Liquidity in a Market for Unique Assets: Specified Pool and TBA Trading in the Mortgage Backed Securities Market

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Abstract

Agency mortgage-backed securities trade simultaneously in a market for specified pools (SPs) and in the to-be-announced (TBA) forward market. TBA trading creates liquidity by allowing thousands of different MBS to be traded in a handful of TBA contracts. SPs that are eligible to be traded as TBAs have significantly lower trading costs than other SPs. We present evidence that TBA eligibility, in addition to characteristics of TBA eligible SPs, lowers trading costs. We show that dealers hedge SP inventory with TBA trades, and they are more likely to prearrange trades in SPs that are difficult to hedge.

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The market for agency mortgage-backed securities (MBS) is among the largest, most active, and most liquid of all securities markets. At first glance, the market's liquidity is surprising because each MBS is unique, composed of specific mortgages with their own prepayment characteristics. In this paper, we study the institutional feature of this market that allows it to work so well – its structure of parallel trading in a to-be-announced (TBA) forward market in MBS and a specified pool (SP) market in which specific MBS are traded.

TBA trading makes the agency MBS market liquid in three ways. First, the TBA market takes thin markets for thousands of different MBS with different prepayment characteristics and trades them through a handful of thickly traded cheapest-to-deliver contracts. In this way, liquidity is increased for the MBS that are traded there instead of as SPs. Second, eligibility for TBA trading makes SPs more liquid by giving dealers an option to lay off SP inventory through the more liquid TBA market. Third, parallel TBA trading increases liquidity for SP trades. There are several possible reasons for TBA trading increasing liquidity for SP trades and we provide evidence for one: dealers use TBA trades to hedge SP positions.

We are not the first to show that TBA trading is cheaper than SP trading. Bessembinder, Maxwell, and Venkataraman (2013) examine trading costs for structured credit products that include but are not limited to MBS. They observe that TBA trades are much cheaper than other MBS trades. Friewald, Jankowitsch, and Subrahmanyam (2014) study the tradeoff between accuracy in measuring liquidity and disclosure of information to market participants. As part of their study, they find that trading costs are much lower for TBA trades than SP trades. Atanasov and Merrick (2012) examine the integration of TBA and SP markets, and show that for large trades the two markets are well integrated. Like the others, they find that SP trading costs are much higher than TBA costs.

Unlike these previous studies, our paper distinguishes between SPs that are eligible to be traded in the TBA market and those that are ineligible to be traded there. We show that TBA-eligible SPs are much cheaper to trade than TBA-ineligible SPs. TBA eligibility itself can increase liquidity by giving dealers and potential buyers of an SP an option to deliver the SP in a TBA trade if market conditions change. We provide evidence, in two separate tests, that TBA eligibility itself does increase liquidity. In the first, we use loan-to-value (LTV) levels and a dummy variable for LTVs greater than 1.05 to see whether there is an abrupt change in trading costs at the LTV cutoff for TBA eligibility. We find that trading costs in general decline with LTV ratios, but increase sharply at the 1.05 cutoff. Our second test is a variation on propensity score matching. In the first stage we estimate the probability that a SP is TBA eligible using characteristics that include minimum and maximum loan values, LTV ratios, and average FICO scores. In the second stage, we group SPs by the estimated probability that the SP is TBA eligible and test whether actual eligibility affects trading costs. After adjusting for the probability that a SP is TBA-eligible, we find that TBA eligibility itself significantly decreases trading costs.

We also provide the first evidence that parallel TBA trading makes the SP market more liquid. We identify an exogenous factor that directly affects TBA trading but not SP trading: TBA settlement dates. There is one settlement date each month for all TBA trades of MBS with a given maturity and issuer. These dates are set by the Securities Industry and Financial Markets Association (SIFMA) well in advance of the settlement month. Traders who do not wish to take or deliver MBS roll over their positions before the settlement date, resulting in TBA trading volume that is three to four times as large in the days prior to settlement dates as it is during the rest of the month. SP trades can be settled at any time during the month. Nevertheless, trading costs for SPs, like TBA trading costs, are much lower prior to TBA settlement dates when the predictable volume of TBA trading is high.

There are several plausible explanations for why parallel TBA trading reduces SP trading costs. Our data allow us to explore one of them. This paper is the first to show that dealers typically hedge specified pool inventory changes with offsetting TBA trades. For individual dealers we regress daily changes in TBA inventory on changes in the inventory of TBA-eligible SPs and TBA-ineligible SPs with the same maturity and coupon. Coefficients are negative, implying that the median dealer hedges specified pool inventories with TBA trades. Coefficients on changes in inventory of SPs that are not TBA-eligible are closer to zero than coefficients on TBA-eligible inventory changes, suggesting that SPs that are not TBA eligible are less likely to be hedged, all else equal. This is not surprising. TBA-ineligible

SPs have different characteristics than TBA-eligible ones, and we find that TBA trades are not as effective at hedging price changes for TBA ineligible SPs as they are at hedging changes in TBA-eligible SP prices.

Difficulty in hedging can reduce liquidity. We present evidence that dealers are reluctant to take hard-to-hedge specified pools into inventory. They are more likely to prearrange a sale of the specified pool to a second customer before purchasing the specified pool from the first customer. This means that investors have to wait to sell unwanted MBS while a buyer is sought. This is a cost that we cannot measure.

Regulators have recently expressed concern about the liquidity of over-the-counter markets for corporate and municipal bonds and have suggested that more transparency is needed. Our findings suggest another way to increase liquidity. Forward market trading of MBS in the TBA market appears to lower trading costs both for those MBS traded in the TBA market and for the MBS traded in the parallel SP market. Some legal obstacles would need to be overcome, but it may make sense to have similar forward markets in municipal and corporate bonds. Bonds included in such a forward market would need to be sufficiently homogeneous with respect to default risk and other characteristics. But there may be, for example, enough relatively homogenous, 5% 20-year, AA-rated industrial bonds to create a liquid cheapest-to-deliver forward market.[1] The existence of a liquid forward market would be likely to create incentives for issuers to issue standardized bonds that could be traded in the forward market.

The rest of the paper is organized as follows. Section I discusses how the secondary market for MBS operates. Section II describes the data used here. Section III provides estimates of trading costs in the TBA and specified pool markets. In Section IV we examine the impact of TBA eligibility on SP liquidity. Section V presents evidence that eligibility for TBA trading lowers SP trading costs. In Section VI, we show that dealers use the TBA market to hedge specified pool positions. Section VII concludes.

[1] Spatt (2004) makes the same point. He observes that many corporate and municipal bonds are close substitutes, but that these bonds, unlike MBS "are not traded interchangeably in the marketplace."

I. How the Market for Agency MBS Works

Tens of thousands of unique agency mortgage backed securities have been issued by Fannie Mae, Freddie Mac or Ginnie Mae. These are pass-through securities in which interest and principal payments on the underlying mortgages are passed through to the MBS investors in proportion to their holdings. If a mortgage holder prepays a mortgage early, the principal payment is passed on to investors at that time. Agency MBS are backed by the issuing agency and are effectively default-free.

Agency MBS can be traded as specified pools where buyer and seller agree to exchange a particular MBS. They are also traded in a forward market known as the TBA (to-be-announced) market where the seller has an option to deliver any MBS that meets agreed-upon criteria. Most trading tales place in the TBA market. Mortgage originators use TBA trades to sell mortgages forward and to hedge their production. Investors also use the TBA market to buy and sell already issued MBS.

All agency MBS are default-free, but each is unique in its prepayment characteristics. From the standpoint of investors, a MBS has more desirable prepayment characteristics if the mortgages in the MBS are less likely to be paid off early if interest rates fall, and more likely to be paid off early if interest rates rise. MBS with the most desirable prepayment characteristics are traded in the specified pool market where sellers can realize the full value of their MBS rather than getting the cheapest-to-deliver price. Buyers in the SP market know the MBS they are getting and can be expected to closely examine the prepayment characteristics of the MBS. Trades in the SP market can be settled at any time rather than on one day during a month. In contrast to TBA trades, SP market transactions generally result in delivery of the MBS.

For TBA trades, buyer and seller agree to six parameters: coupon, maturity, issuer, settlement date, the face value of the MBS, and the price. Sellers will attempt to deliver the cheapest MBS that meets the trade requirements, and buyers expect that is what they will receive. TBA trading works because the MBS exchanged in that market are relatively homogeneous. All TBA trades of MBS with a specific maturity and issuer settle on the same date each month. Most TBA trades settle within the next month, but TBA trades with settlement dates two or three months out are also common.

Forty-eight hours before the settlement date, on the notification date, the seller tells the buyer which specific MBS will be delivered. In most cases though, TBA buyers do not take delivery and TBA sellers do not deliver MBS. Traders instead take offsetting positions before the notification date. The ability to easily close out positions makes TBA trading a useful way to hedge risk from mortgage rate changes. A major source of TBA trading is mortgage originators who use the TBA market to sell mortgages forward.

TBA market investors can observe real-time indicative TBA quotes through Tradeweb, the electronic trading platform. For each TBA contract, Tradeweb provides one bid and one ask price after using a proprietary algorithm to filter out meaningless dealer quotes. These indicative quotes are updated continuously as dealers update their quotes. Atanasov and Merrick (2012, p1) observe that the TBA market "… has excellent pre-trade transparency via electronic platforms." Vickery and Wright (2013) observe that internal Federal Reserve analysis shows that quotes generally track prices of completed transactions closely.

TBA trading converts a market with thousands of MBS into a thick market that trades a handful of contracts. In June, 2011, the first full month of data in our sample, there were 24,528 different specified pools traded. During the last month of our sample, May, 2013, 27,433 specified pools traded. In contrast, across all combinations of maturity, coupon, issuer, and settlement date, only 510 different TBA contracts traded during June, 2011, and only 475 traded during May, 2013. This, however, understates the degree to which TBA trading is concentrated in a few contracts. TBA trading takes place in MBS with maturities of 5, 7, 10, 15, 20, 30 and 40 years and with coupon yields ending in even percents, in half percents (e.g. 3.50%) and in quarter and three-quarter percents (e.g. 3.25% or 3.75%). Over our entire sample period, 12 maturity-coupon combinations account for 96% of the trades: 15-years with 2.5%, 3%, 3.5%, and 4%, and 30-years with 2.5%, 3%, 3.5%, 4%, 4.5%, 5%, 5.5%, and 6%. With so much trading volume channeled into so few TBA contracts, it is easy for dealers to find counterparties and to lay off inventory. It is more difficult for dealers to eliminate inventory risk by laying off positions in one of the many thousands of specified pools. As we will show, dealers instead hedge their specified pool inventory with TBA trades.

The market for agency mortgage backed securities is almost entirely an institutional market. As of 2011, 25% of agency MBS were held by U.S. banks, 9% by insurance companies and pension funds, 11% by mutual funds, and 14% by foreign investors.[2] As a result of its asset purchase programs, the Federal Reserve held 20% of agency MBS. Other investors in agency MBS include Fannie Mae, Freddie Mac, the U.S. Treasury, savings institutions and REITs. These institutions tend to buy and hold MBS for long periods of time. When they trade, they usually trade large quantities of MBS.[3]

II. Data

FINRA began requiring members to report all trades of mortgage backed securities through their TRACE system in May, 2011. In this paper, we examine MBS trading using all TBA and SP trades by all dealers who were FINRA members over May 16, 2011 through April, 2013. This includes virtually all, if not all MBS trades for this period. Data for each trade includes the maturity, coupon, and issuer of the MBS, the price, par value, trade date, trade time, and settlement date for the trade, an indicator for whether the trade was a purchase from a customer, a sale to a customer, or an interdealer trade, and identifying numbers for dealers in the trade. For specified pool trades, there is a variable that indicates whether the traded MBS is TBA eligible. Data includes both interdealer trades and trades between dealers and customers.

[2] Written statement of Richard Dorfman before the House Committee on Financial Services, Subcommittee on International Monetary Policy and Trade, October 13, 2011.
[3] Vickery and Wright (2013) provide a wealth of institutional details about TBA trading and the MBS market. They report that TBA eligibility lowers mortgage interest rates, but are cautious in the interpretation of the evidence because their data does not allow them to separate differences in liquidity from differences in prepayment risk.

Table I provides some summary statistics for MBS trading. Panel A reports the number of trades of various types, and the volume from these trades. As is also noted by Vickery and Wright (2013), the great majority of mortgage backed security volume is in the TBA market. For our sample period, the dollar volume of dealers' TBA trades with customers totals $64.4 trillion. The volume of interdealer TBA trades is $58.5 trillion. The total value of specified pool sales trades with customers is "only" $7.2 trillion. The total dollar volume of interdealer specified pool trades is $1.9 trillion. It is interesting that that interdealer trades account for almost half the volume in the TBA market, but a much smaller proportion of specified pool volume. Interdealer trading is more common in the TBA market because dealers lay off TBA inventory by trading with other dealers, and, as we will show, also hedge specified pool inventory with interdealer TBA trades.

Because the volume of trading in specified pools is so much less than TBA volume, it is tempting to conclude that the specified pool market is unimportant. That is not true. Even though the volume is lower in the specified pool market than in the TBA market, it is still in the trillions of dollars during our sample period. In addition, it is difficult to compare the dollar volumes directly. SP trades can be expected to result in delivery of the MBS, but most TBA trades do not result in delivery.[4] Finally, without specified pool trading, MBS traded in the TBA market would be less homogeneous, and it is likely that the TBA market would therefore be less liquid.

Panel A of Table I also provides information on the volume and numbers of different types of TBA trades. Over the May, 2011 through April, 2013, there are more than 3.3 million interdealer and dealer to customer TBA trades. Outright trades make up the majority of TBA trades. Dollar rolls are the second most common type of trade. Dollar rolls are spread trades that are often compared to repos. The seller of a dollar roll sells the front month TBA contract and simultaneously buys a future month contract with the same characteristics. Dollar rolls differ from repos in that the securities that are purchased for delivery in the later month are "substantially similar" to the one sold in the front month rather than the same securities. In addition, in a dollar roll, the buyer of the front month contract receives coupon and

[4] See Vickery and Wright (2013), p9.

principal payments over the month. Dollar rolls tend to be very large trades, and account for most of the buy, sell, and interdealer volume.

Stipulated trades are TBA trades in which the buyer requires the seller to deliver pools with additional stipulated characteristics. The buyer could, for example, specify that no more than a certain percentage of mortgages in a pool are on California homes. Stipulated dollar rolls are dollar rolls that stipulate additional characteristics of pools to be delivered. They are less common, and account for less than 30,000 trades.

These statistics on dollar rolls and stipulated trades are included to provide a complete picture of the MBS market. For most of the rest of the paper, we focus our attention on outright TBA trades. These are most similar to SP trades. For many traders, a specified pool purchase and an outright TBA purchase are just two different ways to acquire MBS. Similarly, for many traders, a specified pool sale and an outright TBA sale are close substitutes.

Panel A of Table I shows that there are about 1.66 million trades of specified pools. TBA eligible SPs make up the great majority of these trades. These SPs could be sold in the TBA market if the seller so desired. The other SPs have characteristics that make them ineligible for TBA trading. They could, for example, contain mortgages with high loan-to-value ratios. Interdealer trades make up a far smaller proportion of specified pool trades than TBA trades.

Panel B of Table I provides information on trade sizes. The MBS market is a market for financial institutions, not individual investors, so trade sizes are large. The average size of an outright TBA trade between a dealer and customer is $32.64 million dollars. The distribution is right-skewed, but still, over 37% of the TBA trades between dealers and customers are for more than $10 million. Dollar rolls are especially large. The mean size of interdealer dollar roll trades is $59.64 million while the mean size for trades with customers is over $100 million. Trade sizes are far smaller for specified pools than for TBA trades. Interdealer specified pool trades have an average size of only $3.32 million dollars, but, the great majority of trade sizes are smaller. Only 6.7% of specified pool interdealer trades are for $10 million or more. It is interesting that specified pool trades with customers tend to be larger than interdealer specified pool trades. The mean size trade with customers is for $6.49 million par value, and 10.7% of the trades are for $10 million or more.

Panel C of Table I reports the proportion of trades of different types for dealers with different levels of activity. There are over 750 dealers in our sample, but most trades are handled by a small number of them. Panel C shows that the top ten dealers, ranked by the number of trades, account for 54.9% of all trades and 64.6% of all volume. The next 20 dealers account for an additional 27.3% of trades and 29.3% of volume. Active dealers tend to do most of their trading in the TBA market, while inactive ones trade mainly in specified pools. For the ten most active dealers, the average proportion of volume from specified pools is 13.55%. For the twenty next most active dealers, the proportion of volume from specified pools averages 26.16%. For dealers ranked 101 – 758 by number of trades, the proportion of volume from specified pools reaches 87.82%. As we have seen, TBA trades are usually much larger than specified pool trades. To compete effectively as a dealer in the TBA market requires more capital than it takes to trade specified pools – capital that the less active dealers may not have.

Panel C also reveals that the proportion of trades that are interdealer trades is higher for more active dealers than for less active ones. Even for the least active dealers, however, the average proportion of trades that are interdealer is over 44%.

During the sample period, both TBA and specified pool prices increased. This can be attributed to falling mortgage rates over this time. Figure 1 shows weekly national average mortgage rates, from Freddie Mac, for 15 and 30-year mortgages for the period from April, 2011 through April, 2013. Over these two years, 30-year rates were consistently about 75 basis points higher than 15-year rates. Rates declined approximately 125 basis points between April, 2011 and October, 2012. The decline in rates led to increased prices of mortgage backed securities over the sample period, and made prepayment an attractive option for many mortgage holders.

