Online Appendix to The Costs of Quantitative Easing: Liquidity and Market Functioning Effects of Federal Reserve MBS Purchases*

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Appendix. Additional Market Functioning Analysis

Implied Financing Rates

In order to measure general market functioning, I examine the effects of Federal Reserve purchases on implied financing rates of dollar roll transactions. Implied financing rates are frequently monitored by TBA market participants, but are unique to the TBA market and less widely known than the more common measures of liquidity I describe below. For this reason, I provide a more detailed description of implied financing rates in order to explain how they can potentially signal impaired market functioning induced by QE purchases.

A dollar roll transaction comprises two simultaneous TBA trades in which the seller agrees to deliver an MBS in an earlier ("front") month and agrees to purchase a similar MBS in the subsequent ("back") month. Although similar to a collateralized loan, or "repo" transaction, the roll seller does not receive the interest and principal payments in the intervening period, and the mortgage pool returned to the seller in the back month—while possessing the same TBA characteristics—need not be the same as the one delivered by the seller in the front month. Consequently, the roll seller may receive a security with less favorable characteristics, so that the back-month

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purchase takes place at a lower price than the front-month purchase.[1] However, the roll seller can earn interest on the proceeds from the dollar roll transaction that are received in the front month.

Using an assumption for both the interest rate on the proceeds from the dollar roll and the unscheduled principal payments on the delivered MBS, a roll seller can compare (i) the cash return from engaging in a dollar roll with (ii) the expected return from simply holding the MBS over the tenure of the dollar roll. The interest rate earned on the front-month proceeds that equates the returns from those two options is referred to as the implied financing rate (IFR). As IFRs trade below prevailing short-term interest rates, dollar rolls become more attractive to the roll seller.[2] Thus, lower IFRs indicate higher expected returns to roll sellers, who are able to command higher returns when deliverable collateral is relatively scarce and roll buyers must, for example, acquire MBS in order to cover a short position or to fulfill market-making responsibilities. Scarcity of deliverable collateral can thus be alleviated as IFRs trade lower, boosting the incentive for holders of MBS to offer collateral through dollar rolls. For this reason, the FRBNY monitors IFRs, explaining in the web-based FAQs for agency MBS purchases that if prevailing IFRs are notably below other short-term interest rates, "such conditions may signal a shortage ... of supply."[3]

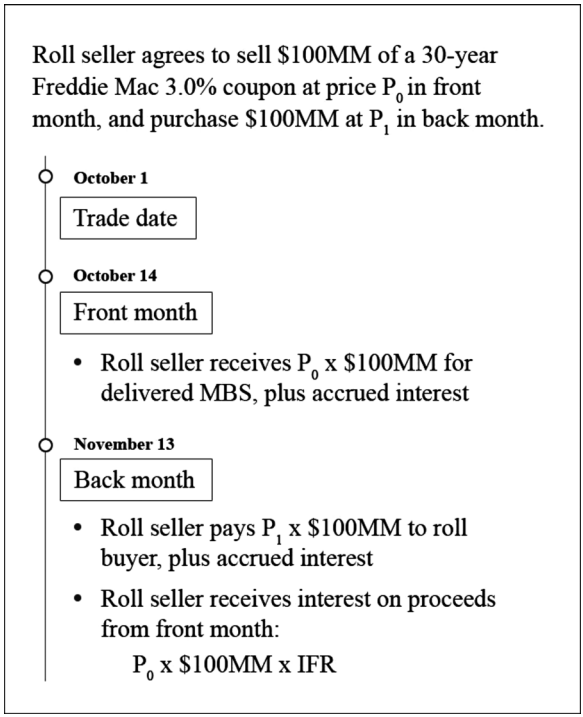
An insufficient available supply of MBS signaled by low IFRs may also precipitate settlement fails, in which some market participants are unable to deliver a security to satisfy an earlier transaction. Moreover, very low IFRs can also affect a seller's incentive to avoid a settlement failure. Because some MBS sellers without adequate MBS inventory would need to purchase a dollar roll in order to satisfy a previous TBA transaction, negative IFRs (or, equivalently, large dollar roll price drops) imply a relatively high cost of satisfying the

[1]This price difference, known as the "drop," also exists because of the principal and interest payment that the roll seller forfeits over the tenure of the dollar roll.

[2] Note that IFRs trading below short-term rates do not necessarily represent arbitrage opportunities. This is principally due to the redelivery risk faced by the roll seller mentioned above.

