prices reacted positively across three measures, suggesting that bondholders benefited from the rule change on the net. However, this result should be interpreted with caution given the small sample size. [24] Moreover, the significant bond return results are reduced substantially by the exclusion of April 1–3 from the return accumulation window.[25] In sum, we are unable to reject the null that no significant wealth transfer from bondholders to shareholders (net of any government subsidy) occurred as the result of the relaxation of the accounting rules.

5. Sensitivity tests

5.1. Receipt of TARP, other confounding events, and feedback

The Treasury Department and Federal Reserve took actions to minimize feedback effects by providing liquidity to banks during the Panic of 2007. By strengthening the liquidity position of banks, these actions could offset feedback arising from mark-to-market accounting. To provide evidence on whether these actions drive our results concerning the effect of the accounting rule change on feedback trading, we focus on banks that do not participate in the Treasury Department's Troubled Asset Relief Program (TARP) program.[26] TARP is a $700B program designed to aid banks and, subsequently, car manufacturers. Approximately $550B of TARP funds were committed as of June 24, 2009. TARP funds were provided to banks in exchange for 5% preferred stock and warrants. TARP data are obtained from Federal Reserve website.

We estimate Eq. (2) based on these non-TARP banks and Table 8 presents the results of this test. The coefficient on RES_RET_q (RES_RET_q*POST) continues to be positive (negative) and statistically significant at the 0.01 level, and the coefficient on $PRED\_RET_q$ ($PRED\_RET_q$*POST) continues to be positive (positive) and statistically indistinguishable from 0. A one-tailed t-test that the coefficient on RES_RET_q*POST is less than or equal to that on $PRED\_RET_q$*POST continues to reject the null at the 0.01 level. The evidence suggests that the TARP assistance program does not drive our results presented in Table 4.

Though we continue to find that feedback trading behavior is alleviated for banks that did not receive TARP (non-TARP), one can argue that the expectations for government bailouts may have increased even for non-TARP banks upon the announcement of TARP, and it is the increased expectations that drive our results. In addition, on March 11 and March 16, 2008, Term Securities Lending Facility program (TSLF) and Primary Dealer Credit Facility program (PDCF) were announced by the Federal Reserve, intending to promote market liquidity. The passage of these two programs can also drive our

[24] The 28 banks in our subsample with available bond return constitute 71% of US bank total assets in our full sample.

[25] A group consisting of bank regulators from G-20 countries met on April 2 and agreed to lobby for higher bank capital requirements in the future. We conduct robustness test in bond market reaction by removing April 1–3 from the return accumulation window. We find almost zero bond prices reaction (RAW_BOND and ABRET_AGG_BOND are indistinguishable from 0 and ABRET_BOND is positive and significant at the 0.01 level).

[26] Other federal government programs could affect feedback. For example, on March 23, 2009, the Treasury Department released details on a public/private partnership investment Program. Treasury—in conjunction with the Federal Deposit Insurance Corporation and the Federal Reserve—announced the Public–Private Investment Program. Using $75–$100 billion in TARP capital and capital from private investors, the Public–Private Investment Program is supposed to generate $500 billion in purchasing power to buy legacy assets—with the potential to expand to $1 trillion over time. Legacy assets include securities that are held by banks as well as insurance companies, pension funds, mutual funds, and funds held in individual retirement accounts. On the announcement of this program, ABX.HE index posted a 1-day return of 2.77% and a 3-day return of 4.41%. For a summary of other Treasury and Federal Reserve programs see Labonte (2009) and Schoenfeld and Loeb-Mclain (2009).

Table 6
Changes in non-agency MBS holdings conditional on the market reaction to the rule change.

Variable	Estimate
Intercept	−0.0000
	(0.926)
RES_RET_q	0.0009
	(0.303)
RES_RET_q*$ABRET_i$	0.0039
	(0.015)
$PRED\_RET_q$	−0.0010
	(0.422)
$PRED\_RET_q$*$ABRET_i$	0.0055
	(0.039)
$\Delta LOANS_{i,q}$	−0.0109
	(0.296)
$\Delta LOANS_{i,q}$*$ABRET_i$	−0.0191
	(0.601)
$\Delta TA_{i,q}$	−0.0059
	(0.012)
$\Delta TA_{i,q}$*$ABRET_i$	0.0002
	(0.983)
$\Delta AG\_MBS\_HC_{i,q}$	0.0012
	(0.933)
$\Delta AG\_MBS\_HC_{i,q}$*$ABRET_i$	−0.0157
	(0.451)
$ABRET_i$	0.0007
	(0.222)
Adj. R^2	0.02
N	1226

