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How Do Treasury Dealers Manage Their Positions?

Michael J. Fleming
Joshua V. Rosenberg

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Abstract

Using data on U.S. Treasury dealer positions from 1990 to 2006, we find evidence of a significant role for dealers in the intertemporal intermediation of new Treasury security supply. Dealers regularly take into inventory a large share of Treasury issuance so that dealer positions increase during auction weeks. These inventory increases are only partially offset in adjacent weeks and are not significantly hedged with futures. Dealers seem to be compensated for the risk associated with these inventory changes by means of price appreciation in the subsequent week.

Key words: Treasury market, dealer, positions, inventory, hedging, issuance

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Fleming: Federal Reserve Bank of New York (e-mail: michael.fleming@ny.frb.org). Rosenberg: Federal Reserve Bank of New York (e-mail: joshua.rosenberg@ny.frb.org).

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1. Introduction

An extensive literature examines how dealer firms manage the inventory risk of the securities in which they make a market. Garman (1976), Stoll (1978), and Amihud and Mendelson (1980), for example, present models where dealers adjust prices to control inventory changes. Numerous empirical papers assess the actual inventory management behavior of dealers in equity markets, futures markets, and the foreign exchange market.[1]

Few studies examine dealer inventory management in fixed income markets, despite their importance; the Naik and Yadav (2003b) study of U.K. government bond dealers is one exception. A distinctive feature of fixed income markets is that dealer positions are subject to inventory changes not pertinent to other markets, specifically, issuance and redemptions. That is, fixed income securities are often underwritten by dealers, and by the same dealers who make secondary markets in the securities. Moreover, fixed income securities are redeemed, often within weeks of issuance, providing a regular manner of disposition distinct from the secondary market.

Extant studies also largely ignore how dealers use derivatives to manage their overall risk exposure, and no study examines the behavior of U.S. Treasury security dealers in this regard. Naik and Yadav (2003b) find that U.K. gilt dealers use futures to take directional bets and also selectively hedge spot position changes. They also find that dealers offset changes in their spot risk to a greater extent when the cost of hedging is lower, when capital constraint pressures are greater, and when economic uncertainty is greater. When Naik and Yadav

[1] See Hasbrouck and Sofianos (1993), Madhavan and Smidt (1993), and Madhavan and Sofianos (1998) for the New York Stock Exchange, Hansch, Naik, and Viswanathan (1998), Reiss and Werner (1998), and Naik and Yadav (2003a) for the London Stock Exchange, Manaster and Mann (1996) for futures markets, and Lyons (1995) and Cao, Evans, and Lyons (2006) for the foreign exchange market.

examine the profitability of dealer trading strategies, they find no evidence that dealer positions appreciate in value.

The U.S. Treasury securities market is one of the largest and most liquid fixed income markets, with an outstanding size of $4.3 trillion.[2] Our paper is the first to analyze how dealers in this market manage their positions. In particular, we assess how dealer positions respond to issuance and redemptions of Treasury securities – factors affecting dealer inventories not heretofore examined in the literature. We also examine how dealers use futures to manage their risk exposure and whether futures use is driven by the same factors that cause spot positions to change. Lastly, we test whether dealers are compensated for bearing risk and, in particular, inventory risk associated with Treasury issuance.

There is limited data on U.S. Treasury dealer positions. Our analysis is based on the weekly net positions of the primary government securities dealers over the July 1990 to June 2006 period. Dealers report their long and short spot (and historically, futures) positions in various fixed income securities to the Federal Reserve Bank of New York, which then publishes the data netted and aggregated across dealers. To our knowledge, no other paper has analyzed this positions data.[3]

We find evidence of a significant role for dealers in intertemporal intermediation. Specifically, dealers absorb a large share of new Treasury supply so that dealer positions increase during auction weeks. The inventory impact seems to be fairly persistent, lasting at least a week. Furthermore, dealer positions decline at redemption, especially for bills, suggesting that dealers buy and hold many securities from issuance through maturity. Our

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[2] Market size is based on marketable debt outstanding as of December 31, 2006 as reported in the U.S. Treasury Department's Monthly Statement of the Public Debt.
[3] Adrian and Fleming (2005) analyze changes in dealer leverage and the effects on dealer risk taking using related dealer financing data. Related trading volume and settlement fails data are analyzed in other studies.

analysis shows that Treasury issuance and redemptions by themselves explain a large share of the variation in Treasury dealer positions, highlighting a key difference in the inventory management problem facing government bond dealers versus dealers in other markets.

We also find that dealers respond differently to inventory taken on from different types of trades, by selectively hedging spot position changes depending on information content (Naik and Yadav (2003b)). In our case, information content is proxied by counterparty type. There is little asymmetric information from purchases at auction (the Treasury Department is precommitted to regular and predictable auctions), but there is potential for significant asymmetric information in trades with customers. Consistent with dealers wanting to mitigate adverse selection risk, we find that dealers use futures to hedge a much smaller share of spot position changes attributable to Treasury issuance than they do of other position changes.

Lastly, we show that dealers seem to be compensated for the inventory risk they take on during auction weeks, consistent with the prediction of standard microstructure models. We thus document a negative correlation between dealer position changes due to issuance and contemporaneous Treasury returns and a positive correlation between dealer position changes due to issuance and future Treasury returns. These results suggest that dealers buy Treasuries during auction weeks when prices are depressed and then sell these securities sometime later after prices have recovered. We therefore identify and explain a component of Treasury yield predictability not previously explored. Moreover, our findings add to the evidence from equity markets (Hendershott and Seasholes (2007)) that inventories have significant asset pricing effects at a multi-day horizon, and show that such effects can exist even when the inventory changes are common knowledge.

The paper is organized as follows. In Section 2, we discuss the role of Treasury dealers and institutional features of the market. Section 3 then discusses the data used in our empirical analysis. We present our findings on the effects of issuance and redemptions on dealer inventories in Section 4. Section 5 assesses dealer use of futures for inventory management, while Section 6 examines the asset pricing effects of dealer position management. Section 7 concludes.

2. The role of Treasury dealers

U.S. Treasury securities trade in a multiple-dealer over-the-counter market. Trading takes place 22 to 23 hours per day during the week, although 95% of the volume occurs during New York trading hours, roughly 7:30 a.m. to 5:00 p.m. (Fleming (1997)). The predominant market makers are the primary government securities dealers. Primary dealers are banks and securities broker-dealers that trade with the Federal Reserve Bank of New York in the course of its open market operations. The dealers also buy securities at auction, make markets for their customers, and take positions for hedging and speculative purposes.

When dealers trade with one another, it is nearly always through an interdealer broker (IDB). The IDB market has undergone structural change in recent years, with trading migrating from voice-assisted to fully electronic brokers (Mizrach and Neely (2006)), but the basic role of IDBs is unchanged. IDBs offer proprietary electronic screens that post bid and offer prices of participating dealers, along with the associated quantities bid or offered. Dealers execute trades by notifying brokers (by phone, and lately electronically), who then post the resulting trade price and size. The IDBs thus match buyers and sellers while ensuring anonymity, even after a trade.

A. Participating in auctions

Certain features of the Treasury market make it a good laboratory for examining how dealers manage their inventory. In the Treasury market, the primary dealers have a special obligation to "participate meaningfully" in auctions of U.S. Treasury securities.[4] This underwriting function is somewhat analogous to the "firm commitment" underwriting of an initial public offering, e.g., Ritter (1987). Dealers can consolidate advance customer orders and act as a broker for customer orders at auction. However, Treasury dealers are also expected to place competitive bids for their own account, and they are encouraged to submit bids at a range of prices to ensure that the entire issue is sold at a reasonable price**.**[5]

Because of this underwriting role, primary dealer inventories are subject to large, predictable changes associated with the Treasury auction cycle. Using data available since May 2003, Fleming (2007) finds that primary dealers acquire an average 71% share of Treasury issues sold at auction for their own accounts. These auction purchases cause dealer positions to deviate from desired levels. While this creates pure inventory risk for dealers, adverse selection risk from trading with counterparties with superior information is small. This is because the Treasury Department commits itself to a "regular and predictable" issuance schedule (Garbade (2007)), explicitly minimizing strategic behavior based on private information.