Lower mortgage rates also mean that the MBS issued later in the sample period had lower coupon rates than the MBS issued earlier. We obtain from JP Morgan the gross production, net production, and outstanding balance of MBS with each coupon and maturity from each issuer. JP Morgan, in turn, obtains these MBS production summary statistics from FNMA ("Monthly Summary"), FHLMC ("Monthly Volume Summary), and GNMA ("Monthly Issuance Report")[5]. Gross production is the value of new MBS issued and net production is the gross production minus the reduction in value of current MBS from mortgage payments. Figure 2 shows the net production in millions of dollars, across all issuers, of 30 year MBS with 3%, 3.5%, 4%, and 4.5% by month. At the beginning of our sample period, in May, 2011, net production of 30-year 4.5% MBS is positive. With falling mortgage rates, production of 4.5% 30-year MBS quickly declined however, and turned negative in September, 2011. In other words, by September, 2011, the dollar value of prepayments of the mortgages in existing 4.5% 30-year MBS exceeded the dollar value of new 4.5% 30-year MBS. Production of 30-year MBS with coupons of 4% rose from almost nothing in May 2011 to over $20 billion in September, 2011. After June of 2012, low mortgage rates led to negative net production of 30-year 4% MBS. Production of 3.5% MBS began in September, 2011, and production of 3% 30-year MBS did not begin until 2012.

Figure 2B depicts net production of 15-year MBS. Patterns of net production are similar to those of 30-year MBS. As mortgage rates fell, production of MBS with high coupon rates declined and turned negative. Production of MBS with lower coupon rates began. Greater production can be expected to increase liquidity. One of the major sources of TBA volume is from mortgage originators who hedge by selling mortgages forward. When mortgage rates fall, originators shift their hedging demand toward TBA trades with lower coupons. We expect liquidity to be greatest for the TBA trades with demand from originators. Hence we expect low coupon TBA trades to become more liquid over our sample period.

III. Specified Pool and TBA Trading Costs

[5]These data are available at the following websites: http://www.fanniemae.com/portal/about-us/investor-relations/monthly-summary.html, http://www.freddiemac.com/investors/volsum/, http://www.ginniemae.gov/data_and_reports/reporting/Pages/monthly_issuance_reports.aspx.

In this section we extend the MBS portion of the work of Bessembinder, Maxwell, and Venkataraman (2013) by examining the impact of TBA eligibility and MBS production on trading costs. We have four objectives in this section. First, we want to compare trading costs for TBA-eligible SPs with TBA trading costs. This tells us how much TBA trading, as opposed to MBS characteristics, lowers trading costs. Second, we want to examine the impact of TBA eligibility on trading costs. Third, we want to estimate the impact of MBS production and the balance of outstanding MBS on MBS trading costs. Finally, much of the rest of this paper revolves around the impact of TBA eligibility and TBA trading on SP trading costs. In this section, we establish some trading cost benchmarks.

To date, a handful of studies of the microstructure of MBS markets have been conducted. Estimates of MBS trading costs appear in Atanasov and Merrick (2012), Bessembinder et al (2013), and Friewald, Jankowitsch, and Subrahmanyam (2014). The approach of Bessembinder, Maxwell, and Venkataraman (2013) most closely resembles ours. They examine trading of MBS and other structured credit products for the period from May 16, 2011 through January 31, 2013. They estimate trading costs by regressing differences in price between successive trades on a variable for changes from a dealer purchase to a dealer sale (+1) or dealer sale to a dealer purchase (-1), along with variables for changes in bond and equity indices over the trade period. Their estimates of one-way trading costs are 40 basis points for specified pools, and just 1 basis point for TBA trades.

Like Bessembinder et al (2013), we employ a regression methodology to estimate trading costs. Each observation is two consecutive trades between dealers and customers in an MBS with a specific CUSIP, but each regression includes observations from all CUSIPs with a particular maturity. With differences in prices between two consecutive trades as the dependent variable, we estimate:

$$\Delta P_t = \alpha_0 + \alpha_1 \Delta Q_t + \alpha_2 \Delta Q_t \cdot \left(ln\left(\frac{Size_t}{1{,}000{,}000}\right) + \ln\left(\frac{Size_{t-1}}{1{,}000{,}000}\right)\right) + \alpha_3 \Delta Q_t \cdot \text{TBA Eligible}$$

$$+ \alpha_4 \Delta Q_t \cdot \text{TBA Eligible} \cdot \left(ln\left(\frac{Size_t}{1{,}000{,}000}\right) + \ln\left(\frac{Size_{t-1}}{1{,}000{,}000}\right)\right)$$

$$+ \alpha_5 \Delta Q_t \cdot \ln\left(\frac{\text{MBS Production}_t}{\text{Avg Production}}\right) + \alpha_6 \Delta Q_t \cdot \ln\left(\frac{\text{MBS Balance}_t}{\text{Avg Balance}}\right) + \Sigma \beta_i \text{ Ret}_{i,t} + \varepsilon_t. \quad (1)$$

where ΔP_t is the percentage change in prices between trade t and trade t-1, ΔQ_t is 1 if the dealer purchases in trade t-1 and sells in trade t and -1 if the dealer sells in trade t-1 and purchases in trade t, Size is the par value of the traded securities, TBA Eligible is a dummy variable that equals one if the specified pool is eligible to be traded TBA, MBS Production is the gross amount of new MBS with the same coupon and maturity that was created in the previous month, and MBS Balance is the value of MBS with the same coupon and maturity outstanding at the end of the previous month. Five return variables are also included to capture changes in MBS values when consecutive trades take place on different days. They are the percentage changes in 1) the Barclay Capital's U.S. MBS index, 2) the Barclay Capital's 7-10 Year U.S. Treasury Bond index, 3) the Barclay Capital's U.S. Corporate Bond Index, 4) the Barclay Capital's U.S. Corporate High-Yield Bond Index, and 5) the S&P 500 index. These indices are also used in the study of structured credit products by Bessembinder et al (2013). Index values are available daily, so if consecutive trades occur on the same day, all of these return values are zero. This regression is run separately for SP and TBA trades, but the variables for TBA eligibility are, of course, omitted in the regressions using TBA trades.

We include only 30-year MBS with coupon rates of 2.5%, 3.0%, 3.5%, 4.0%, 4.5%, 5%, 5.5% and 6%, and 15-year MBS with coupon rates of 2.5%, 3.0%, 3.5%, 4.0%. Together, these MBS account for 96% of our sample trades. Atanasov and Merrick (2014) show that small lots of MBS are particularly illiquid because they are not considered suitable for small investors and are difficult to aggregate into larger lots. Hence, we omit trades of less than $10,000 par value.

Regression estimates are reported in Table II. Panel A reports estimates for TBA trades while Panel B reports results for specified pools. The first regression in Panel A measures trading costs for 30-year TBA trades. The coefficient on ΔQ is an estimate of the difference between prices investors pay for MBS, and prices they receive when selling MBS, or, in other words, round trip trading costs. The coefficients on interactions between ΔQ and other explanatory variables indicate how transactions costs are affected by these other variables. In the first regression, the coefficient on ΔQ is 0.0357 and is highly significant. The dependent variable is the percentage change in the price of the MBS, hence 0.0357 means 3.57 basis points. In estimating this regression, we incorporate the size of the trade by taking the natural logarithm of the par value of the trade divided by $1,000,000. Similarly, for our MBS production and outstanding balance variables, we use natural logarithms of the variable divided by its average. Hence the coefficient estimate of 0.0357 on ΔQ is an estimate of the round-trip TBA trading costs for $1,000,000 par value trades when monthly production and the balance of the MBS are at their average. In other regressions in Panel A, the coefficient on ΔQ reaches as high as 0.0377 – still indicating that the round-trip TBA trading costs for $1,000,000 par value trades is less than four basis points.

Trading costs decrease with trade size for every regression in Table II. This is similar to the findings of Bessembinder et al (2013). The coefficient on the interaction between ΔQ and the logarithm of the trade size is a highly significant -0.0056 in the first regression. The natural logarithm of 2,000,000/1,000,000 is about 0.69, so an increase in the trade size from $1,000,000 par value to $2,000,000 would reduce round-trip TBA trading costs by about 0.69 x 0.0056 = 0.39 basis points.

The second regression includes interactions between ΔQ and the natural logarithm of the ratio of the gross production to the average gross production of MBS with the same coupon and maturity and between ΔQ and the log of the ratio of the previous month's balance to the average balance of outstanding MBS with the same coupon and maturity. Gross production is the dollar value of new mortgage backed securities created during the previous month with the same coupon and maturity. It varies significantly across coupon rates during a month. Greater gross production implies greater demand by originators to hedge new mortgages in the TBA market, and could affect trading costs in this way. A greater outstanding balance of MBS with a given maturity and coupon implies a deeper market for TBA trading. It suggests that dealers may know more potential buyers (or sellers) for MBS with the particular coupon and maturity characteristics. It also suggests higher trading volume as some investors unwind positions.

In the second regression in Panel A, the coefficient on the interaction between ΔQ and production is insignificant. The coefficient on the interaction between ΔQ and the balance of outstanding MBS is negative and highly significant. To summarize, a $1,000,000 par value round-trip TBA trade costs about

3.5 basis points, with costs falling for larger trade sizes and during times when there is a large balance of outstanding 30-year MBS with the same coupon.

The remainder of Panel A reports results for regressions using 15-year TBA trades. Round-trip costs for a $1,000,000 par value trade are about 3.1 basis points. Trading costs decline with trade size. While trading costs do decline with the balance of outstanding MBS with the same coupon and maturity, they appear to anomalously increase with MBS production.

Panel B provides regression estimates of trading costs for specified pool MBS. In the first regression, the percentage change in price for consecutive trades of 30-year specified pools is regressed on ΔQ and interactions between ΔQ and the trade size ratio and between ΔQ and a dummy variable for TBA eligibility. The coefficient of 0.6324 on ΔQ indicates that the round-trip trading cost for $1,000,000 of 30-year specified pools that were not TBA eligible was 63.24 basis points – far greater than the 3.5 basis points for similar TBA trades.[6] For TBA eligible specified pools, the round-trip trading costs were 63.24 – 39.57 or 23.47 basis points. This is much less than the trading costs for TBA-ineligible specified pools, but much more than TBA trading costs. The first regression also indicates that trading costs for specified pools, like TBA trading costs, decline with trade size. The second regression includes an interaction between the TBA eligibility dummy and the trade size ratio. It is positive and significant, indicating that trading costs do not decline as fast with trade size for TBA eligible pools as with TBA ineligible specified pools.

The next regression in Panel B estimates the effects of gross production of MBS and the balance of outstanding MBS on specified pool trading costs. A large balance of outstanding MBS with a particular coupon and maturity means that there is a large supply of these MBS and that dealers probably know which institutions may want to buy or sell MBS with these characteristics. For 30-year specified pools, both high gross production and a large balance of outstanding MBS are associated with lower trading

[6] Both SP and TBA trading cost estimates are similar to those in Bessembinder, Maxwell, and Venkataraman (2013).

costs. The coefficient on the balance of outstanding is highly significant with a t-statistic of -5.92, while gross production, with a t-statistic of -1.93 is of marginal significance.

The next row reports results for specified pools with maturities ranging from 16 through 30 years. All of these maturities are eligible for delivery in 30-year TBA trades. Now we include an extra dummy variable which takes a value of one if the maturity is exactly 30 years. Specified pools with maturities between 16 and 29 years are seasoned pools. They can be compared to off-the-run bonds. When these odd maturities are included in the regressions, trading costs still decline with trade size, with TBA eligibility, with the previous month's gross production of mortgages, and with the balance of MBS at the end of the previous month. The coefficient on the dummy variable for 30-year maturity is negative and highly significant. Specified pools with 30 years to maturity are cheaper to trade than the seasoned SPs with maturities from 16-29 years.

The remaining rows of the table report regression estimates of trading costs for specified pools with 15 years to maturity. Trading costs are, again, much higher than for similar TBA trades. The first regression for 15-year MBS has a coefficient on ΔQ of 0.6193. Round-trip trading costs for a \$1,000,000 par value trade of 15-year specified pools is 61.93 basis points if the specified pool is not TBA-eligible, and 61.93 – 32.12 = 29.81 basis points if the pool is TBA eligible. For 15-year MBS, like 30-year MBS, trading costs decline with trade size and with greater gross production of MBS with the same coupon. The outstanding balance of 15-year MBS with the same coupon seems to have little impact on trading costs of 15-year specified pools. Shorter maturities are eligible for delivery as 15-year MBS, so the last regression includes all specified pools with 15 years or less to maturity. The coefficient on the dummy for 15 years to maturity is negative, indicating that seasoned specified pools with less than 15 years to maturity are more expensive to trade than specified pools with 15 years to maturity.

To summarize, we can draw four conclusions about MBS trading costs. First, larger trades have lower trading costs, as a percentage of value, than smaller trades. Second, TBA trades are much cheaper than specified pool trades of similar size. These findings are similar to those of Bessembinder et al

(2013). In addition, TBA-eligible specified pools are cheaper to trade than TBA ineligible SPs. Finally, trading costs fall with a greater amount of outstanding MBS with the same coupon and maturity.

IV. Does the Option to Trade Specified Pools in the TBA Market Reduce Trading Costs?

A. TBA Eligibility and the Value of the Option to Deliver an SP in a TBA Trade

We have shown that trading costs are significantly lower for TBA-eligible specified pools than for other specified pools. One possible reason for this is that characteristics of the SP that make it TBA eligible also make it more liquid. This would be possible, for example, if the requirements for TBA eligibility were associated with less uncertainty about the likelihood of prepayment. A second reason would be that TBA trades are better hedges for TBA-eligible SPs than for other SPs. Another possibility is that TBA prices provide better benchmarks for TBA-eligible SPs than for other SPs. Each of these three potential explanations for lower trading costs for TBA-eligible SPs suggest that trading costs will decline as SP characteristics get closer to TBA-eligibility requirements. There should be little difference in trading costs between SPs that are TBA-eligible and those that almost TBA-eligible.

There is, however, another possible reason why trading costs are lower for TBA-eligible SPs than for other SPs. TBA-eligibility gives dealers an option to sell an SP in the much more liquid TBA market. This option may be valuable to dealers, particularly when market conditions change and a specified pool's pay-up or premium over TBA prices disappears. As an article in Mortgage News Daily observes

> "The importance of deliverability stems from the fact that if the pay-ups for the products disappear, the pools can still be sold into TBAs. This limits the risk that changing circumstances will cause investors to be stuck with illiquid and difficult-to-sell securities.[7]"

There is anecdotal evidence that volume does shift between the specified pool and TBA market as conditions change. An article in the July 1, 2012 Asset Securitization Report notes that

> "…when bond prices move lower, both specified pool pay-ups and the share of MBS traded as specified pools will drop."[8]

More generally, a particular MBS can become more or less likely to be traded in the TBA market as mortgage rates change. Sophisticated mortgage holders may prepay mortgages to take advantage of lower rates, but there are other reasons for prepayments. Mortgage holders may prepay if they move for a new job, or because of a divorce, retirement, or death. A mortgage default can also lead to prepayment by the GSE. A mortgage pool can be characterized as having fast payers or slow payers. A pool with fast or slow payers can be desirable under some market conditions but not others. For example, an MBS with slow payers is desirable if mortgage rates have fallen and MBS investors have to reinvest prepayments at lower coupon rates. This MBS is likely to be traded as an SP. The same MBS can become undesirable if rates rise. Now investors in the MBS will have to wait longer to reinvest at higher coupon rates. This MBS is unlikely to have a pay-up under these circumstances, and will probably be traded in the TBA market. Alternatively, an MBS with fast payers is desirable if interest rates have risen and investors in the MBS want to reinvest in MBS with higher coupons. If mortgage rates later fall sufficiently, the same MBS, with fast payers, would lose its pay-up and would be delivered in a TBA trade. Note that even if mortgage rates did not fall, that particular MBS would become less desirable over time as the fastest

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[7] See Berliner (2012a).
[8] See Berliner (2012b).

payers among the mortgage holders prepay their mortgages. When the remaining borrowers are slow payers, the MBS is likely to trade in the TBA market rather than as an SP.

TBA eligibility gives dealers an option to trade an SP in the TBA market, an option that may be exercised if market conditions change, or as the characteristics of the MBS itself change. This option allows the dealer to take advantage of the greater liquidity of the TBA market, and establishes the TBA price as a floor for the value of the MBS.[9] If the option to trade an SP in the TBA market is valuable to dealers, or if it makes it easier to sell the SP to investors, we should see a sharp difference in trading costs between SPs that are TBA-eligible, and those with characteristics that leave them almost TBA-eligible.

B. *The Value of the Option to Deliver an SP in a TBA Trade: Regression Discontinuity Tests*

In this section, we explore whether TBA eligibility itself, rather than just MBS characteristics associated with TBA eligibility, leads to greater liquidity for specified pools. There are several characteristics of loans that make them ineligible for inclusion in TBA-eligible pools. Loans with loan-to-value ratios greater than 1.05 are ineligible for inclusion in TBA pools.[10] For 30-year TBA pools, maturities must be greater than 15 years and less than or equal to thirty years. For 15-year TBA pools, maturities must be less than or equal to 15 years. In addition, there are several characteristics mortgages must have for unlimited inclusion in TBA-deliverable pools. They include a fixed rate, a first lien on the property, level payments, full amortization of the loan, and a servicing fee of at least 25 basis points. The loan should not include a prepayment penalty, should not have an extended buydown provision, should not be a cooperative share loan, should not be a relocation loan, and should not have biweekly payments.

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[9] Atanasov and Merrick (2012, p6) observe that SP traders should regard the TBA market "…as an extremely liquid backstop, which ensures a price floor equal to the current price of the corresponding standardized TBA contract."
[10] These unusually high LTV mortgages are "HARP loans." The HARP refinancing program under the Making Home Affordable Program offered refinancing to borrowers who were current on their mortgage payments and had loans guaranteed by Fannie Mae or Freddie Mac. HARP originally authorized the agencies to buy fixed-rate loans with LTVs greater than 80% as long as the current LTVs did not exceed 125%. In December 2011, the upper limits on LTVs were eliminated for loans that closed on or before May, 21, 2009.