This table reports results on the relation between the changes in non-agency MBS security holdings and the residual ABX index returns for the public banks in our sample for the period prior to the accounting rule change i.e., 2006Q4–2009Q1. The regression model is estimated based on Eq. (4) for banks, where ABRET is the cumulative abnormal stock returns for the 15 days of events relating to the news about the change of mark-to-market accounting requirements. The computation of the residual ABX returns is included in Appendix A and the variable definitions are included in Appendix B. Standard errors are corrected for two-way clustering by time and firm. *P* values are in parentheses.

$$\Delta NA\_MBS\_HC_{i,q} = \beta_0 + \beta_1 * RES\_RET_q + \beta_2 * RES\_RET_q * ABRET_i + \beta_3 * PRED\_RET_q + \beta_4 * PRED\_RET_q * ABRET_i + CONTROLS + CONTROLS * ABRET_i + ABRET_i + \varepsilon_q \quad (4)$$

Table 7
Abnormal bank bond returns around events surrounding the changes of mark-to-market accounting requirements.

	Bank bond returns		
	RAW_BOND	**ABRET_BOND**	**ABRET_AGG_BOND**
Mean	2.1801	5.2660	1.8777
[Median]	[0.1279]	[2.5909]	[−0.2769]
(*p*-value)	(0.038)	(0.001)	(0.075)
N	28 Banks	28 Banks	28 Banks

This table reports cumulative raw and abnormal bond percentage returns for 28 unique banks and 480 unique bond issues in our sample. We compute abnormal daily bond returns by subtracting the cumulative Barclay US Bond index (ABRET_BOND) or the Barclay aggregate bond index (ABRET_AGG_BOND), respectively. Returns are cumulated over four event dates relevant to the change of mark-to-market accounting requirements, viz., 12 Jan 2009, 10 March 2009–12 March 2009, 17 March and 1–2 April 2009, and a day prior and after each of these sub-periods. *P*-values under the mean are based on *Z*-statistics computed using the standard deviation of daily raw or abnormal returns (cumulative over 15 days, using non-overlapping windows), excluding event days, for the period January 2008–March 2010.

results. To address these concerns, we first restrict the post period to the fourth quarter of 2008 and the first quarter of 2009, after the passage of the TARP but before the accounting rules changes, and conduct the pre- and post analysis. Second, we repeat the same procedure but re-define the post period to be between the second quarter of 2008 and the first quarter of 2009, after the passage of the two liquidity programs but before the accounting rule changes. We do not find the reduced feedback effect during the post period under these two alternative definitions suggesting that the expectation of TARP assistance and the two liquidity programs played a different role in easing banks' feedback trading compared to the accounting rule changes.

It is possible that other confounding events contaminate our event study results reported in Tables 5 and 6. For example, on March 11, 2009, Treasury Department requests more money for purchasing preferred stocks in banks; on

Table 8
Multivariate regression of change in bank holdings of non-agency MBS for banks that did not receive TARP.

Variable	Estimate
Intercept	0.0003
	(0.155)
RES_RET_q	0.0021
	(0.009)
RES_RET_q*POST	−0.0061
	(<0.001)
$PRED\_RET_q$	0.0011
	(0.503)
$PRED\_RET_q$*POST	0.0006)
	(0.644
POST	−0.0011
	(<0.001)
$\Delta LOANS_{i,q}$	−0.0163
	(0.023)
$\Delta LOANS_{i,q}$*POST	0.0196
	(0.016)
$\Delta TA_{i,q}$	−0.0077
	(0.003)
$\Delta TA_{i,q}$*POST	0.0016
	(0.595)
$\Delta AG\_MBS\_HC_{i,q}$	−0.0051
	(0.374)
$\Delta AG\_MBS\_HC_{i,q}$*POST	−0.0179
	(0.006)
Adj. R^2	0.03
N	3245

This table reports results on the relation between the changes in non-agency MBS security holdings and the residual ABX index returns over the period 2006Q4–2010Q1 for banks that did not receive TARP assistance as specified in Eq. (3). POST is an indicator variable equal to 1 for the quarters after 2009Q1. The computation of the residual ABX returns is provided in Appendix A and variable definitions are show in Appendix B. Standard errors are corrected for two-way clustering by time and firm. *P* values are in parentheses.

