Liquidity and Value in the Deep vs. Shallow Ends of Mortgage-Backed Securities Pools*

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Abstract

We use new TRACE data to investigate the liquidity and pricing of agency mortgage-backed pass-through securities. We distinguish between two trading channels -- a To-Be-Announced (TBA) forward delivery market and a specified-pool market. Institutional specified-pool traders in the deep end of the market have easy access to the TBA market, while retail specified-pool traders in the shallow end of the market have virtually no access to this market. We first confirm that only large specified-pool transactions show strong integration with the TBA market in terms of settlement dates and prices. We then show that TBA access for traders in the deep end translates into abundant liquidity with balanced two-way trade flow and realized bid-ask spreads of less than 0.1%. In contrast, retail traders who do not benefit from integration with the TBA market suffer 4-to-1 sell-to-buy trade flow imbalance and 0.5% to 1% realized bid-ask spreads. Because trading in the same security can occur in both the shallow and deep ends of the market, we can estimate the price discounts due to illiquidity by comparing the prices of small and large-sized trades. Our empirical tests paint a consistent picture that illiquidity in the shallow end causes 2% to 5% price discounts.

1. Introduction

Agency mortgage-backed securities (MBS) are crucial conduits for housing market finance and represent a large share of both total US debt issuance flows and outstanding values. The three sponsoring agencies in the US are the Federal National Mortgage Association (FNMA), commonly known as Fannie Mae; the Federal Home Loan Mortgage Corporation (FHLMC), commonly known as Freddie Mac; and the Government National Mortgage Association (GNMA), commonly known as Ginnie Mae. Together they issued a total of $1.4 trillion in new MBS in 2010. Roughly $5.5 trillion of agency MBS were outstanding as of mid-2011.

While the agency guarantee shields investors from default risk, investors remain subject to substantial cash flow timing risk due to uncertain prepayments tied to loan refinancing. In addition, the securities themselves trade in an over-the-counter dealer market. Given their complex nature as well as the lack of public trading channels, one might expect the MBS market to be as fragmented and illiquid as the municipal debt market. Yet, neither complexity nor potential fragmentation has kept the agency MBS from being extremely liquid. The agency MBS market has almost 25 times the daily trading volume of the US municipal bond market, and trails only Treasuries among all US debt markets.

There are two channels for trading agency MBS securities – a specified-pool channel and a "to be announced" (TBA) channel. The majority of trading takes place within the deferred delivery TBA channel, which has excellent pre-trade transparency via electronic platforms. In contrast, specified-pool trading has no pre or post-trade transparency. The existing academic literature for MBS studies TBA contract pricing (Boudoukh *et al.*, 1997; Gabaix, Krishnamurthy, and Vigneron, 2007), but a previous data vacuum has prevented any academic research of specified-pool trading. As a result, in stark contrast to the vast body of literature on the pricing and liquidity of equity, government bond, and corporate bond markets, little is known about specified-pool MBS trading and its integration with the TBA market.

We present the first comprehensive empirical study of specified-pool trading using new TRACE data collected by the Financial Industry Regulatory Authority (FINRA) from mortgage market dealers on all transactions in Fannie Mae mortgage pass-through securities taking place between May 16, 2011 and October 31, 2011. These data offer a detailed look into the liquidity and pricing of individual pools and permit estimates of transaction costs using methods applied by Hong and Warga (2004) and Green, Hollifield, and Schürhoff (2007) to the municipal bond market. The data also allow us to analyze the degree of integration between the murky specified-pool and translucent TBA segments of the MBS market. Finally, we use these new data and a unique research design to quantify the impact of liquidity on security valuation, a key issue in asset pricing research.

We find that the pricing process in Fannie Mae specified pools trading performs exceedingly well for transactions of large sizes (the "deep end" of the pool). Indeed, we find near perfect market integration between the TBA market and the market for those specified pool MBS that are deliverable on active coupon TBA trades. The majority of large specified-pool trades occur on TBA settlement dates and the distribution of prices across the full range of possible decimal values matches the uniform distribution in the TBA market. The variation in TBA pricing also explains between 94% and 97% of the variation in MBS pricing for deep-end trades sized at $25,000 or more in current face value. We next document that institutional investors in the deep end of the market (who can access both the TBA and specified pool channels) get excellent liquidity in specified-pool trading. Trading in the deep end of Fannie MBS occurs at realized bid-ask spreads of less than 0.1% and we observe customer sell/buy order balance.

The features of the TBA market that make it an attractive platform for the large-sized trades of institutions also make it costly to access by traders wishing to execute small-sized transactions, because of high costs to acquire and bundle small positions in order to comply with TBA delivery guidelines. In marked contrast to our deep-end results, TBA benchmarks explain very little of the variation in MBS pricing for shallow-end trades. This low level of explained variance indicates that there is little price integration of specified pool and TBA markets for small-sized trades. Shallow-end trades are five to twenty times more likely to be executed at integer prices. They also exhibit unbalanced two-way flow, with customer sell volume more than four times larger than customer buy volume, and are executed at 0.5% to 1% realized bid-ask spreads.

After establishing the significant relations between, on one hand, trade size and integration with the TBA market and, on the other hand, trade size and liquidity, we next examine the impact of liquidity on pricing. Amihud, Mendelson, and Pedersen (2005) recommend that test for liquidity effects on asset values involve a comparison of assets with identical cash flows but differing levels of liquidity. More generally, unbiased estimates of the causal effect of liquidity on asset values require variation in liquidity that is exogenous to asset prices (e.g. Amihud, Mendelson, and Lauterbach, 1997). Following the recommendation of Amihud et al (2005), we compare the prices of deep and shallow-end trades in the same specified pool within the same day. Based on our previous analysis, deep-end trades in a given security are priced in a large, liquid market while shallow-end trades in the same exact security are priced in a fragmented, illiquid market. By exploiting this unique opportunity to observe identical streams of cash flows that are exposed to different liquidity regimes (i.e., small-sized trades vs. large-sized trades in the same security), we do not need to control for other possible confounding valuation factors that would be present in the typical cross-sectional or time-series study of the impacts of liquidity on asset pricing (Amihud and Mendelson, 1991; Kamara, 1994; Krishnamurthy, 2002; Goldreich, Hanke, and Nath, 2005).

We find that small-sized specified-pool MBS trades on average price 2% to 5% below large-sized trades in the same specified pool. We interpret these pricing patterns as evidence that the lack of liquidity in the shallow-end segment of the specified-pool market causes a significant price discount to the deep-end segment. More generally, our results show that, in the specified-pool MBS market, trade size affects fair value in a manner that is over and above the direct impact on effective spreads, documented for municipal bonds by Harris and Piwowar (2006) and Green, Hollifield, and Schürhoff (2007), and for corporate bonds by Goldstein, Hotchkiss, and Sirri (2007) and Feldhütter (2012).

The remainder of the paper is structured as follows. Section 2 provides background information about MBS trading and institutional characteristics and describes the FINRA-contributed data. Section 3 presents our analyses of the relations between 1) trade size and integration between the specified-pool and TBA markets and 2) between trade size and liquidity. We perform our empirical tests of the effect of illiquidity on MBS prices in Section 4. Section 5 concludes.

2. Background and Data

A. Trading in Agency MBS

A basic type of agency MBS is the pass-through participation certificate that entitles its owner to a pro-rata share of all principal and interest payments made on a pool of residential property loans that conform to underwriting standards set by the sponsoring agency. Vickery and Wright (2011) emphasize the liquid over-the-counter dealer market in TBA convention contracts that call for deferred delivery of "to be announced" pass-through securities as the key to the efficient functioning of the MBS market. The TBA contracts leave the underlying MBS pass-through pool unspecified until the seller chooses the "cheapest to deliver" from a broad set of eligible pools as the actual delivery process begins. Buyers anticipate this behavior and therefore price the contract off of a generic cheapest to deliver pool. The significant level of homogeneity in the agency underwriting and pooling process in combination with rules governing TBA channel trading generates effective fungibility for a broad class of mortgage-backed securities.

The TBA market features characteristics thought to promote liquidity and efficiency: standardized terms and excellent pre-trade transparency. The TBA market's electronic trading platforms display current prices for a range of contracts standardized by an issuer/coupon rate/settlement date triplet.[1] This market's price discovery process brings about a balance between investor buy and sell orders and allows huge sizes to transact every day. As a consequence, institutional investors with large scale mortgage product trading needs find TBA contracting to be a desired liquid channel.[2] Furthermore, such TBA trading aggregates pricing information about mortgage prepayment risk and other market-wide factors.

The fixed-rate agency MBS market naturally partitions along agency issuer and "product" (i.e., the original maturities for the underlying mortgages) dimensions. Trading in TBA contracts for fixed-rate MBS exist for all three issuers (FNMA, FHLMC, and GNMA)

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[1] Figure A-1 in the Appendix presents a screen-shot example of Bloomberg Electronic Market for FNMA 30-year TBA contracts.

[2] Silber (1981) emphasizes that successful innovation of a futures market to supplement or replace over-the-counter forward markets stems from reducing the cost of contracting. Nothaft, Lekkas, and Wang (1995) suggest that the liquidity of the TBA market doomed the Chicago Board of Trade's attempt to find market acceptance of its GNMA-based MBS futures contract launched in 1989. Johnston and McConnell (1989) analyze the rise and fall of the Chicago Board of Trade's previous GNMA CDR futures contract that was launched with some success in 1975 but effectively died out by 1987.

across four products (30-year; 20-year; 15-year; 10-year). Typically, TBA trading is open for between three to six active contract coupon rates and three settlement months. There is one specific settlement date per product per month. Thus, a TBA contract trade embodies its issuer (e.g., FNMA), product (e.g., 30-yr fixed rate), coupon (e.g., 4%), and settlement date (e.g., 8/11/2011).

The limited number of TBA contracts is designed to enhance liquidity and price discovery. Other standards such as the Securities Industry and Financial Markets Association (SIFMA) "Good Delivery Guidelines" facilitate trading in large sizes. The SIFMA guidelines require: 1) a $25,000 current face value minimum trade size; 2) all delivered pools should have original par greater than or equal to $25,000; and 3) limit the number of delivered pools to one for trades below $500,000 in current face value, two for trades between $500,000 and $1 million in current face, and three per million for trades above $1 million in current face.[3] These guidelines make TBA delivery of pools with small current face values inconvenient. For example to deliver a pool with current face of $24,000, one would need to bundle this pool with another pool with $476,000 current face with the same issuer, product type and coupon.

For deep-end investors having large enough MBS holdings to comply with TBA delivery guidelines, the trading conventions simplify their analytical and risk management challenges. The price of any TBA-eligible specified pool should sell for at least the delivery value of the pool against its respective TBA contract. Thus, deep-end market participants should view the TBA channel as an extremely liquid backstop, which ensures a price floor equal to the current price of the corresponding standardized TBA contract. Assuming a "fair" TBA market, deep-end investors need only analyze the "pay-up," the difference between quoted specified-pool and TBA

[3] These guidelines apply to TBA trades with coupons less than 8%, which cover all trades in our sample.

prices. This pay-up is related to the difference in the prepayment rate of the specified pool versus that of the generic cheapest-to-deliver pool driving TBA trading.

All of the positive pricing and liquidity spillovers of the TBA market to the specified-pool market do not accrue to shallow-end investors who face high costs of complying with TBA delivery guidelines. There are mechanisms offered by each of the three GSEs to bundle small-sized pools into a pool of pools that has a single CUSIP and is treated as a single pool for trading and TBA delivery purposes. Theoretically, this pooling-of-pools process could provide a bridge between the shallow and deep ends of the specified-pool market. It is an empirical question whether the costs of pooling-of-pools are small enough to enable full integration between the shallow and deep ends of the market.

B. Data

FINRA extended TRACE reporting requirements to securitized products on May 16, 2011. As of that date, FINRA required member firms to report trades executed in asset-backed and mortgage-backed securities.[4] These new report requirements encompass all agency MBS trades, both specified-pool and TBA. FINRA provided these transactions data to us for the period from May 16, 2011 and October 31, 2011. During our sample period FINRA collected but did not yet publicly disseminate the trade-by-trade results.[5] FINRA began releasing weekly aggregated market activity summaries on October 18, 2011. [6]

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[4] See http://www.finra.org/web/groups/industry/@ip/@reg/@notice/documents/industry/p121319.pdf.

[5] A substantial literature has investigated the impacts of TRACE trade dissemination on trading costs in the US corporate bond market: Bessembinder, Maxwell, and Venkataraman (2006), Edwards, Harris, and Piwowar (2007), and Goldstein, Hotchkiss, and Sirri (2007). Furthermore, Cici, Gibson, and Merrick (2011) suggest that observed declines in the dispersion of month-end valuations placed on identical corporate bonds by different mutual funds may be due in part to the rollout of TRACE trade dissemination. Notice that our MBS and TBA TRACE data is not being disseminated during our sample period and we are not examining any information effects of specific trade reports on MBS prices.