Dealers can hedge the risk of new inventory acquired at auction by selling Treasuries prior to the auction in the when-issued market, selling after the auction in the secondary

[4] Primary dealers are also expected to "make reasonably good markets in their trading relationships with the Fed's trading desk" and to "provide the trading desk with market information and analysis that may be useful to the Federal Reserve in the formulation and implementation of monetary policy." Dealer responsibilities are listed in the Federal Reserve Bank of New York's January 22, 1992 memorandum, "Administration of Relationships with Primary Dealers," posted at http://www.newyorkfed.org/markets/pridealers_policies.html.
[5] See "U.S. Primary Dealers Say Fed Urges More Active Tsy Bids at Mtg," Market News International, June 15, 2004.

market, or taking offsetting positions in other Treasury securities or derivatives markets. Alternatively, a dealer can reduce its offer price for the newly auctioned security to increase the likelihood that another customer will buy it, i.e., quote shading as discussed in Ho and Stoll (1981).

B. Making markets

Another role of dealers is to make secondary markets, meeting the transaction needs of customers and other dealers by buying and selling securities for their own account. Until 1992, the primary dealers were required to maintain a 1% share of total customer activity reported by all primary dealers. Since then, making markets to customers has not been a criterion for being a primary dealer, but the dealers are nonetheless still the predominant market makers. In the third quarter of 2006, for example, primary dealers reported average daily Treasury trading volume of $291 billion with customers and $220 billion with other dealers.[6] Dealers can hedge positions acquired through market making using the same methods described in the previous section.

Dealers generally make markets in several types of debt instruments resulting in a more complicated inventory risk management problem. Perhaps due to the decentralized decision-making of individual traders within a dealing firm, dealers could manage inventory risk over asset classes separately, e.g., Naik and Yadav (2003a). However, portfolio theory suggests that risk management should occur at the firm level as discussed in Ho and Stoll (1983).

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[6] From Federal Reserve Bank of New York's October 12, 2006 release on the "Market Share of Primary Dealer Transaction Volume," posted at ftp://ftp.ny.frb.org/Mshare/2006/Oct/ms1012.06. The customer figure is based on reported trading that did not occur through an interdealer broker, and the dealer figure is based on trading that did occur through an interdealer broker. The latter figure includes significant double-counting, because trades between primary dealers are reported by both parties.

C. Taking speculative positions

To the extent that dealers have a perceived informational advantage over other market participants, they may take on or maintain interest rate exposure by initiating transactions or by opportunistically hedging positions acquired through market making. For example, a dealer that expects interest rates to fall in the near future might accumulate a long Treasury securities position. If interest rates do indeed fall, the dealer can sell the securities at a higher price.

Given that there is no asymmetric information about Treasury security cash flows, the ability of market participants to forecast future price changes is probably limited. Nonetheless, it is possible that some market participants are better able to forecast future price changes because they have better information about discount rates. Such information might emanate from fundamentals, such as a superior ability to evaluate the state of the economy, or from technical considerations, such as knowledge of customer order flow or security ownership.

Several studies show that order flow of U.S. Treasury dealers is informative for prices, both in general (Fleming (2003) and Brandt and Kavajecz (2004)) and around macroeconomic announcements (Green (2004) and Pasquariello and Vega (2007)). Vitale (1998) finds that U.K. gilt dealer trades are informative for prices, but that customer trades are not. Massa and Simonov (2003) identify the dealers in the Italian government bond market whose trades move prices the most. In terms of profitability, Naik and Yadav (2003b) conclude that dealers do not profit from their positions, whereas Massa and Simonov (2003) identify types of dealers whose trades are profitable.

3. Data

A. Treasury dealer positions

Our data on dealer positions come from the Federal Reserve Bank of New York's FR 2004A release. The Fed collects positions data from the primary dealers on U.S. Treasury securities, agency debt securities, mortgage-backed securities (MBS), and corporate debt securities. The data are reported to the Fed on a weekly basis, as of the close of business each Wednesday. Summary data are then released by the Fed with a one-week lag.[7] The data are netted and aggregated across all dealers and are only available for broad categories of securities.

We analyze dealer Treasury positions over the weeks ending July 4, 1990 to June 28, 2006. Spot positions data are available for the full sample period, whereas futures and options data are only available until June 27, 2001.[8] Spot and futures positions are reported in terms of market value.[9] Options positions are reported in terms of the delta-weighted value of the security underlying the option. In our analyses, we generally combine the options and futures positions and refer to the combined positions as futures positions for brevity.[10]

[7] The positions data were released with a four-week lag until January 15, 2004.
[8] Spot positions include securities transacted for immediate or forward delivery. For part of our sample, futures and options positions are reported as separate categories, and for part of our sample futures positions are reported together with longer-term forward positions. For Treasuries and agencies, we group longer-term forward positions with futures positions when reported together. Longer-term forwards are a minimal part of the Treasury or agency debt markets, so our processing results in fairly consistent Treasury and agency spot and futures series. For MBS, we group longer-term forward positions with spot positions when forwards and futures are reported together. Longer-term forwards are important in the MBS market, and there has never been a large market for MBS futures, so our processing results in a consistent MBS spot series.
[9] Spot position changes are almost entirely determined by changes in portfolio composition as opposed to valuation effects. For bills and coupon-bearing securities, the overall standard deviations of weekly position changes are $7.95 and $6.94 billion, respectively, with valuation effects producing standard deviations of $0.01 billion and $0.32 billion. The valuation effects are estimated as the weekly price change of the 6-month bill (for bills) or 5-year note (for coupon-bearing securities) times dealer positions at the beginning of the week. The paper's findings are essentially unchanged when position changes are adjusted for valuation effects.
[10] The one exception is in Table 5, columns 4 and 7, where we examine dealer futures positions exclusively for consistency with other futures data with which we are comparing dealer positions.

Net dealer positions in Treasuries over our sample period are shown in Figures 1 and 2. In Figure 1, we see that spot bill positions are mostly positive over our sample, whereas positions in coupon-bearing securities ("coupon securities," or "coupons") are mostly negative and declined significantly after 2003.[11] Figure 2 plots spot and futures positions over the shorter futures sample period for bills (Figure 2A) and coupons (Figure 2B). In both panels of Figure 2, there appears to be a negative correlation between spot and futures positions. This is consistent with dealers using futures to hedge spot exposures. We also see that bill and coupon futures positions are typically negative, i.e., dealers usually hold short positions in these contracts.

In Table 1, we report summary statistics for the positions data. Coupon position levels fluctuate more than bill position levels, with a standard deviation in levels of $38.4 billion for coupons versus $12.0 billion for bills. Including futures positions results in a smaller difference; the standard deviation of the combined (hedged) position in levels is reduced to $15.6 billion for coupons, while the standard deviation falls to $9.4 billion for bills. In terms of week-to-week changes, bill positions exhibit somewhat higher volatility than coupon positions.

Previous studies (e.g., Naik and Yadav (2003b)) have interpreted a mean reversion coefficient on positions of less than one as evidence that dealers have a fixed inventory target. We find that bill positions are more strongly mean-reverting than coupon positions, with one-week spot autocorrelations of 0.77 and 0.98, respectively, and one-week hedged

[11] Bills are reported as a distinct category for our entire sample. Coupon securities are reported in several buckets, but bucket definitions change (twice) during our sample. The current buckets are: due in 3 years or less, due in more than 3 but less than or equal to 6 years, due in more than 6 but less than or equal to 11 years, and due in more than 11 years. Treasury inflation-protected securities (TIPS) are reported in their own bucket and are excluded from the paper (the data we retain reflects positions in TIPS from their introduction in January 1997 until a February 1998 reporting change separated out these positions).

