

# Quantitative Easing and Financial Institution Risk Taking\*

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## Abstract

An emerging literature documents the link between central bank quantitative easing (QE) and financial institution *credit* risk taking. This paper tests the complementary hypothesis that QE affects institution solvency, liquidity, and interest rate risk taking. We study Agency mortgage REITs (MREITs), which are levered shadow banks that invest in guaranteed U.S. Agency mortgage-backed securities (MBS) funded via short-term repurchase agreements. We document that Agency MREITs contracted in size and increased leverage in response to the Federal Reserve's Agency MBS purchases during QE, consistent with portfolio rebalancing and "reaching for yield." However, these institutions concurrently reduced their liquidity and interest rate risk profiles.

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# 1 Introduction

Following the recent global financial crisis and into the Great Recession, the Federal Reserve reduced its overnight interest rate effectively to the zero lower bound and engaged in large-scale purchases of long-term U.S. Treasury and Federal Agency MBS.<sup>1</sup> Several empirical studies demonstrate that quantitative easing (QE) lowered long-term interest rates for U.S. Treasury securities and Agency MBS as intended.<sup>2</sup> However, as U.S. monetary policy accommodation lingered, some policymakers and pundits grew concerned about the emergence of financial stability risks. For example, former Federal Reserve Chairman Bernanke (2013) noted that “maintaining low interest rates for too long may create incentives for market participants to take on greater duration or credit risks, or to employ additional financial leverage,” in an effort to “reach for yield.”<sup>3</sup> Consistent with this concern, Chodorow-Reich (2014), DiMaggio and Kacperczyk (2016), and Choi and Kronlund (2018) provide empirical evidence of heightened risk taking by U.S. non-bank financial institutions during the Federal Reserve’s QE.<sup>4</sup> However, each of these studies focuses exclusively on *credit* risk taking in terms of the investment choices made by money market funds, pension funds, and corporate bond funds.

In this paper, we test the complementary hypothesis that QE influences financial institution risk taking in terms of solvency, liquidity, and interest rate risk. We focus on Agency Mortgage REITs (Agency MREITs), which are shadow banks that invest almost exclusively in mortgage-backed securities (MBS) guaranteed by one of the U.S. government agencies (Fannie Mae, Freddie Mac, and Ginnie Mae). Agency MREIT portfolios are financed by broker-dealers predominantly using short-term repurchase agreements and with collateral haircuts establishing permissible leverage. Given their investment focus, Agency MREIT assets are not subject to credit risk. However, these institutions are exposed to significant solvency, interest rate, and liquidity risks, arising from funding long-term callable bonds with short-term liabilities. This simple structure allows us to effectively shut off any QE-induced response in terms of credit risk taking and conduct a clean test of the hypothesis that financial institutions respond to QE by taking on greater solvency, liquidity, and interest rate risk.

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<sup>1</sup> From the start of 2008 through the end of 2017, the Federal Reserve’s balance sheet grew from \$0.9 trillion to \$4.5 trillion and is now principally comprised of long-term U.S. Treasury notes and bonds (\$2.5 trillion) and Federal Agency mortgage-backed securities (\$1.8 trillion). Federal Reserve balance sheet information is available weekly from the Federal Reserve Statistical release under <https://www.federalreserve.gov/releases/h41/> (H.4.1. Factors Affecting Reserve Balances).

<sup>2</sup> See Gagnon, Raskin, Remache, and Sack (2011); Hancock and Passmore (2011); Krishnamurthy and Vissing-Jorgensen (2011); Neely (2012); Hamilton and Wu (2012); D’Amico and King (2013); and Bauer and Rudebusch (2014).

<sup>3</sup> While heightened risk taking is seemingly an intended consequence of unconventional monetary policy, recent theoretical research points to it being potentially distorted by Agency problems associated with delegated asset management (e.g., Rajan 2005; Feroli, Kashyap, Schoenholtz, and Shin 2014; Acharya and Naqvi 2015; Morris and Shin 2016). Specifically, very low interest rate environments make asset managers especially sensitive to a funds’ relative performance, which induces them to take on more risk than would otherwise be the case.

<sup>4</sup> This research is part of a broader literature describing a “risk taking channel” of monetary policy, distinct from the interest rate and credit channels (e.g., Adrian and Shin, 2010; Borio and Zhu, 2012). Empirical analyses of bank behavior suggest that they make *ex ante* riskier loans as monetary policy becomes more accommodative (Jimenez, Ongena, Peydro, and Saurina, 2014; Ioannidou, Ongena, and Peydro, 2015; Dell’Ariccia, Leaven, and Suarez, 2017; Bonfim and Soares, 2018). Related research finds that accommodative monetary policy is associated with tighter yield spreads for U.S. corporate loans – particularly for the riskiest borrowers (Delis, Hasan, and Mylolonidis, 2017; Paligorova and Santos, 2017).

Agency MREITs experienced a surge in total assets from \$79.2 billion to \$363.5 billion (356 percent) during QE1 and QE2, followed by a decline during QE3 and Tapering. During all QE regimes, Agency MREITs issued and repurchased stock to adjust the size of their balance sheets to market conditions. This suggests that the Federal Reserve's activity in the Agency MBS market directly affected investment opportunities for Agency MREITs, which provides a useful setting for our empirical analysis. Looking ahead, as the central bank steadily withdraws from the Agency MBS market, Agency MREITs may emerge as an important investor class. However, the U.S. Financial Stability Oversight Council (2013) warns about financial stability risks emanating from these institutions, given their reliance on maturity transformation without access to government liquidity backstops. This current policy concern is an additional motivating factor for our analysis of the financial risk profile of Agency MREITs.

To identify the effects of QE on institution-level outcomes, we employ a cross-sectional comparison between Agency MREITs and all other MREITs. Non-Agency MREITs constitute a natural control group since they are subject to the same statutory requirements as Agency MREITs but hold a broader portfolio of mortgage-related assets. As a result, we expect Agency MREITs to be more sensitive to the Federal Reserve's posture in the Agency MBS market than Non-Agency MREITs. Our empirical approach is similar to that in Rodnyansky and Darmouni (2017) and Chakraborty, Goldstein, and MacKinlay (2017), both of whom examine lending responses to QE across U.S. commercial banks with differential exposure to the Agency MBS market.

We begin by conducting a high-frequency event study of equity market reactions by Agency and Non-Agency MREITs to QE-related central bank communications. Federal Reserve announcements of large-scale purchases of Treasury and Agency MBS during QE1 had a positive cumulative effect on both types of MREITs, reflecting an increase in legacy asset values that raised net worth. This result expands on the evidence for life insurers, banks, and the stock market presented in Chodorow-Reich (2014). We further show that Agency MREITs benefitted relatively less from these announcements than Non-Agency MREITs (2.2 percent cumulative increase in equity prices for Agency MREITs versus 4.0 percent for Non-Agency MREITs), owing to the negative convexity profile of Agency MBS. We document that the announcements regarding QE2, which was limited to Treasury purchases, benefitted Agency MREITs and Non-Agency MREITs to a similar degree. We also find that Agency MREITs reacted significantly more negatively than Non-Agency MREITs to the announcements around the so-called Taper Tantrum (-2.5 percent versus -1.1 percent cumulatively). These communications unanchored market expectations about future policy rates previously tied down by the Federal Reserve's forward guidance. Agency MREITs likely showed a stronger reaction to the prospect of rising interest rates due to their heavy reliance on short-term debt.

Next, we turn to an analysis of Agency MREIT asset growth, equity issuance, and stock repurchases over the 2005:Q1—2015:Q4 period. Conditioning on macroeconomic fundamentals, institution characteristics, and Federal Reserve purchase activity in the Treasury market, we find that Agency MREIT asset growth responded negatively to the Federal Reserve's quarterly purchase share of newly issued Agency MBS during that period. We estimate that a one-standard deviation increase in the Federal Reserve's purchase share of Agency MBS was associated with a reduction in Agency MREIT asset growth by 3.6 percentage points per quarter, or approximately

40 percent of the unconditional mean. These results are predominantly driven by the central banks' Agency MBS purchases during the Tapering period. We document similar evidence for Agency MREIT equity issuance and share repurchases. These results demonstrate how the central banks' activity in the Agency MBS market directly crowds out private-sector investment and induces portfolio rebalancing by equity investors in Agency MREITs.

We then test whether Agency MREITs took on greater solvency risk in response to QE. We first show that the Federal Reserve's purchase share of Agency MBS during QE3 and Tapering was associated with a significant decline in Agency MREITs' equity-to-assets ratio (i.e., increased leverage and thus solvency risk). Our estimates suggest that a one-standard deviation increase in the Federal Reserve's purchase share of Agency MBS during QE3 and Tapering was *each* associated with a decline in the equity-to-assets ratio of over two percentage points, or more than 16 percent of the unconditional mean. This result represents novel evidence of the effect of QE on risk taking by financial institutions in terms of their capital structure choices and is consistent with "reaching for yield."

We further analyze the response to QE in Agency MREIT liquidity risk taking. Our estimates suggest that the overall amount of repo finance employed by Agency MREITs was insensitive to the Federal Reserve's Agency MBS purchases, although these institutions reduced their reliance on very short-term repo debt during MEP, QE3 and Tapering. We also document that Agency MREITs increased cash holdings during the Tapering period. Lastly, we analyze Agency MREIT interest rate risk taking. We find that their shares of fixed-rate MBS holdings were unrelated to the Federal Reserve's Agency MBS purchase activity during QE. However, Agency MREITs did increase their hedging intensity via derivatives during the Tapering. Overall, we find no evidence that Agency MREITs increased their liquidity or interest rate risk exposures in response to QE.

We contribute to the emerging literature on QE-induced risk taking by financial institutions. Chodorow-Reich (2014) provides evidence that money market funds with higher expenses reached for higher returns between 2009 and 2011; and that some private defined-benefit pension funds increased their risk taking around the same time. DiMaggio and Kacperczyk (2017) find that money market funds invested in riskier asset classes during QE. Choi and Kronlund (2018) study corporate bond funds and find that these institutions generate higher returns and attract more inflows when they reach for yield during periods of low interest rates, although these yields tend to be negative on a risk-adjusted basis. We complement the existing literature, which focuses exclusively on credit risk taking, by providing novel evidence for QE-induced risk taking by financial institutions in terms of solvency, liquidity, and interest rate risks. We show that Agency MREITs increased their leverage in relation to the Federal Reserve's purchase share of Agency MBS, but concurrently reduced liquidity and interest rate risk exposure.

We also contribute to the recent literature linking QE to the investment decisions of financial institutions. Joyce et al. (2017) report that U.K. insurance companies and pension funds shifted allocations from government bonds to corporate bonds in response to the Bank of England's QE. Chakraborty, Goldstein, and MacKinlay (2017) find that U.S. banks with a high portfolio concentration of Agency MBS increased their mortgage originations and decreased their holdings of commercial loans (relative to other banks with low Agency MBS concentrations) in response to the Federal Reserve's Agency MBS purchase activity. Rodnyansky and Darmouni

(2017) show that U.S. commercial banks with greater Agency MBS holdings expanded their mortgage lending (and ultimately total lending) during QE1 and QE3. Di Maggio, Kermani, and Palmer (2018) present evidence of a relationship between QE and mortgage refinancing activity for loans eligible for purchase by the Federal Reserve. Kandrac and Schlusche (2017) link increased central bank reserves to expanded lending by U.S banks during QE. We illustrate how the Federal Reserve’s Agency MBS purchases altered the investment opportunities of Agency MREITs. We expand on prior work by showing that the central banks’ purchase activity was positively related to Agency MREIT share repurchases, with investors redeeming shares to rebalance portfolios and deploy capital elsewhere. Our results complement those by DiMaggio and Kacperczyk (2016) for the money fund industry.

Our results further relate to the debate on the channels through which QE influences long-term interest rates.<sup>5</sup> The “signaling” and “portfolio balance” channels are the most widely discussed. Under the signaling channel large-scale asset purchases by the central bank act as a commitment device to a low interest rate policy, which lowers the expected level of future short-term interest rates, similar to forward guidance (e.g., Clouse et. al, 2003; Eggertsson and Woodford, 2003; Bauer and Rudebusch, 2014). Under the portfolio balance channel, large-scale asset purchases reduce the amount of long-term, low-risk bonds in private-sector portfolios and thus lower the term (risk) premium in long duration assets (e.g., Bernanke, 2010). Most recent studies into the response of various types of financial institutions to QE are inherently about the portfolio balance channel. The evidence we present that central bank activity in the Agency MBS market crowds out private investment is consistent with this view.

Our analysis also relates to the future structure of Agency MBS holdings across financial institutions. The Federal Reserve is currently the largest holder of Agency MBS (\$1.8 trillion or 27 percent) but has recently launched a balance sheet normalization plan to markedly reduce its footprint in this market. Commercial banks have long been important Agency MBS investors and currently hold 26 percent of outstanding securities. For several years prior to the financial crisis, Fannie Mae and Freddie Mac were collectively the largest holders of Agency MBS. However, their role has receded since the two institutions were placed into conservatorship (3 percent). This creates an opening for private-sector, non-bank investment in Agency MBS.<sup>6</sup> While Agency MREITs currently maintain a modest share of the \$6.4 trillion Agency MBS market, their recent rapid expansion suggests that they could become a prominent investor class in the future, perhaps assuming the role of the marginal price-setting investor.<sup>7</sup>

We proceed as follows. Section 2 presents institutional detail on MREITs. Section 3 describes the results of the high-frequency event study. Section 4 outlines data and sample selection for the main empirical analysis. Section 5 discusses the empirical approach and results on the effects of QE on Agency MREIT growth. Section 6 presents the analysis of QE and MREIT risk taking. Section 7 concludes.