[6] These end-of-day aggregated market activity summaries are available at www.finra.org/TRACE/StructuredProductsReports and https://vantage.interactivedata.com/aggregate.

Each specified-pool trade report includes a security identifier (e.g., CUSIP), transaction size (measured by convention as the original face value of MBS traded), date and time of execution, settlement date, trade price, pool factor (if not the most recently published factor), and a variety of codes defining trade type. The latter include flags for counterparty type (dealer buy, dealer sell, customer buy, customer sell) and dealer capacity (principal or agent). Commissions (if any) must be built into the reported prices.

We expunge duplicate trade reports arising from interdealer trades by dropping all "dealer buy" reports. We then remove cancelled trades and keep only the last trade correction report in sequences of original trade, and one or more corrections. We check the resulting transaction data for discernible errors and drop several outliers.[7]

FINRA also provided a securities database encompassing individual MBS terms and selected pool characteristics. The securities database includes characteristics like issuer, collateral type, issue date, original balance, weighted average loan balance, credit score, coupon and factor as of month end for May to October. We merge this database with the transactions data to link trade prices with underlying pool characteristics.

We focus only on pass-through securities issued by Fannie Mae based on conventional fixed coupon single-family mortgages and the corresponding TBA contracts. There are four main types of pools categorized by maximum maturity for a pool's constituent mortgages: 10-year, 15-year, 20-year, and 30-year.

Table 1 presents summary statistics for trading in each of the four product maturity sectors for both TBA contracts and those specified pool MBS that match standard TBA coupons.

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[7] Understandably, the rollout of new reporting requirements may cause confusion on the part of some participants early in the process. For example, we uncovered and subsequently dropped numerous trade reports from one dealer who reported trades for sizes equal to entire multi-million dollar MBS pools at identical prices of 100 (even though the matched TBA prices were above 109). These reports most likely represented MBS swap trades between the dealer and issuer FNMA.

We categorize trades in each product and market by dealer counterparty (i.e., another dealer, a customer who buys, and a customer who sells). These results clearly show that the TBA market is the dominant trading channel for MBS. For example, the total volume of interdealer trades in the TBA market is more than sixty times that of specified-pool trades. Moreover, the implied $20 million average size of all interdealer TBA trades is almost seven times as large as the $3 million average interdealer specified-pool trade.

<Insert Table 1 >

Furthermore, the TBA market is well balanced in terms of customer order flow in the sense that the volume of customer purchases roughly equals the volume of customer sales. Dealers keep busy servicing this customer flow: the (unduplicated) volume of interdealer trades is more than double each side of their customer volume. Note that the specified pool market is not as well balanced. The total volume of customer buy trades is only about 75% of customer sell trade volume. Moreover, the total volume of interdealer trading in specified pools is dramatically lower than even the customer buy volume.

The 30-year and 15-year product segments of the TBA market are by far the most active. The low level of trading volume in the 10-year and 20-year products limits our ability to reference a reliable TBA benchmark price to match any particular corresponding specified pool trade. Thus, we drop the 10-year and 20-year products from the remainder of our analysis. Note that this restriction decreases our volume coverage of all customer TBA trades by less than 0.5%. The remaining sample of MBS trades includes securities with coupons ranging from 2.5% to 11% for 15-year and from 3% to 16% for 30-year products. Again, we keep only MBS with coupons that match the actively traded TBA coupons for our sample. These active coupon rates range between 3% and 6% for 15-year product and between 3.5% and 6.5% for 30-year product. This restriction reduces the sample by about 5%.

The TBA market provides a natural set of price benchmarks for specified-pool trades with the same collateral type, coupon, and settlement date. Before proceeding to create these price benchmarks, we must recognize that the FINRA database includes four different types of TBA trades. “Stipulated trades” differ from regular trades by placing restrictions on the pools that can be delivered in final settlement.[8] The third category of trades is a “dollar roll.” A dollar roll is a linked pair of trades in which, say, a customer agrees to both sell an August settlement contract and buy a September settlement contract. In this way the customer maintains general risk exposure to the mortgage market (via being long the September contract), but has no right to any cash flows between the two settlement dates. The fourth category is for stipulated dollar roll trades (i.e., dollar roll trades that entail delivery restrictions). Table A-1 in the Appendix reports statistics on trading volume and the number of trade by each counterparty type for the four different types of TBA trades. This activity breakdown reveals regular trades to be largest type of trade followed by dollar rolls. Both types of stipulated trades are minor components of the market.

We drop all non-regular TBA trades – stipulated, dollar rolls, and stipulated dollar roll trades from the data and proceed with the construction of TBA price benchmarks for each specified-pool trade in our sample. We separate the MBS trades into two categories – 1) trades with a settlement date that matches the settlement date of the relevant TBA contract (TBA settlement date trades); and 2) trades with settlement dates different from the settlement dates of the TBA contract (non-TBA settlement date trades). For the TBA settlement date trades, the

[8] Stipulations can be placed on, among other things, year of issuance, weighted average coupon, loan age, geographic concentration, pools per trade, etc.

TBA price benchmark is just the weighted-average price of TBA trades on the same execution date for the same collateral type (15 or 30-year), same coupon, and same settlement date. For non-TBA settlement date trades, we make a crude adjustment for net financing impact on benchmark value for each MBS trade by using the "Drop" implied by the difference in the front month and next deferred TBA contract prices.[9] Define the TBA "Drop per day" as the difference between weighted average daily prices of the front (priceTBA1) and next deferred TBA contract prices (priceTBA2) divided by the number of days between their respective TBA settlement days:

TBA Drop per day = (priceTBA1 – priceTBA2)/(Days between TBA Settlements)

For non-TBA settlement date trades, we use the number of days between the MBS settlement date and the front month TBA settlement date (MBS Days between Settlements) to calculate the TBA price benchmark as:

TBA price benchmark = priceTBA1 + (MBS Days between Settlements*TBA Drop per Day)

We define the pay-up of each MBS trade in our sample as: [10]

Pay-up = price MBS – TBA price benchmark

3. Analysis of Specified-Pool Trades: Integration with the TBA market and Liquidity

We first investigate two dimensions of possible integration between specified-pool trades in 15-year and 30-year conventional Fannie MBS and the corresponding trading in the TBA market. The first dimension is the percentage of trades executed at TBA settlement dates. The second dimension is the mass of the distribution of trade prices clustered at integer values. The

[9] See Chaudhary (2006) for a discussion of the "drop" implicit in the pricing of dollar roll trades.

[10] The pay-up concept for specified pool MBS for a standard TBA settlement date is akin to the "net basis" for an individual Treasury security calculated relative to its futures market delivery invoice price. Only the cheapest-to-delivery cash market Treasury issue(s) should be delivered against a Treasury futures contract. Any Treasury issue that is worth more than its Treasury futures delivery invoice price should be sold in the cash market at a positive spread (net basis) to its benchmark delivery value rather than be delivered against the futures (see Merrick, Naik, and Yadav, 2005). Likewise, absent market frictions, high-value pools should not be delivered against TBA trades. Such pools should trade only in the specified pool market.

TBA market trades in increments of one 64th of a price point and there is no clustering around particular price values, e.g. 0, ¼, ½, or ¾ (see Table A-2 about the percentage of TBA trades with integer prices). If specified-pool trades are driven by TBA prices, their pricing will also be uniformly distributed without any clustering at round values. We report the percentage of trades that settle on TBA dates and occur at integer prices for different trade-size categories in Table 2. Consistent with differential access to the TBA market, there are monotone relations between trade size and both the percentage of trades executed at TBA settlement dates and the percentage of trades executed at integer prices. The differences in both categories observed for large versus small trade sizes is striking. Compare small trades below $5,000 with large trades above $250,000 in current face. As little as 15% of the small trades settle on TBA dates and as much as 42% occur at integer prices. Conversely, 70% of the large trades settle on TBA dates and only 2% have integer prices. We interpret these patterns as indirect evidence that specified pool MBS market participants prefer to link to the TBA market to discipline negotiations with dealer counterparties, especially for transactions of large size.

<Insert Table 2 >

Figure 1 overlays the distribution of various individual specified pool MBS transactions prices against a daily plot of the price on the 30-year, 5% coupon, August 2011 TBA contract, restricting the sample only to trades with the same settlement date as the August 2011 TBA contract (August 11, 2011). The MBS trades are categorized as large trades, small buys, and small sells. A $25,000 current face value cutoff is used to define large versus small trades. Figure 1 shows that large specified-pool trade prices generally are equal to or greater than their associated TBA benchmark prices (i.e., large specified-pool trade prices respect their corresponding TBA benchmark price floor). In contrast, small specified-pool sell trades occur at large discounts to corresponding TBA prices. Many small sells are priced between 3% and 5% through their respective TBA floors (i.e., "cheap"). One small sell takes place at an egregious discount of over 25%. Interestingly, small buys can also occur at prices below the TBA benchmark. Based on Table 2, most small trades do not have an exact TBA settlement date. Figure A-2 in the Appendix expands the sample to all small trades executed after July 10 with settlement date on or before the August 2011 TBA settlement date. Compared to Figure 1, the plots include many more small trades, but conclusions about the prices of small trades remain the same.

<Insert Figure 1>

Table 3 reports results of panel data regressions of specified-pool trade prices on their matched TBA benchmark prices for 30-year product. As previously discussed, the TBA benchmark prices match each MBS trade by product and coupon, and either match settlement date for TBA settlement date trades or adjust for the dollar roll for non-TBA settlement dates. These regressions aim to offer some basic insights about the degree to which specified-pool trade prices can be explained by matched TBA benchmark prices. We delve into differences owing to transaction size by running separate regressions for large trades and small trades. Panel A reports results for large trades, again defined as trades sized above $25,000 of current face value. These estimates clearly show the importance of trade size in determining how prices in the specified pool MBS and TBA markets co-move. The estimated slope coefficients from the large trade sample are quite close in magnitude to 1.0 regardless of counterparty type. Furthermore, the R-squared statistics range between 0.94 and 0.97, implying almost perfect market integration even for non-TBA settlement date trades.

Panel B reports results for trades sized below $25,000 of current face value. The estimated slope coefficients from the small trade sample are much lower than one in magnitude for every counterparty type. Furthermore, the R-squared statistics are shockingly low, ranging between 0.03 and 0.41. These results suggest that very little integration exists between specified pool small trade pricing and the corresponding TBA benchmarks. Corresponding results for 15-year product trade data are qualitatively similar to those for the 30-year product (see Table A-3 in the Appendix).

<Insert Table 3 >

We investigate further the strong positive relation between specified-pool trade size and the explanatory power of TBA price benchmarks for specified-pool pricing revealed in Table 3 using the following rolling-window procedure. First, we sort all specified-pool customer trades in the 30-year product by trade size. We then run a separate set for customer buys and customer sells of rolling window regressions of specified-pool price on TBA price benchmark. The window size we choose is 1,000 observations. In particular, we run one regression for the smallest 1,000 sell customer trades and record its R-squared. Then we run a second regression with a sample of sell trades sizes ranked from 2 to 1,001, then one with ranks from 3 to 1,002 and so on until the last regression with the largest 1,000 customer sell trades. We repeat the procedure for customer buys. We plot regression R-squared versus trade size in Figure 2. The R-squared starts at zero for very small trades but increases steeply with trade size for customer trades of current face value below $25,000. The R-squared for trades in sizes above $25,000 in current face value is already above 80% and converges to one for trades above $100,000.

<Insert Figure 2>

We next analyze the liquidity of large vs. small-sized specified-pool trades. Our first measure of liquidity is the balance between customer buy and sell volume. Figure 3 presents a daily plot of customer buy and customer sell specified pool MBS volume for 30-year product for both our small trade (< $25,000 current face) and large trade (≥ $25,000 current face) samples. Indeed, Figure 3 reveals that specified pool trading exhibits unbalanced two-way customer flow for small-sized transactions. In this segment, customer sell volume is routinely more than four times larger than buy volume. Note that the large trade segment exhibits balanced two-way flow that provides dealers adequate opportunities to turn over acquired inventories as they service their customers' needs.