Loans that violate any of these provisions can be included in TBA eligible pools only to a limited extent.[11]

We obtain data from eMBS on characteristics of specified pools to see if TBA eligibility itself, in addition to pool characteristics, creates liquidity. The data consists of summary statistics about pool characteristics at the time the MBS is originated rather than data on individual loans. The data includes the average FICO score, the maximum and minimum loan size, average loan-to-value (LTV) ratio, the percentage of the loans that are for owner-occupied houses, the percentage that have been refinanced, the percentage of the loans that are for single family homes, the state with the largest percentage of mortgages, and the originator that provided the most mortgages. These characteristics are widely regarded as important predictors of prepayment tendencies, but, with the exception of the LTV ratio are not the characteristics that are used to determine TBA-eligibility.

For our first tests of whether TBA eligibility affects trading costs, we employ a regression discontinuity approach that makes use of the breakpoint for TBA eligibility that occurs for LTV ratios greater than 1.05.[12] For specified pools with various ranges of LTVs, we run the following regression:

$$\Delta P_t = \alpha_0 + \alpha_1 \Delta Q_t + \alpha_2 \Delta Q_t \cdot \left[\ln\left(\frac{Size_t}{1{,}000{,}000}\right) + \ln\left(\frac{Size_{t-1}}{1{,}000{,}000}\right)\right] + \alpha_3 \Delta Q_t \cdot LTV + \alpha_4 \Delta Q_t \cdot D_{LTV>105} + \alpha_5 \Delta Q_t \cdot FICO + \Sigma \beta_i \, Ret_{i,t} + \varepsilon_t \quad (2).$$

As before, ΔP_t is the percentage change in price between two successive trades in the same specified pool, while ΔQ_t takes a value of one (negative one) if trade t-1 was a dealer purchase (sale) and trade t was a dealer sale (purchase). We include the interaction between ΔQ and the loan-to-value ratio to capture any effects that the LTV ratio has on trading costs other than helping to determine whether a pool is TBA eligible. We also include the interaction between ΔQ and the average FICO score for loans in the MBS and the fixed income index returns used previously. Our main interest is in α_4, the coefficient on the

[11] See Securities Industry and Financial Markets Association (2013).
[12] See Lee and Lemieux (2010) for a survey of regression discontinuity models in economics.

interaction between ΔQ and a dummy variable for LTVs greater than 1.05. If TBA eligibility affects trading costs, we would expect trading costs to increase abruptly for LTVs greater than 1.05, and hence for this coefficient to be positive and significant.[13]

The first row of Table III reports results for 30 year SPs with mean LTV ratios of 0.95 to 1.15.[14] We could use a wider range of LTV values and try to capture a nonlinear relation between trading costs and LTV values using interactions between ΔQ and a polynomial function of LTV. Instead, we restrict the range of LTV ratios to 0.95 to 1.15 because the impact of LTV ratios on trading costs may be better approximated with a linear relation over this narrow range of LTV values than over a wider range. A disadvantage of restricting the range of LTV ratios to 0.95 to 1.15 is that there are a small number of SPs with LTV ratios this high, and hence the number of observations is only 5,450.

In this regression, the estimated coefficient on the interaction between ΔQ and the loan-to-value ratio is -0.0290 with a t-statistic of -4.04. Higher LTV ratios mean lower trading costs. This is not surprising. High LTV ratios mean that mortgage holders are less likely to refinance, and hence there is less uncertainty about prepayments and the value of the MBS. Of more interest though is that the coefficient on the interaction between ΔQ and a dummy variable for a loan-to-value ratio above 1.05 is 0.4505 with a t-statistic of 3.87. Trading costs increase abruptly when the LTV ratio slips above 1.05, the highest LTV level at which an SP remains eligible for TBA trading. This is what we would expect if TBA eligibility itself, not characteristics that are correlated with TBA eligibility, makes TBA eligible SPs cheaper to trade. The next row repeats the regression but extends the sample by including SPs with LTV ratios from 0.85 to 1.25. This increases the sample size to 33,838, mostly by increasing the number of

[13] Some mortgage originators have been accused of artificially inflating property values and hence understating the true LTV ratio. See for example Superior Court of Washington for King County (2010), Federal Home Loan Bank of Seattle vs Goldman Sachs. If some LTVs are understated, any economic relation between the *true* LTV and trading costs is likely to be blurred. TBA-eligibility, on the other hand, only depends on whether the *stated* LTV is $\leq$ 1.05. Biases in stated LTVs will not affect tests of whether TBA eligibility, as affected by LTV ratios, influences trading costs.

[14] We use only SPs with maturities of 15 or 30 years even though SPs with shorter maturities can be used to settle TBA trades. Our LTV measure is a snapshot taken at one time. As SPs age, the LTV can change as a result of prepayments or defaults. A small number of SPs with LTVs in our data that are greater than 1.05 become TBA eligible as they age. There are no SPs with 15 or 30 years to maturity with LTVs greater than 1.05 that are TBA eligible.

observations with LTVs less than 1.05. The interaction between ΔQ and the loan-to-value ratio remains negative and statistically significant while the coefficient on the interaction between ΔQ and a dummy variable for a loan-to-value ratio above 1.05 remains positive and statistically significant. Both coefficients, however, are closer to zero than in the original regression.

To summarize, the regressions in the first two rows of Table IV show that trading costs generally decline with the LTV ratio, but they increase sharply at the 1.05 breakpoint between TBA eligibility and ineligibility. This suggests that TBA eligibility itself, rather than characteristics correlated with TBA eligibility, is responsible for lower trading costs.

The next two rows of the table provide the results of "placebo" regressions. In the third regression, the range of LTVs is from 0.85 to 1.05 and a dummy variable for LTVs in excess of 0.95 is included. In the fourth regression, the range of LTVs is from 1.05 to 1.25 and there is a dummy variable for LTV ratios of 1.15 or greater. For both of these regressions, the coefficient on the interaction between ΔQ and the dummy variable is the opposite sign from the regressions with a 1.05 breakpoint. It is the breakpoint of 1.05, above which an SP is not TBA eligible, which is important.

The next four rows of the table report results of identical regressions with 15-year SPs. In the first two rows, the coefficient on the interaction between ΔQ and the dummy variable is positive, the expected sign. There are far fewer observations for 15-year than for 30-year SPs though, so the t-statistic is only 1.51 when the range of LTV ratios is from 0.95 to 1.15, and 2.10 when the range is from 0.85 to 1.25. The last two rows of the table present the placebo regressions for the 15-year SPs. There are far fewer observations with 15-year SPs, so we would expect lower significance levels in these regressions. As with the 30-year SPs, the coefficient on the interaction between ΔQ and the dummy variable is negative, the opposite of what we find with the 1.05 breakpoint. To summarize, for the 15-year SPs, like the 30-year SPs, it appears that there is a sharp increase in trading costs when LTV ratios exceed 1.05 and the SP is not eligible for TBA trading. TBA eligibility appears to reduce trading costs.

Researchers who employ regression discontinuities often graph the variable affected at the discontinuity against the explanatory variable. In our case, this makes little sense as the LTV ratio is just one variable in the trading cost regression. So, to graph the discontinuity, we calculate abnormal costs by subtracting the product of estimated regression coefficients from (2) and the size, FICO, change in trade types and index returns for each successive pair of trades. That is,

$$AbNCosts_t = \Delta P_t - \alpha_1 \Delta Q_t - \alpha_2 \Delta Q_t \cdot \left[\ln\left(\frac{Size_t}{1{,}000{,}000}\right) + \ln\left(\frac{Size_{t-1}}{1{,}000{,}000}\right)\right] - \alpha_6 \Delta Q_t \cdot FICO - \Sigma\beta_i\, Ret_{i,t} + \varepsilon_t \quad (3).$$

We do not subtract the intercept or the coefficients on the LTV ratio or the dummy variable for an LTV ratio greater than 1.05 from ΔP_t. Hence the abnormal costs are a measure of costs after adjusting for everything except the LTV ratio. We then calculate the average abnormal trading costs for each LTV ratio from 0.96 through 1.14.

Figure 3a shows average abnormal trading costs for 30-year SPs for each LTV ratio. This graph shows a sharp increase in trading costs when LTV ratios pass the 1.05 threshold for TBA eligibility. The limitations of using this procedure with a small sample are revealed in Figure 3b, which shows mean abnormal trading costs and two standard error confidence intervals. As LTV ratio increase over this range, the number of observations drops (there are none at LTV ratios of 1.06 or 1.07) and the standard errors increase sharply. Differences between abnormal trading costs measured at a *single* LTV ratio greater than 1.05 and LTV ratios less than or equal to 1.05 are not statistically significant.

C. *The Value of the Option to Deliver an SP in a TBA Trade: Propensity Score Matching Tests*

We employ a type of propensity score matching as an additional test to see if TBA eligibility affects trading costs after adjusting for characteristics that may affect pool value. In a first step, we use a logistic regression and characteristics of the specified pools to predict whether a specified pool is TBA eligible. The predictive variables include the average FICO score of the home buyers in the pool, the maximum and minimum sizes of loans in the pool, the proportion of loans that are for owner-occupied housing, the percentage of loans that have been refinanced, and the proportion of mortgages that are on single family properties. These logistic regressions are run separately for specified pools with maturities of 16 to 30 years and for specified pools with maturities of 15 years or less. TBA-eligible pools with 16 to 30 years to maturity may be traded as 30-year TBAs, while TBA-eligible SPs with 15 or fewer years to maturity may be traded as 15-year TBAs. In discussing these results, we will refer to SPs with 16 to 30 years to maturity as 30-year SPs and SPs with 15 or fewer years to maturity as 15-year SPs.

Logistic regression estimates are reported in Table IV. The first two columns report coefficients and z-statistics, while the last two report marginal effects and corresponding z-statistics. Panel A reports results for 30-year SPs. Coefficients on minimum and maximum loan size are negative and highly significant. Coefficients on the mean FICO score, and the percentage of mortgages that are for owner-occupied houses are positive and highly significant. The coefficient on the proportion of the mortgages that are for single family homes and the percentage of mortgages that are refinanced are negative and highly significant. The coefficient on LTV is positive and significant while the coefficient on a dummy variable for LTV greater than 1.05 is negative and highly significant.[15] These mortgage characteristics have a significant ability to predict TBA eligibility. For 30-year SPs the pseudo R^2 is 0.4247.

Results for 15-year SPs, reported in Panel B, are similar. Coefficients on the minimum loan size and percent of mortgages that are for single family homes are negative and significant, while coefficients on the mean FICO score, the percentage of mortgages that are for owner occupied houses, and the percentage refinanced are positive and statistically significant. As with 30-year SPs, the coefficient on LTV is positive and significant, while the coefficient on the dummy variable for LTVs in excess of 1.05 is negative and highly significant. The logistic regression does a better job of explaining TBA eligibility for 15-year SPs than for 30-year SPs. Here the pseudo R^2 is 0.8336.

[15] An LTV greater than 1.05 makes an SP ineligible for TBA trading. Our MBS characteristics are taken from a snapshot at one point in time and LTV ratios are as of that time. LTVs can change as a result of prepayments and defaults and MBS can become or cease being TBA eligible. Hence, with seasoned MBS, an LTV > 1.05 from a different point in time need not indicate with certainty that the SP is TBA-eligible.

We use the probability that a specified pool is TBA eligible from the first stage logistics regressions to see if TBA eligibility itself, rather than variables correlated with TBA eligibility are associated with lower trading costs. For the second stage we estimate

$$\Delta P_t = \quad \alpha_0 + \alpha_1 \Delta Q_t + \alpha_2 \Delta Q_t \cdot (\ln Size_t + lnSize_{t-1}) + \alpha_3 \Delta Q_t \cdot TBA\ Eligible + \alpha_4 \Delta Q_t \cdot Probability\ TBA\ Eligible \ + \Sigma\beta_i\ Ret_{i,t} + \varepsilon_t. \ (4)$$

Note that we include the interaction between ΔQ and the probability that a specified pool is TBA eligible in the regressions. Any remaining impact of TBA eligibility on trading costs is likely to reflect the impact of TBA eligibility itself, not other characteristics associated with TBA eligibility. Regressions are run separately for specified pools with probabilities of less than 10% of being TBA eligible, of 10% to 19.99% of being TBA eligible, and so forth. We estimate the regressions separately for different probabilities of TBA eligibility as a robustness check, and also as a way to restrict observations in the regressions to similar SPs. We also estimate (5) using all observations. Results are reported in Table V.

Panel A of Table V reports results for SPs with 16 to 30 years to maturity. If TBA eligible, these SPs can be delivered to settle 30-year TBA trades. The first ten rows report regressions with SPs with similar probabilities of being TBA-eligible. The number of SPs in the regression that are actually TBA eligible and ineligible are reported for each regression. As expected, the proportion of SPs that are TBA eligible increases with the probability of TBA eligibility estimated in the first stage. The coefficient on the interaction between ΔQ and TBA eligibility is negative for each of the regressions. For seven of the ten regressions, the coefficient on the interaction between ΔQ and TBA eligibility is negative and significant at the 1% significance level. The last regression reports results when all observations, regardless of the predicted likelihood of TBA eligibility are included. As in the other regressions, the coefficient on the interaction between ΔQ and TBA eligibility is negative and significant at the 1% significance level. It is interesting that the coefficient is -0.4078, suggesting the TBA eligibility decreases trading costs by 40.78 basis points. The regression discontinuity estimates using 30-year SPs and a range of LTVs from 0.96 to 1.14 suggests that TBA eligibility decreases trading costs by very similar 45.05 basis points, and our regressions in Table II suggest that TBA eligibility decreases trading costs by 39.6 basis points. Panel B reports results for the regressions with 15-year SPs. In each regression, the coefficient on TBA eligibility is negative and statistically significant. As with 30-year SPs, after adjusting for SP characteristics that are associated with TBA eligibility, it appears that trading costs for TBA-eligible SPs are lower than for TBA-ineligible SPs.

To summarize, we have shown that TBA-eligible and ineligible SPs differ in FICO scores, loan sizes, loan-to-value ratios, percentage of mortgages that are for owner occupied homes, percentage of mortgages that have been refinanced and the percentage of mortgages that are for single family homes. Our propensity score matching results indicate, however, that despite predicting TBA eligibility well, these characteristics do not explain the relation between TBA eligibility and liquidity. Like our finding that trading costs increase sharply when the LTV ratio threshold for TBA-eligibility is crossed, these results are consistent with TBA eligibility itself leading to greater liquidity.

We do not expect the effectiveness of TBA hedging to change abruptly between SPs that are very close to TBA eligibility and those that are TBA eligible. We instead expect the effectiveness of TBA hedging to change continuously as the characteristics of the SP come closer to those of TBA eligible SPs. Likewise, we don't expect the usefulness of TBA prices as benchmarks to change abruptly with TBA eligibility. Rather, we expect TBA prices to become continuously better benchmarks as the characteristics of SPs come closer to the characteristics of TBA eligible pools.

What does change abruptly with TBA eligibility itself is that the holder gains an option to deliver the SP to fulfill a TBA trade. Like all options, the option to deliver the SP in a TBA trade is valuable. Dealers may exercise this option if market conditions change and a previously desirable SP loses its pay-up, or if the difference between the specified pool value and TBA price is small and time and effort are required to sell the specified pool. Our results are consistent with dealers valuing this option enough to trade TBA-eligible SPs for smaller markups than otherwise similar TBA-ineligible SPs.

V. The Impact of TBA Trading on Specified Pool Liquidity

In this section, we examine the issue of whether the existence of parallel TBA trading increases liquidity for MBS while they are traded as SPs. There are several reasons to expect a liquidity spillover from TBA trading to SP trading. One is that TBA prices may provide a benchmark for SP pricing. Price discovery may take place in the TBA market rather than the SP market. In addition, an active TBA market may allow dealers to hedge SP positions with minimal basis risk.

It is not straightforward to test whether TBA trading affects SP liquidity. We would expect that many of the factors that affect TBA trading also directly affect SP liquidity. We however, identify an exogenous factor that directly affects the trading volume in the TBA market but not the SP market. This exogenous factor is TBA settlement dates. TBA contracts for a given maturity and issuer settle on one day during a month. Fannie Mae and Freddie Mac 30-year TBA trades settle on the same Class A schedule. Their settlement dates are typically around the 12^{th} or 13^{th} of each month. The Class B schedule is for 15-year TBA trades. Settlement dates for these trades are typically three trading days after class A settlement dates. The Class C schedule is for Ginnie Mae 30-year TBA trades. Settlement dates are about two trading days after Class B dates.

The impact of settlement dates on TBA trading is particularly strong for dollar rolls. Recall that the purchaser of a dollar roll buys a TBA contract for settlement in the current month and simultaneously sells a TBA contract for settlement in a future (usually the next) month. Likewise, the seller of a dollar roll sells a TBA contract for settlement in the current month and simultaneously buys a TBA contract for settlement in a future month. Investors who trade dollar rolls typically either terminate or roll over their positions before settlement. To avoid being assigned a delivery, TBA traders must terminate positions at least 48 hours before the settlement date. This results in a spike in trading volume from seven trading days through two trading days before each settlement date.

Figure 4a shows daily trading volume from dollar rolls of 30-year TBA trades over our sample period. It is easy to see monthly trading volume spikes in which daily volume is three to five times the daily volume in the rest of the month. These volume spikes are two to five days before the Schedule A settlement dates. It is clear from the figure that timing relative to the settlement date is a major determinant of daily dollar roll trading volume. And, since dollar roll trading accounts for most of the dollar volume of TBA trading, we can say that the settlement date is a major determinant of TBA trading volume in general.