$$\Delta NA\_MBS\_HC_{i,q} = \beta_0 + \beta_1 * RES\_RET_q + \beta_2 * RES\_RET_q * POST + \beta_3 * PRED\_RET_q + \beta_4 * PRED\_RET_q * POST + \beta_5 * POST + CONTROLS + CONTROLS * POST + \varepsilon_q \quad (3)$$

March 17, FDIC extends guarantee of bank senior debt and Federal Open Market Committee (FOMC) extends Term Auction Lending Facility program (TALF) on March 18, 2009. Therefore, we eliminate these three days when calculating banks' cumulative abnormal returns. All our results are robust to this procedure.

5.2. Model specification

To provide further evidence on the time lag between MBS market liquidity shocks and bank MBS holdings discussed in Section 3.3.1, we use lagged ABX_RET_q in Eq. (1) and lagged RES_RET_q and lagged $PRED\_RET_q$ in Eq. (2). Untabulated results show that the coefficient on lagged ABX_RET is positive but not statistically significant in Eq. (1). In Eq. (2), both of the coefficients on lagged RES_RET_q and lagged $PRED\_RET_q$ are positive but neither of them is statistically significant. Therefore, the evidence suggests that the liquidity shock measured contemporaneously captures the first-order effect of liquidity shocks on bank holdings of non-agency MBS.

5.3. OTTI adjustments and measurement of the change in NA_MBS holdings

We measure banks' MBS trading using the change in non agency MBS reported on the balance sheet. However, a negative change in non-agency MBS can arise from the recognition of OTTI rather than the sale of this asset. To address this issue, we collect OTTI from 10Ks and 10Qs for all public banks in our sample and adjust the change in non agency MBS by adding back the quarterly reported OTTI.[27]

We re-run all our analysis using the adjusted change in NA_MBS.[28] Untabulated results show that all our previous findings continue to hold except for the analysis partitioning the sample based on non-performing loans. More specifically,

[27] We thank Jeff Downing who shared the OTTI data with us.

[28] We assume that OTTI is zero if a bank does not report the amount of OTTI in the filings. Out of 1869 firm years of public banks, 419 firm years report non-zero OTTI. The mean of OTTI scaled by total assets is 0.029% and the majority are recognized after the second quarter of 2007. We make

we find feedback trading behavior for banks with both high non-performing loans and low non-performing loans–albeit weaker for banks with high non-performing loans.

5.4. Constant sample of banks

Over the sample period, we allow banks to enter and exit the dataset, which can affect the estimation. To ensure the robustness of our results to this effect, we require all banks in the sample to have at least one observation on each side of the accounting rule change. The results are similar to those reported in Table 4.

5.5. Serial correlation

We conduct diagnostic analysis of serial correlation in error terms using a Durbin–Watson test and find positive serial correlations. To address inflated standard errors caused by serial correlation together with cross-sectional correlation, we present all results in the paper using two-way clustering of standard errors at both the firm and the quarter level as suggested by Petersen (2009). Alternatively, we include a firm-fixed effect in the model to control for serial correlation related to a within-firm constant component. Durbin–Watson test shows serial correlation statistically indistinguishable from zero in error terms using this procedure, and more importantly, all our results hold after controlling for firm fixed effects.

5.6. Adjusting the change in total assets for NA_MBS

We include the change in total assets in the regression to control for the concurrent change in banks' overall investment policy. However, one can argue that there is a mechanical relation between the change in NA_MBS, our dependent variable, and the change in total assets. We therefore subtract the change in NA_MBS from the change in total assets and use this variable as a control variable instead. All our results are robust to this adjustment.