[3]In fact, the Desk explicitly refrains from purchasing Treasury securities that trade with heightened scarcity value as indicated by specific securities' repo rates.

Figure A1. Timeline of a Hypothetical Dollar Roll Transaction

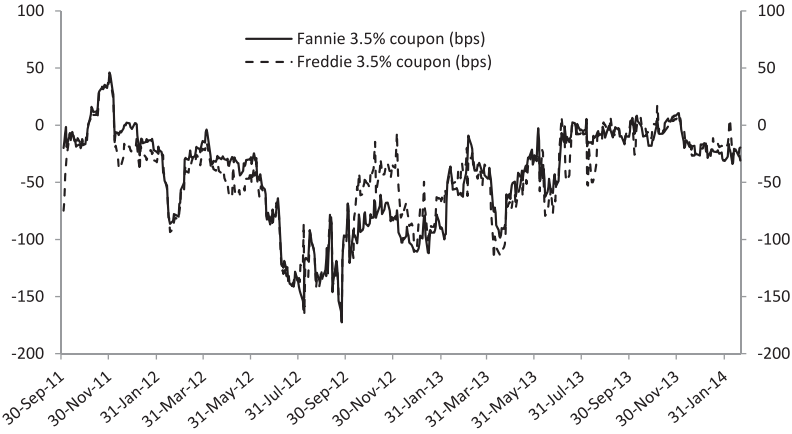


Notes: A TBA dollar roll transaction occurs on October 1, at which point no funds are exchanged. At the time of the trade, the roll seller can calculate the rate at which funds received in the front month can be invested—the so-called implied financing rate (IFR)—that will generate the same expected return as simply holding the MBS between October 14 and November 13.

TBA trade even when weighed against the fails charge. As Fleming and Garbade (2005) note, most instances of widespread settlement failures can be linked to market participants' incentives to avoid failing. Thus, by reducing incentives to satisfy a delivery requirement, sufficiently low IFRs can interfere with the normal delivery and settlement of MBS.

Figure A1 provides a timeline of a hypothetical dollar roll, describing the roll seller's cash outlays and receipts for the transaction described at the top of diagram. All of the parameters

Figure A2. Implied Financing Rates for Fannie Mae and Freddie Mac Thirty-Year 3.5 Percent Coupon TBA Securities



Source: J.P. Morgan.
Notes: Implied financing rates are calculated by J.P. Morgan using a model for conditional prepayment rates on TBA securities. IFRs trading well below prevailing short-term interest rates can indicate scarcity of deliverable collateral.

of dollar roll transactions are determined at the time of the trade, which typically occurs within two months of the front-month delivery, as TBA contracts generally trade up to three months before settlement.

Figure A2 depicts the history of IFRs for two thirty-year securities that were regularly traded during the sample period—the Fannie Mae and Freddie Mac 3.5 percent securities—as calculated by J.P. Morgan. IFRs for these securities were roughly unchanged over the entire sample period but traded increasingly negative in the summer of 2012, well below prevailing short-term funding rates. If Federal Reserve MBS purchases are substantial enough, the price of the front-month contract could rise, thereby pushing IFRs lower, indicating a scarcity of deliverable collateral. Thus, if Federal Reserve MBS purchases correlate with lower IFRs, this may provide an indication that QE can induce scarcity in the MBS market leading to a deterioration in market functioning.

Empirical Analysis

As a test of the effects of Federal Reserve purchases on market functioning, I estimate the relationship between Desk purchases and changes in IFRs. Specifically, I employ a cross-sectional time-series model with panel-corrected standard error estimates as follows:

$$\Delta IFR_{it} = \beta \times Fed\ Purchase_{it} + \chi_t + \alpha + \varepsilon_{it}. \qquad \text{(A1)}$$

In equation (A1), i indexes a security so that *Fed Purchase* represents the total amount (in billions) of security i purchased on day t. In order to capture a host of potential factors influencing IFRs across securities, I include daily fixed effects, χ_t. For example, time fixed effects can control for daily movements in short-term rates and any changes in MBS prepayment expectations.[4] Additionally, because I am including only class A (Fannie Mae and Freddie Mac thirty-year) securities in the estimation of (A1), day fixed effects are more likely to be correctly specified, since all of the securities have the same settlement calendar and original term to maturity. The errors in (1) are allowed to be heteroskedastic and contemporaneously correlated across panels.[5]