Specified pool trades, on the other hand, may be settled on any day during the month. Atanosov and Merrick (2012) note that many dealers choose to settle SP trades on TBA settlement dates for convenience,[16] but unlike dollar rolls and other TBA trades, specified pool trades almost always lead to delivery. Hence the monthly settlement dates and the corresponding trades to avoid delivery that are so important in the TBA market are unimportant for specified pool trades. Nevertheless, if dollar roll trading makes the market for specified pools more liquid, we would expect specified pool trading to peak when dollar roll trading is high.[17] Figure 3b is a scatter plot of daily trading volume for 30-year specified pools against daily trading volume of TBA dollar rolls. Days with dollar roll volume of more than $200 billion correspond to monthly peaks in trading volume before settlement dates. Figure 4b shows that SP volume is also typically high on these days. The correlation between the daily 30-year dollar roll and specified pool volumes is 0.45.[18]

We test whether TBA trading affects specified pool liquidity by running the following regression:

[16] Atanosov and Merrick (2012) find that 71.5% of 30-year specified pool trades of more than $250,000 settle on TBA settlement dates. A smaller proportion of smaller trades and 15-year specified pool trades are settled on TBA settlement dates.

[17] See Admati and Pfleiderer (1988) for a model in which those liquidity traders with discretion over the timing of their trades may endogenously choose to concentrate their trading in the same period.

[18] The volume for TBA trades is 3.30 times as high in the period before the settlement date as it is on other dates. When we separate 30-year SP volume into TBA-eligible and TBA-ineligible volume, we find that TBA-eligible volume is 2.03 time as high on days -7 to -2 before a settlement date, and TBA ineligible volume is 2.00 times as high. The seasonality for TBA-ineligible SP volume is as pronounced as the seasonality for TBA-eligible volume. This suggests that the seasonality in SP volume is not driven by market participants trading to acquire SPs to deliver into TBA trades.

$$\Delta P_t = \alpha_0 + \alpha_1 \Delta Q_t + \alpha_2 \Delta Q_t \cdot \left(\ln\left(\frac{Size_t}{1{,}000{,}000}\right) + \ln\left(\frac{Size_{t-1}}{1{,}000{,}000}\right)\right) + \alpha_3 \Delta Q_t \cdot \left(\ln\left(\frac{PredDRoll_t}{MedianDRoll}\right) + \ln\left(\frac{PredDRoll_{t-1}}{MedianDRoll}\right)\right)$$

$$+\alpha_4 \Delta Q_t \cdot \left(\ln\left(\frac{PredDRoll_t}{MedianDRoll}\right) + \ln\left(\frac{PredDRoll_{t-1}}{MedianDRoll}\right)\right) \cdot \left(\ln\left(\frac{Size_t}{1{,}000{,}000}\right) + \ln\left(\frac{Size_{t-1}}{1{,}000{,}000}\right)\right) + \alpha_5 \Delta Q_t D_{\frac{30yr}{15yr}}$$

$$+\Sigma\beta_i \, Ret_{i,t} + \varepsilon_t. \quad (5)$$

Here, PredDRoll is the predicted dollar roll volume using only settlement dates and volume from the previous month. For days that are between two and seven days before a Class A (30-year Fannie Mae and Freddie Mac) TBA settlement date or between two and seven days before a Class B (15-year) TBA settlement date, we use the dollar roll volume from the corresponding day in the previous month as the prediction of dollar roll volume.[19] For other days, we use the average volume from days t-40 to t-20, excluding days that were two to seven days before a settlement date, as a forecast of volume. Hence our predicted dollar roll volume is based only on volume from the previous month and the publicly known settlement date.[20] Other factors that would simultaneously affect TBA dollar roll volume and SP trading costs would be most likely to show up in unexpected dollar roll volume. MedianDRoll is the median predicted dollar roll volume across all trades.

Results are reported in Table VI. Here, the α_1 coefficient is the round-trip trading costs for \$1,000,000 trades when the predicted dollar roll volume is at its median level and the SP does not have 15 or 30 years to maturity. The α_1 coefficient plus the α_5 coefficient provides round-trip trading costs for SPs with 15 or 30 years to maturity. The α_3 coefficient on the interaction between the change in trade type, ΔQ, and the predicted Dollar Roll Volume shows how trading volume affects trading costs. For 30-year outright TBA trades and 30-year TBA-eligible SPs, and 30-year TBA-ineligible SPs the coefficients are negative and highly significant. Increases in TBA dollar roll volume are associated with lower trading costs. The α_3 coefficients are similar for TBA-eligible and ineligible SPs, so dollar roll volume seems to

[19] We find that Class B Settlement dates, which apply to 30-year Ginnie Mae trades, have little predictive power for volume. Ginnie Mae TBA volume in general is significantly less than Fannie Mae and Freddie Mac TBA volume.

[20] This simple model predicts well. When we regress actual 30-year TBA dollar roll volume on the predicted volume, the coefficient on the predicted volume is 0.9625 and the adjusted R^2 is 0.7156. For 15-year TBA dollar roll volume, the coefficient is 1.0023 and the adjusted R^2 is 0.6552.

reduce trading costs by similar amounts for TBA-ineligible and eligible specified pools. The trading costs for TBA ineligible specified pools are much higher, however. So, dollar roll trading reduces trading costs for 30-year TBA eligible and ineligible specified pools by about the same amount, even though TBA ineligible SPs are much more expensive to trade. Some of the regressions include a further interaction between ΔQ, the predicted dollar roll volume, and the trade size. Dollar roll volume has a smaller impact on trading costs for large trades.

These results are economically significant as well. We multiply the coefficient on the interaction between ΔQ and the log of predicted dollar roll volume for TBA-eligible SPs with 16 to 30 years to maturity (-0.0431) on the difference between the 90th and 50th deciles of the log of predicted dollar roll volume. This yields a difference in round-trip trading costs of 7.4 basis points when predicted dollar roll volume goes from the median to the 90th percentile. As a rough rule of thumb, that suggests that trading costs are about 7.4 basis points lower on a day just before the settlement date than they are on a typical day. For the TBA-ineligible specified pools the coefficient is larger in absolute value (-0.0570) and the difference in round-trip trading costs is 9.8 basis points.

The last five rows of the table report results for similar regressions using 15-year TBA and specified pools with 15 years or less to maturity. Trading costs decline significantly with predicted dollar roll trading volume both for TBA trades and for trades of TBA eligible specified pools. The volume of dollar roll trading seems, however, to have little impact on trading costs for 15-year TBA ineligible specified pools. It is true that only 1,941 observations are included in the regression with 15-year TBA ineligible specified pools, but the coefficients on ΔQ and the interaction between ΔQ and trade size remain highly significant in the regression.

To summarize, predictable TBA dollar roll volume spikes that occur before exogenously determined settlement dates are associated with lower specified pool trading costs. Unlike TBA trades, SP trades can be settled at any time within a month, and SP traders, unlike dollar roll TBA traders, generally take delivery. Hence, the reasons for a spike in TBA volume before settlement dates do not apply to SP trades. But, before TBA settlement dates SP volume is high and SP trading costs are low. This suggests that heavy TBA trading volume increases liquidity for specified pools.

VI. TBA Market Hedging and Specified Pool Liquidity

Our results suggest that TBA trading creates liquidity not only for the MBS that are traded in the TBA market, but also for SPs. In this section, we examine one (but not necessarily the only) way in which TBA trading can make the specified pool market more liquid: it provides a way for dealers to hedge specified pool positions. Because each specified pool is unique, it may take some time for dealers to sell them. The low trading costs in the TBA market allow dealers to hedge the inventory they intend to sell in the specified pool market cheaply. They also have the option, in most cases, to deliver the SP to close out the TBA position. In addition, hedging with TBA trades rather than, say, treasury securities, minimizes basis risk for the dealer. The likelihood of prepayment changes with interest rates. This can be at least partly captured with a hedge from a TBA trade, but not by hedging with derivatives on treasuries.

A. Hedging with TBA Trades

We study dealers' use of the TBA market to hedge the risk of specified pool inventory by examining daily changes in TBA and specified pool inventory for each dealer i each day. For a given maturity-coupon combination (i.e. 30 years, 3.5%) we calculate the change in dealer i's TBA inventory each day using all of the dealer's trades with customers and with other dealers. In calculating the changes in dealer inventory, we aggregate across all issuers (e.g. Fannie Mae) and all settlement dates. For each dealer each day, we also calculate changes in inventory of specified pools with the same maturity and coupon. For each dealer i, we then regress daily changes in TBA inventory on same-day changes in TBA-eligible and TBA-ineligible SP inventory with the same coupon and maturity. That is,

$$\Delta\, TBA\ \ Inv_{i,c,t} =$$

$$\alpha_{1i} + \alpha_{2i}\Delta TBAElig.Spec.Pool\ Inv_{i,c,t} + \alpha_{3i}\Delta TBAInelig.Spec.Pool\ Inv_{i,c,t} + \varepsilon_{i,t} \quad (6).$$

Here, the c subscript refers to maturity-coupon combination c and t refers to day t.

A simple way to hedge is to offset a long (short) position in specified pools by selling (buying) an equivalent amount of MBS with the same maturity and coupon in the TBA market. If a dealer follows this strategy the coefficients in the regression should equal -1. If the dealer hedges some specified pool positions but not others, we would expect the coefficients to be negative, but between negative one and zero. If a dealer hedges more TBA-eligible SP positions than TBA-ineligible SP positions, we would expect the α_2 coefficients to be closer to -1 than the α_3 coefficients.

Some maturity-coupon combinations are not traded actively throughout the sample period. For example, 30 year 5%, 5.5%, and 6% MBS were only traded in the TBA market in the early part of the sample period. By 2013, trading in these maturity-coupon combinations had virtually disappeared from the TBA market. Hence, in estimating the inventory regressions, we use only days when the dealer had a change in either TBA-eligible or TBA-ineligible specified pool inventory.

Table VII provides statistics on the distribution of regression coefficients across dealers. We weight the individual dealer regression coefficients by the number of observations in the regression to provide a weighted median. The number of observations in each regression is the number of days when the dealer had positive or negative changes in SP inventory. Hence these weighted medians can be interpreted as the proportion of positions hedged. As an example, for 3% 30-year maturity TBA-eligible SPs, the weighted median is -0.9131, so about 91% of the SP positions taken in that maturity-coupon combination are hedged. Across maturity-coupon combinations, the weighted median coefficients for TBA eligible SP inventory range from -0.9220 to -0.1130. A coefficient of -1.0 would imply that SP trades were offset one-for-one with TBA trades. So, our results imply partial hedging. Weighted median coefficients are closest to zero for 30-year SPs with coupons of 5% or more. These MBS were not in production during our sample period and there was relatively little TBA trading for these maturity-coupon combinations. This suggests that dealers are more likely to hedge SP inventory when there is an active TBA market.

There are large differences in the number of observations in each individual dealer regression and large differences across dealers in the standard errors of the regression coefficients. So, in calculating mean coefficients, we use a Bayesian framework employed by Panayides (2007), and Bessembinder et al (2009). It assumes that the estimated α coefficient for each dealer i is distributed

$$\tilde{\alpha}_i |\, \alpha_i \sim i.i.d.N\left(\alpha_i,\, s_i^2\right)$$

And

$$\alpha_i \sim i.i.d.N\ (\alpha, \sigma^2)$$

The average α estimate across N dealers is given by

$$\tilde{\alpha} = \frac{\sum_{i=1}^{N} \frac{\tilde{\alpha}_i}{\left(s_i^2 + \tilde{\sigma}_{m.l.e.}^2\right)}}{\sum_{i=1}^{N} \frac{1}{\left(s_i^2 + \tilde{\sigma}_{m.l.e.}^2\right)}} \quad (7)$$

With independence across dealers, the variance of the aggregate estimate is

$$Var\ (\widetilde{\alpha}) = \frac{1}{\sum_{i=1}^{N} \frac{1}{\left(s_i^2 + \tilde{\sigma}_{m.l.e.}^2\right)}} \quad (8)$$

Our individual dealer regressions produce sample variances s_{i2}^2 and s_{i3}^2 for each dealer i. We then use maximum likelihood to jointly estimate the mean coefficient $\alpha_{2,}$ its variance $\sigma_2{}^2{}_{m.l.e.}$, and separately, the mean coefficient $\alpha_{3,}$ and its variance $\sigma_3{}^2{}_{m.l.e.}$.

The cross-sectional mean and t-statistics for the coefficients from the dealer hedging regressions are reported in the columns just after the weighted median. The 30-year specified pools with yields of 5.0%, 5.5% and 6.0% trade relatively infrequently. Mean coefficients on TBA-eligible SP inventory range from -0.2594 to -0.1620 for these maturity coupon combinations. They are not significantly different from zero. The mean coefficients for the other maturity-coupon combinations are closer to -1 and are significantly different from zero. On average, for the actively traded TBA-eligible SPs, dealers hedge most of their SP inventory with TBA trades, and the coefficients are significantly less than zero.

The 25th and 75th percentile of individual dealer regression coefficients for each maturity-coupon combination are reported next. For example, for 3% 30-year maturity TBA-eligible SP, the 25th percentile of coefficients is -0.9801 and the 75th percentile is -0.3609. The 75th percentile of dealer coefficients is negative for all maturity-coupon combinations of TBA-eligible SP inventory changes, implying that more than 75% of dealer coefficients are negative regardless of maturity or coupon. The great majority of dealers seem to hedge at least some of their positions in TBA-eligible specified pools.

Another way to look at dealers' use of TBA trades to offset SP trades is that the dealers are selling forward the MBS that they have purchased in the SP market. That is, rather than maintaining an offsetting TBA position, they intend to deliver the SPs to settle their TBA trades but also have an option to deliver other MBS. It is not clear that there is a useful distinction between hedging and selling their SP positions in the forward market. TBA-ineligible SPs, however, cannot be delivered to fulfill a TBA trade. For TBA ineligible SP positions, offsetting TBA trades would instead be hedges that the dealer would expect to maintain until the SP was sold.

The last six columns of the table report the weighted-median, the median, and the 25th and 75th percentile of individual dealer regression coefficients for each maturity-coupon combination for TBA ineligible SPs along with the number of dealers for which the coefficients can be estimated. Weighted median and mean coefficients are negative for TBA-ineligible SPs, suggesting that dealers hedge TBA-ineligible SPs. They are not selling them forward as they cannot deliver them to settle the TBA trades. For most maturity-coupon combinations, both weighted median and mean coefficients are closer to -1 for TBA eligible trades than for TBA ineligible trades. This suggests that the median dealer is less inclined to hedge TBA-ineligible SP inventory than TBA-eligible SP inventory. Or, alternatively, that some dealers with TBA eligible positions expect to deliver the SPs to settle the TBA trade rather than looking at the TBA trade as one to be reversed when the SP position is closed.

B. Hedging with TBA Trades Versus Hedging with Derivatives Tied to Treasuries

Our evidence suggests that dealers hedge SP positions with offsetting TBA trades. Dealers could, alternatively, hedge using derivatives on treasury securities. Agency mortgage backed securities, like treasuries, are default free securities with prices that vary inversely with interest rates. For MBS though, changes in interest rates affect the likelihood of prepayment as well as the present value of future cash flows. This suggests that hedging with TBA trades will mean lower basis risk as the value of TBA positions, like the value of SPs, is affected by changes in the likelihood of prepayment. On page 4 of the Securitization Module, The Federal Housing Finance Agency's Examination Manual notes that

> "While this interest-rate risk could also be hedged with other types of instruments, TBAs are a superior hedging instrument because they more directly offset the risks associated with a mortgage. The price movements of Treasury futures, for instance, can diverge significantly from those of MBS for a number of reasons, including different sensitivities to interest rates."

To examine the effectiveness of hedging, we estimate returns on actual dealer positions and see how well these returns can be replicated by returns from TBA or treasury trading. We estimate returns on dealer positions by identifying cases where dealers bought and sold the exact same par value of the same specified pool. We include only purchases from and sales to customers. We miss cases where a dealer split the position into multiple transactions, or cases where an SP position was liquidated by delivering it to fulfill a TBA trade. We omit positions that were opened and closed on the same day. Nevertheless, we have identified over 100,000 round trip positions and can use these to compare the effectiveness of TBA hedging versus hedging with treasuries.

We categorize SP positions on three dimensions: the maturity of the SPs (≤ 15 years versus 16-30 years), whether they are TBA eligible or ineligible, and whether the position was held for one to five days, six to 20 days, 21 – 60 days, or more than 60 days. For each group of SP positions, we run the following cross-sectional regression:

$$\Delta P_i = \alpha_0 + \alpha_1 \Delta Q_i + \alpha_2 \Delta Q_i \cdot \ln\left(\frac{Size_i}{1{,}000{,}000}\right) + \beta_i \, Ret_{i,j}^{Hedge} + \varepsilon_i \quad (9)$$

where ΔP_i is the percentage price change in the specified pool position i, ΔQ_i takes a value of one if i was a long position and negative one if it was a short position. We include these variables to adjust for trading costs in the return regression to enable a more accurate reading of how well the hedges could work. The regressions are run separately for hedges with TBA positions and hedges with treasuries. To obtain the TBA hedge return, we first find the last interdealer TBA trade each day with the same coupon and maturity as the SP. If there are TBA trades with multiple settlement dates, we choose the earliest settlement date. The TBA return over the life of the hedge is the ratio of the TBA price on the day the position is established to the TBA price on the day the position was closed. Hedge returns for treasuries are the total returns of a CRSP treasury index over the life of the position. We use the CRSP five, seven, and ten year treasury indices.

We report results in Table VIII. To compare how well different hedges work, we compare the adjusted R^2's across the otherwise identical regressions. A higher R^2 indicates that the hedging variable explains a larger portion of the SP return and therefore provides a hedge with less basis risk. We also report coefficients and t-statistics for the hedging variables.

Panel A reports the results for SPs with 16 to 30 years to maturity. If they are TBA eligible, SPs with these maturities can be delivered to settle TBA trades. There are 15,833 30-year TBA-eligible SP positions that are held for one to five days. With no hedge variable in the regression, the adjusted R^2 is 0.1710. This is the proportion of position returns that can be explained by transaction costs. When the TBA hedge is included the coefficient on the hedge return is positive with a t-statistic of 3.56, but the adjusted R^2 increases only slightly to 0.1716. For this short time period, adjusted R^2 are slightly higher for five and seven year treasuries at 0.1717, and slightly lower for ten-year treasuries at 0.1714. For this short holding period, none of the potential hedges explain much of the SP returns.