(combined spot and futures) autocorrelations of 0.74 and 0.93. We can reject a random walk for hedged bill positions with an augmented Dickey-Fuller p-value of less than 0.01, but we just barely fail to reject (at the 10% level) a random walk for hedged coupon positions (p-value = 0.11). Our subsequent analysis of the inventory effects of issuance and redemptions provides a more refined test of dealer position management.

B. Variables used to explain dealer positions

To explore the determinants of dealer positions, we collect data on Treasury issuance and redemptions and several control variables. Our issuance data is from the U.S. Treasury Department. We identify the auction date, issuance size (in terms of par value), and time to maturity of every marketable Treasury security sold over our sample period. Average weekly issuance by quarter is shown in Figure 3. Bill issuance over our sample averages $42.0 billion per week and coupon issuance averages $10.4 billion, including the many weeks when there was no coupon issuance. The increase in bill issuance in the second half of 2001 and first half of 2002 can be explained by the introduction of the 4-week bill series in July 2001, as well as the Treasury's increased borrowing needs after September 11.

We also collect data on the redemption date, size, and time to maturity (at auction) of every Treasury security that matured or was called over our sample period, as well as every security that was bought back in a debt buyback operation.[12] Over our sample, 18 bonds with a total par value of $53 billion were called. All of these bonds were originally issued between 1973 and 1981; the Treasury does not currently issue callable securities. Bonds with a market

[12] See Longstaff (1992) for an analysis of callable bonds and Han, Longstaff, and Merrill (2007) for an analysis of debt buyback operations. Our sample also contains five "flower" bonds, which could be effectively redeemed before maturity by being used in lieu of cash to pay estate taxes (see Mayers and Smith (1987) for an analysis of flower bonds). Maturing amounts of flower bonds are based on the amounts outstanding at the end of the month preceding maturity (the last of which was in 1998).

value of $87 billion were bought back in 45 operations between March 9, 2000 and April 25, 2002. Average weekly redemptions by quarter are plotted in Figure 4. Overall, bill redemptions in our sample average $41.4 billion per week and coupon redemptions $8.7 billion. Securities called and bought back are dwarfed by the maturing amounts of securities.

We control for the possible effects of central bank purchases on dealer positions using data on Treasury security holdings of the Federal Reserve and foreign central banks. The holdings data are reported by the Fed on a weekly basis as of the close of business each Wednesday, and thus match the timing of the dealer data. Note that while the Fed data are comprehensive, the foreign central bank data only include holdings held in custody at the Fed and not holdings held through other financial institutions. Over our sample, Fed holdings of bills and coupon securities average $190.8 billion and $268.9 billion, respectively, and foreign central bank holdings of all Treasuries average $589.2 billion (the split between bills and coupons is not reported for foreign central banks).

To control for changes in dealer Treasury positions due to transactions in other debt securities, we collect data on dealer spot MBS and agency debt positions. These positions are also reported in the FR 2004A release. Over our sample period, MBS positions average $30.6 billion and agency debt positions $43.5 billion. We do not use data on corporate debt positions, because such data have only been collected by the Fed since July 4, 2001. However, we do incorporate data on U.S. corporate bond issuance from Thomson Financial's SDC database. We exclude convertible issues, private placements, issues denominated in foreign currencies, and issues of financial institutions. Corporate issuance – aggregated by week to correspond with our other data – averages $5.55 billion over our sample.

C. Treasury security risk and return

To assess how position changes are related to contemporaneous and future Treasury returns, we use data from the Center for Research in Securities Prices (CRSP). Daily returns are first extracted from CRSP for the on-the-run 3- and 6-month bills and 2-, 5-, and 10-year notes.[13] Daily excess returns are then calculated as actual returns less the overnight risk-free return. The overnight risk-free return is proxied by the average daily return on the 3-month bill over its remaining life, calculated as the log ratio of face value to price for the bill, divided by the number of days to maturity.[14] Log daily excess returns are summed by week ending Wednesday to correspond with our other data.

For our analysis of Treasury returns, we also construct the Cochrane-Piazzesi (2005) return forecasting factor for each week in our sample. The Cochrane-Piazzesi factor is derived from a regression of monthly Treasury bond excess returns on Treasury forward rates. To construct a weekly version of the factor, we combine forward rates from the Board of Governors (Gurkaynak, Sack, and Wright (2006)) each week using the weights given in Cochrane and Piazzessi (2005; Table 1, Panel A). Over our sample, the factor has an average value of -0.07 and a standard deviation of 1.43.

Lastly, we use Treasury price data from CRSP to calculate dealer positions in terms of the dollar value of a basis point (DV01) for robustness tests. Because our positions data are reported in aggregate terms, we estimate the DV01s on a weekly basis using the modified

[13] On-the-run securities are the most recently auctioned securities of a given maturity. We use the return for the first off-the-run security when the return for the on-the-run security is missing. Missing data include data classified as missing by CRSP as well as data that are plainly erroneous. CRSP data are completely missing from September 11-20, 2001, so we exclude from our returns analysis the weeks ending September 12, 19, and 26, 2001.

[14] We also obtained data on the overnight Treasury general collateral rate for the subset of our data starting in May 1991. Results are nearly the same when we use the return on this series instead as a proxy for the overnight risk-free return.

durations of representative, on-the-run securities.[15] Over our sample, our DV01 estimates average $0.4 million for bills and -$25.0 million for coupons.

4. The impact of issuance and redemptions on dealer inventories

A. Baseline issuance and redemption effects

We now investigate how Treasury issuance and redemptions affect dealer inventories to better understand dealer position management. It turns out that these two factors explain from one-quarter to one-half of the variation in dealer positions, thus pointing out the unique role dealers play in the intermediation of Treasury supply. Because Treasury issuance is exogenous to dealers' existing positions and risk preferences, use of this data allows for a fairly clean test of supply effects on dealer positions.

Evidence from other securities markets shows that there is substantially variability in dealer willingness to hold new inventory. For example, in the foreign exchange and futures markets, dealers typically close out their positions by the end of the trading day (Lyons (1995) and Manaster and Mann (1996)). In contrast, inventory adjustment of NYSE specialists seems to be much slower, lasting from several days to as long as one or two months (Hasbrouck and Sofianos (1993) and Madhavan and Smidt (1993)). The fact that the particular supply changes we examine in the Treasury market have a small adverse selection component suggests that Treasury dealers might be willing to take the new supply into inventory for a relatively long period of time.

[15] For bills, the DV01 is thus calculated as the market value of dealer bill positions times the average duration of the on-the-run 13- and 26-week bills, divided by 10,000. For coupons, we make use of the finer disaggregation of position reporting, so that when coupon positions are reported in four separate maturity buckets, we utilize the duration of the representative on-the-run security for that bucket, be it the 2-, 5-, 10-, or 30-year security. For the part of our sample where coupons are only reported in two buckets, we use the average duration of the representative on-the-run securities for that bucket.

Our analysis of dealer inventory adjustment is based on a regression of weekly changes in dealer positions on Treasury issuance and redemptions, controlling for changes in Federal Reserve holdings, foreign central bank holdings, dealer agency debt positions, dealer MBS positions, and the level of corporate issuance. We report effects on dealer spot as well as futures positions, and we consider bill and coupon positions both separately and together.[16] Position changes are first examined in terms of their market value, with robustness tests examining positions in terms of DV01 discussed later.

As reported in Table 2, Panel A, dealer spot positions increase substantially in response to new Treasury supply. The issuance coefficients we obtain can be interpreted as the change in dealer positions relative to auction amount. Thus, dealer bill positions increase by an average of $303 million per $1 billion of bill issuance in a week and dealer coupon positions increase by an average of $221 million per $1 billion of coupon issuance in a week.[17] The issuance coefficients indicate that dealers do not quickly sell – or hedge with other spot sales – large quantities of the Treasury securities they buy at auction.