The results from estimation of (A1) are reported in the first column of table A1. The point estimate implies that a purchase of $1 billion by the Federal Reserve since the start of reinvestment leads to only a 0.07 basis point decline in the IFR for a given class A security on average. However, the effect of Federal Reserve purchases on IFRs may vary by QE program in light of the substantially different purchase amounts. Thus, I proceed by estimating the following regression, which multiplies *Fed Purchase* by program dummies to capture differential effects of MBS purchases across the two purchase regimes:

$$\begin{aligned}\Delta IFR_{it} = {} & (\beta_{\text{Reinv}} \times Fed\ Purchase_{it}) D_{\text{Reinv}} \\ & + (\beta_{\text{QE3}} \times Fed\ Purchase_{it}) D_{\text{QE3}} \\ & + \gamma \Phi_{it} + \chi_t + \alpha + \varepsilon_{it}.\end{aligned} \qquad \text{(A2)}$$

[4] If the drop fully adjusts to account for the difference in expected prepayments, changes in prepayment expectations need not affect the IFR.

[5] Prais-Winsten estimates of the parameters allowing for panel-specific first-order autocorrelation in the disturbances yield very similar results to those reported below.

Table A1. The Effect of Federal Reserve Purchases on Implied Financing Rates

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Fed Purchase	−0.07					−0.21	
	(0.46)					(0.65)	
Fed Purchase × Reinvestment		−1.15	−1.07	−1.07	−3.08*		−2.83
		(1.28)	(1.33)	(1.33)	(1.67)		(2.45)
Fed Purchase × QE3		0.03	0.08	0.12	−1.80		−0.48
		(0.48)	(0.52)	(0.50)	(1.12)		(0.74)
Issuance			−0.04	−0.04	−0.03		−0.05
			(0.17)	(0.17)	(0.17)		(0.24)
Distance to Current Coupon				0.60	0.79		−0.70
				(3.72)	(3.72)		(3.14)
Fed Purchase × Days Until Settlement					0.06**		
					(0.03)		
Observations	4,972	4,972	4,972	4,972	4,972	4,937	4,937
Securities	10	10	10	10	10	10	10
R-squared	0.339	0.340	0.340	0.340	0.341	0.341	0.339

Notes: The dependent variable in all specifications is the change in the IFR for each security in the sample, measured in basis points. *Fed Purchase* represents total daily Federal Reserve purchases of each security, measured in billions. *Reinvestment* and *QE3* dummies take a value of one for each day in the associated purchase program. *Issuance* measures the reported daily issuance of each security in billions, and *Distance to Current Coupon* is the absolute value of the difference between each security's coupon and the daily current coupon for the relevant agency, measured in percentage points. Columns 6 and 7 report 2SLS estimates.

Moreover, I include controls, Φ, in some specifications to demonstrate robustness. Control variables include daily issuance, which (together with the amount of Federal Reserve purchases) controls for the primary source of daily changes in the supply of each security available to private investors.[6] As an additional control, I include the absolute value of the difference between the coupon of security i and the current coupon on day t, matched by agency. Controlling for this spread may be important, because current trading activity and banks' origination pipelines can be driven by the current coupon,

[6]Accounting for the remaining principal balance outstanding net of Federal Reserve holdings for each security does not materially change the results.

with larger values likely being associated with lower trading and worse liquidity conditions.

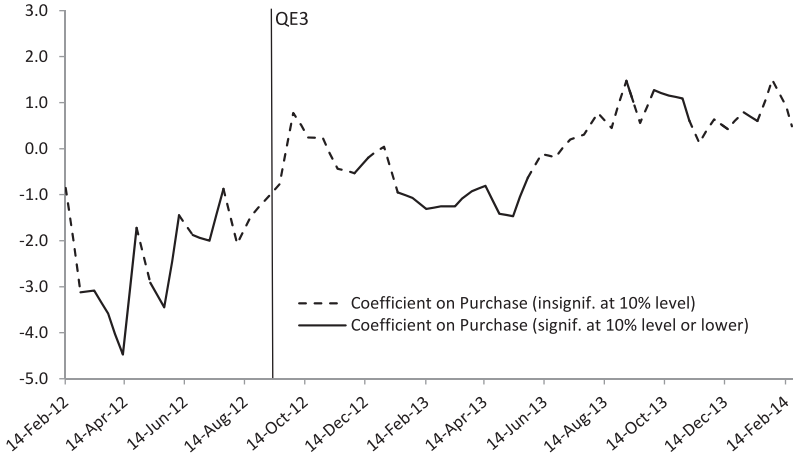
The second through fourth columns in table A1 demonstrate that during the reinvestment program, a $1 billion purchase was associated with a (statistically insignificant) decline in the IFR of about 1.1 basis points. This result is consistent with the findings in Kandrac (2013) and is not meaningfully affected by the inclusion of other controls (columns 3 and 4), which exhibit no meaningful relationship to IFRs. However, Kandrac (2013) also finds a statistically significant effect of a similar magnitude during the QE3 period. Evidently, the longer sample period used in the present study reveals an impermanence of the previously documented effect.