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<sup>5</sup> See Krishnamurthy and Vissing Jorgensen (2011) for an overview of the various channels proposed in the literature.

<sup>6</sup> The “retained portfolios” at Fannie Mae and Freddie Mac provided little social value (Passmore 2005), led to a build-up of systemic risk (Eisenbeis, Frame, and Wall, 2007), and were a primary factor in the timing of the federal takeover (Frame, Fuster, Tracy, and Vickery, 2015). Hence, most reform proposals would place permanent limitations on such holdings.

<sup>7</sup> Gabaix, Krishnamurthy, and Vigneron (2007) show that the marginal investor in the Agency MBS market is indeed a specialized arbitrageur, not a diversified representative investor as hypothesized by traditional asset pricing models.

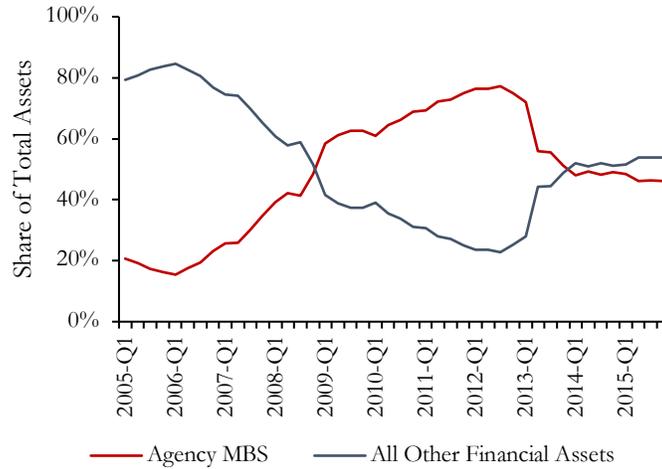
## 2 Mortgage REITs

Real estate investment trusts (REITs) are specialized investment vehicles that invest in real estate-related assets. REITs are exempt from specific provisions of the Investment Company Act, which implies that they are not subject to prudential regulation, including leverage limits. A REIT may be a public company registered with the U.S. Securities and Exchange Commission or privately held. A public REIT may be listed on an exchange or be unlisted and have shares sold directly to investors by broker-dealers. As long as REITs distribute at least 90 percent of their taxable net income annually, they are exempt from federal corporate income tax. To the extent that such distributions are in the form of dividends, these profits are taxed at the shareholder's ordinary income tax rate and hence avoid double-taxation. The level of mandatory dividend distributions implies that REITs fund growth by raising new (equity) capital, rather than through retained earnings.

Other important REIT rules include: (i) maintaining at least 75 percent of total assets in qualifying real estate assets and cash; (ii) receiving at least 75 percent of income from some combination of rent from real property, interest from mortgages securing real property, gains from the sale of real property, and distributions from other REITs; (iii) receiving at least 95 percent of income from the aforementioned qualified real estate sources or from certain other passive sources; (iv) deriving less than 30 percent of gross income from the sale or other disposition of stock or securities held for less than six months, and real property held for less than four years; and (v) issue transferrable shares held by at least 100 individuals with no five or fewer owning more than 50 percent during the last half of the taxable year.

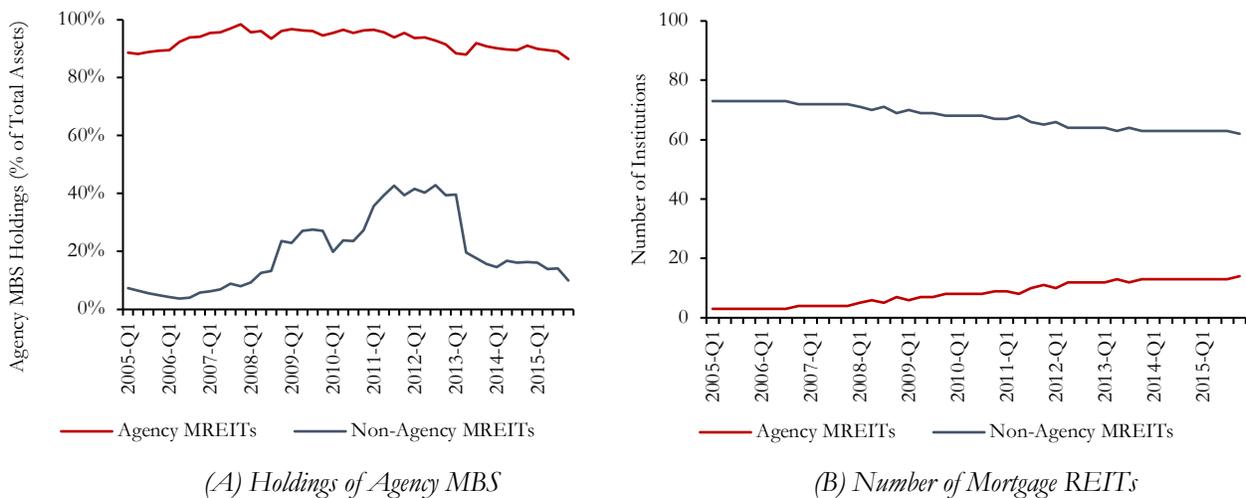
REITs generally specialize in either owning real estate assets or providing debt financing for them. Equity REITs own properties and typically focus on specific geographies and/or sectors (e.g., apartment, retail, or office). By contrast, mortgage REITs invest in whole mortgage loans and/or mortgage-backed securities that are secured by residential and/or commercial properties.

As shown in Figure 1, based on the Federal Reserve's Flow of Funds data, a large share of MREIT investment is in Agency MBS guaranteed by either Fannie Mae, Freddie Mac, or Ginnie Mae. Fannie Mae and Freddie Mac are U.S. government-sponsored enterprises (GSEs) that securitize "conforming" residential mortgages; and since the financial crisis the two institutions have enjoyed "effective" federal backing of all obligations (see, e.g., Frame, Fuster, Tracy, and Vickery, 2015). Ginnie Mae is a government agency within the U.S. Department of Housing and Urban Development (HUD) created exclusively to securitize government-insured mortgages. All three institutions provide blanket guarantees on their MBS in exchange for guarantee fees (insurance premiums) from mortgage originators. While Agency MBS are viewed as effectively having no credit risk, these instruments are very long-term and subject to significant prepayment risk arising from borrower refinancing due to changes in interest rates as well as routine housing turnover.



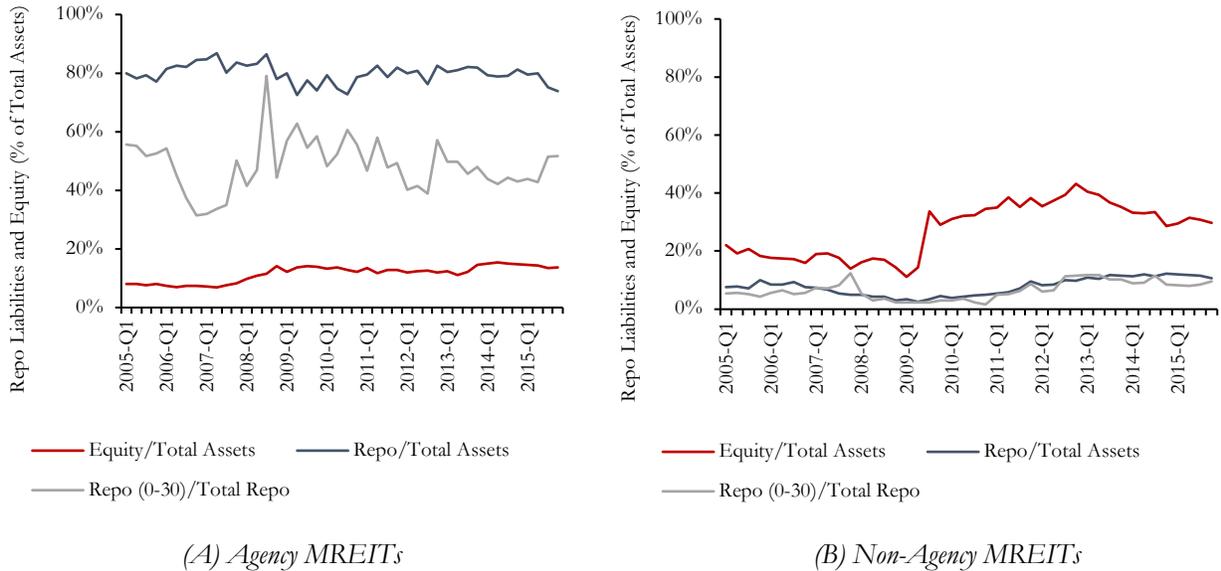
**Figure 1: Mortgage REIT Investment Shares.** This figure shows MREIT investment in Agency MBS and All Other Financial Assets as a share of total assets. The data used are obtained from the Federal Reserve Flow of Funds Reports.

Using institution-level data from S&P Global, Figure 2 (Panel A) shows that MREIT investment in Agency MBS has been persistently concentrated in a subset of these institutions that specialize in managing such portfolios. These so-called Agency MREITs are typically identified as holding, on average, at least 50 percent of total assets in Agency MBS; with an actual portfolio share, on average over time, of about 90 percent. During the early 2000s, there were only three Agency MREITs of note (Annaly Capital Management, Anworth Mortgage Asset Corporation, and Capstead Mortgage Corporation). However, following the onset of the financial crisis and the Great Recession, as many as 14 were in operation in a given quarter. Figure 2 (Panel B) presents the quarterly number of Agency and Non-Agency MREITs based on the standard definition and using S&P Global data.



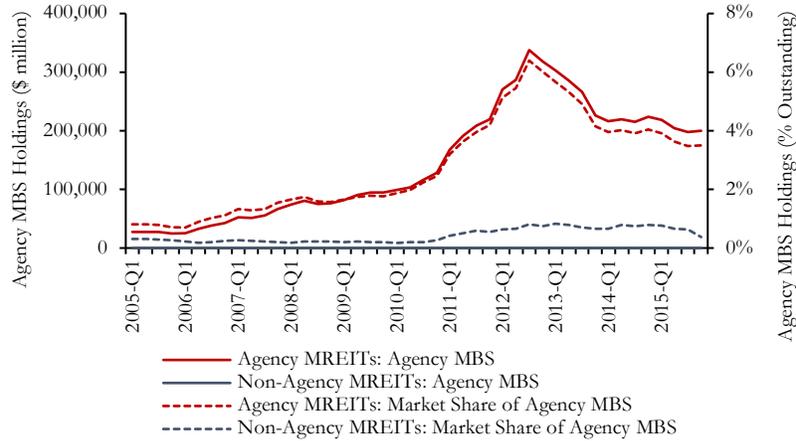
**Figure 2: Mortgage REIT Asset Profile and Number of Institutions.** This figure shows Agency MBS Holdings as share of Total Assets across Agency and Non-Agency MREITs (Panel (A)) and the number of Agency and Non-Agency MREITs in existence (Panel (B)). The data used are obtained from S&P Global.

Figure 3 illustrates the aggregate capital structure of Agency MREITs (Panel A) versus Non-Agency MREITs (Panel B) using the S&P Global data. Agency MREITs collectively averaged approximately eight percent equity prior to the financial crisis, but this ratio subsequently increased and more recently hovered between 12 to 15 percent. Figure 3 also shows that repurchase agreements are the dominant form of Agency MREIT debt financing, accounting for 80 percent of total assets since the early 2000s. Approximately 50 percent of total repo debt matures in less than 30 days. The capital structure of Non-Agency MREITs is different. Their share of equity financing declined prior to the financial crisis from 20 percent to 10 percent, before increasing markedly thereafter. Non-Agency MREITs also rely significantly less on repo financing than their Agency MBS-centric counterparts.



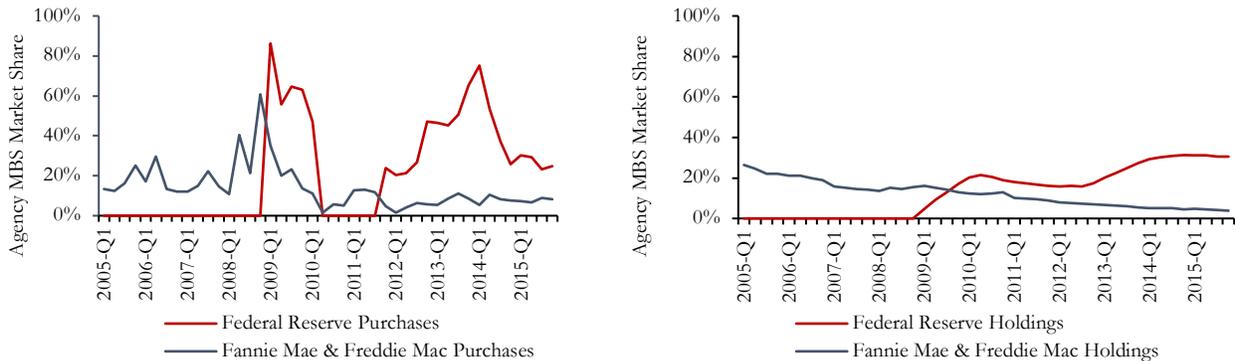
**Figure 3: MREIT Capital Structure.** This figure depicts the time series evolution of Agency MREIT (Panel (A)) and Non-Agency MREIT (Panel (B)) capital structures. For each type of institution, overall leverage, measured as equity-to-assets ratio, the share of repurchase agreements (repo debt) to total assets, and the share of short-term repo (0-30 days maturity to total repo) are shown. The data used are obtained from S&P Global.