6. Conclusions

We use changes in bank holdings of mortgage-backed securities (MBS) to test predictions of feedback between asset trading and asset prices (Shleifer and Vishny, 2009; Plantin et al., 2008). We define feedback as the tendency to sell in the face of liquidity-driven price declines. Using a sample of private and public banks over the period of 2006 and 2010, we find that, on average, changes in bank holdings of MBS are more likely to be reduced surrounding MBS price declines and this feedback effect is more pronounced for banks with more non-agency MBS holdings, higher non-performing loans and lower total capital ratio. Furthermore, we find reduced feedback-related trading after the mark-to-market accounting rule change. Analysis of banks' stock-price reactions indicates that shareholders of banks with more MBS holdings and non-performing loans benefit more from the accounting rule change; these are instances where feedback effect is stronger. We find further corroborating evidence that intensity of the feedback effect prior to the accounting rule change is positively related with the increase of banks' shareholder wealth. Banks' bond prices reacted positively to the rule change albeit the statistical significance is fairly moderate. This evidence suggests that banks' bondholders benefited on the net from the accounting rule change implying that no significant wealth transfer from bondholders to shareholders (net of any government subsidy) occurred as the result of the relaxation of the accounting rules. Lastly, the receipt of TARP assistance over the period of 2008 and 2009 does not drive our main results. Therefore, TARP assistance is unlikely to explain the reduction in feedback associated with changes of mark-to-market.

In sum, our evidence suggests that the feedback-related trading has a measurable economic effect. The change of the mark-to-market accounting rule reduces pressure on banks to sell assets in response to the liquidity shocks to the MBS market, thus it has positive impact on shareholder wealth. Therefore, we conclude that the price change observed in bank stocks stems, in part, from the positive effects on the reduced liquidity-driven trading. We interpret these results as evidence of joint forbearance/efficiency effect. However, given that banks own about 11% of non-agency MBS during our sample period and that we find large price declines are associated with 10% greater MBS selling by banks, our results do not suggest that bank feedback trading had significant effects on the MBS prices.

Appendix A

See Table A1 for computation and summary statistics of the residual ABX index returns and predicted ABX index returns.

(*footnote continued*)
adjustments to non-agency MBS for OTTI in two ways: first, adjusting it by the total amount of OTTI; second, adjusting it by the amount of OTTI based on the weight of non-agency MBS in total investment securities for a bank.

Appendix B

See Table B1 for variable descriptions.

Table A1
Computation and summary statistics of the residual ABX index returns and predicted ABX index returns.

Panel A: Estimation of the residual and predicted ABX index returns

$$\text{ABX\_RET}_m = \beta_0 + \beta_1 * \text{CS\_RET}_m + \beta_2 * \text{R\_RET}_m + \beta_3 * \text{TB\_RET}_m + \varepsilon_m \quad \text{(A.1)}$$

Parameter	Expected sign	Estimate
Intercept	?	0.0129 (0.443)
CS_RET_m	+	2.9395 (0.047)
R_RET_m	+	0.2008 (0.101)
TB_RET_m	−	0.4437 (< 0.001)
Adj. R^2		0.39
N		42

Panel B: Summary statistics

Variable	N	Mean	Std. Dev.	Q1	Median	Q3
ABX_RET_q	14	−0.0370	0.1759	−0.0892	−0.0058	0.0724
RES_RET_q	14	0.0000	0.1021	−0.0191	0.0133	0.0755
PRED_RET_q	14	−0.0370	0.1473	−0.1266	−0.0171	0.0200

In Panel A, ABX index return residuals (RES_RET) are the residuals from the regression of the monthly ABX index returns on the return on the Case–Shiller Home Price Index (CS_RET), the return on a REIT index (R_RET), and the changes in the yield of US Treasury constant maturities 30 year (TB_RET) for the period 2006Q4–2010Q1. The regression equation is shown in A1. See Appendix B for variable descriptions. *P* values are derived from heterosedasticity robust standard errors and presented in parentheses. Panel B reports summary statistics of the quarterly residual and predicted ABX index returns, where quarterly residual and predicted ABX index returns are cumulative over a quarter based on monthly residual and predicted ABX index returns estimated from Panel A.

Table B1
Variable definitions.

Variable	Description	Source
ABRET	The average abnormal bank stock return adjusted for six Fama French portfolios formed on size and book to market. The abnormal bank stock return is cumulative compounded daily over 15 event days relevant to the rule change of mark-to-market accounting	Datastream Kenneth French' website
ABRET_AGG_BOND	Cumulative abnormal daily bond returns by subtracting the cumulative Barclay aggregate bond index	
ABRET_BOND	Cumulative abnormal daily bond returns by subtracting the cumulative Barclay US Bond index	
ABX	ABX.HE.AAA.06-2	Reuters
	This index represents a standardized basket of home equity ABS reference obligations that are subprime with rating AAA issued in 2nd quarter of 2006	Datastream
	Refer to www.markit.com for details of the constituents	
ABX_RET	Return on the ABX.HE.AAA.06–2. Subscript m indicates monthly return while subscript *q* indicates quarterly return (cumulative monthly)	
AG_MBS_AFS_HC	Agency Backed Mortgage Backed Securities at historical cost held as available for sale as percentage of total assets	Y9C data
AG_MBS_AFS_FV	Agency Backed Mortgage Backed Securities at fair value held as available for sale as percentage of total assets	Y9C data
AG_MBS_FV	Agency Backed Mortgage Backed Securities (available for sale and held to maturity) at fair value as percentage of total assets	Y9C data