<Insert Figure 3>

The second liquidity measure we analyze is realized transaction price spread. We implement two alternative matched customer buy-sell trade approaches implemented previously for municipal bonds. Hong and Warga (2004) match each customer buy (sell) order with the closest in time customer sell (buy) order in the same security and on the same date. We also require that the two trades also have the same settlement date. Green, Hollifield, and Schürhoff (2007) additionally require that the two trades have the same traded amount ("immediate match"). We separate the trades into three size buckets – below $25,000, between $25,000 and $100,000, and above $100,000 in current face value, and present average realized spreads for each size bucket in Table 4. We find a strong monotone decline in spreads across the three trade-size buckets. Trades in 30-year conventional MBS in sized below $25,000 in current face have spreads of 0.93 to 1 price points, while trades in sized above $100,000 have spreads of only 0.05 to 0.10 price points.

<Insert Table 4>

In contrast to the municipal bond studies, we have a good pricing benchmark that we can attach to each trade – the matched TBA price. Having this benchmark allows us to decompose the average realized spreads in Table 4 into the average pay-up of customer buy trades and the average pay-up of matched customer sell trades. Our approach follows the decomposition of spreads of BBB-rated corporate bonds in Goldstein *et al*. (2007). We present the decomposed spreads in Table 5 and find that realized spreads mask another important difference between small and large trades. Both customer buy and sell trades of sizes below $25,000 in current face value are priced significantly below their TBA benchmarks (average pay-ups are negative), while trades in sizes above $100,000 are priced on average above their TBA benchmarks. The difference in prices of trades in 30-year conventional MBS between the large and small-size category is close to four points.

<Insert Table 5>

To provide a direct comparison between our results and the results of Goldstein *et al.* (2007) we also calculate average pay-ups for an extended set of size buckets that match the size categories in Table 9 of that paper. We present this comparison in Figure 4. The difference between trading in MBS specified-pools and BBB corporate bonds is striking. On one hand, MBS securities have significantly narrower spreads across all size categories. On the other hand, small-sized trades in MBS securities have a much lower price mid-point than the price mid-point of large trades, suggesting that security fair value depends on trade size. Such a relation is not observed in corporate bonds and is assumed to not exist by the municipal bond literature. In fact, the assumption that security fair value is independent of trade size is critical for the structural transaction cost model of Harris and Piwowar (2006).

<Insert Figure 4>

4. The Impact of Illiquidity on Specified-Pool Prices

In this section we exploit the unique opportunity provided by the differential costs of accessing the TBA market for small and large-sized trades to cleanly identify the effect of liquidity on agency MBS asset prices. From our analysis in Section 3 it is evident that investors executing large-sized trades, especially above \$100,000 in current face, can easily take advantage of the option to transact in the TBA market. Easy access to the TBA market generates positive pay-ups to TBA and low implied bid-ask spreads for large specified-pool trades. In contrast, small-sized trades are decoupled from their benchmark TBA prices and face large buy-sell order flow imbalances and high implied bid-ask spreads. This differential in liquidity for different trade sizes is independent of security characteristics and allows us to compare the prices of large and small trades in a single security. This framework is consistent with the ideal design to test for liquidity effects on pricing outlined by Amihud *et al.* (2005) – compare the prices of two streams of cash flows that have different liquidity, but are otherwise identical.

A. Results

We first analyze the effect of trade size on the prices of a single security, and we choose here the Fannie Mae pass-through security with the largest number of customer specified-pool trades during our sample period. This security is a 6%-coupon, 30-year conventional mega pool, issued in May 2008, and has roughly 1,100 customer trades. We present a scatter plot of prices by trade size (in current face value) for this security over our sample period in Figure 5. Even after keeping security characteristics constant, shallow-end prices are on average 2% to 5% lower than prices in the deep end.

<Insert Figure 5>

In the spirit of the decomposition of spread in Table 5, the following sequence of trades in the same security further illustrates the effect of trade size and direction on security price and implied bid-ask spreads. On June 3 at 3:14 p.m. a customer sells $3,000 in original par ($1,022 in current face) to a dealer at the price of 101. This dealer then sells the same amount, also at 3:14 p.m., to another dealer at 102.4282. Minutes later at 3:26 p.m. a customer sells to a different dealer $142,055 in original par amount ($48,416 in current face) at the price of 110.1406, which is quite close to the TBA price for the same period of 110.41. Based on these three trades, we can decompose the large negative pay-up to TBA of 9.41 points of the small customer sell transaction into two parts – a large illiquidity discount of 7.98 points and a much smaller dealer round-trip profit of 1.43 points. Later in the same day at 4:43 p.m. a customer sells to a dealer $59,000 in original par ($20,110 in current face) for 110.4688, and at 4:51 p.m. a customer buys from the same dealer $323,000 in original par ($110,088 in current face) for 110.5938. Both customer trades are at prices slightly above the TBA price and the round-trip dealer profit from these two trades is only about 0.125 points.

In Table 6, we confirm the visual results in Figure 5 in individual-security regressions with fixed effects for each trade date in the sample (these fixed effects effectively remove the equally-weighted average daily price from each transaction price). We report the results for the 6% coupon the security in Figure 5, as well as two other securities – the 5% and 5.5% coupon securities with the largest number of customer trades. The effect of trade size on the prices of customer transactions is monotonic: customer sells trades below $5,000 in current face are priced 3.5% to 5% lower than average, while customer sell trades in the $10,000 to $25,000 current face range have discounts of about 1.3%. Discounts largely disappear for sizes above $100,000.

<Insert Table 6 >

Finally, we present the equivalent of Table 6 for all securities in our sample. Adding security×trade date fixed effects is not feasible with 20,000 securities and more than 100 trade dates. Instead, we calculate the average daily price for all trades above $100,000 in current face in each security and subtract this average from the price of each trade. We then regress these price differences on a set of size dummies interacted with transaction direction dummies (customer buy and sell). To increase power, we reduce the set of size categories to only three: 1) below $25,000, 2) between $25,000 and $100,000, and 3) above $100,000 in current face. Table 7 reports the results from these regressions, which confirm that customer sell trades in the lowest size category (the shallow end) are priced between 1.6% and 2.4% lower than trades in the highest category (above $100,000). Customer buys in the shallow end are also priced below large buys but the discount is only between 0.4% and 0.9%, implying a bid-ask spread of more than 1% in the shallow end of the pool.

<Insert Table 7 >

The Figure 5, Table 6, and Table 7 estimates of the effect of illiquidity on MBS prices have strong internal validity since we compare small and large trades in the same security. However, this same-security design limits us to studying only the sub-sample of most liquid MBS (i.e., the single most liquid security in Figure 5; the three most liquid securities in Table 6; and a restricted set of securities with sufficient number of trades and occurrences of both small and large trades in Table 7.

The Appendix presents results of additional analyses that extend to all 15-year and 30-year conventional MBS. Based on much larger sample sizes, these tests have better external validity than our baseline single-security tests. This external validity comes at a cost, because we have to compare small trades in one security with large trades in another security. We present a raw comparison of the pay-ups of all 30-year product trades up to $500,000 in current face value in Figure A-3. Consistent with our main results in Section 4A, many customer sell and buy trades in the shallow-end have negative pay-ups of 5% or more. Moreover, the pay-ups profiles are negatively skewed, especially for customer sells. Pay-ups are much more negative for trades less than $10,000 in current face value size (perhaps closer to an individual retail investor's size).

To improve the validity of a cross-security comparison of small and large trades, we introduce controls for different security characteristics and estimate a predicted pay-up model (reported in Table A-4) incorporating factors motivated by Dunsky and Ho (2007) and Stein *et al.* (2011). After controlling for potential differences between the securities typically traded in small trade sizes and the securities typically traded in large trade sizes, we find again strong size effects on specified-pool prices (see Table A-5). Trades below $25,000 in current face have average adjusted pay-ups of -1.5% to 2.5%, which are well below the roughly zero adjusted pay-ups of trades above $100,000 in current face. Based on these extended tests, there is good reason to believe that illiquidity discounts are pervasive in the whole Fannie MBS universe.

B. Further Discussion

There could be alternative, non-liquidity-based, explanations of our results. First, observed trade size impacts on fixed income security transactions prices could be due to differences in transactions costs. For example, Harris and Piwowar (2006) find that retail-sized trades in the municipal bond market are more expensive than institutional-sized trades and attribute this difference to the existence of a fixed cost component for municipal bond trades. Indeed, transactions costs are far from trivial in the shallow end of the MBS market as well. For example, the brokerage arm of one well-known investment company lists charges of $1 per $1,000 of original face value for each trade (subject to a minimum charge of $20 and a maximum charge of $250). Thus, an investor buying $10,000 in current face value of a seasoned MBS with a pool factor of .25 would actually trade $40,000 in original face value at a cost of $40. Such a trade cost structure would lend support to 0.40% of negative pay-up for a customer sell trade. Yet, such transactions costs are much too tiny to explain the 2% to 5% lower prices of small customer sell trades. Moreover, a pure transactions costs explanation is inconsistent with the observed pricing of customer buy trades since higher transactions costs of small buy trades should result in higher not lower prices of small customer buy trades relative to large trades.

Another reason for a relation between trade size and trade prices is provided by Green, Hollifield, and Schürhoff (2007), who argue that fragmentation and lack of transparency may create opportunities for intermediaries to develop and exploit market power and find that dealers' market power is highest for small- to medium-sized transactions. Again, trade size related differences in dealer power seem incapable of explaining the existence of significant price discounts for small versus large customer MBS buy trades since, in such trades, the little guy "wins." Similarly, the difference in search costs between retail and institutional investors, estimated by Feldhutter (2012), can cause price discounts of retail sell trades, but not retail buy trades.

It might also be tempting to relate the retail-sized shallow end of the MBS market to "odd lots" in equity markets (implicitly using the $25,000 current face value level as the unit of trade). This is misleading on at least two counts. In the equity market, round lots and odd lots have both been executed on common NYSE platforms since July 30, 2010. Moreover, while we believe it is correct to describe small MBS customer trades as mainly reflecting retail investors, O'Hara, Yao, and Ye (2011) find that equity odd lot trading to be evolving in way that suggests that small may not always mean unsophisticated.

After addressing alternative explanations for our results, we need to discuss two important limitations. First, we examine transactions in only Fannie Mae securities and only for a five-month period. Fannie Mae is the largest of the three agencies sponsoring MBS issuance. Nevertheless, the entire MBS ecosystem and potential differences among the three agencies could be examined in future work. While the sample period is short, the data set includes a vast number of transactions. Second, while we present evidence of illiquidity discounts in the shallow end of 2% to 5%, we do not explicitly tie these estimates to structural parameters to explain the size of the discount or dynamics as in Acharya and Pedersen (2005).

C. Implications for TRACE Trade Reporting

Dissemination of TRACE transaction reports is now an integral part of the corporate bond market infrastructure, facilitating more transparent trading in corporate bonds. At some future date, FINRA may decide to publicly disseminate the MBS TRACE data. Our results on the varying degrees of integration between the specified-pool and TBA markets have important implications for the design and format of such specified-pool MBS trade data dissemination. In particular, price reports in individual MBS should be cross-referenced with those for matched TBA trades. Specifically, we propose that TRACE reports augment trades in individual agency pass-through securities with the most recent pricing data for first and second-month TBA contracts that match the issuer, coupon, and product type of the security. Table A-6 presents our proposed trade report for a single specified-pool security.

Moreover, total market activity reports of the type that FINRA already releases should be expanded to distinguish customer buy trades from customer sell trades, distinguish exact TBA settlement date trades from others, and include statistics for both raw price and pay-up to matched TBA contracts for two trade samples. One trade sample would be that for the specific security's own transactions. The second (and most likely much larger) trade sample would include all other closely related MBS (i.e., those with issuer, product type, and coupon matches against the specified pool under consideration). Such summary reports should also display results for three discrete trade-size regions: 1) below $25,000 in current face (see Table A-7); 2) between $25,000 and $100,000 in current face (see Table A-8); and 3) $100,000 and above in current face (see Table A-9).

5. Conclusion

Our analysis of new TRACE data on all transactions from mortgage market dealers for the May-October 2011 period reveals near perfect integration between the TBA market and the market for those specified-pool MBS trades that are deliverable on active coupon TBA contracts. The variation in TBA pricing explains between 94% and 97% of the variation in the pricing of specified-pool transactions above $25,000 in current face (the deep end of the market). This level of integration implies that the complexity of specified-pool MBS valuation for the unsophisticated investor is dramatically reduced. Assuming a "fair" TBA market, MBS investors need only analyze the "pay-up" – the difference between quoted specified-pool and TBA prices, and are assured a TBA pricing floor for their sell transactions. In addition, the deep end of the market is extremely liquid: customer buy and sell order flows are balanced, implied bid-ask spreads are low, and investors easily transact in multi-million dollar sizes at almost no price impact.