Figure 4 presents quarterly data on MREIT Agency MBS holdings in terms of both dollar levels and market shares for Agency MREITs and Non-Agency MREITs, respectively. The evidence suggests that Agency MREITs expanded dramatically after the onset of the financial crisis and increasingly became important Agency MBS investors. Between 2008:Q4 and 2012:Q3, Agency MREITs increased their holdings of Agency MBS from \$76.2 to \$337.6 billion; and thereby increased their share of this market by more than a factor of four, from 1.5% to 6.4%. These amounts and shares declined thereafter. By contrast, the collective holdings of Non-Agency MREITs never rose above \$50 billion, which corresponds to less than one percent of the Agency MBS market.



**Figure 4: Mortgage REIT Agency MBS Holdings and Market.** This figure shows total Agency MBS Holdings (Panel (A)) and Agency MBS holdings by share of total Agency MBS outstanding for Agency MREITs versus Non-Agency MREITs. The data used are obtained from S&P Global and the Federal Reserve Bank of New York.

The increase in Agency MREIT market share coincided with the shrinkage of Agency MBS holdings by Fannie Mae and Freddie Mac, which had long been the largest investors in this market. Starting with QE1 in 2008:Q4, the central bank quickly became the largest investor in the Agency MBS market. Panel (A) of Figure 5 presents the Agency MBS purchases by the Federal Reserve and Fannie Mae as well as Freddie Mac as a share of newly issued securities. The Federal Reserve absorbed 86 percent of new issuance in 2009:Q1 before halting purchases one year later. The central bank renewed its Agency MBS purchases in 2011:Q4. This was initially limited to related principal reinvestments to maintain portfolio size, but later expanded during QE3. Purchase amounts subsequently declined during the Tapering period, starting in 2013:Q4. Fannie Mae and Freddie Mac collectively ramped up purchases of Agency MBS during 2008, before reducing them during QE1. Thereafter, the two GSEs together maintained a mean quarterly purchase share of Agency MBS around 10 percent of new issuance.



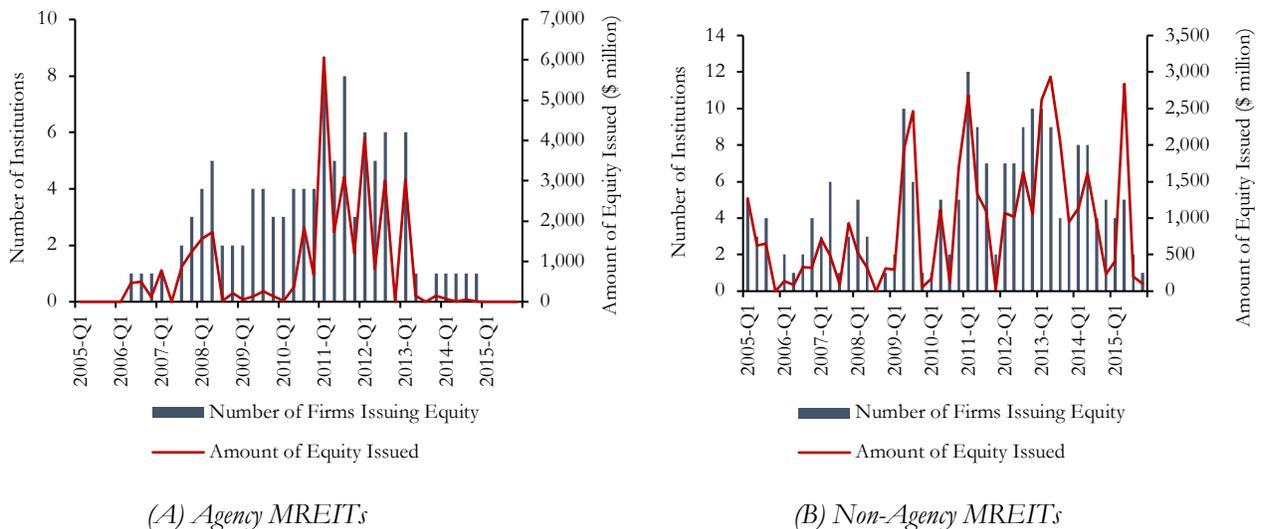
(A) Purchase Share (% of Total Agency MBS Issuance)

(B) Holdings Share (% of Total Agency MBS Outstanding)

**Figure 5: Federal Reserve and GSE Agency MBS Market Shares.** This figure shows the Agency MBS purchase shares (Panel (A)) and holdings (Panel (B)) for the Federal Reserve Bank, Fannie Mae, and Freddie Mac. The data used are obtained from the Federal Reserve Bank of New York.

Panel (B) of Figure 5 shows the share of Agency MBS outstanding held by the Federal Reserve, Fannie Mae, and Freddie Mac. Over the 2008—2015 period, the central bank increased its share from zero to over 30 percent. The GSEs’ share of aggregate Agency MBS investment declined from about 16 percent to four percent, as the terms of the U.S. Treasury’s financing for the conservatorships required that these portfolios shrink.

Given that REITs must distribute at least 90 percent of their taxable net income annually to remain exempt from federal corporate income tax, significant growth requires new equity issuance. Figure 6 presents quarterly equity issuance data for Agency MREITs (Panel A) and Non-Agency MREITs (Panel B) in terms of the number of institutions issuing shares and the total dollar amount of equity issued. For Agency MREITs, new equity issuance is clustered between 2010 and 2012, which aligns with the asset growth pattern described above.



**Figure 6: MREIT Equity Issuance.** This figure depicts equity issuance activity for Agency MREITs (Panel (A)) and Non-Agency MREITs (Panel (B)) in terms of the number of institutions issuing equity in a given quarter, as well as the total amount of equity issued. The data used are obtained from S&P Global.

The rapid growth of Agency MREITs during QE2, coupled with their potentially fragile business model, caught the attention of the newly created Financial Stability Oversight Council in 2013. Policymakers were concerned about the vulnerability of these shadow banks to sharp increases in interest rates that would erode the value of their assets, potentially resulting in a run on their short-term liabilities and a large-scale sell-off in the Agency MBS market. Despite these conjectures, a systematic empirical analysis of Agency MREIT growth and risk taking in the context of QE is absent from the literature. This issue may be of ongoing policy interest as the central bank exits the Agency MBS market under its “portfolio normalization plan.” The recent evidence of rapid Agency MREIT expansion suggests that these institutions could play a significant role in the Agency MBS market going forward, given the post-conservatorship shrinkage of such holdings by Fannie Mae and Freddie Mac.

### 3 Event Study

We begin our empirical analysis by conducting a high-frequency event study of the equity market reactions by Agency and Non-Agency MREITs to the 14 QE announcements identified by Chodorow-Reich (2014). This analysis has two goals. The first is to illustrate that market participants expected MREITs to be materially affected by the Federal Reserve’s QE and that MREIT equity prices reacted accordingly. The second goal is to document the similarities and differences in the reactions across Agency and Non-Agency MREITs, the latter of which we use as control group in our subsequent analysis of Agency MREIT growth and risk taking in response to QE.

Central bank asset purchases are thought to reduce long-term interest rates and thereby increase the value of fixed-income securities held by financial institutions. We expect this effect to benefit both types of MREITs. However, Agency MBS benefit less from declines in long-term interest rates because of negative convexity arising from higher expected fixed-rate mortgage prepayments in a lower interest rate environment.<sup>8</sup> Further, the Federal Reserve’s purchases in the Agency MBS market curtail investment opportunities for Agency MREITs under the QE “portfolio balance channel.” In all, we expect both types of MREITs to react to QE announcements, but we expect that Agency MREITs react more strongly than Non-Agency MREITs, which hold more diverse portfolios.

Following Chodorow-Reich (2014), we obtain high-frequency, tick-by-tick equity price data from TAQ to construct 5-minute average trading prices from 7 to 2 minutes before QE-related announcements to 18 to 23 minutes after. The rationale is to identify a causal relationship between monetary policy surprises and equity market movements in a manner that trades off the need for a narrow enough window such that other aggregate shocks do not influence asset prices, but one long enough so the market can plausibly digest the new information.

Table 1 presents the results for both types of MREITs. For reference, we also reproduce the corresponding results for insurance companies, commercial banks, and the broader market from Chodorow-Reich (2014, Table 2). Our estimates show that both types of MREITs reacted to most QE announcements but with significant differences between Agency and Non-Agency MREITs. During QE1 and QE2, Agency MREITs generally reacted positively and in-line with the broader market, although the reaction was muted relative to Non-Agency MREITs, life insurers, and banks. This evidence is consistent with QE increasing legacy asset values, but with fixed-rate Agency MBS benefitting less due to negative convexity. The two forward guidance announcements during QE2 were perceived more positively for Agency MREITs than for the other financial institutions. This result is likely due to the perception that the cost of Agency MREIT short-term repo liabilities would remain low for a considerable period of time. Agency MREITs reacted more strongly than Non-Agency MREITs and other

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<sup>8</sup> Agency MBS (or pre-payable fixed rate mortgages more generally) are continuously callable debt. As with standard fixed-rate debt, if interest rates rise (decline), the price of the mortgage declines (rises) – and the longer is the maturity of the instrument, the greater are the associated price swings. But the price response is also affected by changes in the rate of mortgage prepayments: Decreases in interest rates induce borrowers to repay their existing mortgages, thereby reducing the capital gain to the Agency MBS investor. Conversely, increases in interest rates lead to slower prepayments. Hence in a falling rate environment, an Agency MBS investor is not as well-off as they would otherwise be, while in the rising rate environment they are even worse off.

financial institutions to the announcements around QE3. The announcements in May and June of 2013, related to the so-called Taper Tantrum, were negative for Agency MREITs, as they unanchored expectations about their funding costs, which had previously been tied-down by forward guidance. This result is reversed in the September 2013 statement, which delayed tapering.

[Table 1 about here.]

This event study serves as the background for our main empirical analysis to follow. The results suggest that: (i) market participants clearly expected MREITs to be affected by QE; and (ii) that there are sufficient similarities, but also important differences, in the equity market reactions across Agency and Non-Agency MREITs to these announcements. This analysis shows that there is some causal impact from the Federal Reserve's QE on MREITs and that Non-Agency MREITs provide a suitable control group for our analysis of Agency MREITs.

## 4 Data and Sample Selection

Our analysis focuses on MREIT growth and risk taking during the Federal Reserve's QE. The primary data source is S&P Global, which includes quarterly information about MREIT balance sheets and capital market activities. The study period is 2005:Q1—2015:Q4.<sup>9</sup> S&P Global lists 60 MREITs over that period.

For each MREIT, we obtain quarterly balance sheet data on total assets, total Agency MBS, total repo debt, repo debt due in 0-30 days, and total equity. We further obtain information on whether an MREIT issued equity or repurchased shares in a given quarter, as well as the amount of equity issued, or number of shares repurchased. Finally, we hand-collect data on the type of Agency MBS holdings in terms of fixed-rate versus variable-rate securities and derivative positions for interest rate swaps and swaptions from MREIT 10-K and 10-Q reports. As these are not required reporting items, the information is only available for a sub-set of institutions. We identify Agency MREITs by computing the ratio of Agency MBS to total assets for each institution-quarter over the study period and classify institutions as Agency MREITs if that ratio exceeds 50 percent on average.<sup>10</sup>

We construct the following set of institution characteristics. *Total Assets* is the book value of total assets, in \$ billion. *Growth in Assets* is the quarterly rate of growth in total assets. *Agency Securities/Assets* is the total amount of Agency MBS held, scaled by total assets. *Issued Equity* is an indicator that takes the value of one if an institution issued equity in a given quarter. *Amount Issued* is the total amount of equity issued in a given quarter, scaled by total assets at the beginning of the quarter. We define *Repurchased Shares* as an indicator that takes the value of one if an institution repurchased shares in a given quarter. *Number Repurchased* is the number of shares repurchased in a given quarter, scaled by the number of shares outstanding at the beginning of the quarter. *Market-to-Book Value of Equity* is the ratio of the market value of equity, obtained as the product of the number of shares outstanding multiplied

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<sup>9</sup> We start in 2005 due to data limitations but lose little as there were only three Agency MREITs previously.

<sup>10</sup> Our results are robust to defining Agency MREITs based on the share of Agency MBS consistently >50 percent.

by the end-of-quarter share price, scaled by the book value of equity. We define  $Equity/Assets$  as a proxy for institution leverage using the ratio of book equity to total assets.  $Cash/Assets$  is the ratio of cash and cash-equivalent securities to total assets.  $Repo/Assets$  is the ratio of repo debt to total assets. We also consider institution exposure to short-term repo, proxied by the ratio of repo debt maturing within 0-30 days to total repo, and denoted  $Repo(0-30)/Total\ Repo$ . We compute  $Fixed-Rate/Agency\ Securities$  as the ratio of fixed-rate MBS to total Agency MBS. We proxy for interest rate risk hedging activity using the ratio of swaps to total liabilities and the ratio of swaps plus swaptions to total liabilities, denoted, respectively, as  $Swaps/Total\ Liabilities$  and  $Swaps\ \&\ Swaptions/Total\ Liabilities$ .