Fleming (2007) reports that dealers buy an average 74% share of bill issues at auction and an average 60% share of coupon issues. A comparison of these figures with our issuance coefficients suggests that at the end of the auction week, dealers retain about 40% of the position exposure taken on through their auction purchases.[18] That is, dealers sell, or hedge with other spot sales, roughly 60% of the Treasuries they buy at auction in the same week.

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[16] In the regressions of bill and coupon positions, the issuance, redemptions, and Federal Reserve holdings variables are defined accordingly (i.e., bills and coupons separately). In contrast, foreign central bank holdings, agency debt positions, MBS positions, and corporate issuance are only defined in aggregate and thus do not vary across regressions.
[17] Our issuance sizes include amounts purchased by the Federal Reserve (i.e., not offered to the public). For the coupon securities, we collected additional data excluding amounts offered to the Fed, re-estimated the regression, and found that the issuance coefficient increases from 0.221 to 0.255.
[18] For bills, the 0.303 position retained divided by the 0.74 position bought = 0.409. For coupons, 0.221/0.60 = 0.368.

Surprisingly, the futures position results in Panel B of Table 2 imply that dealers use futures only minimally to hedge increases in their inventory associated with Treasury issuance.[19] For bill futures positions, the issuance coefficient is close to zero and statistically insignificant. For coupon futures positions, the coefficient is negative and statistically significant, but relatively small. On average, dealers reduce their coupon futures positions by only $31 million for every $1 billion of coupon issuance in a week. Dealers thus seem to absorb, rather than hedge using futures, most of the spot position changes attributable to Treasury issuance.

We also see that redemptions have a meaningful impact on dealer spot inventories. The redemption coefficients in Table 2 can be interpreted as the change in dealer positions relative to redemption amount. That is, dealer bill positions decline by an average of $281 million per $1 billion of bill redemptions in a week, and dealer coupon positions decline by an average of $56 million per $1 billion of coupon redemptions in a week. The large size of the bill coefficient, combined with the fact that bills are often outstanding for only a few weeks, suggest that dealers follow a "buy-and-hold" strategy for a large share of their bill portfolio, holding hold large amounts of these securities from auction through maturity.

Overall, our results point to underwriting as a key determinant of dealer positions. Essentially due to the Treasury issuance and redemption variables, we can explain 49% of the variation in bill spot position changes and 24% of the variation in coupon spot position changes (Table 2, Panel A).[20] In contrast, futures positions react little to dealer underwriting or any of our other explanatory variables. We can thus explain only 1% of the variation in

[19] It is possible that dealers hedge these inventory changes using other instruments, such as forward rate agreements or interest rate swaps, for which we do not have data.
[20] When we estimate the models without control variables – that is, with issuance and redemptions exclusively – the percent of variation explained is 48% for bill position changes and 23% for coupon position changes.

coupon futures position changes, and none of the variation in bill futures position changes (Table 2, Panel B). Our results highlight a key difference in the institutional setting and therefore the inventory management problem of government bond dealers versus dealers in the equity or foreign exchange markets.

While our analysis focuses on results in which the market value of position changes is the dependent variable, the results are robust to defining position changes in terms of DV01. For example, when we regress the weekly change in the estimated DV01 of dealer coupon positions on the DV01 of coupon securities auctioned during the week, the slope coefficient is 0.221 and highly significant statistically (standard error = 0.024). The coefficient is thus virtually the same as the corresponding coefficient in Table 2 and suggests that dealers are absorbing 22% of the risk exposure of a coupon auction as of the end of the auction week.

B. Effects of control variables

Looking at our control variables, we find evidence that dealer Treasury positions are related to MBS positions. The MBS coefficient is significant and negative in all three regressions indicating that, on average, dealer coupon positions tend to decrease (increase) by $142 million per $1 billion increase (decrease) in MBS positions. This could be a result of dealers hedging positions across markets or putting on speculative spread positions.

Federal Reserve holdings and corporate issuance are the only other control variables significant at the 5% level in at least one regression. Changes in Federal Reserve holdings are positively related to coupon position changes, but the reason for this relationship is unclear. If the Fed were buying securities from dealer inventory, one might expect to see a negative relationship. Corporate debt issuance is negatively related to changes in bill positions and all positions combined, consistent with dealer hedging of underwriting activities. The coefficient is not significant for coupons, however, where one would expect a stronger relationship because of the closer maturity match with corporate bonds.

C. Issuance and redemption effects by maturity

We next analyze whether dealer inventory management varies across the maturity dimension using finer classifications than before. We re-estimate the Table 2 regressions replacing the bill and coupon issuance and redemption variables with maturity-specific issuance and redemption variables (e.g., 3 months and 10 years). The issuance and redemption coefficients are reported in Table 3. Coefficients for the control variables are qualitatively the same as in Table 2 and are omitted from the table to save space.[21]

Consistent with our results in Table 2, the results in Table 3 show that issuance and redemptions have a larger effect on dealer bill positions than coupon positions. Moreover, the bill coefficients tend to decrease with maturity, whereas the coupon coefficients are more stable across maturities. For cash management bills, which tend to have the shortest maturities, the issuance coefficient is 0.45 and the redemption coefficient is -0.25. For 52-week bills, the longest term bills, the issuance coefficient is 0.26 and the redemption coefficient is -0.09. Coefficients for 13-week and 26-week bills are imprecisely estimated, because weekly issue sizes of these bills are highly persistent.

Shorter-term bills, and especially cash management bills, might have a greater effect on dealer inventories for various reasons. First, for the irregularly scheduled cash management bills, dealers may not be able to effectively reduce inventory by selling to customers. Customers may avoid these securities because of their irregular issuance and

[21] Also omitted to save space are coefficients for securities not issued but redeemed over our sample period (i.e., 15- , 20-, 25-, and 40-year bonds), and coefficients for securities only issued a small number of times over our sample (i.e., 4- and 7-year notes).

maturity dates as well as their short maturities. Second, dealers may be willing to hold large positions in cash management bills, because of their short maturity and hence low interest rate risk. This is consistent with an inventory management strategy focused on duration risk, which is found by Naik and Yadav (2003b) for U.K. gilt dealers.

D. Issuance effects surrounding auctions

The results in Table 2 suggest that dealers take into inventory a large share of Treasury issuance in weeks of Treasury auctions. We now explore whether dealers smooth the inventory impact of their auction purchases by selling Treasuries in the week before or week after an auction.[22] By actively managing inventories in adjacent weeks, dealers could substantially offset the effects of auctions. To examine this possibility, we refine the regressions reported in Table 2, examining the relationship between issuance and dealer position changes in the weeks surrounding an auction.

As shown by the coefficients reported in Table 4, spot positions do tend to decrease in the weeks before and after an auction. However, the effects are of small magnitude for both types of securities and only statistically significant for bills. Each additional billion dollars of bill issuance causes bill positions to decrease $46 million the week before auction, increase $338 million the week of auction, and then decrease $42 million the week after auction. Thus, our evidence indicates that dealers only marginally offset the impact of issuance on their inventories in adjacent weeks.

[22] Dealers can pre-hedge by selling from inventory securities similar to those expected to be acquired at auction or by selling securities in the when-issued market. FR 2004A data includes when-issued positions.

5. Dealer use of futures for inventory management

In this section, we explore dealer use of futures for inventory management. In particular, we examine the relationship between dealer spot and futures positions by regressing changes in futures positions on changes in spot positions. One might expect that dealers use futures to hedge changes in spot positions, which would generate a negative relationship between changes in spot and futures positions.

In fact, we do find that Treasury futures and spot positions tend to move in opposite directions, as shown in columns 2 and 5 of Table 5. The coefficient on bill spot positions is small and marginally significant and suggests that bill futures positions decrease (increase) by $14 million for every $1 billion increase (decrease) in bill spot positions. In contrast, the coefficient for coupon positions is both sizable in magnitude and highly significant. On average, coupon futures positions decrease (increase) by $219 million for every $1 billion increase (decrease) in coupon spot positions. In both cases, the hedge ratios are significantly less than one, suggesting that dealers retain a significant amount of risk despite their hedging activities.