The next three rows of Panel A look at SP positions of 30-year TBA eligible SPs that were held for 6-20 days, 21-60 days, and more than 60 days. As we move to longer and longer holding periods, going from no hedge to a TBA hedge means a larger and larger increase in the adjusted R^2. When positions held more than 60 days are considered, the adjusted R^2 goes from 0.0423 to 0.2815. This is not surprising. As the holding period gets longer, the variance of returns on MBS increases, while the variance of returns from microstructure effects remains constant. Hence a larger proportion of SP holding period returns can be explained by changes in TBA prices. The adjusted R^2 from the regressions with the TBA hedge is much higher than the adjusted R^2 from five, seven, or ten year treasuries. Hence a hedge with an offsetting TBA trade can reduce uncertainty far more than a hedge with treasuries. Notice also that as we go toward longer holding periods, the coefficient on the TBA return approaches one, indicating that returns on a TBA position get closer to offsetting returns on the SP position one-for-one. That is not true for the coefficients on treasury returns.

The next four rows of Panel A report results for positions of TBA-ineligible SPs. Note that positions without hedges have much higher R^2s than comparable TBA-eligible positions without hedges. This is because trading costs are larger and explain a larger proportion of returns for TBA-ineligible positions than for TBA-eligible positions. As we have seen in Table V, TBA ineligible SPs typically differ from TBA-eligible SPs in FICO scores, loan sizes, the proportion of mortgages refinanced, the proportion of homes that are owner-occupied and other characteristics. Nevertheless, Panel A shows that for TBA-ineligible SPs, adjusted R^2's increase when the return on the TBA hedge is included in the regression, particularly when the holding period is long. This indicates that TBA trades can be useful for hedging TBA ineligible SPs. The increase in R^2's, however, is much smaller for TBA ineligible SPs than for TBA eligible SPs. So, for example, when the holding period is 21-60 days, the adjusted R^2 increases from 0.1420 to 0.2126, or 0.0706 when the TBA returns are added to the TBA-eligible regression, but only from 0.4354 to 0.4840, or 0.0486 when the TBA returns are added to the TBA-ineligible regression. Finally, notice that for TBA ineligible securities, R^2s with treasuries as the hedging variable are similar to R^2s for the TBA hedge. The advantages of hedging with TBA trades appear to be smaller for TBA-ineligible SPs than for TBA-eligible SPs.

Panel B of Table VIII reports analogous regressions for TBA-eligible and ineligible SPs with 15 years or less to maturity. At least for 15-year TBA-eligible SPs, we can draw the same conclusions as in Panel A. Adjusted R^2s are greater when TBA returns are included in the regression than when five, seven, or ten-year treasuries are included. Hence hedging with TBA trades can be more effective than hedging with treasuries. Also, as in Panel A, increases in adjusted R^2s from hedging are greater for longer holding periods. For 15-year TBA-ineligible SPs, sample sizes are very small and estimates are noisy. For long holding periods, TBA hedging appears to work better than hedging with treasuries, but estimates are too noisy to draw strong conclusions.

C. Prearranged Trades as a Way of Reducing Risk When Dealers Can't Hedge

If a dealer is unwilling to take the risk of holding inventory, he can act as a broker and find a buyer for specified pools that a customer wants to sell rather than take the securities into inventory before finding a buyer. These brokered trades should play an especially important role for specified pools that cannot be easily hedged with TBA trades. To examine this, we look at all purchases of all specified pools – regardless of coupon or maturity - by dealers from customers. We then see if the dealer who purchased the specified pool sold the same par value of the same specified pool within five minutes.[21] We define purchases that were sold within five minutes as brokered or prearranged trades.[22] Trades that are not prearranged are likely to remain in a dealer's inventory for days or weeks.

We separate these prearranged trades into those in which the dealer sold to another dealer and those in which the dealer sold to a customer. We view these as very different transactions. When a dealer sells to a customer in a prearranged trade, the dealer takes no inventory risk. We hypothesize that

[21] Harris (2015) examines riskless principal trades in corporate bonds and defines them as offsetting trades within one minute of each other. These are equivalent to prearranged trades.
[22] The choice of five minutes is arbitrary. We tried to pick a time interval that would allow dealers enough time to get back to the other leg of a prearranged trade and execute it, but not so long as to include trades that are not prearranged. When we use two minutes instead of five, the proportion of trades that are prearranged with customers falls from 3.99% to 3.21%. Other results are qualitatively the same.

prearranged trades with customers should be especially common for specified pools that are difficult to hedge with TBA sales. On the other hand, when a dealer purchases from a customer and immediately resells to another dealer, we find that it is very unusual for the second dealer to have a prearranged trade with a customer. The second dealer almost always takes the specified pool into inventory and assumes inventory risk. It is likely that the second dealer would prefer to be able to hedge this risk. A dealer sale to another dealer may occur because the second dealer specializes in a particular type of specified pool. It is possible that some of the cases in which a dealer sells to another dealer within five minutes are not actually prearranged, but reflect dealers' knowledge of the positions and interests of other dealers.[23]

Panel A of Table IX describes the proportion of trades of various types of specified pools that are prearranged with other dealers and with customers. In total, we have 699,263 purchases of specified pools by dealers from investors. Of these, 3.99% represent trades that are prearranged with customers and 29.28% are trades that are prearranged with other dealers. When we subtract out the trades that are prearranged with other dealers, we are left with 494,513 trades that dealers elected to handle themselves. Of these, 5.65% were prearranged, and dealers took the other 94.35% into inventory.

The next two rows of the table report the proportion of prearranged trades that are larger than the median size and the proportion that are smaller than the median size. Almost half of the small trades are prearranged with another dealer, but less than 9% of the large trades are immediately resold to another dealer. When we look at the trades that dealers handled themselves, we find that 7.73% of the trades that are smaller than the median are prearranged with customers, but only 4.49% of the large trades. Trades that are prearranged with customers tend to be small, but the difference between the proportions of small and large trades that are prearranged is not as dramatic as it is for trades that are prearranged with other dealers.

[23] Zitzewitz (2010) finds that 46% of dealer trades of corporate bonds with customers are followed by an interdealer transaction within 60 seconds if the trade size is less than $100,000. Only 4.5% of customer trades of over $500,000 are matched with an interdealer transaction within 60 seconds. These figures are upper bounds on the proportion of trades that dealers reverse through offsetting interdealer trades. Zitzewitz uses data without dealer identities though, so in some cases the interdealer trade following a trade with a customer will involve different dealers.

The next two rows show the proportion of prearranged trades for TBA eligible and TBA ineligible specified pools. TBA ineligible pools are more difficult to hedge than the eligible pools, so we might expect dealers to be especially likely to prearrange trades for ineligible specified pools. This is indeed true for trades that are prearranged with customers. Looking just at the trades that dealers chose to handle themselves, we see that dealers prearrange trades with customers for 5.08% of the TBA eligible specified pools and 13.41% of the TBA ineligible pools. Trades of specified pools that are difficult to hedge are more likely to be prearranged.

The difference in the proportions of TBA-eligible and TBA-ineligible SPs trades that are prearranged with customers suggest that we have understated the differences in liquidity between TBA-eligible and ineligible SPs. Not only are trading costs much higher for TBA-ineligible SPs than for TBA-eligible SPs, investors are more likely to have to wait until a counterparty is found before trading. We have no way to determine whether TBA-ineligible traders have to wait minutes, hours, or days before a counterparty is located.

When we compare TBA-eligible and TBA-ineligible trades, the contrast between trades that are prearranged with customers and trades that are prearranged with other dealers is striking. TBA eligible specified pools trades are much more likely to be prearranged with other dealers than TBA ineligible trades. This is the opposite of what we observe for prearranged trades with customers. Dealers prearrange trades of TBA-ineligible SPs with customers because the dealers don't want to take the TBA-ineligible SPs into inventory. They are difficult to hedge and cannot be delivered to fulfill a TBA trade. Other dealers don't want to take them into inventory for the same reasons. So, TBA-ineligible SPs are unlikely to be part of a prearranged trade with another dealer.

Finally, in the last two rows of Panel A we compare the proportion of prearranged trades of specified pools with coupons that match TBA coupons with the proportion of prearranged trades for specified pools that do not match TBA coupons. If the specified pool had a coupon yield that ended in an even percent or half percent and was in the range from 2.5% to 6% we define it as having a matching yield among TBA trades. Specified pools with coupons that ended in a quarter or three-quarter percent, like 3.25%, or with coupons greater than 6% are among those that do not match TBA coupons. Many of these specified pools have coupon payments that are higher than coupons used in TBA specifications at the time. Because prepayment is a complicated non-linear function of yields, it is difficult to hedge specified pools with TBA trades with different yields.

Because they are more difficult to hedge, we expect that specified pools with coupons that do not match TBA coupons are more likely to be purchased by dealers in combination with a prearranged trade to a customer than are specified pools with coupons that do match TBA coupons. When we omit prearranged interdealer trades and look only at the trades that dealers chose to handle themselves, we see that 13.36% of specified pool trades are prearranged with customers if the specified pool has a coupon that does not match TBA coupons. For the specified pools with coupons that do match TBA coupons, the proportion that is prearranged is only 4.17%. In this case, the difference between prearranged trades with dealers and prearranged trades with customers is, again, striking. Of the trades of specified pools with yields that match TBA coupons, 29.79% are prearranged with other dealers. For trades of specified pools with yields that do not match TBA coupons, only 26.47% are prearranged with other dealers. Prearranged trades with other dealers are again less common if the specified pool is difficult to hedge.

In Panel B of Table IX, we report regressions that test more formally how specified pool characteristics influence the decision to prearrange a trade with another dealer. In all regressions in this panel, the dependent variable takes the value of one when a trade is prearranged with another dealer. In each regression, standard errors are clustered by dealer. The first regression is an OLS regression of the dummy for a prearranged trade on a dummy variable that equals one when the coupon of the specified pool matches a coupon rate used for TBA trades, a dummy variable that equals one if the specified pool is TBA eligible, and the natural log of the size of the trade. Dealer fixed effects are included. The coefficient on the yield match dummy variable is 0.0442 with a t-statistic of 2.33. The coefficient on the natural logarithm of the trade size is -0.0097 with a t-statistic of -2.32. Larger trades are less likely to be prearranged with another dealer. The coefficient on TBA eligibility is 0.0172, with a t-statistic of 0.87. The insignificance may be surprising given the univariate differences in prearranged trades with other dealers for TBA eligible and ineligible SPs shown in Panel A. Much of the difference in prearranged trades with other dealers can be explained by dealer identity however, so clustering by dealer and dealer fixed effects render TBA eligibility insignificant in determining prearranged trades with dealers.

The next two rows report analogous logistic regressions. Here, z-statistics are reported in parentheses under the coefficients, and marginal effects in brackets under the z-statistics. The first logistic regression includes dealer TBA market share. Its coefficient is negative and highly significant. A dealer with a large market share is less likely to prearrange a trade with another dealer. The coefficient on the dummy for a coupon equal to a TBA coupon is positive and significant. Trade size is also negative and highly significant, indicating that dealers are less likely to prearrange large trades with other dealers. The second logistic regression drops TBA dealer share. The dummy variable for a coupon equal to a TBA coupon is now insignificant. As before, the logistic regression results indicate that dealers are less likely to prearrange a large trade with another dealer. On the whole, Panel B suggests that trades that are easy to hedge are prearranged with other dealers, but it is weak.

Panel C reports similar regressions, but now the dependent variable is a dummy variable that equals one if the trade is prearranged with a customer. In each regression, we use only trades that were not prearranged with another dealer. The decision to prearrange a trade with a customer differs from the decision to prearrange a trade with another dealer in important ways, so the results here are very different from those of Panel B.

The first regression is an OLS regression and the last two are logistic regressions. Each has standard errors clustered by dealer. The regression results for prearranged trades with customers in Panel C are very different from the regression results for prearranged trades with other dealers in Panel B. If an SP has a coupon that matches a TBA coupon, Panel B shows that the trade is more likely to be prearranged with another dealer while Panel C shows it is less likely to be prearranged with a customer. If an SP has a TBA matching coupon dealers can hedge it. They are more willing to take the SP into inventory and other dealers are also more willing to take it into inventory. If an SP is TBA eligible, Panel C shows that dealers are less likely to prearrange a trade with a customer. Dealers don’t mind taking it into inventory because it can be hedged more easily and can be delivered through a TBA trade. On the other hand, as Panel B shows, TBA eligibility seems to have little impact on determining whether a trade is prearranged with another dealer.

The results in Panel C suggest that dealers are more likely to take a specified pool into inventory if it can be hedged with a TBA trade. If it cannot be hedged, the investor who owns the specified pool may have to bear risk himself until the dealer can find a buyer. This suggests a benefit to TBA trading that is not captured by trading costs. If similar MBS trade in the TBA market, an investor doesn't need to hold an unwanted specified pool while a dealer searches for a buyer.

Our findings indicate that dealers hedge SP positions with TBA trades, and are reluctant to hold inventory that they cannot hedge. We do not, however, mean to imply that the *only* reason TBA trading improves SP liquidity is that it provides a superior hedging option. We can posit other ways in which TBA trading could contribute to specified pool liquidity. It could, for instance, provide benchmark prices for specified pools.[24] MBS trade frequently in the TBA market with low trading costs and minimal price impact. Less frequently traded specified pools can be priced off of the TBA trades. We hope to explore this in future work.

VII. Conclusions

The secondary market for agency mortgage backed securities is among the largest and most liquid securities markets in the world. In a way, this is surprising because each of the tens of thousands of MBS is a claim on the cash flows of a different set of mortgages, and is therefore unique. An important reason why this market is so liquid is the existence of TBA trading, in which MBS are traded in a forward

[24] Duffie, Dworczak, and Zhu (2014) analyze the use of benchmarks in over-the-counter markets. They demonstrate that benchmarks can lower search costs, increase trading volume, and generate more efficient trade matching between dealers and investors.

market on a cheapest-to-deliver basis. TBA trading takes thousands of thinly-traded MBS and combines them into a few thickly traded forward contracts.

We provide evidence that TBA eligibility makes SPs more liquid. SPs can be ineligible for TBA trading if they are not fully amortizing, include a prepayment penalty or have LTV ratios above 1.05. We present evidence that TBA eligibility itself, not just SP characteristics associated with eligibility, leads to greater SP liquidity. We show that trading costs in general decrease with LTV ratios, but increase abruptly when the 1.05 threshold is crossed. In addition, we use characteristics of the SPs to predict the likelihood that the SP is TBA eligible. After adjusting for the estimated probability that the SP is TBA eligible, actual eligibility decreases trading costs significantly.

We also present evidence that the existence of parallel trading in the TBA market also increases liquidity for the MBS that are traded individually in the SP market. For a given issuer and maturity, all TBA trades settle on the same day of the month. Most traders do not want to take delivery or deliver on the TBA trades they have made, and so will reverse their positions in the few days just before the settlement date. This leads to high TBA volume, particularly from dollar rolls, just prior to the settlement date. This high volume is easily predicted well in advance of the actual trading. SPs can settle any day of the month. Nevertheless, trading costs for SPs decrease significantly on days of predictable high TBA volume. Exogenous increases in TBA trading volume lower SP trading costs.

One way in which TBA trading can increase the liquidity of the SP market is by providing a way for dealers to hedge their SP inventory positions. Consistent with this, we find that when we regress dealers' daily changes in TBA inventory on the same day changes in SP inventory are consistently negative and usually between -0.5 and -1.0. Dealers offset most of their positions in SPs with TBA trades. Coefficients are smaller for TBA-ineligible SPs, indicating that a smaller proportion of these trades are hedged.

In some cases, dealers act as brokers and find a purchaser for an SP before buying it from a customer. This appears in the data as dealer purchases followed by offsetting sales within five minutes. We find that prearranged or brokered trades are most common for the SPs that are least likely to be hedged with TBA trades – that is TBA ineligible SPs, or SPs with coupons that are unmatched by TBA coupons.

Corporate and municipal bonds trade in relatively illiquid over-the-counter markets. Parallel trading in the securities themselves and a forward contract on a generic security may increase the liquidity of those markets. Specific highly-rated municipal bonds, for example, could trade in parallel with forward contracts on, say, 30-year, AA-rated, general obligation New York municipals. Our results suggest that a forward contract of this type could lower trading costs for the municipal bonds themselves by converting thin markets for multiple municipals to thick markets in a handful of forward contracts. Forward contracts would also allow dealers to hedge inventory. A forward contract on municipal bonds could also lower the risk to underwriters by allowing them to hedge while selling a bond issue. It is true that municipals, unlike corporates, have state clienteles. Separate contracts would be needed for different large states and forward markets may not be possible for small-state municipals. On the other hand, within states, highly-rated municipals are very good substitutes for each other because they are very unlikely to default.[25] The unique structure of parallel trading in SPs and the forward TBA market looks like it could enhance liquidity in other markets as well.

[25] The one year default rate for all rated municipals over 1970-2011 was 0.01%. See Moody's Investors Services (2012).

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Table I

Summary Statistics for MBS Trading in the TBA and Specified Pool Markets

The sample consists of all secondary market MBS trades from May 16, 2011 – April, 2013. Volume is in $1,000,000's of face value.