We collect data for three interest rate variables that capture the principal drivers of the profitability of Agency MBS investment. The 3-month and 10-year Treasury constant maturity rates are obtained from the Federal Reserve Bank of St. Louis. Based on those rates, we construct measures of the level (3-month CMT) and slope of the U.S. Treasury yield curve (10-year CMT less 3-month CMT). The option-adjusted mortgage spread (OAS) is an important measure of the attractiveness of Agency MBS investment versus holding long-term Treasury bonds.<sup>11</sup> We use Bloomberg Barclay's US MBS Fixed Rate Average OAS as a proxy.<sup>12</sup> We also collect data for two variables that are primarily related to credit-sensitive mortgage investments held by Non-Agency MREITs. The first is the quarterly growth rate in the S&P/Case-Shiller Home Price Index. The second is the quarterly spread between Moody's Seasoned Baa Corporate Bond yield and the yield on the 10-Year CMT.

Appendix A provides a comprehensive timeline of the Federal Reserve's QE, which started shortly after the failure of Lehman Brothers in September 2008, based on the published minutes from the Federal Open Market Committee meetings. According to the timeline, the first round of quantitative easing (QE1) was announced in 2008:Q4 and ran through 2010:Q1. It included the purchase of \$1.25 trillion in Agency MBS, \$300 billion of U.S. Treasury securities, and \$200 billion of Agency debt. QE2 was a short-lived program (2010:Q4—2011:Q2) that involved the central bank purchasing an additional \$600 billion in U.S. Treasury securities but no more Agency MBS. This was followed by the Maturity Extension Program (2011:Q3—2012:Q4) which included the purchase of another \$400 billion in very long-term U.S. Treasury securities (6–30 years) and the sale of similar amounts of short-term securities in an effort to “twist” the yield curve. The Federal Reserve also began principal reinvestments of proceeds from their Agency MBS portfolios back into similar assets. During this period, the Federal Reserve began ratcheting up its use of “forward guidance” to anchor expectations of the very short-term policy rate at the effective zero lower bound for up to two years out. QE3 (2012:Q3—2013:Q4) saw a renewal of Federal Reserve purchases of Agency MBS and the continuation of long-term U.S. Treasury purchases. During the Tapering regime (2013:Q4—2014:Q3), the Federal Reserve continued but gradually slowed the pace of long-term asset purchases. We supplement this information about the dates and duration of QE regimes with quarterly data from the Federal

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<sup>11</sup> The mortgages underlying Agency MBS all have an embedded continuous prepayment option, whose value increases in the volatility of mortgage rates. The OAS measures the yield spread of the MBS after adjusting for the estimated value of this option.

<sup>12</sup> Ideally, one would want to observe an institution-quarter panel of security holdings and collect the related OAS to compute an institution-specific portfolio OAS. Such information is not available as MREITs do not file form 13-f.

Reserve Bank of New York on the central banks' actual quarterly purchases and holdings of Agency MBS, as well as the total amount of these securities issued and outstanding.

Table 2 presents descriptive statistics for our sample of Agency and Non-Agency MREIT over the study period. The sample contains 1,002 institution-quarter observations from 15 Agency MREITs and 35 Non-Agency MREITs. Agency MREITs on average are significantly larger than Non-Agency MREITs (\$18.0 billion versus \$4.3 billion in total assets). Agency MBS account for 84 percent of Agency MREIT total assets, compared to six percent for all other MREITs. 26 percent of Agency MREIT institution-quarters include equity issues, with the mean amount issued per quarter equivalent to 1.1 percent of total assets at the beginning of the quarter. For Non-Agency MREITs, these statistics are 14 percent and 1.7 percent, respectively. The mean equity-to-assets ratio also differs across the two types of MREITs, with 14 percent for Agency MREITs and 29 percent for Non-Agency MREITs. For Agency MREITs, the mean ratio of repo to total assets is 78 percent and the mean share of short-term repo (0-30 days) to total repo is 47 percent. Non-Agency MREITs also utilize repo debt but at 16 percent their mean share is substantially lower. Non-Agency MREITs, on average, also maintain slightly larger cash buffers.

[Table 2 about here.]

As noted, we hand-collect data on the types of Agency MBS held in terms of fixed-rate versus variable-rate securities and the use of interest rate swaps and swaptions for a subset of MREITs. We are able to obtain information on the type of Agency MBS held for 26 institutions and data on derivative usage for 25 institutions. Agency MREITs hold mostly fixed-rate securities (58 percent), although with a wide dispersion (0 to 100 percent of total Agency MBS holdings). By contrast, Non-Agency MREITs predominantly invest in variable-rate Agency MBS, as the average share of their fixed-rate MBS is only nine percent. For Agency MREITs, the mean share of swaps to total liabilities is 47 percent. Adding swaptions increases this figure to 48 percent. Non-Agency MREITs use interest rate derivatives much less intensively; the mean ratio of swaps to total liabilities is 14 percent, irrespective of the inclusion of swaptions. For both types of MREITs, there is significant cross-sectional variation in the use of such derivatives.

The mean 3-month constant maturity Treasury rate is one percent but ranged from 0.01 to 5.08 percent. In terms of other interest rate variables, the slope of the term structure averages 2 percent and the mean option-adjusted mortgage spread is 0.49 percent. The Federal Reserve's quarterly mean share of Agency MBS purchases to newly issued securities is 25 percent but ranges from zero to 86 percent.

## **5 QE and Agency MREIT Growth**

### *5.1 Empirical Approach*

To identify the effects of QE on Agency MREIT asset growth we compare them with Non-Agency MREITs. As illustrated by the event study in Section 3, Non-Agency MREITs constitute a natural control group since they

are subject to the same statutory requirements as Agency MREITs but hold a broader portfolio of mortgage-related debt. Our approach is similar to Rodnyansky and Darmouni (2017) and Chakraborty, Goldstein and MacKinlay (2017), who analyze differences in commercial bank lending responses to QE by comparing banks with high versus low Agency MBS portfolio holding shares.

We begin our analysis with the baseline regression model for MREIT asset growth shown in Eq. (1):

$$Asset\ Growth_{i,t} = \alpha Agency\ MREIT_i + \beta Fed\ MBS\ Purchase\ Share_t + \gamma \mathbf{Macro}_t + \theta \mathbf{Controls}_{i,t} + \varepsilon_{i,t} \quad (1)$$

where  $Asset\ Growth_{i,t}$  denotes the quarterly growth in total assets for institution  $i$  at time  $t$ .  $Agency\ MREIT$  is an institution-specific, time-invariant indicator that takes the value of one if institution  $i$  is an Agency MREIT (versus a Non-Agency MREIT).  $Fed\ MBS\ Purchase\ Share$  is the Federal Reserve's quarterly purchase share of Agency MBS.

$\mathbf{Macro}_t$  is a matrix of interest rate variables that determine the profitability of (Agency) MBS investment. Specifically, we account for the level and slope of the term structure by including the 3-month constant maturity Treasury rate (*3-Month CMT*) and the difference between the 10-year and 3-month constant maturity rates (*Term Structure*). We control for the relative attractiveness of Agency MBS versus Treasury bonds through the option-adjusted mortgage spread (*Option-Adjusted Spread*). In order to capture drivers of growth specific to Non-Agency MREITs, we include the quarterly rate of national house price growth based on the Case-Shiller Index (*Case-Shiller Index*) and the credit risk premium (*Credit Spread*). The latter is defined as the spread between Baa-rated corporate bonds and the yield on the 10-year CMT. We further include the Federal Reserve's purchase share of Treasury securities (*Fed Treasury Purchase Share*).

$\mathbf{Controls}_{it}$  is a matrix of institution-specific, time-varying characteristics. We include the amount of new equity issued as a percentage of total equity at the beginning of the quarter (*Amount Issued*). This variable reflects that REITs must distribute a large fraction of their earnings as dividends, hence asset growth must largely be financed through new equity issuance. Conversely, MREITs may also contract when investment opportunities decline. Thus, we include the number of shares repurchased as a percentage of total shares outstanding at the beginning of the quarter (*Number Repurchased*). We further control for MREIT *Size*, defined as the natural logarithm of total assets, lagged by one quarter. We estimate Eq. (1) via OLS with standard errors clustered by institution.

To the baseline model in Eq. (1), we add an interaction term between *Agency MREIT* and *Fed MBS Purchase Share*. This term reflects the differential response between Agency and Non-Agency MREITs to variation in *Fed MBS Purchase Share*. We hypothesize that the central banks' Agency MBS purchases have a direct (and larger) effect on investment opportunities for the specialized Agency MREITs and expect a negative coefficient on this term.

We further examine MREIT responses to central bank Agency MBS purchases across the QE regimes, which each defined by slightly different policy objectives. For example, QE1 was especially important for Agency MBS market functioning and hardening expectations about federal support for Fannie Mae and Freddie Mac (Hancock and Passmore, 2011). During the Tapering period, by contrast, the Federal Reserve was extremely transparent and

consistent in its monthly asset purchase activity so as to not materially affect markets. We thus estimate a version of Eq. (1) where we construct interaction terms between *Agency MREIT* and *Fed MBS Purchase Share* where the latter is QE regime-specific. We consider the following QE regimes: QE1, Maturity Extension Program (MEP), QE3, and the Tapering period. The Federal Reserve did not purchase Agency MBS during QE2 and hence we include a simple indicator to control for any unobservable policy effects during this period.

Equity issuance plays an important role in MREIT asset growth given the substantial payout requirements for these institutions. We thus examine the response in equity issuance and share repurchases to variation in the Federal Reserve’s posture in the Agency MBS market. Eq. (2) shows the specification of the regression model:

$$Issued\ Equity_{i,t} = \alpha Agency\ MREIT_i + \beta Fed\ MBS\ Purchase\ Share_t + \gamma Macro_t + \theta Controls_{i,t} + \varepsilon_{i,t} \quad (2)$$

where *Issued Equity<sub>i,t</sub>* is an indicator that takes the value of one if institution *i* issued new equity at time *t*. Here the time-varying institution characteristics included are: institution *Size* and the ratio of *Market-to-Book Value of Equity*, lagged one quarter, which captures market timing considerations that drive equity issuance decisions (Baker and Wurgler, 2000). Notation and the remaining variables are as in Eq. (1). We also estimate the same variations for this regression as for Eq. (1). Eq. (2) is estimated via OLS with standard errors clustered by institution. We estimate the likelihood of quarterly share repurchases (*Repurchased Shares*) in the same framework.

## 5.2 Results

Table 3 presents the results of the asset growth regressions. The estimates in column (1) suggest that Agency MREITs on average experienced higher rates of asset growth than Non-Agency MREITs. The same estimates also suggest that the Federal Reserve’s purchase share of Agency MBS was negatively related to MREIT growth. The results reported in column (2) show that this effect is driven by the Agency MREITs in our sample. In economic terms, the estimates in column (2) suggest that a one-standard deviation increase in the Federal Reserve’s purchase share was associated with a marginal reduction in Agency MREIT asset growth of 3.6 percentage points per quarter, or approximately 40 percent of the unconditional mean.<sup>13</sup> The estimates presented in column (3) suggest that MREIT growth was concentrated in QE2 and the MEP when the Federal Reserve halted its Agency MBS purchases. The MREIT type-specific estimates in column (4) suggest that the growth during QE2 was unique to Agency MREITs, while that during the MEP period was attributable to both types of MREITs. The results in column (4) suggest that Agency MREIT asset growth was concentrated in QE1 and QE2; with a later decline during the Tapering period. As discussed above, QE1 had the effect of driving down long-term interest rates and resulting in large capital gains for fixed-income investors that would have facilitated growth in Agency MREITs. The further expansion of Agency MREITs during QE2 can be explained by the central bank halting its purchases

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<sup>13</sup> Based on estimates in Table 3, column (2). Coefficient (−0.145) x SD of Federal Reserve Purchase Share (0.2473) = economic effect (−0.0359), rounded to −3.6 percentage points. Multiplying this effect (−0.0359) by the unconditional mean Agency MREIT asset growth (0.0888) equals an effect equivalent to approximately −40 percent of the unconditional mean.

and no longer crowding out private investment. While the Federal Reserve’s purchase share of Agency MBS declined over the course of the Tapering period, the central banks’ share of the stock of these assets remained relatively constant (see Figure 5). The estimates in Table 3 also suggest that MREIT growth is positively associated with the amount of equity issued and negatively related to share repurchases. This finding reflects the strict pay-out requirements for REITs and the resulting reliance on external funding to finance any material growth.

[Table 3 about here.]

Given the important role of equity issuance for MREIT growth, we examine this directly in Table 4. The estimates in columns (1) through (4) show that Agency MREITs on average are more likely to issue equity than Non-Agency MREITs. Our results also suggest that the Federal Reserve’s QE program had different implications across MREIT types. The estimates in column (2) imply that a one-standard deviation increase in the Federal Reserve’s Agency MBS purchase share was associated with a decline in the likelihood of equity issuance by Agency MREITs of 16 percentage points, or more than 60 percent of the unconditional mean.<sup>14</sup> With respect to individual QE regimes, the estimates in column (3) suggest that MREIT equity issuance across institution types was insensitive to QE-related MBS purchases. However, the estimates in column (4) indicate that Agency MREITs issued significantly more equity than Non-Agency MREITs during QE2, and less during QE3 and Tapering. The finding of no significant difference in equity issuance across MREIT types during QE1, suggests that the growth of Agency MREITs at that time was organic and facilitated by the windfall associated with the announcement of that intervention. By contrast, the significant expansion and contraction of Agency MREITs during QE2 and QE3 was primarily driven by equity issuance and repurchase behavior – i.e., the crowding-in and crowding-out of private capital. The reduction in Agency MREIT equity issuance during the Tapering Period mirrors the results we document in terms of their asset growth at that time.