We are particularly interested in whether dealers selectively hedge their spot positions by adjusting the amount they hedge depending on the nature of the trade. For this reason, we separate position changes into components attributable to issuance, redemptions, and other factors (which may reflect speculative, hedging, or customer flows). The issuance and redemption components are derived from the Table 2 models for bills and coupons and the third component is estimated as the position change not attributable to issuance or redemptions. To test for selective hedging, we regress futures position changes on all three components.

The results, shown in columns 3 and 6 of Table 5, reveal that futures are used to hedge position changes due to issuance and redemption to a much smaller degree than other position changes. For bills, the coefficients on position changes due to issuance and redemptions are close to zero and statistically insignificant, whereas the coefficient on position changes due to other factors is negative (-0.039) and statistically significant. For coupons, the coefficient on position changes due to issuance is negative (-0.104) and statistically significant, but smaller than the coefficient on position changes due to other factors (-0.273). The coefficient on position changes due to redemptions for coupons is statistically insignificant.[23]

Why might dealers use futures to hedge changes in inventory attributable to issuance and redemptions to a much smaller degree than position changes attributable to other factors? The rationale for the insignificant redemption coefficients is fairly straightforward. Securities that are about to mature have very low price risk and high liquidity and are thus similar to cash, obviating the need for hedging. While redemptions are important in an accounting sense when evaluating dealers' nominal position changes, they are not very important to dealers in managing inventory risk.

The explanation for the smaller issuance coefficients may be that position changes due to issuance expose dealers to relatively little adverse selection risk and are thus not as important to hedge. As noted earlier, the Treasury limits its ability to benefit from private information through its regular and predictable issuance schedule. In contrast, position

[23] For both bills and coupons, the coefficients on position changes due to issuance are significantly different from the coefficients on position changes due to other factors at the 1% level. For coupons, the coefficient on position changes due to redemptions is significantly different from the one on position changes due to other factors at the 5% level, but the coefficients are insignificantly different for bills. For bills, the coefficients on issuance and redemptions are significantly different at the 10% level, but the coefficients are insignificantly different for coupons.

changes due to market-making activities might emanate from customer trades that are based on private information. These are exactly the types of inventory changes that a dealer would prefer to offset. This interpretation of our findings is consistent with Naik and Yadav (2003b), who find that U.K. gilt dealers hedge more when perceived informational asymmetry is high, such as on days before major macroeconomic announcements.

While it may seem more natural to assume that dealers hedge spot positions with futures – and this is the interpretation offered by Naik and Yadav (2003b) – it is possible that dealers hedge futures positions with spot positions. Evidence offered in columns 4 and 7 of Table 5, however, is consistent with the former interpretation. The results show that primary dealer futures position changes are highly correlated with the futures position changes of commercial traders as reported by the Commodity Futures Trading Commission in the weekly Commitments of Traders report.[24] Commercial traders are generally classified as those who use futures or options markets for hedging. This evidence therefore suggests that primary dealers generally categorize themselves as hedgers in the futures market.

6. Asset pricing effects of dealer position management

We now use our data on Treasury dealer positions, Treasury issuance, and Treasury returns to examine asset pricing effects related to dealer inventory management. In their underwriting and market-making roles, dealers accumulate undesired inventory. This inventory is costly to dealers, because it generates both inventory risk and asymmetric information risk. We investigate whether dealers are indirectly compensated for the resulting

[24] We match the weekly Commitments of Traders positions data (reported as of the close each Tuesday) as close as possible to the weekly FR 2004A positions data (reported as of the close each Wednesday).

risk by price appreciation of these positions.[25] Specifically, we assess whether dealers acquire positions at prices below their long-run expected value, and, if so, whether such positions subsequently appreciate in value.[26] We then extend this analysis by determining whether dealer compensation for risk depends on counterparty type (U.S. Treasury versus other dealers or customers).

The existing literature addresses several closely related questions. First, a number of studies have shown that dealers are compensated for participating in the primary market in that Treasuries tend to be auctioned at prices lower than those in the secondary market, e.g., Cammack (1991), Spindt and Stolz (1992), and Simon (1994). Second, a negative relationship has been found between Treasury supply and prices. Individual issue sizes are examined in Simon (1991, 1994), Duffee (1996), and Fleming (2002), long- versus short-term supply is examined by Greenwood and Vayanos (2008), while Krishnamurthy and Vissing-Jorgensen (2007) analyze overall outstanding Treasury supply. Third, Hendershott and Seasholes (2007) identify asset pricing effects at a multi-day horizon for market-maker (NYSE specialist) inventory shocks.

Our analysis differs from the existing literature in several ways. First, our primary interest is in dealer compensation for the risk associated with inventory changes as evidenced by future appreciation of these positions. This is in contrast to analyses of underpricing, which focus on contemporaneous differentials between primary and secondary market

[25] Compensation for risk need not only be received by dealers. Other market participants who provide liquidity services (e.g., hedge funds or proprietary trading desks) would also receive such compensation.

[26] As explained in Hendershott and Seasholes (2007), "Empirical studies linking liquidity provision to asset prices follow naturally from inventory models…. [L]iquidity suppliers/arbitrageurs are willing to accommodate trades – and, therefore, hold suboptimal portfolios – only if they are able to buy (sell) at a discount (premium) relative to future prices. (p. 210)"

prices.[27] Second, previous studies of asset pricing effects of Treasury supply identify permanent price effects, whereas we examine the transitory price impact associated with issuance and the reallocation of supply from a small group of intermediaries to a broader set of market participants.

Our approach is most similar to Hendershott and Seasholes (2007) in that we explore whether there is a transitory but somewhat persistent price effect of shocks to market-maker inventories. However, an interesting difference is that Hendershott and Seasholes focus on price effects of private-knowledge inventory shocks measured using individual NYSE specialist inventories. In contrast, our analysis measures price effects of predictable, publicly known inventory changes; namely, those due to Treasury issuance. The fact that the size and timing of the issuance inventory changes is common knowledge does not preclude a price effect to the extent that such an effect is fair compensation for bearing inventory risk. In fact, anecdotal evidence supports the idea that Treasury issues cheapen around auction dates to attract sufficient demand for the new supply.[28]

A. Preliminary analysis using aggregate dealer position changes

We are interested in whether dealers tend to acquire Treasury positions at prices below equilibrium, and, if so, whether such positions subsequently appreciate in value. If dealers are compensated for inventory risk in this way, and dealer position changes are dominated by inventory considerations, then we would expect to find evidence of return reversals (e.g., Hendershott and Seasholes (2007)). In particular, we would expect to see a

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[27] Because we only examine secondary market prices, our analysis does not incorporate dealer compensation for buying securities at auction versus in the secondary market.

[28] For example, see, "Treasurys End Modestly Lower On Refunding Pressures," Ramez Mikdashi, Dow Jones Newswires, November 8, 2004 and "U.S. Treasuries Firm to Day's Highs as Stocks Sag," Ros Krasny, Reuters News, January 11, 2005.

negative contemporaneous relationship between position changes and excess Treasury returns and a positive relationship between position changes and future excess Treasury returns.

In Table 6, we report the aggregate position and return relationship using a regression of weekly excess returns on contemporaneous and lagged values of weekly spot position changes.[29] Bill returns are regressed on changes in bill positions and coupon returns on changes in coupon positions. To control for the Treasury return predictability documented by Cochrane and Piazzesi (2005), we include their return forecasting factor (measured as of the end of the previous week) in our regressions.

Our first evidence on compensation for intertemporal intermediation is mixed. The contemporaneous relationship between returns and aggregate position changes is statistically insignificant for bills. For coupons, the relationship is positive and statistically significant. The positive contemporaneous relationship is inconsistent with dealers receiving compensation for inventory risk by buying when prices are low. In contrast, the finding is consistent with dealer order flow containing information that moves prices and with that flow originating from dealers as opposed to customers.[30]

When we examine the relationship between returns and the previous week's position changes, we find that a change in positions is generally followed by an appreciation in position value. Specifically, the coefficients on the previous week's position change are

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[29] Results based on combined spot and futures positions (for the shorter sample period over which we have futures data) are qualitatively similar. This is not surprising given our earlier finding that dealers only partially hedge their spot position changes with futures.