Panel A: Total Trading by Trade Type

	Number of Trades With Customers	Volume from Customer Trades	Number Interdealer Trades	Interdealer Volume
		TBA Trades		
Outright Trades	837,011	27,363,239	1,531,919	25,807,536
Dollar Rolls	287,098	33,436,663	544,153	32,525,031
Stipulated Trades	74,396	2,126,427	14,624	170,244
Stip. Dollar Rolls	26,121	1,456,637	1,711	28,310
Total TBA trading	1,224,681	64,382,977	2,092,407	58,531,121
		Specified Pool Trades		
TBA Eligible	949,378	6,281,280	472,574	1,394,371
Non-Eligible	150,299	870,925	89,625	474,355
Total Specified Pool	1,099,677	7,152,205	562,199	1,868,726

Panel B: Trade Sizes by Trade Type

	Interdealer Trades			Trades with Customers		
	Number	Avg. Size ($millions)	% > $10 million	Number	Avg. Size ($millions)	% > $10 million
Specified Pools	562,067	$3.32	6.7%	1,099,260	$6.49	10.7%
TBA Outright	1,531,919	$16.71	37.1%	837,011	$32.64	37.2%
TBA Dollar Roll	544,153	$59.64	60.8%	287,158	$116.43	68.1%
TBA Stipulated	14,624	$11.64	12.0%	74,396	$28.58	36.4%
TBA Stip. Rolls	1,711	$16.55	32.0%	26,121	$55.77	66.1%

Panel C: Dealer Activity Levels and Trade Type

Dealer Rank by Number of Trades	%of Trades that are Specified Pools	% of Volume from Specified Pools	% of Trades that are Interdealer	% of All Trades	% of All Volume
1-10	23.83%	13.55%	56.37%	54.9%	64.6%
11-30	42.86%	26.16%	55.09%	27.3%	29.3%
31-50	56.44%	42.08%	53.73%	8.9%	4.2%
51-100	75.35%	63.29%	51.37%	6.5%	1.5%
101-758	91.36%	87.82%	44.73%	2.3%	0.4%

Table II

Estimates of Trading Costs from Regressions of Price Changes on Changes in Trade Type and Other Variables

We regress percentage changes in price between two consecutive trades of the same MBS on the change in trade type (ΔQ), on the interaction between ΔQ and the sum of the natural logs of the trade sizes of the two consecutive trades, on the interaction between ΔQ and a dummy variable for TBA eligible specified pools, on the interaction between ΔQ, trade size and TBA eligibility, on the interaction between ΔQ and the number of MBS with the same coupon and maturity created in the previous month, on the interaction between ΔQ and the outstanding balance of MBS with the same coupon and maturity created in the previous month, and on changes in the 1) a U.S. Agency Fixed Rate MBS index, 2) a U.S. Treasury 7-10 year Bond index, 3) a U.S. Investment Grade Corporate Bond Index, 4) a U.S. Corporate High-Yield Bond Index, and 5) the S&P 500 index:

$$\Delta P_t = \alpha_0 + \alpha_1 \Delta Q_t + \alpha_2 \Delta Q_t \cdot \left(ln\left({Size_t}/{1{,}000{,}000} \right) + ln\left({Size_{t-1}}/{1{,}000{,}000} \right) \right) + \alpha_3 \Delta Q_t \cdot TBA\ Eligible + \alpha_4 \Delta Q_t \cdot TBA\ Eligible \cdot \left(ln\left({Size_t}/{1{,}000{,}000} \right) + ln\left({Size_{t-1}}/{1{,}000{,}000} \right) \right) + \alpha_5 \Delta Q_t \cdot 30\ (15) YearMat + \alpha_6 \Delta Q_t\ 30\ (15) YearMat \cdot (\ln Size_t + lnSize_{t-1}) + \alpha_7 \Delta Q_t \cdot \text{MBS Production} + \alpha_8 \Delta Q_t \cdot \text{MBS Balance} + \Sigma \beta_i\ Ret_{i,t} + \varepsilon_t. \quad (1)$$

ΔQ is positive one when the current trade is a dealer sale and the previous trade was a dealer purchase. It is negative one when the current trade is a dealer purchase and the previous trade was a dealer sale. Consecutive trades are always of the same MBS, but trades from all MBS with the same coupon and maturity are included in the regressions. Trades of less than $10,000 face value are deleted. Robust t-statistics are in parentheses.

Panel A: TBA Trades

Maturity	ΔQ	ΔQ x Trade Size	ΔQ x Production	ΔQ x Balance	Return Variables	Obs.	R^2
30 Years	0.0357	-0.0056			Yes	651,234	0.0473
	(25.47)	(-23.33)					
30 Years	0.0377	-0.0055	0.0003	-0.0199	Yes	650,643	0.0504
	(25.55)	(-22.97)	(0.82)	(-23.71)			
15 Years	0.0313	-0.0052			Yes	144,531	0.0991
	(11.29)	(-10.75)					
15 Years	0.0140	-0.0058	0.0089	-0.0145	Yes	144,531	0.1003
	(3.59)	(-11.91)	(6.55)	(-8.99)			

Panel B: Specified Pools										
				ΔQ ×						
Maturity	1	Trade Size	TBA Eligible	TBA Elg x Size	30/15 Year Mat.	Gross Production	Balance	Return Variables	Obs.	R^2
30	0.6324	-0.0548	-0.3957					Yes	134,119	0.4594
Years	(46.05)	(-51.23)	(-28.53)							
30	0.7877	-0.1351	-0.5672	0.0890				Yes	134,119	0.4637
Years	(47.51)	(-34.30)	(-32.71)	(21.77)						
30	0.7668	-0.1324	-0.5316	0.0864		-0.0052	-0.0203	Yes	133,426	0.4641
Years	(41.57)	(-32.14)	(-26.52)	(20.23)		(-1.93)	(-5.92)			
16-30	1.0953	-0.1793	-0.4199	0.0513	-0.3034	-0.0743	-0.0318	Yes	443,346	0.1713
Yrs	(89.34)	(-52.55)	(-32.19)	(14.05)	(-40.28)	(-37.94)	(-10.21)			
15	0.6193	-0.0415	-0.3212					Yes	49,063	0.4379
Years	(14.60)	(-24.53)	(-7.55)							
15	0.7605	-0.1514	-0.4652	0.1117				Yes	49,063	0.4392
Years	(13.65)	(-7.65)	(-8.28)	(5.63)						
15	0.7688	-0.1493	-0.4682	0.1110		-0.0196	0.0111	Yes	49,063	0.4396
Years	(13.68)	(-7.50)	(-8.30)	(5.57)		(-4.53)	(1.56)			
0-15	1.0351	-0.0978	-0.6530	0.0609	-0.1354	-0.0185	-0.0064	Yes	92,973	0.2612
Yrs.	(21.40)	(-5.65)	(-13.39)	(3.50)	(-14.86)	(-4.91)	(-0.78)			

Table III

Regression Discontinuity Estimates Around Loan-to-Value Ratios

30 (15) year specified pools with mean LTV ratios within a certain range, we estimate the following regression using consecutive trades

$$\Delta P_t = \alpha_0 + \alpha_1 \Delta Q_t + \alpha_2 \Delta Q_t \cdot \left[\ln\left(\frac{Size_t}{1{,}000{,}000}\right) + \ln\left(\frac{Size_{t-1}}{1{,}000{,}000}\right) \right] + \alpha_3 \Delta Q_t \cdot LTV + \alpha_4 \Delta Q_t \cdot D_{LTV>x} + \alpha_6 \Delta Q_t \cdot FICO + \Sigma \beta_i \, Ret_{i,t} + \varepsilon_t \quad (3).$$

ΔP is the percentage change in the specified pool, ΔQ is 1 (-1) for a dealer purchase (sale) followed by a sale (purchase), LTV is the loan to value ratio. D is a dummy that equals 1 if LTV ratios are above a specific level. LTV ratio greater than 1.05 cannot be included in TBA eligible SPs.

	ΔQ	ΔQ x ln Trade Size	ΔQ x LTV > D	ΔQ x LTV	ΔQ x FICO Score x e^6	Index Returns	Obs.	R^2
30 Year, D = 1.05	2.8020	-0.0339	0.4505	-0.0290	0.7090	Yes	5,450	0.0766
0.95 < LTV < 1.15	(3.65)	(-4.05)	(3.87)	(-4.04)	(0.17)			
30 Year, D = 1.05	2.0773	-0.0811	0.1666	-0.0189	1.4500	Yes	33,838	0.0609
0.85 < LTV < 1.25	(6.76)	(-25.73)	(2.49)	(-7.11)	(0.56)			
30 Year, D = 0.95	-1.5246	-0.0831	-0.4531	0.0174	5.6700	Yes	31,818	0.0665
0.85< LTV < 1.05	(-3.51)	(-25.94)	(-10.97)	(4.48)	(2.06)			
30 Year, D = 1.15	-1.4043	-0.0641	-0.1254	0.0152	-2.2500	Yes	2,106	0.1157
1.05< LTV < 1.25	(-0.40)	(-4.71)	(-1.28)	(0.53)	(-0.14)			
15 Year, D=1.05	4.4364	-0.1992	0.3259	-0.0202	-0.0027	Yes	275	0.3274
0.95< LTV < 1.15	(1.80)	(-3.15)	(1.51)	(-1.64)	(-1.08)			
15 Year, D=1.05	3.3310	-0.1151	0.3011	-0.0176	-0.0018	Yes	1,328	0.1405
0.85< LTV < 1.25	(3.61)	(-6.03)	(2.10)	(-3.49)	(-1.39)			
15 Year, D=0.95	3.5180	-0.1230	-0.0669	-0.0163	-21.8000	Yes	1,034	0.1540
0.85< LTV < 1.05	(2.98)	(-6.21)	(-0.53)	(-1.79)	(-1.61)			
15 Year, D = 1.15	-7.7204	-0.0071	-0.1553	0.0831	-0.0022	Yes	294	0.0786
1.05 < LTV < 1.25	(-1.08)	(-0.16)	(-0.51)	(1.18)	(-0.53)			

Table IV

Logistic Regression Estimates of TBA Eligibility on Specified Pool Characteristics

Panel A. Specified pools with 16-30 years to maturity. If one of these pools is TBA eligible, it can be traded as a 30-year TBA.

	Coefficient	Z-Statistic	dy/dx	Z-Statistic
Average FICO Score	0.0122	52.77	0.00037	42.86
Maximum Loan Size	$-1.92e^{-6}$	-68.37	$-5.77e^{-8}$	-60.60
Minimum Loan Size	$-1.54e^{-5}$	-174.18	$-4.61e^{-7}$	-81.98
Percent Owner Occupied	2.9463	86.32	0.08837	65.24
Percent Refinanced	-0.2278	-4.15	-0.00683	-4.25
Percent Single Family	-1.3409	-14.24	-0.04022	-13.83
LTV	0.0034	2.26	0.00010	2.23
LTV > 1.05	-12.5178	-17.43	-0.97320	-2762.12
Constant	-3.8932	-16.19		
Observations	401,346			
Pseudo R^2	0.4247			

Panel B. Specified pools with 15 years to maturity or less. If one of these pools is TBA eligible, it can be traded as a 15-year TBA.

	Coefficient	Z-Statistic	dy/dx	Z-Statistic
Average FICO Score	0.0189	8.80	$1.13e^{-5}$	7.26
Maximum Loan Size	$5.81e^{-8}$	0.19	$3.48e^{-11}$	0.19
Minimum Loan Size [3]	$-2.62e^{-5}$	-57.57	$-1.57e^{-8}$	-11.39
Percent Owner Occupied	4.8898	19.65	0.00598	11.66
Percent Refinanced	9.9795	47.28	-0.00527	-4.36
Percent Single Family	-8.7973	-4.59	0.00293	9.48
LTV	0.0648	7.74	$3.89e^{-5}$	6.08
LTV > 1.05	-32.9982	-41.17	-0.9995	-9999.99
Constant	-13.5466	-6.18		
Observations	91,954			
Pseudo R^2	0.8336			

Table V

Propensity Score Matching and the Impact of TBA Eligibility on Trading Costs

The probability that a specified pool is TBA eligible is estimated using a logistic regression with TBA eligibility as the dependent variable and the specified pool's average FICO score, maximum loan size, minimum loan size, percent owner occupied, percent refinanced, and percent single family used as explanatory variables. Using the estimated probability of TBA eligibility, we estimated trading costs using all maturity-coupon combinations and the following regression

$$\Delta P_t = \alpha_0 + \alpha_1 \Delta Q_t + \alpha_2 \Delta Q_t \cdot \left(ln\left({}^{Size_t}/_{1,000,000} \right) + ln\left({}^{Size_{t-1}}/_{1,000,000} \right) \right) + \alpha_3 \Delta Q_t \cdot TBA\ Eligible + \alpha_4 \Delta Q_t \cdot Probability\ TBA\ Eligible + \Sigma\beta_i\ Ret_{i,t} + \varepsilon_t. \quad (4)$$

ΔP is the percentage change in the specified pool price over consecutive trades, ΔQ is 1 (-1) for a dealer purchase (sale) followed by a sale (purchase), TBA Eligible is a dummy variable that takes a value of one for TBA eligible specified pools and TBA Ineligible is a dummy variable that takes a value of one if the SP is TBA ineligible. The regression is run separately for SPs with estimated probabilities of TBA eligibility of 0.0 to 0.1, 0.1 to 0.2, etc.

Panel A. Specified pools with 16-30 years to maturity. If one of these pools is TBA eligible, it can be traded as a 30-year TBA.

	ΔQ	ΔQ x ln Trade Size	ΔQ x TBA Eligible	ΔQ x Prob TBA Elg	Index Returns	No. TBA Eligible	No. TBA Ineligible	R^2
0.0 ≤ Prob < 0.1	0.6375	-0.1338	-0.1519	0.1593	Yes	76	9,554	0.4570
	(19.02)	(-21.74)	(-0.29)	(9.54)				
0.1 ≤ Prob < 0.2	1.6725	-0.1693	-0.7734	-3.7399	Yes	63	1,301	0.3988
	(5.45)	(-12.64)	(-3.54)	(-2.05)				
0.2 ≤ Prob < 0.3	-0.0116	-0.1504	-0.2241	4.3761	Yes	102	1,925	0.3524
	(-0.03)	(-12.83)	(-0.85)	(2.70)				
0.3 ≤ Prob < 0.4	1.1993	-0.1481	-0.6930	-0.4099	Yes	225	1,318	0.3425
	(2.29)	(-9.26)	(-5.66)	(-0.27)				
0.4 ≤ Prob < 0.5	3.0517	-0.1985	-0.6122	-3.5449	Yes	730	709	0.2924
	(1.89)	(-8.23)	(-3.11)	(-1.02)				
0.5 ≤ Prob < 0.6	2.0192	-0.1933	-0.3827	-1.6049	Yes	1,428	509	0.3984
	(1.88)	(-13.96)	(-3.03)	(-0.83)				
0.6 ≤ Prob < 0.7	4.6466	-0.1863	-0.3510	-5.2814	Yes	2,947	1,945	0.2871
	(4.96)	(-16.89)	(-3.95)	(-3.73)				
0.7 ≤ Prob < 0.8	1.3558	-0.1626	-0.2831	-0.5358	Yes	10,176	4,676	0.2449
	(2.87)	(-29.23)	(-7.91)	(-0.86)				
0.8 ≤ Prob < 0.9	-1.2663	-0.1837	-0.0411	2.6198	Yes	42,708	6,496	0.2982
	(-3.19)	(-74.13)	(-1.61)	(5.58)				
0.9 ≤ Prob < 1.0	8.7195	-0.0997	-0.9167	-7.5077	Yes	308,646	5,812	0.1199
	(30.30)	(-58.21)	(-28.22)	(-25.56)				
0.0 ≤ Prob < 1.0	1.1177	-0.1295	-0.4078	-0.1740	Yes	367,101	34,245	0.1441
	(62.24)	(-95.50)	(-21.83)	(-6.17)				

Panel B. Specified pools with 15 years or less to maturity. If one of these pools is TBA eligible, it can be traded as a 15-year TBA.