[Table 4 about here.]

Table 5 presents the regression results for quarterly Agency MREIT share repurchases. Agency MREITs were, on average, as likely as Non-Agency MREITs to repurchase shares (columns (1) through (4)). However, Agency MREIT repurchase activity increased significantly in response to the Federal Reserve’s Agency MBS purchases (column (2)). When considering individual QE regimes, we show that all MREITs increased their share repurchase activity during QE2 and in relation to the Federal Reserve’s Agency MBS purchases during QE3 (column (3)). The estimates in column (4) suggest that Agency MREIT share repurchases (relative to Non-Agency MREIT share repurchases) decreased significantly in response to the Federal Reserve’s Agency MBS purchase activity during

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<sup>14</sup> Based on estimates in Table 4, column (2). Coefficient (−0.636) x SD of Federal Reserve Purchase Share (0.2473) = economic effect (−0.1573), rounded to −16 percentage points. Multiplying this effect (−0.1573) by the unconditional mean likelihood of Agency MREIT equity issuance (0.2573) equals an effect equivalent to −61 percent of the unconditional mean.

QE1, QE2, and MEP and increased during QE3 and the Tapering period. In all, the estimates reported in Table 5 indicate that the likelihood of Agency MREIT share repurchases mirrors the dynamics of their equity issuance.

[Table 5 about here.]

## 6 QE and Agency MREIT Risk Taking

### 6.1 Empirical Approach

To identify the effects of QE on Agency MREIT risk taking, we again employ the cross-sectional comparison to all other MREITs. We begin by estimating the ratio of equity to total assets, as a measure of leverage or solvency risk. We then turn to three measures of liquidity risk: (i) the ratio of repurchase agreements to assets; (ii) short-term repo (< 30 days) to total repo debt; and (iii) cash to assets. Eq. (3) presents the regression specification:

$$Risk_{i,t} = \alpha Agency\ MREIT_i + \beta Fed\ MBS\ Purchase\ Share_t + \gamma Macro_t + \theta Controls_{i,t} + \varepsilon_{i,t} \quad (3)$$

where  $Risk_{i,t}$  denotes the specific measure of solvency or liquidity risk considered. Variables and notation are as in Eq. (2). The institution characteristics in Eq. (3) are lagged values of institution *Size* and a set of other risk characteristics. The other risk characteristics included depend on the outcome variable considered. In the leverage regressions, we control for lagged values of the ratio of cash to assets (*Cash/Assets*) and the exposure to short-term repo debt (*Repo (0-30)/Total Repo*). When studying the ratio of repurchase agreements to assets, we control for lagged values of *Cash/Assets*. When considering the ratio of short-term repo (< 30 days) to total repo debt as an outcome, we include lagged values of *Equity/Assets* and *Cash/Assets*. Lastly, when analyzing variation in *Cash/Assets*, we control for *Equity/Assets* and *Repo (0-30)/Total Repo*. The model in Eq. (3) is estimated via OLS with standard errors clustered by institution. We estimate variations of Eq. (3) by adding interaction terms between the (period-specific) Federal Reserve Agency MBS purchase shares and the Agency MREIT indicator as previously described in the context of Eq. (2).

For a sub-set of MREITs with available data, we examine two measures of interest rate risk exposure: (i) the ratio of fixed-rate to total Agency MBS; and (ii) the ratio of interest rate swaps and swaptions to total liabilities. We estimate the relationships between QE and these measures of interest rate risk exposure using the specification described in Eq. (3). The institution characteristics we include in these interest rate risk regressions are *Equity/Assets*, *Repo (0-30)/Total Repo*, and *Cash/Assets*.

### 6.2 Results

Table 6 presents the results of the leverage regressions. The estimates in column (1) suggest that Agency MREITs hold a lower baseline-level of equity, or are more levered, than Non-Agency MREITs. The results reported in column (2) indicate that the Federal Reserve's purchase activity in the Agency MBS market was not associated with any significant effect on MREIT leverage overall. The estimates presented in column (3) break

down this overall effect into the individual QE regimes during our study period. The results suggest a slight decline in equity held during QE1 and an increase during QE3. When considering institution type-differential responses to period-specific purchases of Agency MBS by the Federal Reserve (column (4)), we document that Agency MREITs lowered their equity-to-assets ratios (i.e., increased leverage) during QE3 and Tapering in relation to Federal Reserve Agency MBS purchase activity. In economic terms, the estimates from column (4) suggest that a one-standard deviation increase in the Federal Reserve's purchase share of Agency MBS during QE3 and Tapering were each associated with a decline in the equity-to-assets ratio of Agency MREITs of over two percentage points, or approximately 16 percent of the unconditional mean.<sup>15</sup> This result is consistent with “reaching for yield” behavior by Agency MREITs during a time when investment growth opportunities for these institutions were curtailed by the Federal Reserve's purchase activity in the Agency MBS market.

Table 7 presents the results for MREIT use of repo debt financing. Here we see that Agency MREITs use repurchase agreements more heavily overall (column (1) through (4)) consistent with their business model focusing on maturity transformation. The proportion of repo debt used by MREITs is inversely related to cash holdings, suggesting some hedging of liquidity risk. Agency MREITs generally increased their use of repo during the MEP, QE3, and Tapering periods (Column (3)). Yet, the estimates suggest no significant relationship between the Federal Reserve's Agency MBS purchase share and Agency MREIT repo financing in particular.

Table 8 presents the results for the maturity of repo financing as measured by the ratio of short-term repo (0-30 days) to total repo. Across columns (1) through (4), we see a positive relationship between short-term repo and the Agency MREIT indicator. We also find a positive relation between very short-term debt and the Federal Reserve's Agency MBS purchase shares (columns (1) and (2)), although the results in column (3) do not attribute this to a specific QE regime. These two findings are reconciled in column (4) which indicates that Non-Agency MREITs significantly increased their use of very short-term repo in QE3 and Tapering in relation to the Federal Reserve's Agency MBS purchase activity, while Agency MREITs significantly decreased their use.

Table 9 presents the regression results for MREIT cash holdings. Notably, the estimates in column (4) suggest that Non-Agency MREITs decrease their cash holdings in response to the Federal Reserve's Agency MBS purchase share during the Tapering period, while we document the opposite result for Agency MREITs.

[Tables 6 through 9 about here.]

Turning to interest rate risk exposure, Table 10 presents the results for MREIT fixed-rate Agency MBS share of their total Agency MBS holdings. We document that Agency MREITs consistently hold a larger fraction of fixed-rate securities than their Non-Agency counterparts (column (1) through (4)). The estimates in column (1)

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<sup>15</sup> Based on estimates in Table 6, column (4). Coefficient (−0.199) [respectively Tapering (0.121)] x SD of Federal Reserve Purchase Share in QE3 (0.1135) [respectively Tapering (0.1865)] = economic effect (−0.0226) in both regimes, rounded to −2 percentage points in each case. Multiplying these effects by unconditional mean Agency MREIT equity-to-assets ratio (0.1388) equals an effect equivalent to approximately −16 percent of the unconditional mean, for both QE3 and Tapering.

suggest that, for all MREITs, the fixed-rate share is positively related to the Federal Reserve’s Agency MBS purchase share. The estimates in column (2) indicate no significant difference in the response to the Federal Reserve’s purchase share across Agency and Non-Agency MREITs. Column (3) suggests that baseline the result from column (1) is driven by QE2, MEP, QE3, and the Tapering period, although there is no differential response across Agency and Non-Agency MREITs (column (4)). The greater share of fixed-rate Agency MBS holdings through several QE regimes suggests increased interest rate risk exposure over time.

[Table 10 about here.]

Given the previous result, we next explore the intensity of interest rate hedging by MREITs, proxied by the ratio of interest rate swaps and swaptions to total liabilities, in Table 11. The estimates reported in column (1) suggest that Agency MREITs hedge their interest rate risk exposure more intensively, reflecting that maturity transformation and thus interest rate risk management is their principal focus. The estimates in column (2) indicate that hedging by Agency MREITs increased in response to the Federal Reserve’s Agency MBS purchase share while we document the reverse for Non-Agency MREITs. The results in column (3) suggest heightened hedging activity for all MREITs during MEP and QE3. Finally, the results in column (4) show that Agency MREITs increased their hedging activity relative to Non-Agency MREITs in response to the central bank’s Agency MBS purchases during Tapering. Overall, it seems that MREITs took on more interest rate risk during QE as their portfolios tilted towards fixed-rate Agency MBS, although Agency MREITs concurrently intensified their use of swaps to hedge this risk.

[Table 11 about here.]

## 7 Concluding Remarks

The prolonged use of unconventional monetary policy since the financial crisis resulted in concerns about the potential for such accommodation to undermine financial stability. Recent research presents evidence consistent with “reaching for yield” by non-bank financial institutions during QE via increased credit risk taking. We test the complementary hypothesis that QE influences financial institution risk taking in terms of solvency, liquidity, and interest rate risk. We study Agency Mortgage REITs, which are shadow banks that hold long-term Agency MBS and financed using short-term repo debt provided by broker-dealers. This simple intermediation structure allows us to shut off any credit risk taking response to QE and isolate any potential response in terms of financial risk taking. To identify the effects of QE on institution-level outcomes, we employ a cross-sectional comparison between Agency MREITs and all other MREITs, which serve as a control group holding a broader portfolio of mortgage-related assets.

We first conduct a high-frequency event study of equity market reactions by Agency and Non-Agency MREITs to QE-related central bank communications. The results suggest a causal impact from the Federal Reserve’s QE

on MREITs, and that Non-Agency MREITs provide a suitable control group for our analysis of Agency MREITs. We then show that Agency MREIT asset growth responded negatively to the Federal Reserve's purchase share of newly issued Agency MBS during QE. This dynamic is confirmed by additional analysis studying Agency MREIT equity issuance and share repurchase behavior. These results demonstrate that the Federal Reserve's Agency MBS purchases directly crowd out private-sector investment and induce portfolio rebalancing by equity investors in Agency MREITs. We further document that the Federal Reserve's purchase activity in the Agency MBS market during QE3 and Tapering was associated with a significant increase in Agency MREIT leverage. This result represents novel evidence that financial institutions respond to QE by making riskier capital structure choices, consistent with "reaching for yield." However, we also show that Agency MREITs concurrently increased cash holdings and interest rate risk hedging.

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**Table 1: Event Study**

This table presents the results from the event study. Difference is the difference in the estimates for Agency MREITs versus Non-Agency MREITs. Significance is indicated as follows: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ , respectively, based on the larger of the conventional or robust standard error from a regression of the change in the asset price on a constant on the date indicated. Periods are defined as follows: Initial QE: 12/16/2008 and 03/18/2009; Taper: 05/22/2013 and 06/19/2013; Sample end: 07/10/2013 and 09/18/2013. Totals may differ due to rounding or sample composition.

Regime	Date	Treasury	Life Insurers	Banks	Market	Agency MREITs	Non-Agency MREITs	Difference
QE1	12/01/2008	-9.2	-0.4	-0.6***	-0.5***	0.3	-0.6	0.9*
QE1	12/16/2008	-16.8	3.6***	2.2***	1.3***	1.2***	2.2***	-1.0**
QE1	01/28/2009	3.1	-1.2***	-0.3	-0.3***	0.0	-0.7***	0.7***
QE1	03/18/2009	-22.8	4.0***	2.5***	1.5***	1.0**	1.7**	-0.7
QE1	09/23/2009	-8.9	0.6***	0.6***	0.6***	0.4***	0.6***	-0.2*
QE2	08/10/2010	-5.8	0.8***	0.9***	0.7***	0.4***	0.5***	-0.1
QE2	09/21/2010	-1.8	0.6***	0.7***	0.5***	0.1**	0.1	0.0
FG	08/09/2011	-14.4	-2.0***	-1.7***	-1.4***	1.7**	-0.4	2.1***
FG	01/25/2012	-6.3	-0.6***	0.0	0.3***	0.6***	0.3***	0.3*
QE3	09/13/2012	6.4	1.3***	1.0***	0.5***	0.3***	0.3***	0.0
QE3	05/22/2013	6.6	-0.4***	-0.5***	-0.5***	-1.2***	-0.5***	-0.7**
QE3	06/19/2013	7.8	0.1	0.2***	-0.2***	-1.3***	-0.6***	-0.7**
QE3	07/10/2013	-7.3	0.3	0.0	0.3***	0.5	0.5	0.0
QE3	09/18/2013	-14.0	0.4	0.9***	1.0***	2.8***	1.8***	1.0***
Initial QE		-39.7	7.6***	4.5***	2.9***	2.2***	4.0***	-1.9*
Taper		14.4	-0.3***	-0.4***	-0.6***	-2.5***	-1.1***	-1.3**
Sample end		-21.4	0.4	0.9***	1.2	3.2***	1.9***	1.2***