[30] Extant studies (e.g., Fleming (2003) and Brandt and Kavajecz (2004)) show that dealer order flow is informative for U.S. Treasury security prices, but cannot distinguish between flow that originates with dealers (e.g., due to dealer speculation) versus flow that originates with customers (and then is passed on via dealers). If the latter were true, one would expect to see prices responding to order flow without dealer positions changing. In contrast, if the former is true, one would expect to see dealer positions changing in the same direction as prices as we find here.

positive and statistically significant for all five securities. This evidence is consistent with dealers being compensated for inventory risk and/or dealers profiting from speculation.[31] Lastly, we find that the Cochrane-Piazzesi coefficient is positive and significant in all three coupon regressions, and positive but insignificant in the bill regressions.

The explanatory power of these models ranges from 0.0% for the 6-month bill to 5.8% for the 10-year note, suggesting that dealer position changes explain only a small share of the variation in excess Treasury returns. Moreover, for the notes, most of the explanatory power is coming from the contemporaneous position change. For the 10-year note, for example, the contemporaneous position change explains 4.3% of the variation in returns so that the incremental contribution from the previous week's position change and the Cochrane-Piazzesi factor is 1.5% (1.5% = 5.8% - 4.3%).[32]

As a robustness test, we repeat our analysis using the estimated DV01 of dealer bill and coupon positions. The results are qualitatively similar. For the 2-year note, for example, each $1 million increase in the DV01 of dealer coupon positions is associated with a return increase of 1.19 (standard error = 0.26) basis points (bp) that week and 0.44 (standard error = 0.19) bp the following week. The Cochrane-Piazzesi coefficient is nearly the same in this model and the adjusted R^2 of 4.6% is slightly higher. Qualitative results are also similar for DV01 robustness tests on subsequent analyses and are therefore not discussed separately.

[31] Since data on dealer positions are only released to the public with a lag, any value positions data have at explaining future price changes would not necessarily be arbitraged away.

[32] In monthly Treasury return predictability regressions, Cochrane and Piazzesi (2005) document explanatory power ranging from 9% to 16% for forward versus spot spreads, from 22% to 26% for slope, level, and curvature factors, from 15% to 33% for combinations of one-, four-, and five-year spot yields, and from 36% to 39% for one- to five-year forward rates.

B. Dealer compensation for inventory risk and other factors

In this section, we examine differences in dealer compensation for inventory risk and other factors. We decompose position changes into a component attributable to issuance and a component attributable to other factors (e.g., customer flows, dealer hedging, or dealer speculative activity). The issuance component is derived from the Table 2 models for bills and coupons and the other component is estimated as the position change not attributable to issuance.

The results in Table 7 provide fairly strong evidence that dealers are compensated for intertemporal intermediation of new Treasury supply. We find a negative and statistically significant contemporaneous relationship between position changes due to issuance and excess Treasury returns for all five securities. The negative relationship is consistent with dealers accumulating positions during the week of an auction when the new supply also causes prices to decline. Looking at what happens the subsequent week, we see that the excess inventory taken on by dealers at auction tends to appreciate. The coefficients on the previous week's position changes due to issuance are thus positive for all five securities and statistically significant for all three notes. Taken together, the results suggest that dealers receive compensation for intertemporally intermediating issuance by buying when prices are low and selling when prices are high.

In contrast, we do not find evidence that dealers are compensated for the non-issuance component of position changes. In particular, we do not detect a significant relationship between the non-issuance component of bill position changes and contemporaneous returns. For coupon securities, the non-issuance component of position changes is significantly positively correlated with contemporaneous returns.[33] However, there is little indication of a relationship between the non-issuance component of position changes and returns in the subsequent week. The coefficients are positive, but significantly so only for the 3-month bill, providing at best weak support for the hypothesis that dealers are successfully speculating or being compensated for this type of inventory risk.

In sum, we uncover evidence that dealers are compensated for inventory risk associated with Treasury supply changes via return reversals. Despite the Treasury market's liquidity, new Treasury issues are large enough to temporarily depress prices. Dealers mitigate price disruptions by buying securities at auction and selling them to other market participants over time. Such intertemporal intermediation is facilitated by the Treasury's commitment to not use private information, but also by the compensation dealers receive through the subsequent price appreciation of securities bought at the time of auction.

In terms of magnitude, the results in Table 7 show that each additional billion dollars of position changes attributable to coupon issuance is associated with a 5-year note return 1.5 bp lower over the auction week and 2.6 bp higher the following week. Given an average coupon auction size of $16.9 billion over our sample, and that dealers retain 22.1% of what is auctioned at the end of that week, the results imply that a single auction is associated with 5-year note returns 5.6 bp lower the auction week and 9.7 bp higher the following week.

The effects in terms of yield can be estimated by dividing the returns by the negative of the security's average modified duration over our sample (e.g., -4.7 for the 5-year note). A single auction is thereby associated with 5-year yields 1.2 bp higher the week of an auction

[33] This is the opposite relationship we saw for position changes due to issuance, but the same relationship we saw for aggregate position changes in Table 6, pointing to the importance of our decomposition in assessing inventory risk compensation. Additional evidence supporting the relevance of our decomposition comes from the higher explanatory power of these models. That is, the adjusted R-squared values in Table 7 are uniformly higher than those in Table 6.

and 2.1 bp lower the following week. The effects in terms of yield are similar for the 2-year note (+1.5 bp auction week, -1.1 bp subsequent week) and 10-year note (+1.0 bp auction week, -2.5 bp subsequent week).

For comparison, studies of underpricing in Treasury auctions conducted over our sample period identify a primary versus secondary market yield differential of about ½ to 1 bp (Simon (1994), Nyborg and Sundaresan (1996), and Goldreich (2007)). As mentioned above, we find a pattern whereby secondary market yields tend to be 1 to 2.5 bp lower the auction week than adjacent weeks. Our results thus imply that much of the return to dealers from underwriting Treasury auctions come from the dealers' intertemporal intermediation of supply across weeks.

C. Analysis of Trading Strategies

Another way to consider the potential returns from the intertemporal intermediation of new Treasury supply is to assess the profitability of a trading strategy that attempts to exploit the relationship between issuance and returns. To do this, we measure the risk and return to a strategy of selling Treasury securities if there is a coupon auction in the coming week and buying securities if there was a coupon auction in the preceding week. If neither or both conditions hold, then no position is assumed. The positions are closed out one week later. We do not assess the strategy for bills because there is a bill auction in every week of our sample.

We report results for this "issuance strategy" in Panel A of Table 8. On average, such a strategy is profitable, leading to average excess returns of 2.5 bp for the 2-year note, 9.7 bp for the 5-year note, and 17.0 bp for the 10-year note. The increase in expected return along the maturity dimension is accompanied by an increase in risk. The standard deviation of weekly returns is thus 23.5 bp for the 2-year note, 58.3 bp for the 5-year note, and 94.2 bp for the 10-year note. Sharpe ratios for the notes are 0.11, 0.17, and 0.18, respectively. These results support our earlier findings that dealers are compensated for bearing the risk of inventory taken in at auction.

While we do not incorporate transaction costs in our analysis, such costs tend to be appreciably smaller than the excess returns we identify. For example, Fleming (1997) reports average interdealer bid-ask spreads (in terms of price) of roughly 0.8, 1.5, and 2.5 bp for the 2-, 5-, and 10-year notes.

We also note that our analysis implicitly takes general financing costs into account by considering excess returns, but that our analysis does not incorporate "special" financing costs. As explained in Duffie (1996), on-the-run securities frequently trade special, making it more expensive for a short seller to borrow such securities to make delivery, but also providing an additional return to owners of the securities who can lend them out. Since the issuance strategy we consider involves taking a long position as often as taking a short position, a trader could potentially profit from lending a special security as often as it incurred additional costs to borrow a special security.