In comparison, the shallow end of the market exhibits very different liquidity and pricing characteristics. Pricing in this segment shows almost no integration with TBA benchmark prices and suggest illiquidity discounts versus TBA benchmarks or deep-end trades of 2% to 5%. Facilities allowing dealers to purchase and aggregate small lots of MBS pools into "Mega pools" for sale in the TBA market fail to pull small trade prices back to their TBA benchmarks. Clearly, mechanisms designed to work for institutional players in the deep end leave retail investors roped off in the shallow end. Here, the implicit trade-off is over the efficiency of the minimum size and pool bundling rules that work to facilitate the 99.5% of market volume accruing to large size trades versus poorer liquidity for small trades.

Our findings have specific implications for the design and format of future FINRA trade reports as well as current market activity summaries for MBS. These include cross-referencing MBS trades with associated coupon-matched TBA contract trades, adding statistics for both raw price and pay-up to matched TBA contracts for all other closely related MBS as well as for a specific security's own transactions, and reporting market activity results for three distinct trade-size regions. Our proposed reports would alert retail investors that their pay-ups on small-sized specified-pool sales are mostly upside down.

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Table 1. Trading in FNMA securities – TBA and Specified Pools

Sample period: May 16, 2011 to October 31, 2011. For specified-pool trades, volume is measured in $million original face value, for TBA trades volume is measured in current face. The FNMA products are defined as follows: 1) FNMA Product 10 is conventional mortgages with original maturities up to 10 years, pool type FNCN; 2) FNMA Product 15 is conventional mortgages with original maturities up to 15 years, pool type FNCI; 3) FNMA Product 20 is conventional mortgages with original maturities up to 20 years, pool type FNCT; and 4) FNMA Product 30 is conventional mortgages with original maturities up to 30 years, pool type FNCL. To avoid double counting trades, we keep only the sell-side reports of interdealer trades.

		Specified Pools			TBA		
FNMA Product	Statistic	Interdealer	Customer Buy	Customer Sell	Interdealer	Customer Buy	Customer Sell
10	Volume (mil)	12,031	11,951	13,253	766	3,745	7,534
	Number of Trades	2,561	2,639	2,249	63	204	441
15	Volume (mil)	46,167	58,236	94,593	2,007,418	924,417	914,485
	Number of Trades	13,665	10,179	22,566	134,688	19,897	23,320
20	Volume (mil)	14,864	14,617	17,745	439	2,603	9,707
	Number of Trades	2,742	2,677	2,270	55	172	576
30	Volume (mil)	101,735	242,019	357,297	10,176,755	4,366,082	4,318,676
	Number of Trades	37,267	17,893	56,941	450,013	51,920	65,541
Totals							
23,717,135	Volume (mil)	174,797	326,823	482,888	12,185,378	5,296,847	5,250,402
920,539	Number of Trades	56,235	33,388	84,026	584,819	72,193	89,878

Table 2. Integration of Specified-Pool Trades with the TBA Market

Sample period: May 16, 2011 to October 31, 2011. Trade size is measured in current face value, calculated as the product of original par value and latest reported factor. The table reports for each size bucket the percentage of all specified-pool trades that are executed at TBA settlement dates (one date a month) and the percentage of all trades that are executed at integer prices (e.g. 100). We report separately trades in Fannie Mae 15-year conventional MBS from 30-year conventional MBS.

	Percentage of Trades with TBA Settlement Dates		**Percent of Trades Executed at Integer Prices**	
Trade Size (Current Face)	30-year Conventional	15-year Conventional	30-year Conventional	15-year Conventional
Below $5,000	17.0%	14.9%	28.5%	42.0%
$5,000 to $10,000	30.9%	18.8%	17.2%	23.3%
$10,000 to $25,000	45.1%	24.1%	11.3%	15.7%
$25,000 to 50,000	59.3%	33.8%	7.4%	9.4%
$50,000 to $100,000	58.6%	43.8%	5.4%	8.5%
$100,000 to $250,000	62.5%	49.4%	3.7%	5.7%
Above $250,000	71.5%	68.3%	1.9%	2.6%

Table 3. Regressions of 30-Year Conventional Specified Pool Prices on Benchmark TBA Prices – Large vs. Small Trades

Sample period: May 16, 2011 to October 31, 2011. Sample is restricted to securities with coupon rates between 3.5% and 6.5%. The dependent variable is reported trade price. Current face value is calculated as the product of original par value and latest reported factor. For trades with TBA settlement date, Price TBA is calculated as the daily volume-weighted average price of regular TBA trades (excluding dollar rolls and specified TBA trades) with the same settlement date, product type, and coupon. For trades with non-TBA settlement dates we use a simple adjustment for the "drop" described in the end of Section 2.B.

Panel A. Large Trades (above $50,000 of current face)

	TBA Settlement Date				Non-TBA Settlement Date			
	InterDealer	Customer Buys	Customer Sells	All	InterDealer	Customer Buys	Customer Sells	All
Price TBA	1.121***	1.067***	1.053***	1.086***	0.978***	1.010***	0.992***	0.989***
	(337.51)	(293.73)	(443.04)	(653.22)	(303.60)	(292.77)	(658.41)	(745.93)
Const.	-12.382***	-6.574***	-5.359***	-8.665***	2.199***	-0.755**	0.808***	1.217***
	(-35.12)	(-17.22)	(-21.66)	(-49.80)	(6.44)	(-2.08)	(5.13)	(8.74)
N Obs.	9,270	8,778	16,562	34,610	4,038	4,391	14,388	22,817
R-squared	0.94	0.96	0.97	0.96	0.94	0.97	0.97	0.96

Panel B. Small Trades (below $50,000 of current face)

	TBA Settlement Date				Non-TBA Settlement Date			
	InterDealer	Customer Buys	Customer Sells	All	InterDealer	Customer Buys	Customer Sells	All
Price TBA	1.228***	0.775***	0.441***	1.023***	0.774***	0.744***	0.794***	0.761***
	(50.70)	(10.58)	(7.74)	(45.99)	(72.61)	(70.48)	(157.83)	(96.83)
Const.	-26.175***	22.715***	57.712***	-4.346*	22.609***	26.741***	20.952***	23.785***
	(-9.96)	(2.90)	(9.44)	(-1.81)	(19.84)	(24.28)	(39.65)	(28.32)
N Obs.	4,643	577	2,487	7,707	21,066	6,919	33,958	39,126
R-squared	0.29	0.14	0.03	0.20	0.25	0.41	0.36	0.19

Table 4. Effective Spread for Matched Customer Buy and Customer Sell Trades in the Same Security

Sample period: May 16, 2011 to October 31, 2011. Sample is restricted to 30-year conventional securities with coupon rates between 3.5% and 6.5% and 15-year conventional securities with coupons between 3% and 6%. Current face value is calculated as the product of original par value and latest reported factor. We implement the Hong and Warga (2004, HW2004) methodology as follows. For each customer buy trade we find the closest in time customer sell trade in the same security, execution date, size bucket, and settlement date. Our implementation of Green et al. (2007) starts with the same HW2004, but also requires that the matches buy and sell trades have the same size.

		30-Year		15-year	
Trade Size (Current Face)	Statistic	HW 2004	Green *et al*. 2007	HW 2004	Green *et al*. 2007
Less than $25,000	Mean Spread	1.03	0.93	0.55	0.36
	Median Spread	0.67	0.70	0.45	0.27
	Number of trade pairs	774	537	217	162
Between $25,000 and $100,000	Mean Spread	0.38	0.28	0.20	0.18
	Median Spread	0.14	0.02	0.13	0.09
	Number of trade pairs	326	231	122	111
More than $100,000	Mean Spread	0.10	0.05	0.28	0.23
	Median Spread	0.02	0.02	0.12	0.07
	Number of trade pairs	1,692	1,168	939	638

Table 5. Decomposition of Hong-Warga (2004) Effective Spread into Customer Buy vs. Customer Sell Pay-Ups

Sample period: May 16, 2011 to October 31, 2011. Sample is restricted to 30-year conventional securities with coupon rates between 3.5% and 6.5% and 15-year conventional securities with coupons between 3% and 6%. Current face value is calculated as the product of original par value and latest reported factor. We implement the Hong and Warga (2004, HW2004) methodology as follows. For each customer buy trade we find the closest in time customer sell trade in the same security, execution date, size bucket, and settlement date. After finding the HW2004 matched trades, we calculate pay-up by subtracting the TBA price benchmark from each reported price. For trades with TBA settlement date, the TBA price benchmark is calculated as the daily volume-weighted average price of regular TBA trades (excluding dollar rolls and specified TBA trades) with the same settlement date, product type, and coupon. For trades with non-TBA settlement dates we use a simple adjustment for the "drop" described in the end of Section 2.B.

Trade Size (Current Face)	Statistic	30-Year	15-year
Less than $25,000	Mean Pay-up (Buys)	-3.40	-2.34
	Mean Pay-up (Sells)	-4.43	-2.89
	Mean Spread	1.03	0.55
	Number of trade pairs	774	217
Between $25,000 and $100,000	Mean Pay-up (Buys)	0.41	0.27
	Mean Pay-up (Sells)	0.04	0.07
	Mean Spread	0.38	0.20
	Number of trade pairs	326	122
More than $100,000	Mean Pay-up (Buys)	0.45	0.36
	Mean Pay-up (Sells)	0.36	0.08
	Mean Spread	0.10	0.28
	Number of trade pairs	1,692	939

Table 6. Three Single-Security Regressions of Raw Prices on Time Dummies and Trade Size

The table presents regressions of all customer trades in the 30-year conventional securities with the largest number of trades with coupons of 5%, 5.5% and 6%. The regressions include fixed effects for each trade date in our sample. The reported coefficients are for the interactions between dummies for each size category and dummies for customer buys vs. sells. The baseline category is customer buys with current face above $250,000. Robust t-stats in parentheses.

Trade Size (Current Face)	Trade Type	5% coupon	5.5% coupon	6% coupon
Below $5,000	Buy	-4.526***	-3.547**	-5.079***
		(-4.70)	(-2.21)	(-5.24)
	Sell	-4.309***	-4.017***	-4.689***
		(-15.94)	(-12.66)	(-19.25)
$5,000 to $10,000	Buy	-0.582	-0.487	-0.945*
		(-1.60)	(-1.07)	(-1.73)
	Sell	-1.752***	-1.355***	-2.252***
		(-10.65)	(-5.22)	(-9.71)
$10,000 to $25,000	Buy	-0.614*	-0.157	-0.300
		(-1.95)	(-0.59)	(-1.08)
	Sell	-1.337***	-0.947***	-1.329***
		(-8.89)	(-4.64)	(-6.59)
$25,000 to 50,000	Buy	-0.189	0.042	-0.023
		(-0.67)	(0.19)	(-0.09)
	Sell	-0.758***	-0.488**	-0.834***
		(-4.73)	(-2.52)	(-4.11)
$50,000 to $100,000	Buy	-0.116	-0.026	-0.078
		(-0.52)	(-0.11)	(-0.32)
	Sell	-0.548***	-0.603***	-0.609***
		(-3.30)	(-3.07)	(-3.29)
$100,000 to $250,000	Buy	-0.085	-0.003	0.209
		(-0.42)	(-0.01)	(0.79)
	Sell	-0.330	-0.143	-0.433**
		(-1.60)	(-0.43)	(-2.21)
Above $250,000	Buy	Baseline	Baseline	Baseline
	Sell	-0.161	-0.000	-0.221
		(-1.04)	(-0.00)	(-1.09)
Trade Date Fixed Effects		Yes	Yes	Yes
Constant		106.291***	108.252***	110.002***
		(280.02)	(432.08)	(318.15)
N obs.		895	728	1078
R-squared		0.44	0.41	0.41

Table 7. Regressions of Price minus Average Daily Price of Large Trades in the Same Security

The dependent variable is price for each trade minus the average price of large trades (above 100,000 in current face) in the same security on the same day. The reported coefficients are for the interactions between dummies for each size category and dummies for customer buys vs. sells. The baseline category is customer buys with current face above $100,000. Model 1 includes all observations. Model 2 restricts the estimation to securities with at least five trades in the sample period. Model 3 restricts the estimation to securities, which have at least two trades in each size category on that day. T-stats using standard errors clustered on securities are in parentheses.