**Table 2: Descriptive Statistics**

This table presents descriptive statistics for the variables of interest over the study period 2005—2015. All variables are as defined in the text. Difference is the difference in means between Agency MREITs and Non-Agency MREITs. Significance for a two-sided t-test across Agency and Non-Agency MREITs is indicated as follows: \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

<b>Panel A: Agency MREITs</b>	<b>N</b>	<b>Mean</b>	<b>SD</b>	<b>P25</b>	<b>Median</b>	<b>P75</b>	<b>Min</b>	<b>Max</b>	<b>Difference</b>
Total Assets	447	18.0000	25.5000	4.4600	8.6300	17.5000	0.1920	142.0000	13.6700***
Growth in Assets	447	0.0888	0.2582	-0.0263	0.0149	0.0972	-0.3471	1.6464	0.0254
Agency Securities/Assets	447	0.8364	0.1547	0.7290	0.9091	0.9608	0.4135	0.9960	0.7760***
Issued Equity	447	0.2573	0.4376	0.0000	0.0000	1.0000	0.0000	1.0000	0.1222***
Amount Issued	447	0.0864	0.2356	0.0000	0.0000	0.0032	0.0000	1.6105	0.0262
Repurchased Shares	447	0.2215	0.4157	0.0000	0.0000	0.0000	0.0000	1.0000	0.1062***
Number Repurchased	447	0.0039	0.0127	0.0000	0.0000	0.0000	0.0000	0.1275	0.0021***
Market-to-Book Value of Equity	447	0.8897	0.1636	0.774	0.8857	0.9966	0.3208	1.4137	-0.0515**
Equity/Assets	447	0.1388	0.0509	0.1053	0.1247	0.1561	0.0617	0.3770	-0.1552***
Cash/Assets	447	0.0208	0.0189	0.0073	0.0191	0.0297	0.0000	0.2201	-0.0185***
Repo Debt/Assets	447	0.7831	0.0965	0.7387	0.8077	0.8545	0.3152	0.9147	0.6211***
Repo Debt (0-30 days)/Total Repo	447	0.4661	0.3006	0.2636	0.4735	0.7232	0.0000	1.0000	0.2976***
Fixed-Rate/Agency Securities	319	0.5762	0.3872	0.0030	0.7358	0.9095	0.0000	1.0000	0.4855***
Swaps/Total Liabilities	400	0.4505	0.2254	0.3567	0.4542	0.5764	0.0000	1.2060	0.3127***
Swaps & Swaptions/Total Liabilities	400	0.4792	0.2492	0.3567	0.4629	0.6030	0.0000	1.2060	0.3414***

<b>Panel B: Non-Agency MREITs</b>									
Variable									
Total Assets	555	4.3300	7.1700	0.6910	1.9700	5.3000	0.0050	57.5000	
Growth in Assets	555	0.0634	0.2507	-0.0286	0.0103	0.0916	-0.5563	1.9771	
Agency Securities/Assets	555	0.0604	0.1378	0.0000	0.0000	0.0386	0.0000	0.8453	
Issued Equity	555	0.1351	0.3422	0.0000	0.0000	0.0000	0.0000	1.0000	
Amount Issued	555	0.0602	0.3175	0.0000	0.0000	0.0000	0.0000	4.0618	
Repurchased Shares	555	0.1153	0.3197	0.0000	0.0000	0.0000	0.0000	1.0000	
Number Repurchased	555	0.0018	0.0096	0.0000	0.0000	0.0000	0.0000	0.1452	
Market-to-Book Value of Equity	555	0.9412	0.4041	0.7361	0.9569	1.1644	-0.3463	2.0508	
Equity/Assets	555	0.2940	0.2523	0.0978	0.2197	0.4191	-0.1007	0.9945	
Cash/Assets	555	0.0393	0.0927	0.0066	0.0160	0.0384	0.0002	1.0000	
Repo Debt/Assets	555	0.1620	0.2079	0.0000	0.0625	0.2664	0.0000	0.8864	
Repo Debt (0-30 days)/Total Repo	555	0.1685	0.3279	0.0000	0.0000	0.0998	0.0000	1.0000	
Fixed-Rate/Agency Securities	166	0.0907	0.2294	0.0000	0.0000	0.0000	0.0000	1.0000	
Swaps/Total Liabilities	518	0.1378	0.2145	0.0000	0.0519	0.1938	0.0000	1.7574	
Swaps & Swaptions/Total Liabilities	518	0.1378	0.2145	0.0000	0.0519	0.1938	0.0000	1.7574	

<b>Panel C: Macro Environment</b>									
3-Month CMT	44	1.0250	1.7187	0.0300	0.0900	1.1500	0.0100	5.0800	
CMT Term Structure	44	2.0040	1.0159	1.6100	2.1800	2.6700	-0.5200	3.5800	
Option-Adjusted Spread	44	0.4866	0.2911	0.2700	0.3800	0.5800	0.1100	1.4500	
Credit Spread	44	2.7349	0.7816	2.2600	2.7500	3.0800	1.5900	5.8200	
Case-Shiller House Price Index	44	0.0049	0.0301	-0.0078	0.0066	0.0272	-0.0696	0.0742	
Fed MBS Purchase Share	44	0.2470	0.2473	0.0000	0.2383	0.4641	0.0000	0.8622	
Fed Treasury Purchase Share	44	0.0993	0.0850	0.0364	0.0671	0.1912	0.0000	0.2815	

**Table 3: Quarterly Asset Growth**

This table presents the panel regression results for Agency versus Non-Agency MREIT asset growth (quarterly percentage change in the book value of assets) as a function of macroeconomic factors (level and slope of the term structure, option-adjusted mortgage spread, credit spread, growth in the Case-Shiller House Price index), institution characteristics (equity issuance, share repurchases, lagged institution size), as well as Federal Reserve purchase shares of Treasury Securities and Agency MBS. The study period is 2005—2015. All estimates are produced using OLS. Robust standard errors (clustered by institution) are reported in parentheses. Significance is indicated as follows: \*\*\* p<0.01; \*\* p<0.05; \* p<0.1.

VARIABLES	(1) Asset Growth	(2) Asset Growth	(3) Asset Growth	(4) Asset Growth
3-Month CMT	-0.029 (0.018)	-0.027 (0.018)	0.002 (0.017)	0.001 (0.017)
CMT Term Structure	-0.019 (0.020)	-0.018 (0.020)	-0.012 (0.020)	-0.014 (0.020)
Option-Adjusted Spread	-0.099*** (0.031)	-0.095*** (0.031)	-0.098** (0.040)	-0.095** (0.040)
Credit Spread	-0.006 (0.020)	-0.008 (0.020)	-0.006 (0.021)	-0.006 (0.020)
Case-Shiller House Price Index	0.230 (0.301)	0.266 (0.303)	0.179 (0.279)	0.202 (0.280)
Amount Issued	0.545*** (0.085)	0.539*** (0.084)	0.548*** (0.083)	0.537*** (0.081)
Number Repurchased	-1.849*** (0.275)	-1.683*** (0.263)	-1.805*** (0.309)	-1.526*** (0.274)
L.Firm Size	-0.015** (0.007)	-0.015** (0.007)	-0.015** (0.007)	-0.016** (0.007)
Agency MREIT	0.038** (0.018)	0.076*** (0.027)	0.036* (0.018)	0.033 (0.021)
Fed Treasury Purchase Share	0.362 (0.239)	0.361 (0.238)	-0.075 (0.198)	-0.058 (0.199)
Fed MBS Purchase Share	-0.080** (0.035)	-0.013 (0.045)		
Agency MREIT*Fed MBS Purchase Share		-0.145** (0.063)		
Fed MBS Purchase Share QE1			-0.013 (0.040)	-0.066 (0.044)
QE2			0.099** (0.037)	-0.002 (0.041)
Fed MBS Purchase Share MEP			0.462* (0.235)	0.386 (0.465)
Fed MBS Purchase Share QE3			-0.015 (0.050)	0.052 (0.079)
Fed MBS Purchase Share Taper			0.024 (0.039)	0.113* (0.061)
Agency MREIT*Fed MBS Purchase Share QE1				0.126** (0.060)
Agency MREIT*QE2				0.207*** (0.048)
Agency MREIT*Fed MBS Purchase Share MEP				0.119 (0.497)
Agency MREIT*Fed MBS Purchase Share QE3				-0.121 (0.074)
Agency MREIT*Fed MBS Purchase Share Taper				-0.159** (0.068)
Constant	0.367*** (0.130)	0.345** (0.130)	0.333** (0.130)	0.345** (0.131)
Observations	1,002	1,002	1,002	1,002
R-squared	0.443	0.448	0.449	0.467
Number of Firm Clusters	50	50	50	50

**Table 4: Quarterly Equity Issuance**

This table presents panel regression results for Agency versus Non-Agency MREIT quarterly equity issuance (measured as an indicator taking the value of one if the institution issued equity) as a function of macroeconomic factors (level and slope of the term structure, option-adjusted mortgage spread, credit spread, growth in the Case-Shiller House Price index), institution characteristics (market-to-book ratio, lagged institution size), as well as Federal Reserve purchase shares of Treasury Securities and Agency MBS. The study period is 2005—2015. All estimates are produced using OLS. Robust standard errors (clustered by institution) are reported in parentheses. Significance is indicated as follows: \*\*\* p<0.01; \*\* p<0.05; \* p<0.1.

VARIABLES	(1) Issued Equity	(2) Issued Equity	(3) Issued Equity	(4) Issued Equity
3-Month CMT	-0.083** (0.031)	-0.073** (0.029)	-0.103*** (0.027)	-0.100*** (0.027)
CMT Term Structure	0.037 (0.034)	0.039 (0.034)	-0.010 (0.027)	-0.009 (0.027)
Option-Adjusted Spread	0.056 (0.066)	0.071 (0.065)	0.087 (0.075)	0.097 (0.074)
Credit Spread	0.035 (0.036)	0.029 (0.036)	0.035 (0.035)	0.034 (0.035)
Case-Shiller House Price Index	0.030 (0.505)	0.134 (0.508)	0.054 (0.508)	0.123 (0.509)
L.Market-to-Book Value of Equity	0.222*** (0.041)	0.242*** (0.045)	0.229*** (0.042)	0.193*** (0.042)
Firm Size	-0.001 (0.012)	0.000 (0.012)	-0.001 (0.012)	0.002 (0.012)
Agency MREIT	0.111** (0.053)	0.280*** (0.058)	0.113** (0.053)	0.191*** (0.048)
Fed Treasury Purchase Share	1.707*** (0.383)	1.655*** (0.381)	1.733*** (0.506)	1.827*** (0.512)
Fed MBS Purchase Share	-0.088 (0.102)	0.212** (0.087)		
Agency MREIT*Fed MBS Purchase Share		-0.636*** (0.138)		
Fed MBS Purchase Share QE1			0.088 (0.108)	0.046 (0.074)
QE2			0.079 (0.067)	-0.053 (0.093)
Fed MBS Purchase Share MEP			(0.269)	(0.061)
Fed MBS Purchase Share QE3			(0.283)	(0.542)
Fed MBS Purchase Share QE3			-0.104 (0.100)	0.207 (0.151)
Fed MBS Purchase Share Taper			0.004 (0.119)	0.382** (0.157)
Agency MREIT*Fed MBS Purchase Share QE1				0.084 (0.239)
Agency MREIT*QE2				0.239** (0.105)
Agency MREIT*Fed MBS Purchase Share MEP				-0.510 (0.639)
Agency MREIT*Fed MBS Purchase Share QE3				-0.600*** (0.168)
Agency MREIT*Fed MBS Purchase Share Taper				-0.719*** (0.193)
Observations	1,002	1,002	1,002	1,002
R-squared	0.128	0.164	0.131	0.178
Number of firm clusters	50	50	50	50

**Table 5: Quarterly Share Repurchases**

This table presents panel regression results for Agency versus Non-Agency MREIT quarterly share repurchases (measured as an indicator taking the value of one if the institution repurchased shares) as a function of macroeconomic factors (level and slope of the term structure, option-adjusted mortgage spread, credit spread, growth in the Case-Shiller House Price index), institution characteristics (market-to-book ratio, lagged institution size), as well as Federal Reserve purchase shares of Treasury Securities and Agency MBS. The study period is 2005—2015. All estimates are produced using OLS. Robust standard errors (clustered by institution) are reported in parentheses. Significance is indicated as follows: \*\*\* p<0.01; \*\* p<0.05; \* p<0.1.