How do returns from the issuance strategy compare to those from a strategy derived from the Cochrane-Piazzesi factor? To answer this question, we measure the risk and return to a simple trading strategy based on the factor. The strategy involves taking a long position in Treasuries when the Cochrane-Piazzesi factor is positive and a short position when the factor is negative. Positions are closed out one week later. As shown in Panel B of Table 8, returns and Sharpe ratios for the "Cochrane-Piazzesi strategy" are less than half those of the issuance strategy for the 5- and 10-year notes. The two strategies perform similarly for trades involving the 2-year note.

Finally, we report the characteristics of a simple long-only trading strategy in which a security is purchased in the secondary market at the end of each week, held for one week, and then sold. Return characteristics of this "long only strategy" are shown in Panel C of Table 8. Notably, we see that Sharpe ratios for the strategy (ranging from 0.04 to 0.05) are well below those of the issuance strategy and the Cochrane-Piazzesi strategy for the corresponding securities.

7. Conclusions

The regular issuance and redemption of securities creates a different inventory management problem for government bond dealers versus equity or foreign exchange dealers. We assess how U.S. Treasury dealers manage their positions and in fact find that underwriting plays a key role. As explained by Madhavan (2000), "[J]ust as physical market places consolidate buyers and sellers in *space*, the market maker can be seen as an institution to bring buyers and sellers together in *time* through the use of inventory." Our findings emphasize the key role of dealers in the intertemporal intermediation of new Treasury supply.

Specifically, we find that Treasury dealers absorb a large share of new Treasury supply by retaining securities bought at auction instead of immediately selling these or similar securities to other investors. Moreover, dealers retain this exposure for at least a week, offsetting only small shares of their auction week purchases in adjacent weeks. Further results show that dealers still hold large shares of issues at maturity, especially issues with short original maturities.

We also find that dealers adjust their response to new inventory differently depending on the source of the trade. In particular, we show that Treasury dealers engage in selective hedging, offsetting a much smaller share of spot position changes in the futures market when such changes are explained by issuance and redemptions. Presumably there is less need to hedge these inventory changes because they are not information-based. Such behavior is consistent with that of U.K. government bond dealers, documented by Naik and Yadav (2003b), who also adjust their hedging depending on the perceived level of asymmetric information.

Lastly, we identify patterns in Treasury returns related to dealer intermediation of new Treasury supply, thus explaining a component of Treasury yield predictability not previously explored. These patterns suggest that dealers are compensated for their intertemporal intermediation of Treasury issuance, consistent with the prediction of standard microstructure models. That is, dealers tend to buy Treasuries during auction weeks when prices are depressed by the new supply and are then compensated by price appreciation the subsequent week. Our results therefore add to the evidence from equity markets (Hendershott and Seasholes (2007)) that inventories have significant asset pricing effects at a multi-day horizon, and show that such effects can exist even when the inventory changes are publicly known.

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Table 1: Descriptive Statistics of Dealer Treasury Positions

This table reports descriptive statistics of primary dealer net spot (Panel A), futures (Panel B), and spot and futures combined (Panel C) positions in U.S. Treasury securities in billions of dollars for the weeks ending July 4, 1990 to June 28, 2006 (Panel A) or July 4, 1990 to June 27, 2001 (Panels B and C).

Panel A: Spot Positions

	Levels		Weekly Changes	
	Bill Positions	Coupon Positions	Bill Positions	Coupon Positions
Mean	11.04	-46.72	-0.04	-0.14
Standard deviation	11.97	38.38	7.95	6.94
Autocorrelation (1 week)	0.772	0.980	-0.068	-0.165
Number of observations	835	835	834	834

Panel B: Futures Positions

	Levels		Weekly Changes	
	Bill Positions	Coupon Positions	Bill Positions	Coupon Positions
Mean	-3.67	-4.94	0.01	0.02
Standard deviation	5.25	12.03	1.63	3.25
Autocorrelation (1 week)	0.951	0.963	0.117	-0.043
Number of observations	574	574	573	573

Panel C: Combined Spot and Futures Positions

	Levels		Weekly Changes	
	Bill Positions	Coupon Positions	Bill Positions	Coupon Positions
Mean	5.03	-31.99	0.01	-0.03
Standard deviation	9.43	15.59	6.83	5.64
Autocorrelation (1 week)	0.737	0.934	-0.175	-0.271
Number of observations	574	574	573	573

Table 2: Determinants of Dealer Treasury Positions

This table reports results from regressions of weekly changes in primary dealer net spot (Panel A) and futures (Panel B) positions in U.S. Treasury securities on weekly auction amounts of Treasury securities, redemptions of Treasury securities (including buybacks, calls, and regular maturities), changes in Federal Reserve holdings of Treasury securities, changes in foreign central bank holdings of Treasury securities, changes in dealer agency debt positions, changes in dealer MBS positions, and U.S. corporate bond issuance for the July 4, 1990 to June 28, 2006 period (Panel A) or July 4, 1990 to June 27, 2001 period (Panel B). Results are reported separately for bills, coupon-bearing securities, and all Treasury securities combined and the issuance, redemption, and Federal Reserve holdings variables are defined accordingly (the other variables are only defined in aggregate and do not vary across columns). Coefficients are reported with heteroskedasticity- and autocorrelation-consistent (Newey-West) standard errors in parentheses. All variables are in billions of dollars. One, two, and three asterisks indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Panel A: Spot Position Change			Panel B: Futures Position Change		
	Dependent Variable: Weekly Spot Position Change			Dependent Variable: Weekly Futures Position Change		
Independent Variable	All Positions	Bill Positions	Coupon Positions	All Positions	Bill Positions	Coupon Positions
Constant	-1.531 **	-0.563	-1.866 ***	0.586	-0.311	0.568 **
	(0.712)	(0.407)	(0.418)	(0.602)	(0.270)	(0.256)
Issuance	0.213 ***	0.303 ***	0.221 ***	-0.008	0.006	-0.031 **
	(0.013)	(0.017)	(0.018)	(0.009)	(0.004)	(0.014)
Redemptions	-0.178 ***	-0.281 ***	-0.056 ***	-0.003	0.003	-0.008
	(0.016)	(0.017)	(0.019)	(0.010)	(0.005)	(0.014)
Federal Reserve holdings	-0.144	0.021	0.446 **	0.044	-0.016	0.116
	(0.112)	(0.081)	(0.224)	(0.066)	(0.028)	(0.134)
Foreign central bank holdings	0.097	-0.001	-0.044	0.041	0.000	0.034
	(0.061)	(0.041)	(0.051)	(0.038)	(0.013)	(0.036)
Agency debt positions	0.007	0.080 *	-0.028	-0.035	0.022 *	-0.059
	(0.072)	(0.047)	(0.053)	(0.045)	(0.012)	(0.043)
MBS positions	-0.316 ***	-0.144 ***	-0.142 ***	-0.056	-0.018	-0.046
	(0.075)	(0.046)	(0.053)	(0.047)	(0.015)	(0.044)
Corporate issuance	-0.153 **	-0.103 **	-0.038	-0.037	0.006	-0.048 *
	(0.059)	(0.040)	(0.047)	(0.032)	(0.010)	(0.029)
Adjusted R^2	29.3%	49.1%	24.2%	-0.2%	-0.6%	1.4%
Number of observations	834	834	834	573	573	573