		30-year			15-year		
Trade Size (Current Face)	Trade Type	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
Below $25,000	Buy	-0.804***	-0.816***	-0.892***	-0.381*	-0.407*	-0.401
		(-4.53)	(-4.59)	(-4.68)	(-1.74)	(-1.80)	(-1.29)
	Sell	-2.333***	-2.349***	-2.460***	-1.609***	-1.755***	-2.183***
		(-15.74)	(-15.82)	(-17.15)	(-6.40)	(-6.26)	(-6.99)
$25,000 to $100,000	Buy	0.238***	0.229***	0.202***	-0.057	-0.079	-0.034
		(4.49)	(4.26)	(3.24)	(-0.93)	(-1.24)	(-0.86)
	Sell	-0.336***	-0.363***	-0.456***	-0.117***	-0.152***	-0.222***
		(-10.64)	(-11.58)	(-15.56)	(-5.34)	(-5.80)	(-5.42)
Above $100,000	Buy	Baseline	Baseline	Baseline	Baseline	Baseline	Baseline
	Sell	-0.027***	-0.041***	-0.081***	-0.070***	-0.089***	-0.144***
		(-13.63)	(-12.47)	(-17.68)	(-24.79)	(-23.38)	(-30.03)
Constant		0.021***	0.032***	0.057***	0.051***	0.065***	0.092***
		(13.33)	(13.02)	(17.25)	(22.42)	(22.76)	(27.60)
N obs.		43,499	24,047	16,489	22,194	12,489	9,608
R-squared		0.33	0.31	0.30	0.22	0.24	0.28

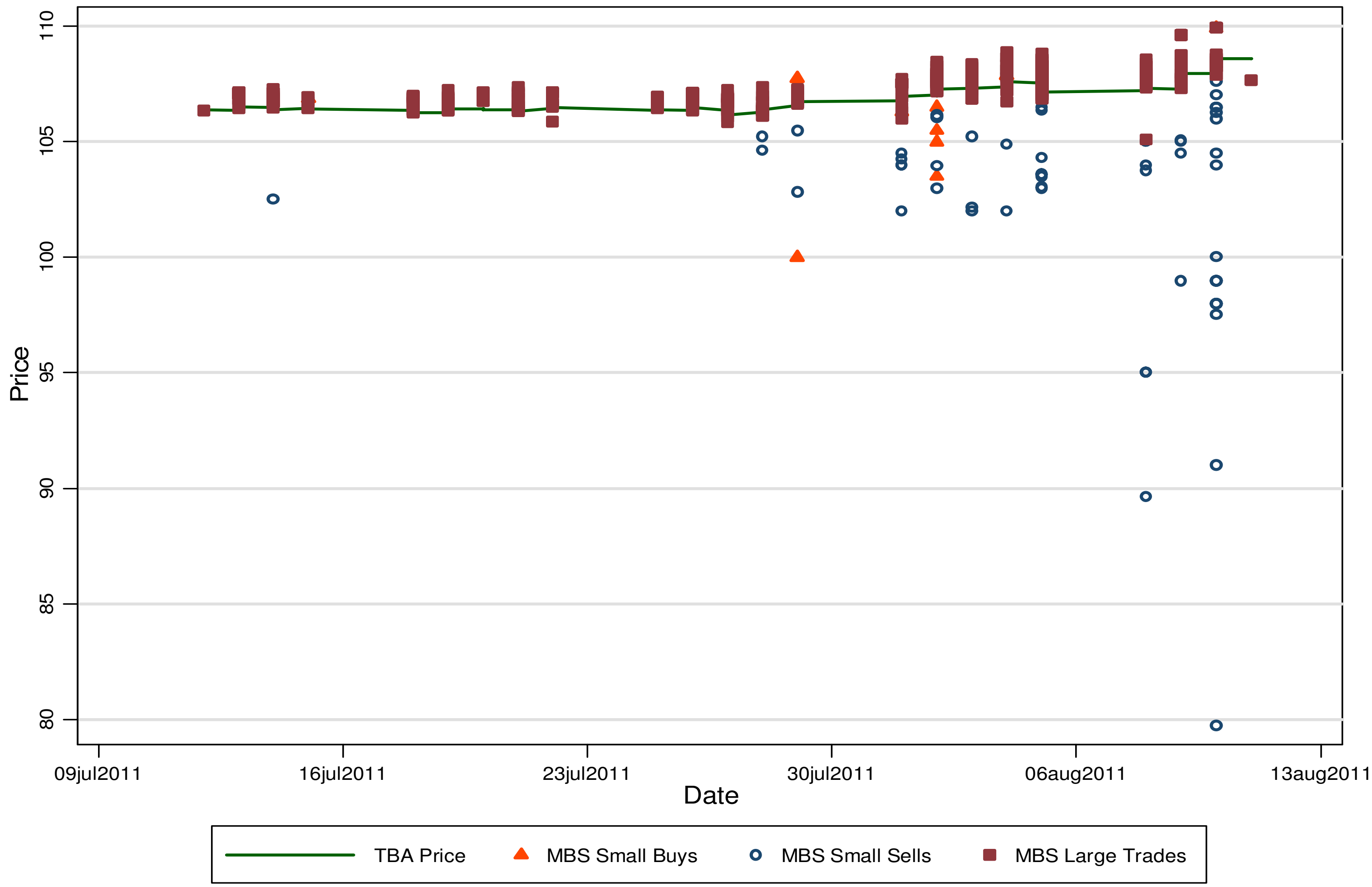

Figure 1. Distribution of the Prices of Small Buys, Small Sells, and Large Trades Relative to TBA prices (30-Year Conventional, 5% Coupon, August 2011 TBA Settlement)

Small trades are defined as trades with current face of less than $25,000. Only trades with exact TBA August 2011 settlement date are included.

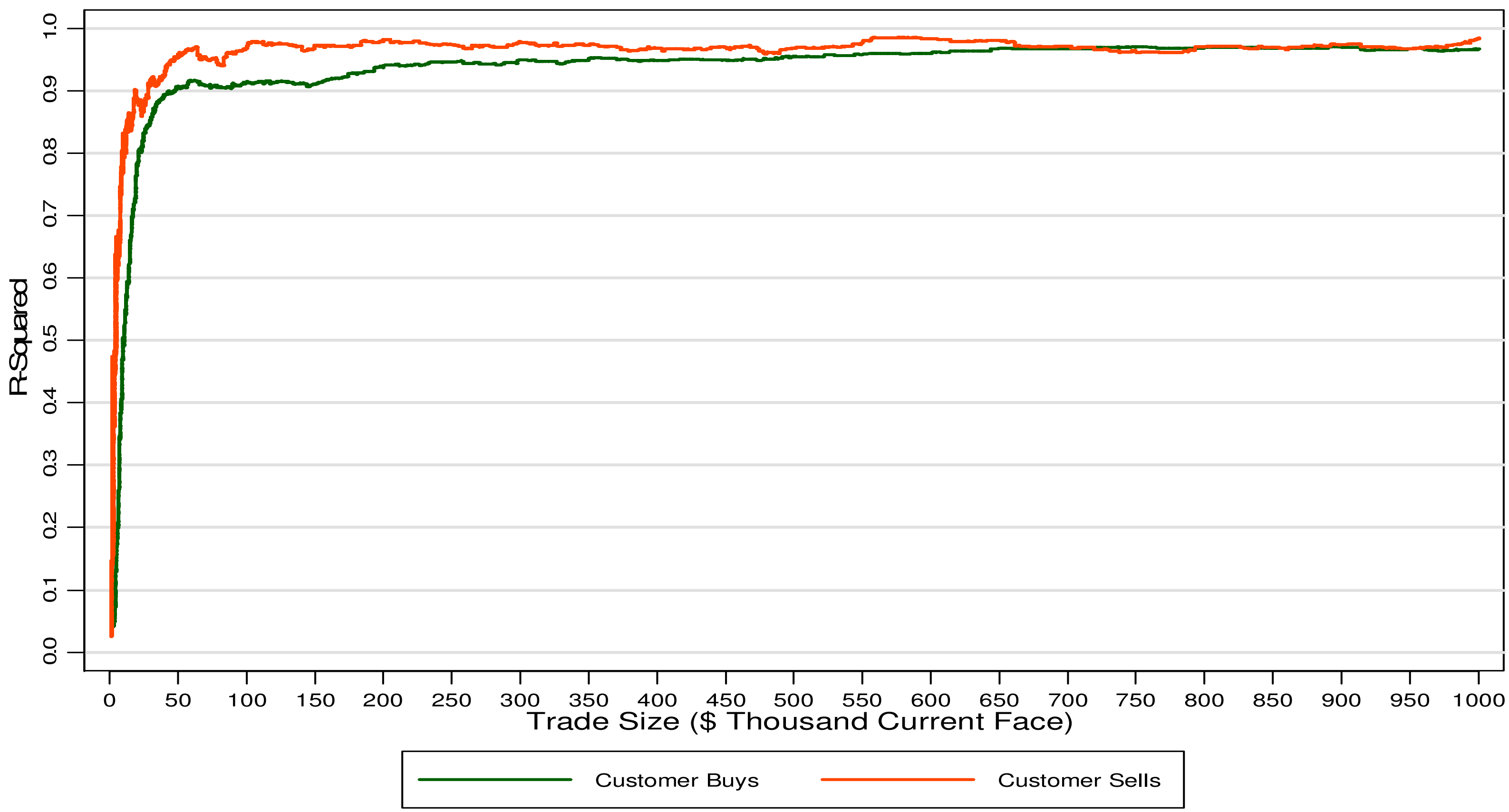

Figure 2. R-squared of Rolling-Window Regressions of Specified-Pool Prices for Customer Buy and Sell Trades on TBA Benchmark Prices as a Function of Trade Size

Sample period: May 16, 2011 to October 31, 2011. Sample is restricted to 30-year conventional securities with coupon rates between 3.5% and 6.5%. We sort all customer buy (sell) trades by current face value and then estimate a series of regressions as in Table 3 with 1,000 observations each. The first regression uses the smallest 1000 buy (sell) trades, the second regression uses trades ranged 2 to 1001 in size, all the way to the last regression, which uses the 1,000 largest buy (sell) trades. We collect the r-squared of each regression and then plot the r-squared as a function of trade size.

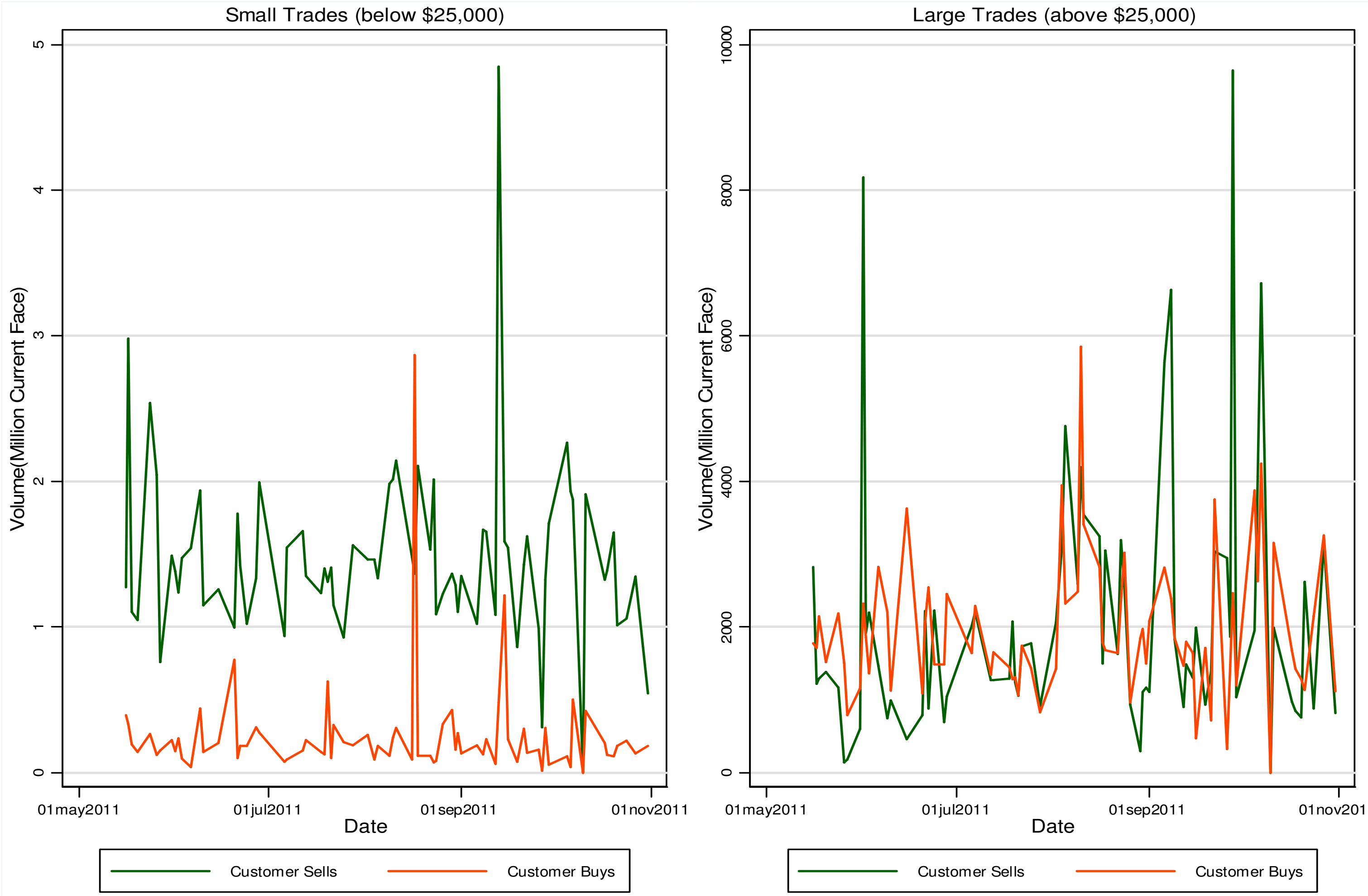

Figure 3. Customer Buy and Sell Daily Volume in 30-Year Conventional Specified-Pool Large and Small Trades

Sample is restricted to 30-year conventional securities with coupon rates between 3.5% and 6.5%. Small trades are defined as trades of less than $25,000 in current face.