VARIABLES	(1) Repurchased Shares	(2) Repurchased Shares	(3) Repurchased Shares	(4) Repurchased Shares
3-Month CMT	-0.009 (0.022)	-0.015 (0.022)	0.035 (0.026)	0.037 (0.027)
CMT Term Structure	-0.064*** (0.024)	-0.065*** (0.024)	-0.043 (0.028)	-0.040 (0.029)
Option-Adjusted Spread	-0.126*** (0.035)	-0.136*** (0.035)	-0.100*** (0.031)	-0.107*** (0.031)
Credit Spread	-0.001 (0.028)	0.003 (0.028)	-0.023 (0.021)	-0.022 (0.020)
Case-Shiller House Price Index	-0.479 (0.390)	-0.548 (0.381)	-0.217 (0.453)	-0.264 (0.446)
L.Market-to-Book Value of Equity	-0.145** (0.059)	-0.159** (0.063)	-0.148** (0.062)	-0.093 (0.062)
Firm Size	0.010 (0.017)	0.009 (0.017)	0.009 (0.017)	0.006 (0.017)
Agency MREIT	0.063 (0.054)	-0.048 (0.048)	0.062 (0.054)	0.053 (0.050)
Fed Treasury Purchase Share	-0.773** (0.352)	-0.738** (0.351)	-1.659*** (0.412)	-1.753*** (0.426)
Fed MBS Purchase Share	0.087 (0.075)	-0.113 (0.118)		
Agency MREIT*Fed MBS Purchase Share		0.422*** (0.126)		
Fed MBS Purchase Share QE1			0.001 (0.111)	0.150 (0.162)
QE2			0.152*** (0.043)	0.240*** (0.066)
Fed MBS Purchase Share MEP			0.293 (0.215)	1.136** (0.457)
Fed MBS Purchase Share QE3			0.206** (0.093)	-0.101 (0.062)
Fed MBS Purchase Share Taper			(0.066)	-0.247*** (0.077)
Agency MREIT*Fed MBS Purchase Share QE1				-0.335* (0.175)
Agency MREIT*QE2				-0.163** (0.070)
Agency MREIT*Fed MBS Purchase Share MEP				-1.341*** (0.499)
Agency MREIT*Fed MBS Purchase Share QE3				0.568*** (0.148)
Agency MREIT*Fed MBS Purchase Share Taper				0.342** (0.135)
Observations	1,002	1,002	1,002	1,002
R-squared	0.082	0.100	0.092	0.141
Number of firm clusters	50	50	50	50

**Table 6: Quarterly Equity to Total Assets Ratio**

This table presents the panel regression results for Agency versus Non-Agency MREIT equity to total assets ratios as a function of macroeconomic factors (level and slope of the term structure, option-adjusted mortgage spread, credit spread, growth in the Case-Shiller House Price index), institution and capital structure characteristics, as well as Federal Reserve purchase shares of Treasury Securities and Agency MBS. The study period is 2005—2015. All estimates are produced using OLS. Robust standard errors (clustered by institution) are reported in parentheses. Significance is indicated as follows: \*\*\* p<0.01; \*\* p<0.05; \* p<0.1.

VARIABLES	(1) Equity/Assets	(2) Equity/Assets	(3) Equity/Assets	(4) Equity/Assets
3-Month CMT	-0.049** (0.022)	-0.048** (0.022)	-0.034* (0.017)	-0.033** (0.016)
CMT Term Structure	-0.033* (0.018)	-0.033* (0.018)	-0.021 (0.016)	-0.021 (0.015)
Option-Adjusted Spread	-0.031* (0.018)	-0.030* (0.017)	-0.039** (0.019)	-0.034* (0.019)
Credit Spread	-0.018** (0.007)	-0.018** (0.007)	-0.006 (0.005)	-0.007 (0.005)
Case-Shiller Index	0.058 (0.155)	0.067 (0.152)	0.094 (0.178)	0.110 (0.177)
L.Repo (0-30)/Total Repo	-0.030 (0.033)	-0.031 (0.033)	-0.031 (0.034)	-0.044 (0.038)
L.Cash/Assets	0.830*** (0.088)	0.828*** (0.089)	0.842*** (0.089)	0.863*** (0.091)
L.Firm Size	-0.038*** (0.007)	-0.038*** (0.007)	-0.039*** (0.008)	-0.037*** (0.008)
Agency MREIT	-0.081** (0.039)	-0.068* (0.038)	-0.080* (0.040)	-0.049 (0.030)
Fed Treasury Purchase Share	0.060 (0.215)	0.057 (0.216)	-0.003 (0.199)	0.017 (0.204)
Fed MBS Purchase Share	-0.019 (0.026)	0.003 (0.043)		
Agency MREIT*Fed MBS Purchase Share		-0.046 (0.050)		
Fed MBS Purchase Share QE1			-0.071* (0.036)	-0.111 (0.066)
QE2			0.025 (0.023)	0.061 (0.043)
Fed MBS Purchase Share MEP			0.005 (0.095)	0.189 (0.270)
Fed MBS Purchase Share QE3			0.062** (0.029)	0.166** (0.064)
Fed MBS Purchase Share Taper			0.039 (0.028)	0.101* (0.059)
Agency MREIT*Fed MBS Purchase Share QE1				0.093 (0.083)
Agency MREIT*QE2				-0.077 (0.058)
Agency MREIT*Fed MBS Purchase Share MEP				0.362 (0.356)
Agency MREIT*Fed MBS Purchase Share QE3				-0.199** (0.082)
Agency MREIT*Fed MBS Purchase Share Taper				-0.121* (0.066)
Constant	0.988*** (0.157)	0.981*** (0.157)	0.927*** (0.145)	0.889*** (0.143)
Observations	1,002	1,002	1,002	1,002
R-squared	0.443	0.444	0.451	0.466
Number of Firm Clusters	50	50	50	50

**Table 7: Quarterly Repo to Total Assets Ratio**

This table presents the panel regression results for Agency versus Non-Agency MREIT repurchase agreements to total assets ratios as a function of macroeconomic factors (level and slope of the term structure, option-adjusted mortgage spread, credit spread, growth in the Case-Shiller House Price index), institution and capital structure characteristics, as well as Federal Reserve purchase shares of Treasury Securities and Agency MBS. The study period is 2005—2015. All estimates are produced using OLS. Robust standard errors (clustered by institution) are reported in parentheses. Significance is indicated as follows: \*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.1$ .

VARIABLES	(1)	(2)	(3)	(4)
	Repo/Assets	Repo/Assets	Repo/Assets	Repo/Assets
3-Month CMT	0.012 (0.015)	0.013 (0.015)	0.029** (0.011)	0.029** (0.011)
CMT Term Structure	0.000 (0.013)	0.000 (0.013)	0.015 (0.011)	0.014 (0.012)
Option-Adjusted Spread	0.032 (0.020)	0.034* (0.020)	0.019 (0.021)	0.020 (0.021)
Credit Spread	-0.012 (0.011)	-0.013 (0.011)	-0.004 (0.008)	-0.004 (0.008)
Case-Shiller Index	-0.108 (0.171)	-0.093 (0.167)	-0.038 (0.147)	-0.035 (0.146)
L.Cash/Assets	-0.198*** (0.066)	-0.201*** (0.067)	-0.192*** (0.065)	-0.184*** (0.063)
L.Firm Size	0.020 (0.012)	0.020* (0.012)	0.019 (0.012)	0.019 (0.012)
Agency MREIT	0.595*** (0.045)	0.615*** (0.045)	0.594*** (0.045)	0.594*** (0.044)
Fed Treasury Purchase Share	-0.089 (0.132)	-0.094 (0.133)	-0.249 (0.198)	-0.249 (0.198)
Fed MBS Purchase Share	0.050 (0.031)	0.087 (0.058)		
Agency MREIT*Fed MBS Purchase Share		-0.079 (0.077)		
Fed MBS Purchase Share QE1			-0.016 (0.034)	-0.053 (0.048)
QE2			0.019 (0.033)	0.000 (0.041)
Fed MBS Purchase Share MEP			0.155* (0.092)	(0.031) (0.149)
Fed MBS Purchase Share QE3			0.089* (0.049)	0.114 (0.092)
Fed MBS Purchase Share Taper			0.082** (0.041)	0.160* (0.085)
Agency MREIT*Fed MBS Purchase Share QE1				0.088 (0.055)
Agency MREIT*QE2				0.039 (0.039)
Agency MREIT*Fed MBS Purchase Share MEP				0.314 (0.208)
Agency MREIT*Fed MBS Purchase Share QE3				-0.045 (0.104)
Agency MREIT*Fed MBS Purchase Share Taper				-0.141 (0.102)
Constant	-0.114 (0.184)	-0.124 (0.182)	-0.158 (0.175)	-0.152 (0.176)
Observations	1,002	1,002	1,002	1,002
R-squared	0.799	0.799	0.800	0.803
Number of Firm Clusters	50	50	50	50

**Table 8: Quarterly Repo (0-30 days) to Total Repo Ratio**

This table presents the panel regression results for Agency versus Non-Agency MREIT use of short-term repo debt (repo (0-30) to total repo debt), as a function of macroeconomic factors (level and slope of the term structure, option-adjusted mortgage spread, credit spread, growth in the Case-Shiller House Price index), institution and capital structure characteristics, as well as Federal Reserve purchase shares of Treasury Securities and Agency MBS. The study period is 2005—2015. All estimates are produced using OLS. Robust standard errors (clustered by institution) are reported in parentheses. Significance is indicated as follows: \*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.1$ .

VARIABLES	(1) Repo (0-30)/Repo	(2) Repo (0-30)/Repo	(3) Repo (0-30)/Repo	(4) Repo (0-30)/Repo
3-Month CMT	-0.033 (0.040)	-0.031 (0.041)	-0.029 (0.025)	-0.029 (0.026)
CMT Term Structure	-0.008 (0.040)	-0.008 (0.040)	0.001 (0.027)	0.000 (0.028)
Option-Adjusted Spread	0.000 (0.040)	0.003 (0.041)	-0.021 (0.042)	-0.014 (0.045)
Credit Spread	0.017 (0.023)	0.015 (0.023)	0.024 (0.019)	0.022 (0.019)
Case-Shiller Index	-0.330 (0.286)	-0.303 (0.295)	-0.306 (0.251)	-0.265 (0.265)
L.Equity/Assets	-0.180 (0.128)	-0.185 (0.127)	-0.187 (0.133)	-0.238 (0.146)
L.Cash/Assets	0.083 (0.153)	0.082 (0.153)	0.090 (0.160)	0.189 (0.185)
L.Firm Size	0.026 (0.016)	0.027 (0.016)	0.026 (0.017)	0.026 (0.016)
Agency MREIT	0.215** (0.089)	0.254*** (0.088)	0.214** (0.089)	0.276*** (0.084)
Fed Treasury Purchase Share	0.374 (0.278)	0.365 (0.279)	0.361 (0.307)	0.399 (0.306)
Fed MBS Purchase Share	0.090* (0.051)	0.162* (0.094)		
Agency MREIT*Fed MBS Purchase Share		-0.153 (0.152)		
Fed MBS Purchase Share QE1			0.026 (0.079)	-0.070 (0.127)
QE2			-0.020 (0.054)	-0.003 (0.069)
Fed MBS Purchase Share MEP			0.003 (0.227)	0.622 (0.437)
Fed MBS Purchase Share QE3			0.131 (0.096)	0.406** (0.180)
Fed MBS Purchase Share Taper			0.050 (0.061)	0.196* (0.115)
Agency MREIT*Fed MBS Purchase Share QE1				0.219 (0.150)
Agency MREIT*QE2				-0.040 (0.092)
Agency MREIT*Fed MBS Purchase Share MEP				-1.169* (0.628)
Agency MREIT*Fed MBS Purchase Share QE3				-0.521** (0.238)
Agency MREIT*Fed MBS Purchase Share Taper				-0.279* (0.166)
Constant	-0.205 (0.333)	-0.220 (0.333)	-0.217 (0.304)	-0.240 (0.300)
Observations	1,002	1,002	1,002	1,002
R-squared	0.231	0.234	0.233	0.263
Number of Firm Clusters	50	50	50	50

**Table 9: Quarterly Cash to Total Assets Ratio**

This table presents the panel regression results for Agency MREIT cash to total assets ratios, as a function of macroeconomic factors (level and slope of the term structure, option-adjusted mortgage spread, credit spread, growth in the Case-Shiller House Price index), institution and capital structure characteristics, as well as Federal Reserve purchase shares of Treasury Securities and Agency MBS. The study period is 2005—2015. All estimates are produced using OLS. Robust standard errors (clustered by institution) are reported in parentheses. Significance is indicated as follows: \*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.1$ .

VARIABLES	(1) Cash/Assets	(2) Cash/Assets	(3) Cash/Assets	(4) Cash/Assets
3-Month CMT	0.003 (0.004)	0.003 (0.004)	0.005 (0.004)	0.005 (0.004)
CMT Term Structure	0.004 (0.005)	0.004 (0.005)	0.005 (0.005)	0.005 (0.005)
Option-Adjusted Spread	-0.011 (0.007)	-0.011 (0.007)	-0.013 (0.008)	-0.013 (0.008)
Credit Spread	0.003 (0.003)	0.003 (0.003)	0.001 (0.002)	0.001 (0.002)
Case-Shiller Index	-0.007 (0.036)	-0.008 (0.036)	-0.034 (0.047)	-0.036 (0.046)
L.Equity/Assets	0.105*** (0.037)	0.105*** (0.037)	0.106*** (0.037)	0.108*** (0.038)
L.Repo (0-30)/Total Repo	0.004 (0.005)	0.004 (0.005)	0.004 (0.005)	0.006 (0.006)
L.Firm Size	-0.002 (0.002)	-0.002 (0.002)	-0.002 (0.002)	-0.002 (0.002)
Agency MREIT	0.003 (0.005)	0.002 (0.006)	0.003 (0.005)	-0.002 (0.005)
Fed Treasury Purchase Share	-0.035 (0.032)	-0.035 (0.032)	-0.073* (0.038)	-0.075* (0.040)
Fed MBS Purchase Share	0.003 (0.006)	0.001 (0.010)		
Agency MREIT*Fed MBS Purchase Share		0.004 (0.011)		
Fed MBS Purchase Share QE1			0.011 (0.014)	0.018 (0.029)
QE2			0.000 (0.006)	-0.007 (0.009)
Fed MBS Purchase Share MEP			0.062 (0.040)	0.053 (0.070)
Fed MBS Purchase Share QE3			0.004 (0.006)	-0.011 (0.014)
Fed MBS Purchase Share Taper			-0.013 (0.009)	-0.033* (0.017)
Agency MREIT*Fed MBS Purchase Share QE1				-0.016 (0.036)
Agency MREIT*QE2				0.015 (0.011)
Agency MREIT*Fed MBS Purchase Share MEP				0.023 (0.068)
Agency MREIT*Fed MBS Purchase Share QE3				0.029 (0.019)
Agency MREIT*Fed MBS Purchase Share Taper				0.038** (0.018)
Constant	0.019 (0.039)	0.019 (0.040)	0.022 (0.038)	0.023 (0.040)
Observations	1,002	1,002	1,002	1,002
R-squared	0.230	0.230	0.237	0.245
Number of Firm Clusters	50	50	50	50

**Table 10: Agency MREIT Fixed-Rate to Total Agency MBS Ratio**

This table presents the panel regression results for Agency MREIT investment in fixed-rate Agency MBS (measured as the ratio of fixed-rate Agency MBS to total Agency MBS), as a function of macroeconomic factors (level and slope of the term structure, option-adjusted mortgage spread, credit spread, growth in the Case-Shiller House Price index), institution and capital structure characteristics, as well as Federal Reserve purchase shares of Treasury Securities and Agency MBS. The study period is 2005—2015. All estimates are produced using OLS. Robust standard errors (clustered by institution) are reported in parentheses. Significance is indicated as follows: \*\*\* p<0.01; \*\* p<0.05; \* p<0.1.