The fifth column of table A1 additionally interacts the *Fed Purchase* amount for each security with the number of days between the settlement date and purchase date. This interaction term is included to account for the possibility that scarcity-inducing effects of MBS purchases vary with the time to settlement. For example, purchasing securities with substantially later settlement dates may, for instance, allow market participants to offset other trades or allow time for dealers to commit additional origination pipeline to securitization. In other words, the supply of deliverable collateral may be more inelastic in the front month. Indeed, the coefficient on this interaction term is significantly positive, indicating that negative IFR changes in response to Federal Reserve QE purchases are more severe when settlement dates are closer. However, the economic significance of this result is limited. A value of 0.06 implies that for every $1 billion purchased, contracting for settlement one month later resulted in an IFR that was about 1.8 basis points higher than would have otherwise been the case. Because the vast majority of TBA trading occurs for settlement within a three-month horizon, the ability of the Desk to limit declines in IFRs by postponing settlement is constrained.

The final two columns report 2SLS estimates using the Federal Reserve's Survey of Primary Dealers as an instrument, and are roughly in line with previously reported estimates. The relatively imprecise estimation (which here also results from employing a less efficient estimator) persists, particularly for the QE3 period.

Next, in order to evaluate how Federal Reserve MBS purchases affected IFRs over time as holdings grew (see figure 1 in the main paper), I estimate rolling regressions over the sample period.

Figure A3. Rolling Regression—The Effect of Federal Reserve Purchases on Implied Financing Rates



Notes: This graph plots the coefficient on the *Fed Purchase* variable in equation (1) from a rolling regression. The rolling window is ninety days and is reestimated in ten-day increments using a random-effects estimator. The final day of the rolling window is listed on the horizontal axis. Points to the right of the "QE3" line include purchases that occurred during the QE3 program. The value on the vertical axis can be interpreted as the basis point change in a security's IFR as a result of a $1 billion purchase by the Federal Reserve.

Figure A3 plots the coefficient on *Fed Purchase* from a rolling random-effects panel regression with a constant ninety-day window.[7] In other words, the first point in figure A3 represents the value of the key coefficient in equation (A1) generated from a regression for the first ninety days of the reinvestment program. A vertical line indicates the point at which observations from QE3 begin entering the rolling window. Figure A3 reveals an interesting pattern: Shortly after the commencement of a new purchase program, Federal Reserve purchases have scarcity-inducing effects on purchased securities.[8] However, these effects appear to dissipate over time.

[7] A random-effects estimator is used for each ninety-day sample due to the infeasibility of computing panel-corrected standard errors.

[8] Of course, the ability to observe statistical significance at any particular point in figure A3 is restrained by limiting the sample to ninety days.

This pattern could result from the forward-trading nature of the TBA market. When a new purchase program is announced, market participants have already engaged in transactions that are due to settle well after the beginning of the program. Moreover, banks' inability to immediately expand mortgage origination pipelines for current settlement can also generate tightness in the market. Eventually, however, market participants appear able to adjust to the new source of MBS demand, which alleviates the scarcity effects resulting from Federal Reserve purchases. This could also explain the larger effects observed (per $1 billion) for the beginning of the reinvestment period, since the announcement of these purchases came as a greater surprise to the market than did the additional purchases associated with QE3.

Thus, it appears that Federal Reserve purchases have negative effects on market functioning early on in purchase programs, but these effects dissipate over time. However, even in the early stages of each purchase regime, point estimates from figure A3 imply that the average Federal Reserve purchase operation resulted in relatively small effects on IFRs that are swamped by normal daily fluctuations. Nevertheless, it may be the case that the Federal Reserve could lessen the market functioning effects of its MBS purchases by announcing MBS programs well in advance of the start of purchases, or gradually increasing monthly purchase amounts to the desired level. Of course, this strategy would need to be balanced against the policy goals of the QE program, which—especially in light of the modest IFR effects documented above—would likely overwhelm any market functioning concerns.

References

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