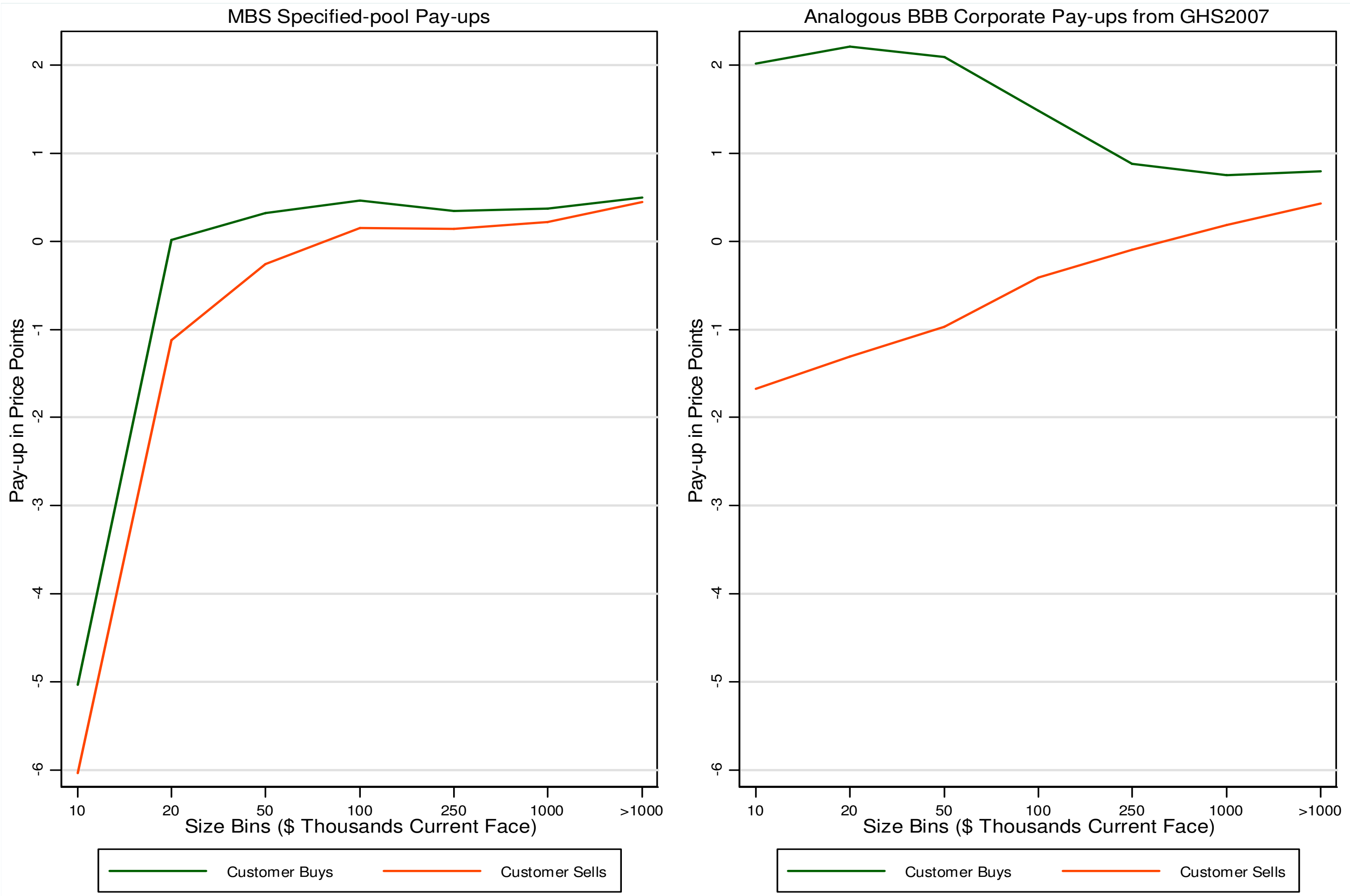

Figure 4. Average MBS Pay-Ups to TBA for Customer Buy and Sell Trades Grouped in Trade-Size Buckets Compared to Analogous Pay-Ups to Reuter Bid Price Benchmarks for BBB Corporate Bonds from Goldstein, Hotchkiss, and Sirri (2007)

The MBS pay-ups plot shows the average pay-up of Hong and Warga (2004) matched customer buy and customer sell trades calculated the same way as in Table 5. We use only 30-year conventional securities with coupons between 3.5% and 6.5%. We report average pay-ups for the same seven size buckets as in Table 9 of Goldstein, Hotchkiss, and Sirri (2007, GHS2007). The reported mean pay-ups of customer buy and sell trades or BBB corporate bonds are based on the regression coefficients reported in Table 9 in GHS2007.

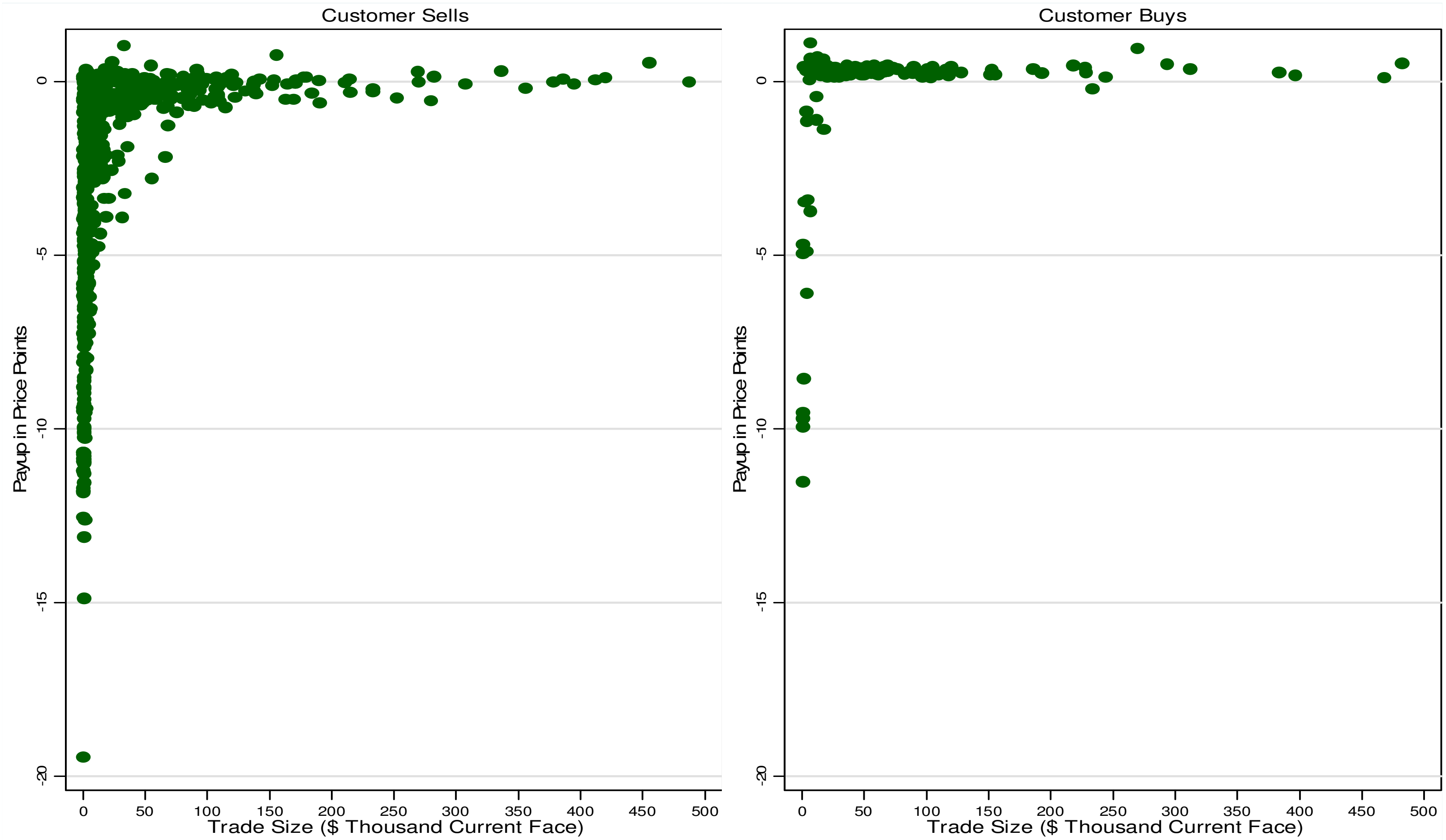

Figure 5. Scatter plots of the Pay-ups of Customer Buys and Sells vs. Trade Size (Current Face) for a Single Security

The plot shows the pay-ups of all customer trades below $500,000 in current face value in the security with the largest number of customer trades in our sample – a 6% coupon, 30-year conventional mortgage security, issued in May 2008, with almost 1,100 customer trades.

Appendix

Table A-1. Types of TBA Trades

Volume is measured in $million current face value.

TBA Trade Type	Statistic	Interdealer	Customer Buy	Customer Sell
Regular TBA	Volume (mil)	6,979,004	2,741,187	2,743,486
	Number of Trades	512,124	49,919	67,889
Stipulated TBA	Volume (mil)	8,582	123,457	74,953
	Number of Trades	2,197	3,891	3,929
Dollar Roll	Volume (mil)	5,189,561	2,334,244	2,391,055
	Number of Trades	70,159	16,361	17,106
Stipulated Dollar Roll	Volume (mil)	7,148	97,657	40,098
	Number of Trades	254	1,754	902

Table A-2. Percent of TBA Trades Executed at Integer Prices

Sample period: May 16, 2011 to October 31, 2011. The table reports for each size bucket the percentage of all TBA trades that are executed at integer prices (e.g. 100). We report separately trades in Fannie Mae 15-year conventional MBS from 30-year conventional MBS.

	Percent of Trades Executed at Integer Prices	
Trade Size (Current Face)	30-year Conventional	15-year Conventional
$25,000 to 50,000	0.63%	1.33%
$50,000 to $100,000	1.98%	0.91%
$100,000 to $250,000	1.57%	0.73%
Above $250,000	1.68%	1.38%

Table A-3. Regressions of 15-Year Conventional Specified Pool Prices on Benchmark TBA Prices – Large vs. Small Trades

Sample period: May 16, 2011 to October 31, 2011. Sample is restricted to securities with coupon rates between 3% and 6%. The dependent variable is reported trade price. Current face value is calculated as the product of original par value and latest reported factor. For trades with TBA settlement date, Price TBA is calculated as the daily volume-weighted average price of regular TBA trades (excluding dollar rolls and specified TBA trades) with the same settlement date, product type, and coupon. For trades with non-TBA settlement dates we use a simple adjustment for the "drop" described in the end of Section 2.B.