VARIABLES	(1)	(2)	(3)	(4)
	Fixed/Agency	Fixed/Agency	Fixed/Agency	Fixed/Agency
3-Month CMT	-0.159*** (0.040)	-0.159*** (0.042)	-0.080** (0.030)	-0.080** (0.031)
CMT Term Structure	-0.143*** (0.044)	-0.143*** (0.044)	-0.094** (0.036)	-0.095** (0.037)
Option-Adjusted Spread	-0.044 (0.052)	-0.044 (0.052)	-0.096* (0.051)	-0.096* (0.050)
Credit Spread	-0.039 (0.026)	-0.040 (0.026)	-0.005 (0.020)	-0.003 (0.020)
Case-Shiller Index	0.438 (0.412)	0.443 (0.378)	0.648 (0.406)	0.701* (0.396)
L.Equity/Assets	-0.671 (0.456)	-0.675 (0.457)	-0.691 (0.467)	-0.726 (0.493)
L.Repo (0-30)/Repo	-0.265 (0.178)	-0.267 (0.180)	-0.258 (0.177)	-0.272 (0.177)
L.Cash/Assets	-0.573 (1.678)	-0.565 (1.677)	-0.700 (1.625)	-0.730 (1.666)
L.Firm Size	0.015 (0.035)	0.015 (0.035)	0.012 (0.035)	0.013 (0.036)
Agency MREIT	0.373*** (0.103)	0.376*** (0.105)	0.371*** (0.102)	0.392*** (0.105)
Fed Treasury Purchase Share	0.040 (0.338)	0.039 (0.342)	-0.819** (0.376)	-0.790** (0.383)
Fed MBS Purchase Share	0.114* (0.057)	0.125 (0.153)		
Agency MREIT*Fed MBS Purchase Share		-0.016 (0.202)		
Fed MBS Purchase Share QE1			-0.088 (0.079)	0.049 (0.264)
QE2			0.149*** (0.046)	0.062 (0.104)
Fed MBS Purchase Share MEP			0.642** (0.258)	0.727 (1.209)
Fed MBS Purchase Share QE3			0.365*** (0.080)	0.590** (0.225)
Fed MBS Purchase Share Taper			0.217*** (0.067)	0.145 (0.184)
Agency MREIT*Fed MBS Purchase Share QE1				-0.189 (0.280)
Agency MREIT*QE2				0.102 (0.128)
Agency MREIT*Fed MBS Purchase Share MEP				(0.151) (1.329)
Agency MREIT*Fed MBS Purchase Share QE3				-0.306 (0.261)
Agency MREIT*Fed MBS Purchase Share Taper				0.103 (0.217)
Constant	0.682 (0.698)	0.679 (0.718)	0.540 (0.671)	0.515 (0.686)
Observations	485	485	485	485
R-squared	0.515	0.515	0.533	0.539
Number of Firm Clusters	26	26	26	26

**Table 11: Agency MREIT Hedging**

This table presents the panel regression results for Agency MREIT interest rate derivatives (measured as swaps and swaptions to total repo debt ratio), as a function of macroeconomic factors (level and slope of the term structure, option-adjusted mortgage spread, credit spread, growth in the Case-Shiller House Price index), institution and capital structure characteristics, as well as Federal Reserve purchase shares of Treasury Securities and Agency MBS. The study period is 2005—2015. All estimates are produced using OLS. Robust standard errors (clustered by institution) are reported in parentheses. Significance is indicated as follows: \*\*\*  $p < 0.01$ ; \*\*  $p < 0.05$ ; \*  $p < 0.1$ .

VARIABLES	(1)	(2)	(3)	(4)
	Swaps and Swaptions/Total Liabilities			
3-Month CMT	-0.007 (0.030)	-0.016 (0.028)	0.030 (0.026)	0.028 (0.024)
CMT Term Structure	0.009 (0.028)	0.007 (0.028)	0.031 (0.021)	0.030 (0.021)
Option-Adjusted Spread	0.044 (0.043)	0.038 (0.040)	0.014 (0.038)	0.011 (0.037)
Credit Spread	-0.033** (0.016)	-0.032* (0.018)	-0.017 (0.014)	-0.017 (0.015)
Case-Shiller Index	-0.425 (0.460)	-0.529 (0.464)	-0.300 (0.419)	-0.364 (0.414)
L.Equity/Assets	-0.231 (0.267)	-0.133 (0.228)	-0.250 (0.265)	-0.136 (0.231)
L.Repo (0-30)/Repo	-0.197*** (0.068)	-0.166** (0.065)	-0.198*** (0.069)	-0.178*** (0.063)
L.Cash/Assets	3.606*** (0.932)	3.400*** (0.843)	3.518*** (0.935)	3.389*** (0.822)
L.Firm Size	0.038 (0.028)	0.036 (0.028)	0.036 (0.028)	0.036 (0.028)
L.Fixed-Rate/Total Agency Securities	0.176** (0.077)	0.178** (0.074)	0.159* (0.077)	0.158** (0.074)
Agency MREIT	0.205*** (0.055)	0.100 (0.061)	0.210*** (0.058)	0.138** (0.053)
Fed Treasury Purchase Share	0.012 (0.179)	0.034 (0.173)	-0.456 (0.299)	-0.502 (0.300)
Fed MBS Purchase Share	0.094 (0.074)	-0.215* (0.125)		
Agency MREIT*Fed MBS Purchase Share		0.426*** (0.142)		
Fed MBS Purchase Share QE1			-0.010 (0.050)	-0.019 (0.072)
QE2			0.072 (0.055)	-0.026 (0.091)
Fed MBS Purchase Share MEP			0.340** (0.159)	0.094 (0.361)
Fed MBS Purchase Share QE3			0.222** (0.100)	0.017 (0.198)
Fed MBS Purchase Share Taper			0.122 (0.078)	-0.288*** (0.082)
Agency MREIT*Fed MBS Purchase Share QE1				0.016 (0.103)
Agency MREIT*QE2				0.139 (0.096)
Agency MREIT*Fed MBS Purchase Share MEP				0.382 (0.407)
Agency MREIT*Fed MBS Purchase Share QE3				0.287 (0.233)
Agency MREIT*Fed MBS Purchase Share Taper				0.581*** (0.122)
Constant	-0.353 (0.485)	-0.278 (0.488)	-0.400 (0.468)	-0.356 (0.470)
Observations	474	474	474	474
R-squared	0.526	0.551	0.535	0.563
Number of Firm Clusters	25	25	25	25

**Appendix A: Timeline of Federal Reserve Policy Actions Over the Period 2008—2014**

This table presents the timeline of Federal Reserve Policy Actions relating to unconventional monetary policy. For each policy measure, the table indicates the announcement date, the target end date for the policy measure, the total target amount of asset purchases under the measure, the type of assets targeted, and program details as provided at the announcement. The data used are obtained from the Federal Open Market Committee meeting minutes.

	<b>Announcement Date</b>	<b>Target End Date</b>	<b>Targeted Total Purchases</b>	<b>Composition of Purchases</b>	<b>Program Details as Announced</b>
<b>Quantitative Easing 1 (QE1)</b>  <b>December 2008—March 2010</b>	November 25, 2008	Over Several Quarters	Agency Debt: Up to \$100b Agency MBS: Up to \$500b	Agency Debt and Agency MBS	Purchase up to \$100b of Agency debt and up to \$500b of Agency MBS. Purchases expected to take place over several quarters.
	December 16, 2008	—	—	—	Lowered the Fed Funds rate to effective lower bound and stated that this was likely to remain for “some time”.
	March 18, 2009	Treasury Securities: September 30, 2009 (Completed Oct. 2009)  Agency Debt & MBS December 31, 2009 (Completed Mar. 2010)	Agency Debt: Add \$100b Agency MBS: Add \$750b Long-Term Treasuries: \$300b	Agency Debt, Agency MBS, and Long-Term Treasuries	Total purchases of Agency MBS will now be up to \$1.25t and Agency debt up to \$200b. Purchase up to \$300b of long-term Treasury securities over the next six months.  Rates likely to remain at the effective lower bound for an “extended period”.
<b>Quantitative Easing 2 (QE2)</b>  <b>November 2010—June 2011</b>	November 3, 2010	June 30, 2011	Long-Term Treasuries: \$600b	Long-Term Treasuries	Purchase \$600b of long-term Treasury securities by the end of 2011:Q2 at a pace of about \$75b per month.
<b>Policy Normalization Principles</b>	June 22, 2011	—	—	—	
<b>Maturity Extension Program (MEP) &amp; Forward Guidance</b>  <b>MEP: September 2011—December 2012</b>	August 9, 2011	—	—	—	Rates likely to remain at the effective lower bound at least until mid-2013.
	September 21, 2011	June 30, 2012	Long-Term Treasuries: \$400b	Long-Term Treasuries	Purchase, by the end of 2012:Q2, \$400b of Treasuries with remaining maturities between 6-30 years and sell an equal amount of Treasury securities with remaining maturities of 3 years or less.

	January 25, 2012	—	—	—	Rates likely to remain at the effective lower bound at least through late 2014.
	June 20, 2012	December 31, 2012	Amount Limited by Remaining Short-Term Treasuries	Long-Term Treasuries	Purchase Treasuries with remaining maturities between 6-30 years at the current pace and sell or redeem an equal amount of Treasury securities with remaining maturities of approximately 3 years or less.
<b>Quantitative Easing 3 (QE3)</b>  September 2012— December 2013	September 13, 2012	None Given	None Given	Agency MBS and Long-Term Treasuries	Purchase Agency MBS at a pace of \$40b per month and continue Twist through year-end, increasing holdings of long-term securities in aggregate by \$85b.  Rates likely to remain at the effective lower bound at least through mid-2015.
	December 12, 2012	None Given	None Given	Agency MBS and Long-Term Treasuries	Purchase Agency MBS at a pace of \$40b per month and long-term Treasuries at a pace of \$45b per month after Twist ends at year-end.  Rates likely to remain at the effective lower bound, but now conditional on economic indicators.
<b>Tapering</b>  December 2013— December 2014	December 18, 2013	None Given	None Given	Agency MBS and Long-Term Treasuries	Purchase Agency MBS at a pace of \$35b per month and long-term Treasuries at a pace of \$40b per month after Twist ends at year-end.
	January 29, 2014	None Given	None Given	Agency MBS and Long-Term Treasuries	Purchase Agency MBS at a pace of \$30b per month and long-term Treasuries at a pace of \$35b per month after Twist ends at year-end.
	March 19, 2014	None Given	None Given	Agency MBS and Long-Term Treasuries	Purchase Agency MBS at a pace of \$25b per month and long-term Treasuries at a pace of \$30b per month after Twist ends at year-end.
	April 30, 2014	None Given	None Given	Agency MBS and Long-Term Treasuries	Purchase Agency MBS at a pace of \$20b per month and long-term Treasuries at a pace of \$25b per month after Twist ends at year-end.

	June 18, 2014	None Given	None Given	Agency MBS and Long-Term Treasuries	Purchase Agency MBS at a pace of \$15b per month and long-term Treasuries at a pace of \$20b per month after Twist ends at year-end.
	July 30, 2014	None Given	None Given	Agency MBS and Long-Term Treasuries	Purchase Agency MBS at a pace of \$10b per month and long-term Treasuries at a pace of \$15b per month after Twist ends at year-end.
	September 17, 2014	None Given	None Given	Agency MBS and Long-Term Treasuries	Purchase Agency MBS at a pace of \$5b per month and long-term Treasuries at a pace of \$10b per month after Twist ends at year-end.  Issue revised Policy Normalization Principles, which suggest that the policy rate will be moved before reducing portfolio size.
	October 29, 2014	—	—	Agency MBS and Long-Term Treasuries	No additional purchases of Agency MBS and long-term Treasuries; maintain balance sheet size through reinvestment (as previous).
<b>Rate Hike</b>	December 2015	—	—	—	—