Table B1 (*continued*)

Variable	Description	Source
AG_MBS_HC	Agency Backed Mortgage Backed Securities (available for sale and held to maturity) at historical cost as percentage of total assets	Y9C data
AG_MBS_HTM_FV	Agency Backed Mortgage Backed Securities at fair value held to maturity as percentage of total assets	Y9C data
AG_MBS_TR_FV	Agency Backed Mortgage Backed Securities at fair value held for trading as percentage of total assets	Y9C data
AG_MBSDIFF	Ratio of AG_MBS at fair value to AG_MBS at historical cost	
AG_MBSDIFF	Ratio of AG_MBS at fair value to AG_MBS at historical cost	
CS	S&P/Case–Shiller U.S. Home Price Index	Bloomberg
CS_RET	Return on Case–Shiller Home Price Index. Subscript m indicates monthly return	
LOANS	Loans and lease financing receivables, which include loans and leases held for sale, and loans and leases, net of unearned income as percentage of total assets	Y9C data
NA_MBS_AFS_HC	Non-Agency Backed Mortgage Backed Securities at historical cost held as available for sale as percentage of total assets	Y9C data
NA_MBS_HTM_FV	Non-Agency Backed Mortgage Backed Securities at fair value held to maturity as percentage of total assets	Y9C data
NA_MBS_TR_FV	Non-Agency Backed Mortgage Backed Securities at fair value held for trading as percentage of total assets	Y9C data
NA_MBS_AFS_FV	Non-Agency Backed Mortgage Backed Securities at fair value held as available for sale as percentage of total assets	Y9C data
NA_MBS_HC	Non-Agency Backed Mortgage Backed Securities (available for sale and held to maturity) at historical cost as percentage of total assets	Y9C data
NPL	Non-performing loans (include loans past due 90 days or more and non-accrual loans) as a percentage of LOANS	
POST	Indicator variable equal to 1 if the observation falls after 2009Q1; 0 otherwise	
POSTTARP	For banks that received TARP, indicator variable equal to 1 if the bank received the TARP assistance in that quarter or prior to that quarter	
PRED_RET	ABX_RET − RES_RET	
R_RET	Return on Real Estate Investment Trusts Index. Subscript m indicates monthly return	Datastream
RAW_BOND	Cumulative daily raw bond return	
REITS	Real Estate Investment Trusts Index. It includes 7 equities	Datastream
REPOLIAB	Securities sold under agreements to repurchase as % of total assets	Y9C data
RES_RET	Residuals of ABX index return estimated from the regression of monthly ABX_RET on CS_RET, R_RET and TB_RET. Subscript m indicates monthly residuals while subscript q indicates quarterly residuals cumulative based on monthly residuals	
TA	Total assets in billions	Y9C data
TB	US treasury constant maturities 30 year	Datastream
TB_RET	Change in the yield of US treasury constant maturities 30 year. Subscript m indicates monthly return	Datastream
TOTALCAP	Total risk based capital ratio reported to regulators on form Y9C. It is computed as the sum of Tier 1, Tier 2, Tier 3 capital adjusted for deductions as a percentage of total risk-weighted assets	Y9C data
ΔAG_MBSDIFF	$AG\_MBSDIFF_t - AG\_MBSDIFF_{t-1}$	
ΔNA_MBSDIFF	$NA\_MBSDIFF_t - NA\_MBSDIFF_{t-1}$	
ΔAG_MBS_HC	$AG\_MBS\_HC_t - AG\_MBS\_HC_{t-1}$	
ΔLOANS	$LOANS_t - LOANS_{t-1}$	
ΔNA_MBS_HC	$NA\_MBS\_HC_t - NA\_MBS\_HC_{t-1}$	
ΔTA	$TA_t - TA_{t-1}$	

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