Panel A. Large Trades (above $25,000 of current face)

	TBA Settlement Date				Non-TBA Settlement Date			
	InterDealer	Customer Buys	Customer Sells	All	InterDealer	Customer Buys	Customer Sells	All
Price TBA	1.052***	1.041***	1.005***	1.023***	1.010***	1.032***	0.977***	0.996***
	(408.70)	(261.06)	(603.77)	(707.47)	(152.20)	(242.97)	(242.30)	(346.95)
Const.	-5.226***	-3.938***	-0.352**	-2.150***	-0.925	-2.942***	2.415***	0.551*
	(-19.65)	(-9.50)	(-2.03)	(-14.31)	(-1.33)	(-6.63)	(5.71)	(1.83)
N Obs.	5,743	4,860	10,782	21,385	1,804	3,210	4,758	9,772
R-squared	0.97	0.95	0.97	0.96	0.94	0.96	0.94	0.94

Panel B. Small Trades (below $25,000 of current face)

	TBA Settlement Date				Non-TBA Settlement Date			
	InterDealer	Customer Buys	Customer Sells	All	InterDealer	Customer Buys	Customer Sells	All
Price TBA	0.795***	0.366***	0.788***	0.762***	0.368***	0.874***	0.534***	0.348***
	(9.57)	(3.27)	(8.78)	(13.54)	(19.30)	(71.47)	(36.85)	(12.65)
Const.	20.469**	65.867***	21.556**	24.116***	65.691***	13.433***	48.523***	67.555***
	(2.30)	(5.50)	(2.25)	(4.01)	(32.55)	(10.54)	(31.87)	(22.94)
N Obs.	903	163	989	2,055	5,249	4,023	9,067	8,567
R-squared	0.05	0.03	0.04	0.04	0.05	0.60	0.12	0.02

Table A-4. Regressions of Pay-ups for Large Interdealer Specified-Pool Trades on Pool Characteristics

Dependent variable is the pay-up to TBA price benchmark. Sample includes only interdealer trades with current face value above $25,000. Columns named TBA include trades with TBA settlement dates. Columns named Non-TBA include trades with non-TBA settlement dates. We use set of average pool-level variables that are available to us from FINRA: Loan Balance, Loan-to-Value Ratio, FICO Credit Score, and Pool Factor. We create dummy variables that allow differential pay-up effects over alternative value ranges of each pool characteristic. For Loan Balance, we define a base bucket for values greater than $175,000 and then create four dummy variables for ranges defined by breakpoints at $150,000; $110,000; $85,000; and $0. For FICO Credit Score, we define a base bucket for values below 725 and then create three dummy variables for ranges defined by breakpoints at 750 and 765. For both Loan-to-Value Ratio and Pool Factor, we use sample quintile buckets. For each variable, we use the first quintile as the base level and then create four dummy variables for quintiles two through five. We use Days to Settlement Date, the number of days between the trade's execution and settlement dates, as an additional control.

	30-Year		15-year	
Variable	TBA	Non-TBA	TBA	Non-TBA
Loan Balance<=175000 & >150000	0.130***	0.263***	0.116***	0.032
	(6.37)	(7.57)	(7.64)	(1.02)
Loan Balance<=150000 &>110000	0.289***	0.372***	0.173***	0.143***
	(13.70)	(9.82)	(11.89)	(4.94)
Loan Balance<=110000 & >85000	0.572***	0.470***	0.347***	0.098*
	(23.67)	(6.52)	(11.83)	(1.79)
Loan Balance<=85000	0.934***	1.162***	0.790***	0.416***
	(26.76)	(13.82)	(23.65)	(4.69)
FICO Credit Score>=725 & <750	0.012	0.040	0.054**	-0.065
	(0.83)	(1.63)	(2.29)	(-1.61)
FICO Credit Score>=750 & <765	-0.063***	0.051	-0.093***	-0.146***
	(-3.41)	(1.52)	(-3.23)	(-2.78)
FICO Credit Score>=765	-0.092***	0.048	-0.071**	-0.157***
	(-4.24)	(1.07)	(-2.29)	(-2.67)
Loan-to-Value Ratio Quintile 2	0.061	0.157***	-0.038***	-0.024
	(1.59)	(3.79)	(-4.01)	(-0.80)
Loan-to-Value Ratio Quintile 3	0.131***	0.099**	0.029*	0.060
	(3.66)	(2.33)	(1.71)	(0.99)
Loan-to-Value Ratio Quintile 4	0.097***	0.057	0.054**	-0.001
	(2.68)	(1.26)	(1.98)	(-0.01)
Loan-to-Value Ratio Quintile 5	0.143***	0.108**	0.119***	0.096
	(3.83)	(2.35)	(3.61)	(1.39)
Pool Factor Quintile 2	-0.024	0.053	-0.039	0.043
	(-0.74)	(1.25)	(-1.36)	(0.84)
Pool Factor Quintile 3	0.202***	0.062	0.077**	0.117*
	(4.12)	(1.41)	(1.96)	(1.74)
Pool Factor Quintile 4	0.360***	-0.025	0.110***	0.319***
	(6.51)	(-0.40)	(2.61)	(3.36)
Pool Factor Quintile 5	0.355***	0.161**	0.078*	0.442***
	(6.27)	(2.18)	(1.73)	(4.36)
Days to Settlement Date	-0.008***	0.021***	0.007**	0.024***
	(-3.04)	(4.16)	(2.14)	(4.95)
Coupon fixed effects	Yes	Yes	Yes	Yes
Execution date fixed effects	Yes	Yes	Yes	Yes
Issue year fixed effects	Yes	Yes	Yes	Yes
Intercept	-1.104***	-0.886***	-2.703***	-1.201***
	(-2.98)	(-4.36)	(-11.61)	(-4.82)
N	9,079	4,032	5,743	1,801
Adjusted R-Squared	0.70	0.55	0.54	0.42

Table A-5. Adjusted Pay-ups to TBA Price by Trade Size Bucket

Mean and median adjusted pay-ups by size buckets for 30-year and 15-year Fannie Mae specified pools over the period between May 15 and October 31, 2011. The adjusted pay-up of any trade is the difference between raw pay-up and its predicted pay-up value for that trade as calculated by applying the coefficient estimates from the Table A-2 regressions against the full sample of trades.

		30-Year		15-Year	
Trade Size (Current Face)	Statistic	Buys	Sells	Buys	Sells
Less than $25,000	Mean Adj. Pay-up	-2.58	-2.53	-1.33	-2.45
	Median Adj. Pay-up	-0.94	-1.26	-0.30	-1.42
	Number of trades	3,137	22,553	1,113	5,852
Between $25,000 and $100,000	Mean Adj. Pay-up	-0.05	-0.56	0.08	-0.20
	Median Adj. Pay-up	-0.14	-0.45	0.13	-0.14
	Number of trades	1,428	5,746	678	2,655
More than $100,000	Mean Adj. Pay-up	0.01	-0.16	0.20	-0.12
	Median Adj. Pay-up	-0.03	-0.12	0.16	-0.11
	Number of trades	11,811	25,562	7,831	13,525

Table A-6. Proposed Trade Report for a Single Security

The table presents a proposed trade report for October 3, 2011, for a single security, a 6% coupon, mega pool of 30-year conventional MBS issued by Fannie Mae in May 2008. To preserve confidentiality, all trade-level numbers are randomly changed from their actual values.

Trades in Chosen Security								Most Recent trade in TBA first contract				Most Recent trade TBA second contract			
Trade Date	Time	Settlement Date	Original Par	Factor	Current Face	Price	Reporting Party Side	Date	Time	Settlement Date	Price	Date	Time	Settlement Date	Price
10/3/2011	11:45:00 AM	13-Oct-11	30000	0.41	12300	108.36	B	10/3/2011	11:36:46 AM	13-Oct-11	109.625	10/3/2011	11:07:03 AM	14-Nov-11	109.500
10/3/2011	12:25:20 PM	13-Oct-11	10000	0.41	4100	108.33	B	10/3/2011	12:08:15 PM	13-Oct-11	109.875	10/3/2011	11:07:03 AM	14-Nov-11	109.500
10/3/2011	1:51:47 PM	13-Oct-11	25000	0.41	10250	109.11	B	10/3/2011	1:50:07 PM	13-Oct-11	109.875	10/3/2011	11:07:03 AM	14-Nov-11	109.500
10/3/2011	4:10:42 PM	13-Oct-11	2500	0.41	1025	98.00	B	10/3/2011	4:03:39 PM	13-Oct-11	109.969	10/3/2011	2:34:08 PM	14-Nov-11	109.750
10/3/2011	4:25:08 PM	13-Oct-11	700000	0.41	287000	110.81	S	10/3/2011	4:03:39 PM	13-Oct-11	109.969	10/3/2011	2:34:08 PM	14-Nov-11	109.750
…	…	…	…												

Table A-7. Proposed Summary Report for a Single Security and Small Trade Size

The table presents proposed trade summary data for the period between October 1 and October 31, 2011, for a single security, a 6% coupon, mega pool of 30-year conventional MBS issued by Fannie Mae in May 2008. To preserve confidentiality, all security-level numbers are randomly changed from their actual values.

Panel A. Trading Summary for Chosen Security

	Exact TBA settlement date		All other settlement dates	
	Customer Buy	Customer Sell	Customer Buy	Customer Sell
Specified-Pool Trading				
Number of trades	4	8	13	77
Volume (current face)	25,700	70,257	65,942	463,614
Weighted average price	109.90	109.34	108.60	107.93
5th percentile price	109.81	100.00	90.00	97.31
25th percentile price	109.86	105.88	99.00	105.44
50th percentile price	110.00	109.75	108.53	107.16
75th percentile price	110.15	110.13	109.16	108.95
95th percentile price	110.43	110.38	109.75	109.88
Standard deviation	0.15	4.10	5.99	2.73
TBA pay-ups for exact coupon match				
Number of trades	3	8	13	77
Volume (current face)	22,000	70,257	65,942	463,614
Weighted average pay-up	-0.15	-0.85	-1.13	-1.61
5th percentile pay-up	-5.45	-9.74	-19.49	-12.83
25th percentile pay-up	-2.45	-3.54	-10.58	-4.54
50th percentile pay-up	0.15	0.03	-1.32	-2.38
75th percentile pay-up	0.45	0.26	-0.65	-0.54
95th percentile pay-up	0.85	0.66	0.32	0.25
Standard deviation	n.a.	4.29	6.17	2.94

Panel B. Trading Summary for All Securities with Same Issuer, Product, and Coupon

	Exact TBA settlement date		All other settlement dates	
	Customer Buy	Customer Sell	Customer Buy	Customer Sell
Specified-Pool Trading				
Number of trades	7	136	164	754
Volume (current face)	35,449	671,813	1,244,920	3,931,145
Weighted average price	109.06	109.37	109.26	108.47
5th percentile price	92.00	94.00	97.00	93.00
25th percentile price	100.00	100.00	107.48	106.06
50th percentile price	109.88	106.50	109.35	108.63
75th percentile price	109.91	110.34	109.78	109.27
95th percentile price	110.13	113.25	110.75	109.88
Standard deviation	8.16	6.09	3.33	4.64
TBA pay-ups for exact coupon match				
Number of trades	6	136	147	754
Volume (current face)	30,657	671,813	1,156,663	3,931,145
Weighted average pay-up	-0.64	-0.25	-0.34	-1.18
5th percentile pay-up	-17.45	-15.81	-12.79	-16.94
25th percentile pay-up	-13.49	-9.65	-2.49	-3.45
50th percentile pay-up	-4.76	-2.99	-0.06	-0.95
75th percentile pay-up	0.24	0.64	0.14	-0.43
95th percentile pay-up	0.45	3.51	1.07	0.15
Standard deviation	8.56	6.07	3.53	4.63

Table A-8. Proposed Summary Report for a Single Security and Medium Trade Size

The table presents proposed trade summary data for the period between October 1 and October 31, 2011, for a single security, a 6% coupon, mega pool of 30-year conventional MBS issued by Fannie Mae in May 2008. To preserve confidentiality, all security-level numbers are randomly changed from their actual values.