	ΔQ	ΔQ x ln Trade Size	ΔQ x TBA Eligible	ΔQ x Prob TBA Elg	Index Returns	No. TBA Eligible	No. TBA Ineligible	R^2
0.0 ≤ Prob < 0.1	1.1680	-0.0929	-1.3043	4.6866	Yes	68	784	0.2373
	(10.55)	(-3.71)	(-4.97)	(1.28)				
0.1 ≤ Prob < 0.2	0.3730	-0.1330	-1.0489	4.3155	Yes	59	175	0.2536
	(0.54)	(-1.08)	(-2.37)	(0.72)				
0.2 ≤ Prob < 0.3	1.0483	-0.0937	-1.1062	-0.3578	Yes	77	197	0.4028
	(1.25)	(-2.90)	(-4.31)	(-0.11)				
0.3 ≤ Prob < 0.4	1.1915	-0.0758	-0.5587	-1.6102	Yes	83	365	0.2079
	(1.37)	(-2.41)	(-4.24)	(-0.63)				
0.4 ≤ Prob < 0.5	4.1117	-0.0034	-0.3382	-8.3389	Yes	84	155	0.2831
	(2.48)	(-0.11)	(-2.43)	(-2.09)				
0.5 ≤ Prob < 0.6	4.9902	0.0079	-1.0707	-7.6779	Yes	23	88	0.5379
	(1.35)	(0.19)	(-4.00)	(-1.12)				
0.6 ≤ Prob < 0.7	4.3284	0.0288	-2.1788	-3.5208	Yes	51	3	0.8302
	(1.53)	(1.20)	(-15.17)	(-0.77)				
0.7 ≤ Prob < 0.8	1.8248	-0.0617	-0.6126	-0.9462	Yes	47	56	0.6562
	(0.61)	(-0.95)	(-2.07)	(-0.23)				
0.8 ≤ Prob < 0.9	3.3528	-0.0454	-1.8620	-1.4075	Yes	194	2	0.3857
	(1.33)	(-1.92)	(-21.53)	(-0.49)				
0.9 ≤ Prob < 1.0	1.2844	-0.0390	-0.9058	-0.0559	Yes	88,673	770	0.2838
	(1.92)	(-26.76)	(-3.85)	(-0.08)				
0.0 ≤ Prob < 1.0	1.061	-0.0399	-0.6649	-0.0765	Yes	89,359	2,595	0.2754
	(17.83)	(-27.23)	(-7.27)	(-0.65)				

Table VI

Trading Costs and Predicted Exogenous Dollar Roll Volume

Dollar roll volume predictions are obtained from the previous month's volume around the settlement date. For days from two to seven days before settlement date, we use the volume from dollar rolls with the same coupon and maturity from the same day relative to the settlement in the previous month as a prediction of current month volume. For other days, we use the average daily volume from 20-40 days before, not including days from two to seven days before the settlement date. To estimate trading costs, we then estimate the following regression using including predicted dollar roll volume:

$$\Delta P_t = \alpha_0 + \alpha_1 \Delta Q_t + \alpha_2 \Delta Q_t \cdot \left(\ln(\frac{Size_t}{1{,}000{,}000}) + \ln(\frac{Size_{t-1}}{1{,}000{,}000})\right) + \alpha_3 \Delta Q_t \cdot \left(\ln(\frac{PredDRoll_t}{MedianDRoll}) + \ln(\frac{PredDRoll_{t-1}}{MedianDRoll})\right)$$
$$+\alpha_4 \Delta Q_t \cdot \left(\ln\left(\frac{PredDRoll_t}{MedianDRoll}\right) + \ln\left(\frac{PredDRoll_{t-1}}{MedianDRoll}\right)\right) \cdot \left(\ln\left(\frac{Size_t}{1{,}000{,}000}\right) + \ln\left(\frac{Size_{t-1}}{1{,}000{,}000}\right)\right) + \alpha_5 \Delta Q_t D_{30yr/15yr} +$$
$$\Sigma \beta_i \, Ret_{i,t} + \varepsilon_t. \quad (5)$$

Type of MBS	ΔQ	ΔQ x Ln Trade Size	ΔQ x Pred. D. Roll Vol.	ΔQ x Size x Pred. D. Roll Vol.	ΔQ x 30/15 yr Mat.	Obs.	R^2
30 yr. TBA	0.0285	-0.0051	-0.0079			614,805	0.0359
	(20.54)	(-21.10)	(-17.52)				
16-30 yr.	0.4936	-0.0936	-0.0431		-0.2643	331,533	0.1623
TBA Eligible	(60.61)	(-89.52)	(-19.13)		(-29.88)		
16-30 yr.	0.4915	-0.0680	-0.0334	0.0115	-0.3161	331,533	0.1650
TBA Eligible	(60.00)	(-57.62)	(-16.32)	(25.72)	(-37.02)		
16-30 Yr.	1.1104	-0.1781	-0.0570		-0.2476	25,511	0.4045
TBA Inelg.	(39.34)	(-51.93)	(-6.33)		(-6.72)		
16-30 Yr.	1.1236	-0.1602	-0.0433	0.0112	-0.3093	25,511	0.4066
TBA Inelg.	(40.61)	(-46.64)	(-5.30)	(6.20)	(-8.68)		
15 Yr. TBA	0.0278	-0.0050	-0.0071			137,666	0.0730
	(9.80)	(-9.99)	(-8.68)				
≤15 Yr. TBA	0.2875	-0.0351	-0.0240		-0.0216	78,626	0.3145
Eligible	(24.12)	(-24.43)	(-10.82)		(-1.84)		
≤15 Yr. TBA	0.2909	-0.0372	-0.0231	-0.0010	-0.0209	78,626	0.3145
Eligible	(23.44)	(-22.54)	(-9.34)	(-1.73)	(-1.79)		
≤15 Yr. TBA	0.9703	-0.1503	0.0117		-0.2356	1,941	0.3334
Ineligible	(7.48)	(-9.64)	(0.65)		(-1.68)		
≤15 Yr .TBA	0.9852	-0.1548	0.0134	-0.0032	-0.2435	1,941	0.3336
Ineligible	(7.35)	(-9.10)	(0.74)	(-0.83)	(-1.72)		

Table VII

The Impact of Daily Changes in Specified Pool Inventory on Same Day changes in TBA Inventory of MBS with the Same Coupon and Maturity

For each dealer i and maturity-coupon combination c, day t changes in TBA inventory are regressed on same day changes in TBA eligible specified pools and TBA Ineligible specified pools. That is

$$\Delta\, TBA\ \ Inv_{i,c,t} = \ \ \alpha_{1i} + \alpha_{2i}\Delta TBAElig.Spec.Pool\ Inv_{i,c,t}\ + \alpha_{3i}\Delta TBAInelig.Spec.Pool\ Inv_{i,c,t} +\ \varepsilon_{i,t}\quad (5).$$

Days are only included in the regression if there was a change in TBA eligible or TBA ineligible specified pools. Specified pool maturities of 16-30 (≤ 15) years are eligible for inclusion in 30 (15) year TBAs and are thus included in the regressions with 30 (15) year TBA inventory changes as the dependent variable. Medians and percentiles are of the distribution of individual dealer coefficients. The average α estimate across N dealers is a weighted average where weights are determined by the sample variance of the dealer coefficient (s_i^2) and the sample variance of the maximum likelihood estimate of the average coefficient ($\tilde{\sigma}^2_{m.l.e.}$). That is

$$\tilde{\alpha} = \frac{\sum_{i=1}^{N} \frac{\tilde{\alpha}_i}{\left(s_i^2 + \tilde{\sigma}^2_{m.l.e.}\right)}}{\sum_{i=1}^{N} \frac{1}{\left(s_i^2 + \tilde{\sigma}^2_{m.l.e.}\right)}}$$

With independence across dealers, the variance of the aggregate estimate is

$$Var\ (\widetilde{\alpha}) = \frac{1}{\sum_{i=1}^{N} \frac{1}{\left(s_i^2 + \tilde{\sigma}^2_{m.l.e.}\right)}}$$

Table VII (continued)

	Δ TBA Eligible SP Inventory (α_2) Coefficients						Δ TBA Ineligible SP Inventory (α_3) Coefficients					
	# Dlrs.	Weighted Median	Mean	t-statistic	25%	75%	# Dlrs.	Weighted Median	Mean	t-statistic	25%	75%
						30 Years to Maturity						
2.5%	35	-0.4001	-0.4985	-2.14	-0.8383	-0.1545	36	-0.0215	-0.0785	-0.28	-0.0627	0.0046
3.0%	65	-0.9131	-0.6454	-3.99	-0.9801	-0.3609	62	-0.3980	-0.3597	-3.11	-0.8530	-0.0028
3.5%	82	-0.8776	-0.7085	-19.87	-0.9664	-0.4615	76	-0.6484	-0.3978	-4.53	-0.8700	0.0041
4.0%	88	-0.7997	-0.5466	-4.58	-0.8912	-0.1528	76	-0.5698	-0.2929	-2.51	-0.7412	-0.0032
4.5%	86	-0.6404	-0.4440	-5.37	-0.7279	-0.1495	73	-0.5178	-0.3610	-3.49	-0.8157	0.0092
5.0%	76	-0.3027	-0.2594	-1.69	-0.3583	-0.0851	66	-0.1643	-0.2351	-3.25	-0.5270	0.0253
5.5%	65	-0.1899	-0.2122	-1.65	-0.2528	-0.0631	56	-0.0104	-0.0895	-0.86	-0.1702	0.0194
6.0%	60	-0.1130	-0.1620	-0.70	-0.2300	-0.0238	44	-0.0046	-0.0777	-0.35	-0.1211	0.0196
						15 Years to Maturity						
2.5%	59	-0.9220	-0.7012	-5.81	-0.9500	-0.3916	33	-1.1087	-0.7076	-3.41	-1.3355	-0.1998
3.0%	71	-0.6709	-0.4844	-2.71	-0.7073	-0.2280	54	-0.8203	-0.3489	-2.40	-0.9109	0.0109
3.5%	78	-0.5667	-0.4328	-3.51	-0.7680	-0.2242	47	-0.3030	NA	NA	-1.0845	0.0249
4.0%	73	-0.4423	-0.3869	-2.96	-0.5903	-0.1468	52	-0.2548	-0.1751	-1.50	-0.6566	0.0660

Table VIII

Regressions of Returns of Dealer Positions in Specified Pools on Returns of Potential Hedging Instruments

We identify a dealer position as a purchase by a dealer from a customer followed by a sale of the same par value of the same specified pool from a dealer to a customer. We also include positions that are initiated with a sale and closed by a purchase. For each position that is held for at least one day, we estimate the following regression: $\Delta P_i = \alpha_0 + \alpha_1 \Delta Q_i + \alpha_2 \Delta Q_i \cdot \ln(\frac{Size_i}{1{,}000{,}000}) + \beta_i \, Ret_{i,j}^{Hedge} + \varepsilon_i$

where ΔP_i is the percentage price change in the specified pool position i, ΔQ_i takes a value of one if i was a long position and negative one if it was a short position. Separate regressions include holding period returns of four potential hedges: TBA trades with the same maturity and coupon, five-year treasury notes, seven year treasury notes, and ten-year treasury notes. Adjusted R^2s from the regressions and coefficients on the hedging variables are reported in the table.

Panel A. Positions of specified pools with 16 to 30 years to maturity.

	Obs.	No Hedge	TBA Hedge		5 Year Treasury		7 Year Treasury		10 Year Treasury	
Holding Period		Adj. R^2	Adj. R^2	Coef.	Adj. R^2	Coef.	Adj. R^2	Coef.	Adj. R^2	Coef.
				TBA Eligible						
≤ 5 Days	15,833	0.1710	0.1716	0.1987	0.1717	0.2408	0.1717	0.1366	0.1714	0.0826
				(3.56)		(3.68)		(3.70)		(2.91)
6-20 Days	14,857	0.1895	0.2092	0.5916	0.1957	0.3402	0.1957	0.1995	0.1965	0.1567
				(19.27)		(10.71)		(10.71)		(11.38)
21-60 Days	16,992	0.1420	0.2126	0.7661	0.1731	0.4382	0.1754	0.2643	0.1724	0.1818
				(39.05)		(25.30)		(26.26)		(25.01)
> 60 Days	29,665	0.0423	0.2815	0.8702	0.0928	0.2913	0.1010	0.1912	0.1010	0.1431
				(99.39)		(40.65)		(44.03)		(44.03)
				TBA Ineligible						
≤ 5 Days	1,983	0.3160	0.3156	0.0098	0.3159	0.1010	0.3157	0.0226	0.3157	0.0207
				(0.17)		(0.85)		(0.34)		(0.40)
6-20 Days	1,513	0.4487	0.4584	0.2638	0.4584	0.3255	0.4577	0.1790	0.4579	0.1327
				(5.28)		(5.29)		(5.10)		(5.16)
21-60 Days	1,479	0.4354	0.4840	0.5081	0.4805	0.5403	0.4800	0.3116	0.4782	0.2261
				(11.83)		(11.37)		(11.30)		(11.05)
60 Days	2,239	0.2633	0.4656	0.5951	0.4266	0.5476	0.4203	0.3302	0.4105	0.2383
				(29.12)		(25.26)		(24.63)		(23.66)

Panel B. Positions of specified pools with 15 or fewer years to maturity.

	Obs.	No Hedge	TBA Hedge		5 Year Treasury		7 Year Treasury		10 Year Treasury	
Holding Period		Adj. R^2	Adj. R^2	Coef.	Adj. R^2	Coef.	Adj. R^2	Coef.	Adj. R^2	Coef.
TBA Eligible										
≤ 5 Days	2,578	0.1713	0.2041	0.2944	0.1796	0.2066	0.1798	0.1184	0.1794	0.0887
				(10.35)		(5.21)		(5.28)		(5.16)
6-20 Days	2,727	0.1415	0.4133	0.6069	0.2595	0.4033	0.2560	0.2320	0.2507	0.1714
				(35.54)		(20.86)		(20.50)		(19.96)
21-60 Days	2,983	0.0410	0.4419	0.6196	0.2544	0.3439	0.2521	0.2003	0.2297	0.1395
				(46.28)		(29.22)		(29.02)		(27.03)
> 60 Days	9,911	0.0159	0.4389	0.6803	0.2180	0.2723	0.2384	0.1756	0.2268	0.1280
				(86.44)		(50.61)		(53.82)		(51.99)
≤ 5 Days	213	0.0364	0.0381	0.4713	0.0402	-0.7537	0.0630	-0.8182	0.0403	-0.3471
				(1.17)		(-1.36)		(-2.64)		(-1.36)
TBA Ineligible										
6-20 Days	93	0.0260	0.0174	-0.3081	0.0154	-0.1007	0.0151	-0.0193	0.0153	0.0306
				(-0.46)		(-0.19)		(-0.06)		(0.14)
21-60 Days	91	0.2118	0.3547	0.6787	0.2507	0.3204	0.2386	0.1573	0.2317	0.1030
				(4.53)		(2.36)		(2.02)		(1.81)
> 60 Days	150	0.0287	0.0465	0.2559	0.0390	0.1249	0.0393	0.0774	0.0328	0.0458
				(1.93)		(1.60)		(1.62)		(1.27)

Table IX
Prearranged Trades

Observations include all purchases of specified pools by a dealer from a customer. The purchase is prearranged with a customer (other dealer) if the purchasing dealer sells the same par value of the specified pool to a customer (other dealer) within five minutes of the purchase. The specified pool has a matching TBA if it has a maturity of 15 years and a coupon of 2.5%, 3.0%, 3.5%, or 4%, or if it has a maturity of 30 years and a coupon of 2.5%, 3.0%, 3.5%, 4%, 4.5%, 5.0%, 5.5%, or 6.0%. The specified pool's yield matches TBA yields if it is 2.5%, 3.0%, 3.5%, 4%, 4.5%, 5.0%, 5.5%, or 6.0%. In the regressions in Panel B the dependent variable equals one if the trade is a prearranged trade with another dealer. In Panel C the dependent variable equals one if the trade is a prearranged trade with a customer. In all regressions, standard errors are clustered by dealer. T-statistics are shown in parentheses for OLS regressions, z-statistics for logistic regressions. For logistic regressions, marginal effects are in brackets.

Panel A: The Proportion of Specified Pool Trades that are Prearranged

	All Observations			Prearranged Interdealer Trades Omitted	
	Number Trades	Prearranged with Other Dealer	Prearranged with Customer	Number Trades	Prearranged with Customer
All	699,263	29.28%	3.99%	494,513	5.65%
Trade Size ≤ Median	350,087	49.54%	3.90%	176,646	7.73%
Trade Size > Median	349,176	8.97%	4.09%	317,867	4.49%
TBA Eligible	657,974	29.94%	3.56%	460,993	5.08%
TBA Ineligible	41,289	18.82%	10.88%	33,520	13.41%
Matching TBA	118,340	14.08%	3.14%	101,674	3.65%
No Matching TBA	580,923	32.38%	4.17%	392,839	6.16%
Coupon = TBA	591,296	29.79%	2.93%	415,128	4.17%
Coupon ≠ TBA	107,967	26.47%	9.83%	79,385	13.36%

Table IX - *Continued*

Panel B: Determinants of Prearranged Trades with Other Dealers								
Regress Type	Dealer FE	Intercept	Coupon = TBA Coup.	Dealer TBA Share	TBA Eligible	Log Trade Size	Obs.	R^2
OLS	Yes	0.2976	0.0442		0.0172	-0.0097	698,770	0.734
		(14.01)	(2.33)		(0.87)	(-2.32)		
Logistic	No	1.1993	0.4812	-50.6842	0.2823	-0.3951	698,770	0.403
		(2.41)	(2.75)	(-4.45)	(0.95)	(-5.24)		
			[0.0373]	[-4.2891]	[0.0216]	[-0.0334]		
Logistic	No	1.6766	0.0507		-0.0979	-0.5225	698,770	0.235
		(3.16)	(0.26)		(-0.34)	(-6.21)		
			[0.0087]		[-0.0173]	[-0.0904]		

Panel C: Determinants of Prearranged Trades with Customers.								
Regress Type	Dealer FE	Intercept	Coupon = TBA Coup.	Dealer TBA Share	TBA Eligible	Log Trade Size	Obs.	R^2
OLS	Yes	0.1095	-0.0332		-0.0478	0.0025	494,066	0.265
		(5.88)	(-3.02)		(-3.66)	(1.93)		
Logistic	No	-1.0440	-0.7310	-23.4561	-0.6871	0.0039	494,066	0.132
		(-2.43)	(-4.60)	(-5.06)	(-3.68)	(0.07)		
			[-0.0264]	[-0.7085]	[-0.0277]	[0.0001]		
Logistic	No	-0.8375	-1.1140		-0.9039	-0.0783	494,066	0.058
		(-1.92)	(-6.64)		(-5.17)	(-1.50)		
			[-0.0658]		[-0.0588]	[-0.0035]		