Panel A. Trading Summary for Chosen Security

	Exact TBA settlement date		All other settlement dates	
	Customer Buy	Customer Sell	Customer Buy	Customer Sell
Specified-Pool Trading				
Number of trades	5	12	5	23
Volume (current face)	200,503	509,367	265,862	1,197,446
Weighted average price	109.93	109.99	109.38	109.3
5th percentile price	109.58	109.63	108.54	108.06
25th percentile price	109.79	109.86	108.89	108.91
50th percentile price	110.02	110.05	109.35	109.27
75th percentile price	110.06	110.12	109.63	109.69
95th percentile price	110.15	110.29	109.81	110.00
Standard deviation	0.15	0.20	0.54	0.53
TBA pay-ups for exact coupon match				
Number of trades	5	12	5	23
Volume (current face)	200,503	509,367	265,862	1,197,446
Weighted average pay-up	0.28	0.27	-0.29	-0.39
5th percentile pay-up	0.24	0.18	-0.92	-1.87
25th percentile pay-up	0.25	0.24	-0.73	-0.78
50th percentile pay-up	0.29	0.28	-0.32	-0.43
75th percentile pay-up	0.42	0.31	0.02	-0.13
95th percentile pay-up	0.44	0.36	0.13	0.20
Standard deviation	0.10	0.07	0.47	0.49

Panel B. Trading Summary for All Securities with Same Issuer, Product, and Coupon

	Exact TBA settlement date		All other settlement dates	
	Customer Buy	Customer Sell	Customer Buy	Customer Sell
Specified-Pool Trading				
Number of trades	12	26	79	117
Volume (current face)	694,854	1,186,891	4,239,235	5,739,006
Weighted average price	110.05	110.13	109.64	109.46
5th percentile price	109.66	108.63	107.50	107.00
25th percentile price	109.83	109.50	109.44	109.13
50th percentile price	109.94	110.09	109.61	109.50
75th percentile price	110.22	110.50	109.80	109.78
95th percentile price	111.63	111.75	110.56	110.44
Standard deviation	0.53	0.90	0.52	0.90
TBA pay-ups for exact coupon match				
Number of trades	11	26	77	117
Volume (current face)	619,299	1,186,891	4,155,668	5,739,006
Weighted average pay-up	0.44	0.47	0.07	-0.23
5th percentile pay-up	0.07	-0.94	-2.04	-2.68
25th percentile pay-up	0.20	0.18	0.00	-0.62
50th percentile pay-up	0.26	0.30	0.09	-0.24
75th percentile pay-up	0.77	0.76	0.14	0.06
95th percentile pay-up	1.95	2.00	0.89	1.01
Standard deviation	0.54	0.84	0.45	0.87

Table A-9. Proposed Summary Report for a Single Security and Large Trade Size

The table presents proposed trade summary data for the period between October 1 and October 31, 2011, for a single security, a 6% coupon, mega pool of 30-year conventional MBS issued by Fannie Mae in May 2008. To preserve confidentiality, all security-level numbers are randomly changed from their actual values.

Panel A. Trading Summary for Chosen Security

	Exact TBA settlement date		All other settlement dates	
	Customer Buy	Customer Sell	Customer Buy	Customer Sell
Specified-Pool Trading				
Number of trades	6	7	7	14
Volume (current face)	38,253,302	4,630,988	27,950,912	32,032,989
Weighted average price	109.89	109.59	109.59	109.63
5th percentile price	109.70	109.45	109.08	108.99
25th percentile price	109.89	109.51	109.49	109.30
50th percentile price	109.92	109.81	109.60	109.49
75th percentile price	110.07	110.14	109.77	109.83
95th percentile price	110.32	110.17	109.83	109.99
Standard deviation	0.23	0.30	0.27	0.33
TBA pay-ups for exact coupon match				
Number of trades	6	7	7	14
Volume (current face)	38,253,302	4,630,988	27,950,912	32,032,989
Weighted average pay-up	0.15	0.03	0.10	-0.09
5th percentile pay-up	0.13	-0.11	-0.04	-0.63
25th percentile pay-up	0.14	-0.05	0.05	-0.25
50th percentile pay-up	0.15	0.27	0.09	-0.09
75th percentile pay-up	0.46	0.41	0.10	0.03
95th percentile pay-up	0.54	0.51	0.11	0.09
Standard deviation	0.20	0.25	0.06	0.23

Panel B. Trading Summary for All Securities with Same Issuer, Product, and Coupon

	Exact TBA settlement date		All other settlement dates	
	Customer Buy	Customer Sell	Customer Buy	Customer Sell
Specified-Pool Trading				
Number of trades	78	58	299	216
Volume (current face)	1,390,058,759	291,390,652	1,949,630,869	629,878,253
Weighted average price	110.16	110.21	110.11	109.73
5th percentile price	109.39	109.44	109.16	109.00
25th percentile price	109.72	109.98	109.52	109.56
50th percentile price	109.95	110.16	109.66	109.77
75th percentile price	110.48	110.56	109.80	109.94
95th percentile price	111.78	112.25	111.31	110.97
Standard deviation	0.69	0.63	0.57	0.59
TBA pay-ups for exact coupon match				
Number of trades	77	58	297	216
Volume (current face)	1,389,657,057	291,390,652	1,948,320,055	629,878,253
Weighted average pay-up	0.65	0.47	0.67	0.08
5th percentile pay-up	0.04	-0.16	-0.15	-0.62
25th percentile pay-up	0.13	0.28	0.03	-0.04
50th percentile pay-up	0.45	0.53	0.07	0.03
75th percentile pay-up	0.88	0.77	0.14	0.16
95th percentile pay-up	2.25	2.50	1.80	1.34
Standard deviation	0.69	0.58	0.54	0.56

Figure A-1. Example of Bloomberg Electronic Market Screen for FNMA 30-year TBA contracts

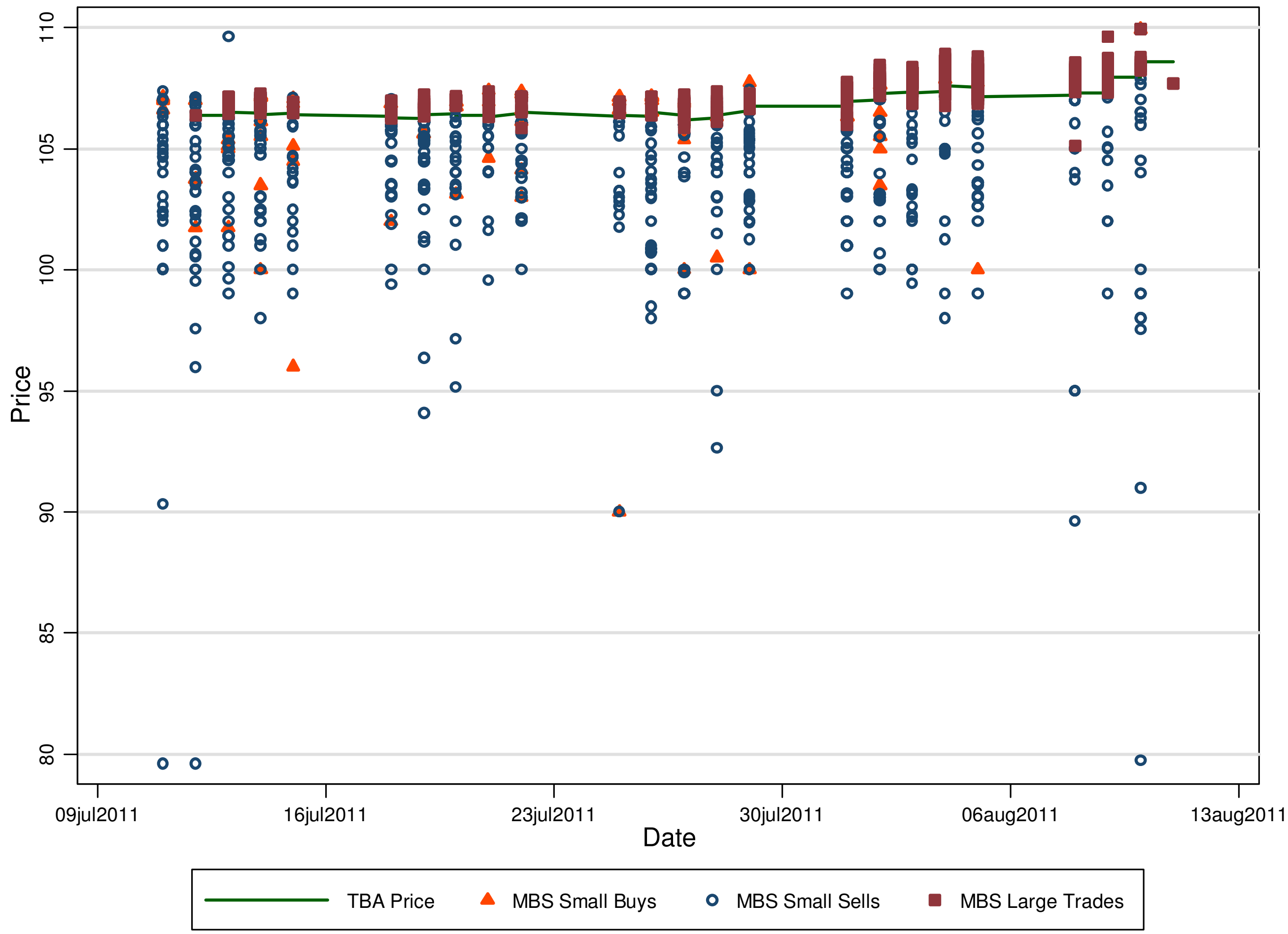

Figure A-2. Distribution of the Prices of Small Buys, Small Sells, and Large Trades Relative to TBA prices (30-Year Conventional, 5% Coupon, August 2011 TBA Settlement)

Small trades are defined as trades with current face of less than $25,000. All small trades executed after July 10, 2011 with settlement date on or before the TBA August 2011 settlement date are included.

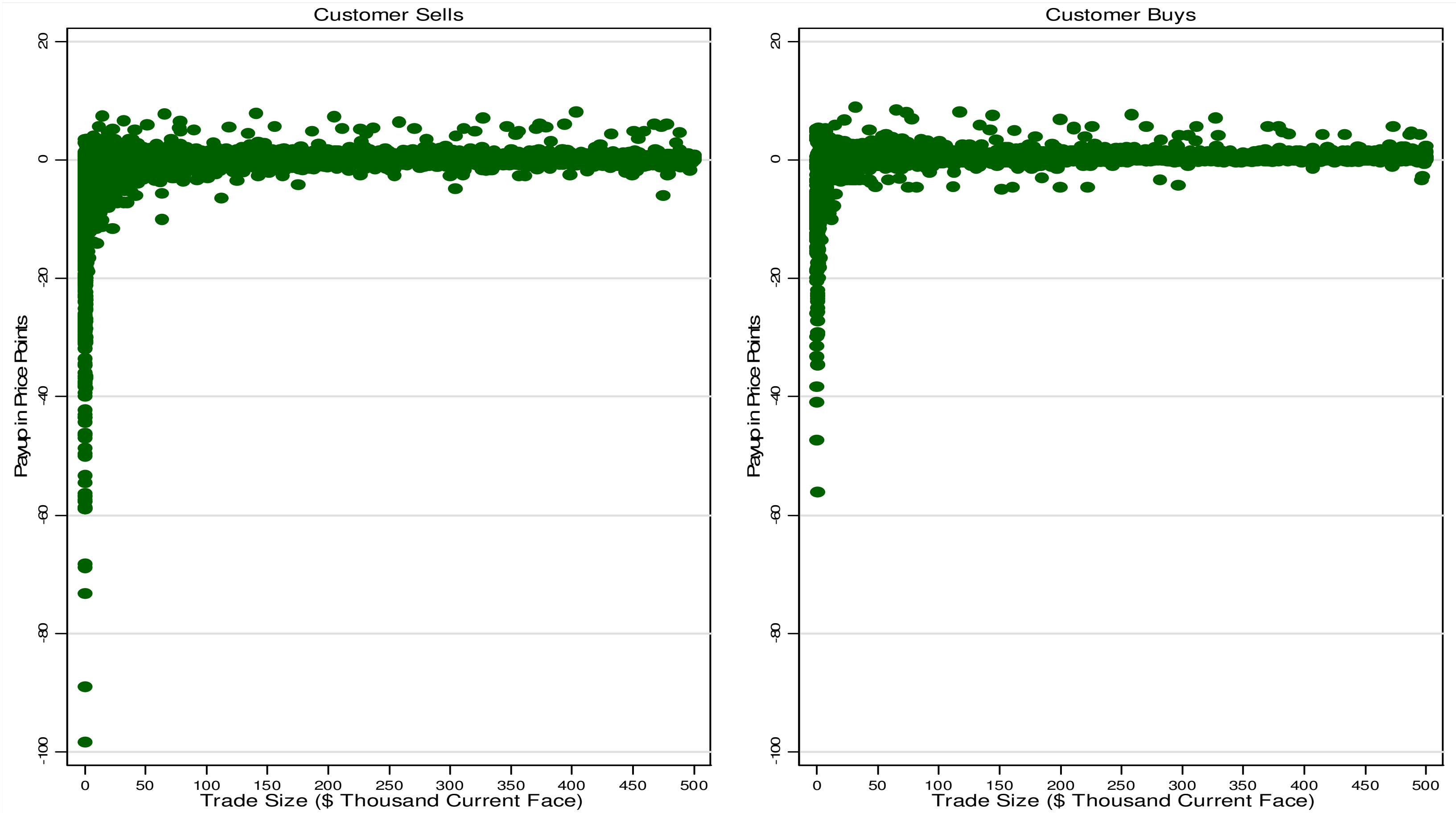

Figure A-3. Scatter plot of the Pay-ups of Customer Buys and Sells and Trade Size (Current Face Value)

The plot shows all customer trades below $500,000 in current face value in all specified-pools trades in FNMA 30-year conventional pass-throughs with coupons between 3.5% and 6.5% over the period between May 16 and October 31, 2011.