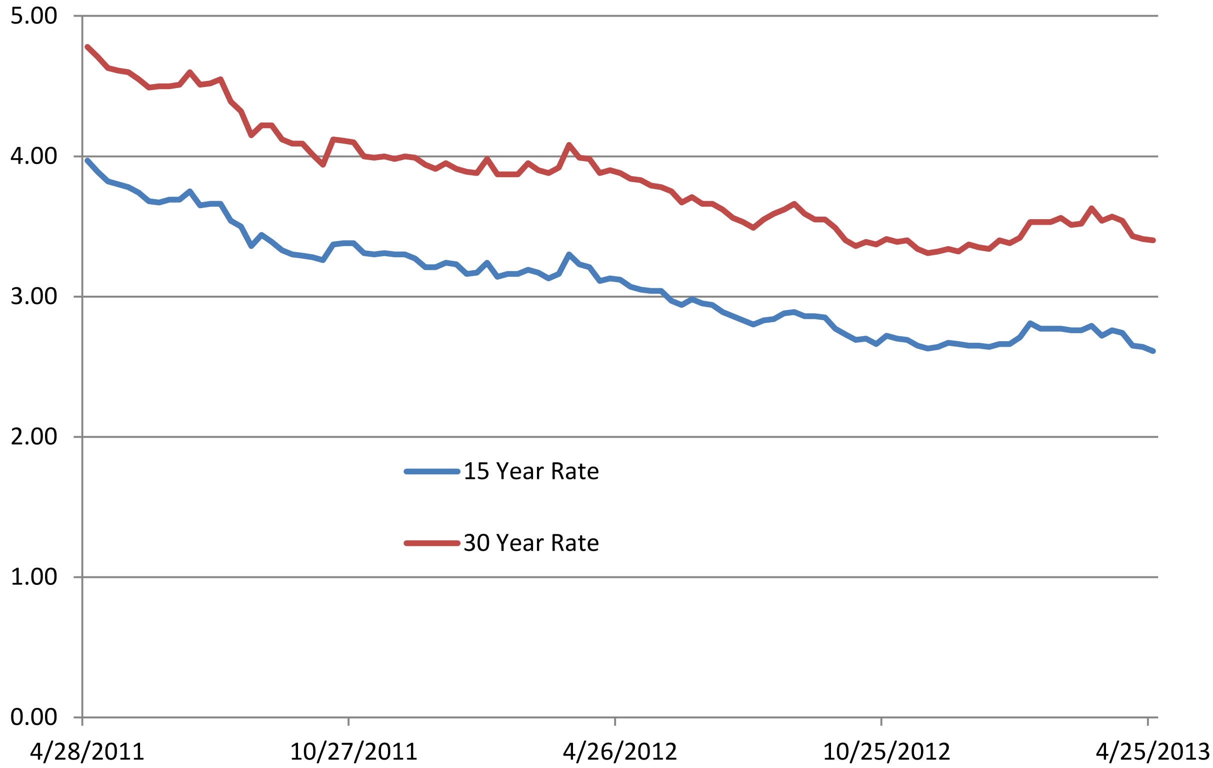
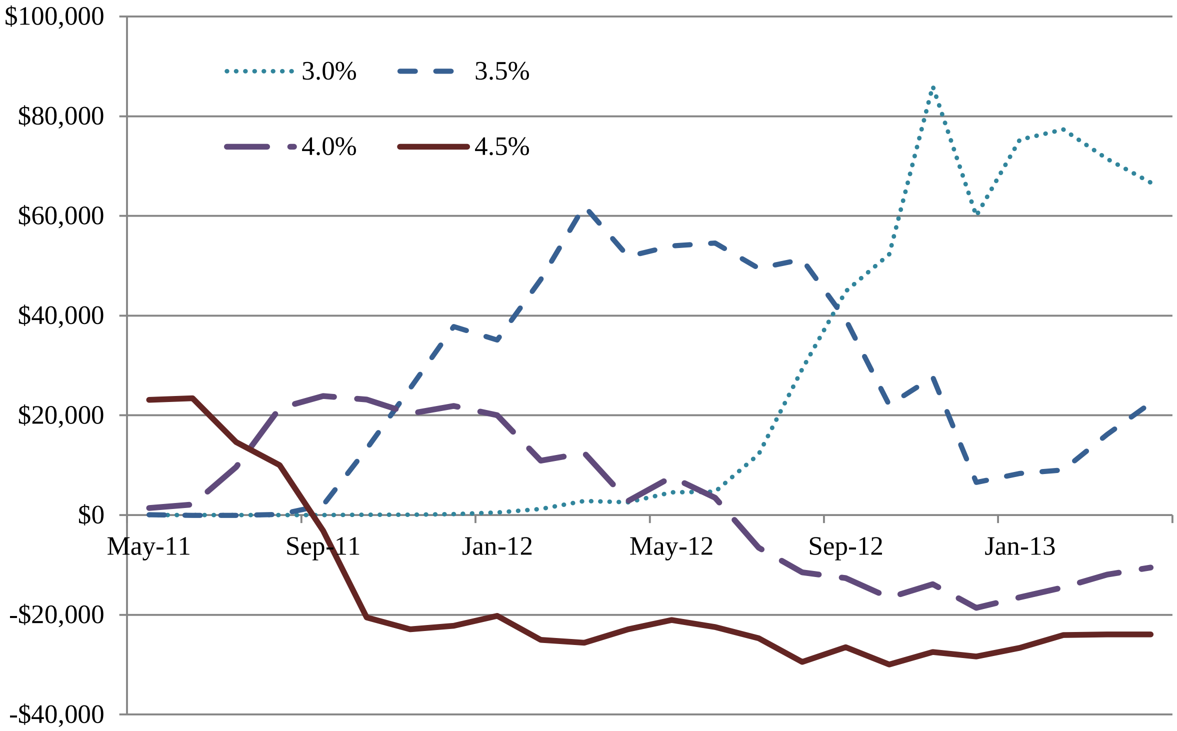
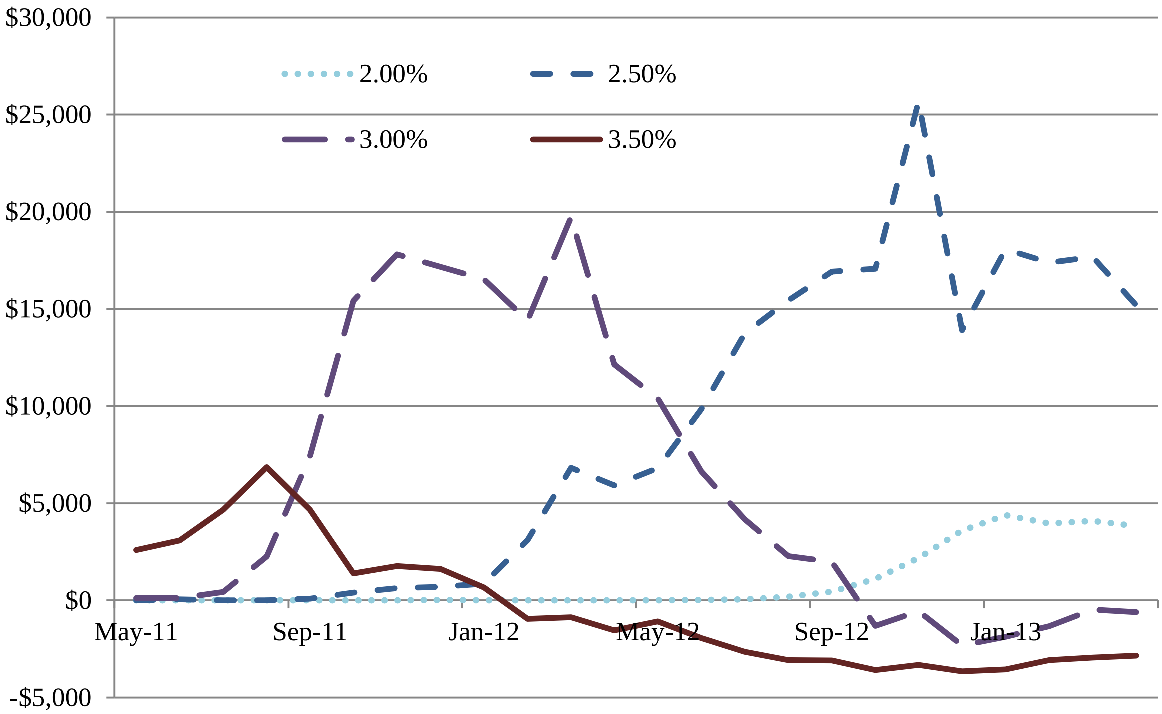


Figure 1. Weekly 15 and 30 year mortgage rates. Source: Freddie Mac.

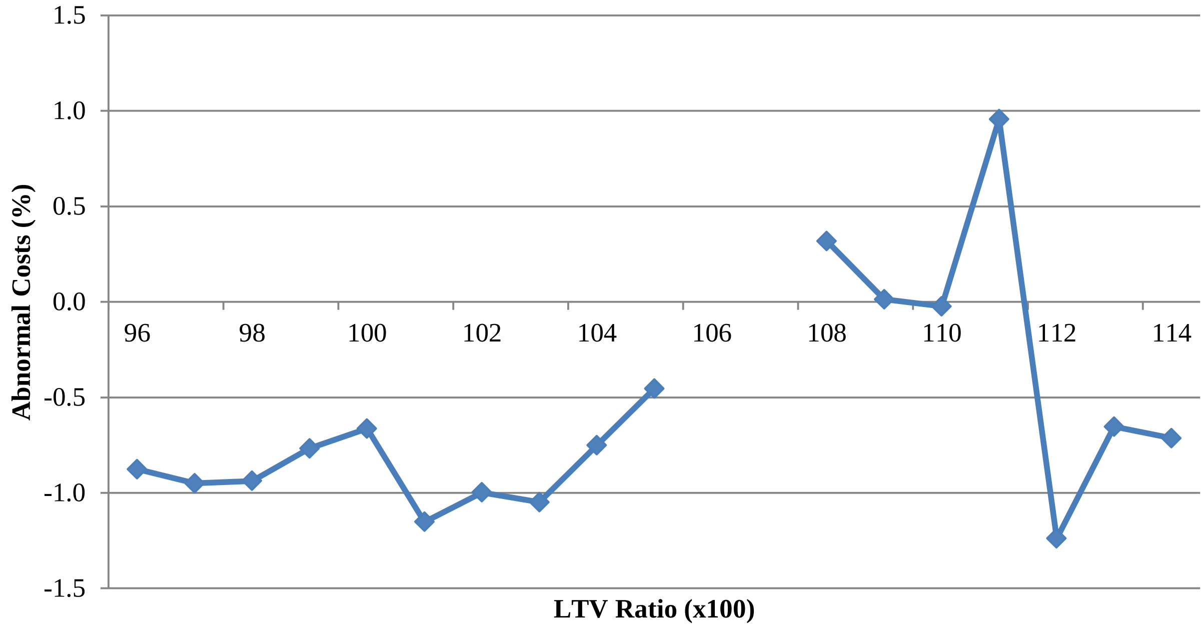


Panel A. Monthly production of 30-year MBS in $ millions. All issuers combined.

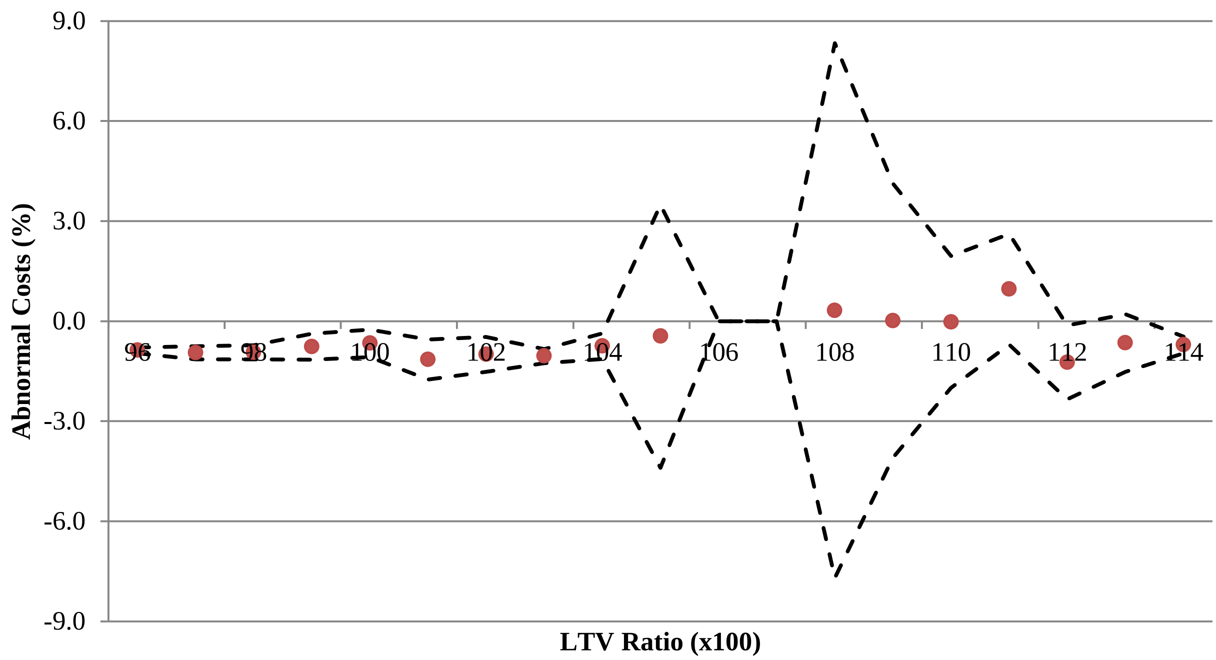


Panel B. Monthly production of 15-year MBS in $millions.

Figure 2. Monthly production of mortgage backed securities. All issuers are included.

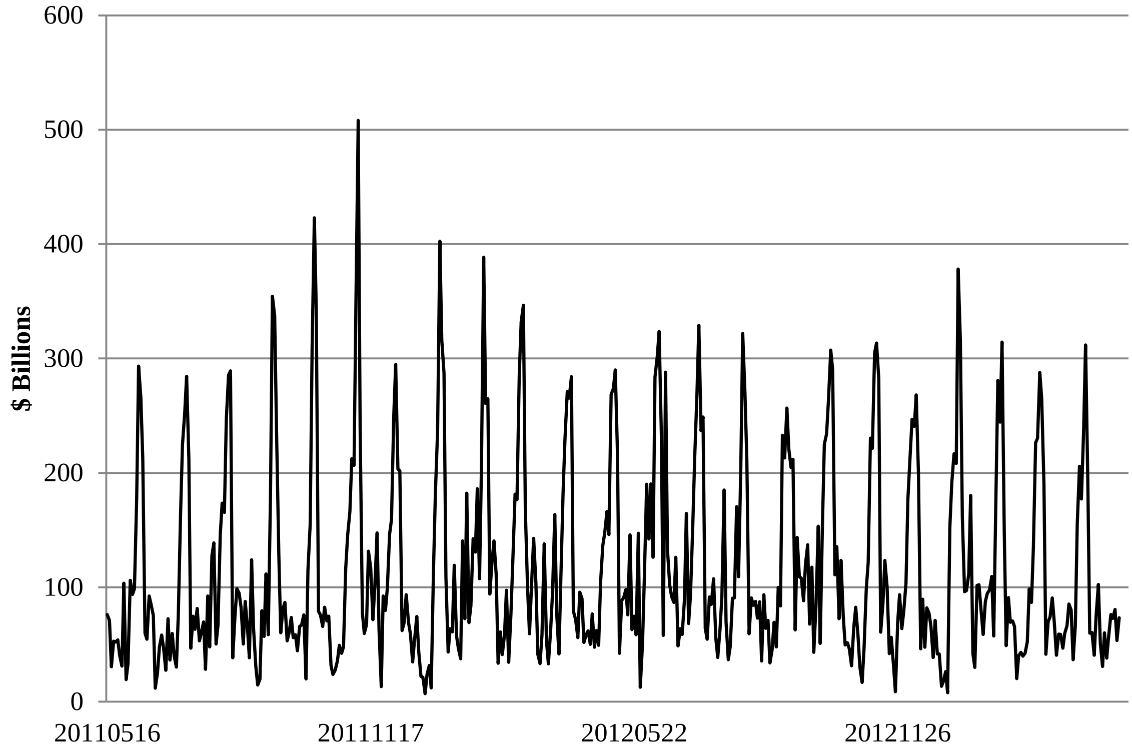


Panel A. Mean abnormal trading costs.

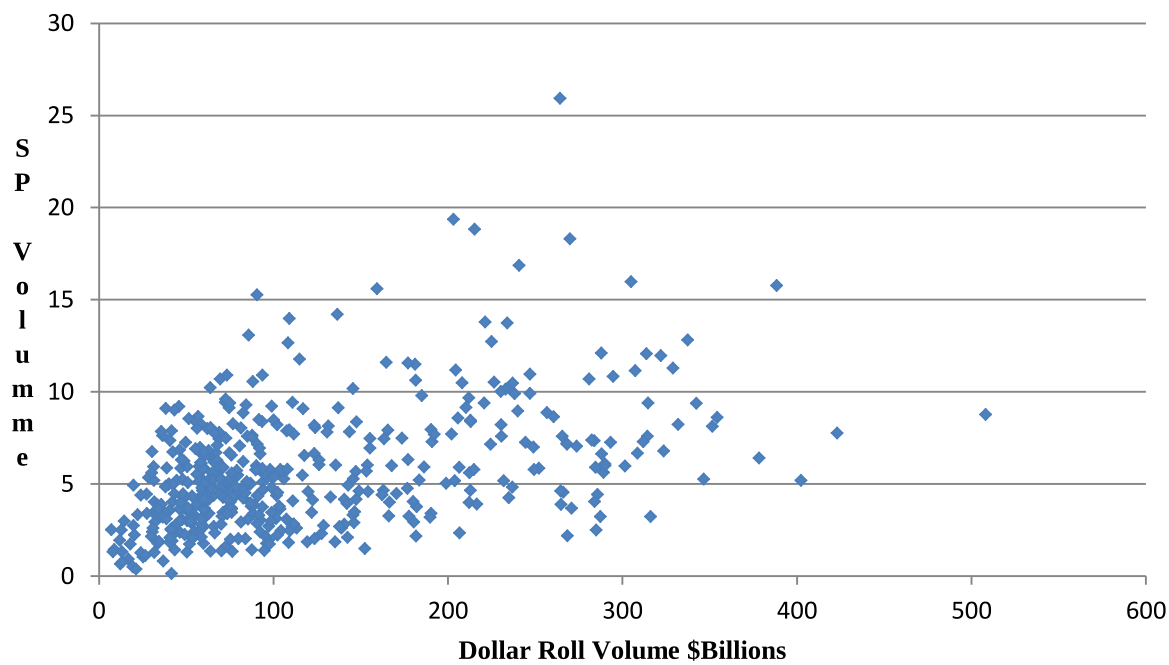


Panel B. Mean abnormal trading costs and the standard error confidence intervals.

Figure 3. Abnormal trading costs for specified pools with LTV ratios greater than 0.95 and less than 1.15.



Panel A. Daily 30-Year Dollar Roll Trading Volume



Panel B. Scatter Plot of Daily 30-Year Specified Pool Trading Volume and Dollar Roll Volume

Figure 4. Daily trading volume of 30-year TBA dollar rolls and 30-year specified pools.