Table 3: Inventory Effects of Issuance and Redemption by Security

This table reports results from regressions of weekly changes in primary dealer net spot positions in U.S. Treasury securities on weekly auction amounts of Treasury securities, redemptions of Treasury securities (including buybacks, calls, and regular maturities), and other variables (specified in Table 2) for the July 4, 1990 to June 28, 2006 period. Coefficients are estimated separately for Treasury bills and coupon-bearing securities. Issuance and redemption coefficients are reported with heteroskedasticity- and autocorrelation-consistent (Newey-West) standard errors in parentheses. One, two, and three asterisks indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: Weekly Spot Position Change	
Issue	Issuance Coefficients	Redemption Coefficients
Cash management bill	0.447 ***	-0.255 ***
	(0.030)	(0.030)
4-week bill	0.385 ***	-0.374 ***
	(0.062)	(0.066)
13-week bill	0.158	-0.240 ***
	(0.137)	(0.090)
26-week bill	0.304 *	-0.202 *
	(0.172)	(0.106)
52-week bill	0.260 ***	-0.065 **
	(0.027)	(0.030)
2-year note	0.203 ***	-0.114 ***
	(0.028)	(0.030)
3-year note	0.188 **	-0.106
	(0.075)	(0.076)
5-year note	0.201 ***	0.067
	(0.050)	(0.062)
10-year note	0.313 ***	-0.046
	(0.087)	(0.106)
30-year bond	-0.044	-0.577
	(0.097)	(0.439)
Control variables	Yes	Yes

Table 4: Inventory Effects of Issuance Surrounding Auctions

This table reports results from regressions of weekly changes in primary dealer net spot positions in U.S. Treasury securities on weekly auction amounts of Treasury securities and other variables (specified in Table 2) for the July 4, 1990 to June 28, 2006 period. Coefficients are estimated separately for bills and coupon-bearing securities and the issuance variables are defined accordingly. Issuance coefficients are reported with heteroskedasticity- and autocorrelation-consistent (Newey-West) standard errors in parentheses. One, two, and three asterisks indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: Weekly Spot Position Change	
Issuance Effect	Bill Positions	Coupon Positions
Effect of next week's issuance	-0.046 ***	-0.021
	(0.015)	(0.020)
Effect of same week's issuance	0.338 ***	0.212 ***
	(0.019)	(0.020)
Effect of previous week's issuance	-0.042 **	-0.033
	(0.019)	(0.022)
Control variables	Yes	Yes
Adjusted R^2	50.4%	24.4%
Number of observations	834	834

Table 5: Explaining Changes in Dealer Treasury Futures Positions

This table reports results from regressions of weekly changes in primary dealer net futures positions in U.S. Treasury securities on changes in dealer spot positions in Treasury securities, changes in dealer spot positions decomposed into issuance, redemption, and other factor effects (derived from the Table 2 models for bills and coupons), and commercial trader Treasury futures positions. The sample period when spot positions are used is July 4, 1990 to June 27, 2001. The sample period when commercial trader positions are used is September 30, 1992 to March 8, 2000 (with gaps) for bill positions and September 30, 1992 to June 27, 2001 for coupon positions. Coefficients are estimated separately for bills and coupon-bearing securities and the independent variables are defined accordingly. Coefficients are reported with heteroskedasticity- and autocorrelation-consistent (Newey-West) standard errors in parentheses. One, two, and three asterisks indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: Dealers' Weekly Futures Position Change					
Independent Variable	Bill Positions			Coupon Positions		
Constant	0.012	-0.438	-0.002	0.008	-0.157	0.017
	(0.061)	(0.272)	(0.055)	(0.108)	(0.191)	(0.120)
Dealers' spot position change						
Total	-0.014 *			-0.219 ***		
	(0.008)			(0.024)		
Due to issuance		0.022			-0.104 **	
		(0.014)			(0.051)	
Due to redemptions		-0.025			0.125	
		(0.019)			(0.185)	
Due to other factors		-0.039 ***			-0.273 ***	
		(0.014)			(0.031)	
Commercial traders' futures position change						
13-week bill futures			0.466 ***			
			(0.073)			
2-year note futures						0.529
						(0.500)
5-year note futures						0.690 ***
						(0.133)
10-year note futures						0.612 ***
						(0.137)
30-year bond futures						0.587 ***
						(0.089)
Adjusted R^2	0.1%	0.9%	21.5%	17.2%	19.4%	31.9%
Number of observations	573	573	348	573	573	454

Table 6: Asset Pricing Effects of Aggregate Dealer Position Changes

This table reports results from regressions of weekly excess Treasury returns on contemporaneous and lagged weekly changes in primary dealer net spot positions in U.S. Treasury securities for the July 4, 1990 to June 28, 2006 period. To control for the Treasury return predictability documented by Cochrane and Piazzesi (2005), we include their return forecasting factor, measured as of the end of the previous week, in our regressions (see Section 3.C. for details). Bill returns are regressed on changes in bill positions and coupon returns are regressed on changes in coupon positions. Coefficients are reported with heteroskedasticity- and autocorrelation-consistent (Newey-West) standard errors in parentheses. Returns are in basis points and position changes are in billions of dollars. One, two, and three asterisks indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: Weekly Excess Treasury Return				
	Bills		Coupons		
Independent Variable	3-Month Bill	6-Month Bill	2-Year Note	5-Year Note	10-Year Note
Constant	0.337 ***	0.832 ***	1.451	3.411	5.278 *
	(0.082)	(0.162)	(0.855)	(2.024)	(3.047)
Same week position change	-0.015	-0.005	0.595 ***	1.845 ***	3.131 ***
	(0.009)	(0.014)	(0.122)	(0.299)	(0.489)
Previous week position change	0.020 **	0.025 *	0.251 **	0.840 ***	1.514 ***
	(0.009)	(0.014)	(0.106)	(0.288)	(0.485)
Cochrane-Piazzesi factor	0.011	0.138	1.640 **	3.081 **	4.905 **
	(0.069)	(0.139)	(0.669)	(1.461)	(2.112)
Adjusted R^2	0.5%	0.0%	4.0%	5.4%	5.8%
Number of observations	830	830	830	830	830

Table 7: Dealer Compensation for Inventory Risk and Other Factors

This table reports results from regressions of weekly excess Treasury returns on contemporaneous and lagged weekly changes in primary dealer net spot positions in U.S. Treasury securities decomposed into issuance and other factor effects (derived from the Table 2 models) for the July 4, 1990 to June 28, 2006 period. To control for the Treasury return predictability documented by Cochrane and Piazzesi (2005), we include their return forecasting factor, measured as of the end of the previous week, in our regressions (see Section 3.C. for details). Bill returns are regressed on changes in bill positions and coupon returns are regressed on changes in coupon positions. Coefficients are reported with heteroskedasticity- and autocorrelation-consistent (Newey-West) standard errors in parentheses. Returns are in basis points and position changes are in billions of dollars. One, two, and three asterisks indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: Weekly Excess Treasury Return				
	Bills		Coupons		
Independent Variable	3-Month Bill	6-Month Bill	2-Year Note	5-Year Note	10-Year Note
Constant	0.825 ***	1.420 ***	4.234 ***	7.957 **	10.261 **
	(0.227)	(0.430)	(1.315)	(3.152)	(4.866)
Position change					
Due to issuance, same week	-0.041 ***	-0.060 **	-0.726 **	-1.533 **	-1.983 *
	(0.015)	(0.028)	(0.298)	(0.729)	(1.132)
Due to issuance, previous week	0.020	0.050	0.544 **	2.569 ***	4.853 ***
	(0.017)	(0.031)	(0.246)	(0.628)	(1.051)
Due to other factors, same week	-0.004	0.018	0.949 ***	2.856 ***	4.738 ***
	(0.011)	(0.018)	(0.136)	(0.337)	(0.571)
Due to other factors, previous week	0.021 **	0.018	0.070	0.140	0.280
	(0.010)	(0.017)	(0.108)	(0.294)	(0.512)
Cochrane-Piazzesi factor	-0.036	0.082	1.618 **	2.923 **	4.594 **
	(0.073)	(0.148)	(0.646)	(1.421)	(2.065)
Adjusted R^2	1.2%	0.5%	7.9%	10.8%	11.1%
Number of observations	830	830	830	830	830

Table 8: Analysis of Trading Strategies

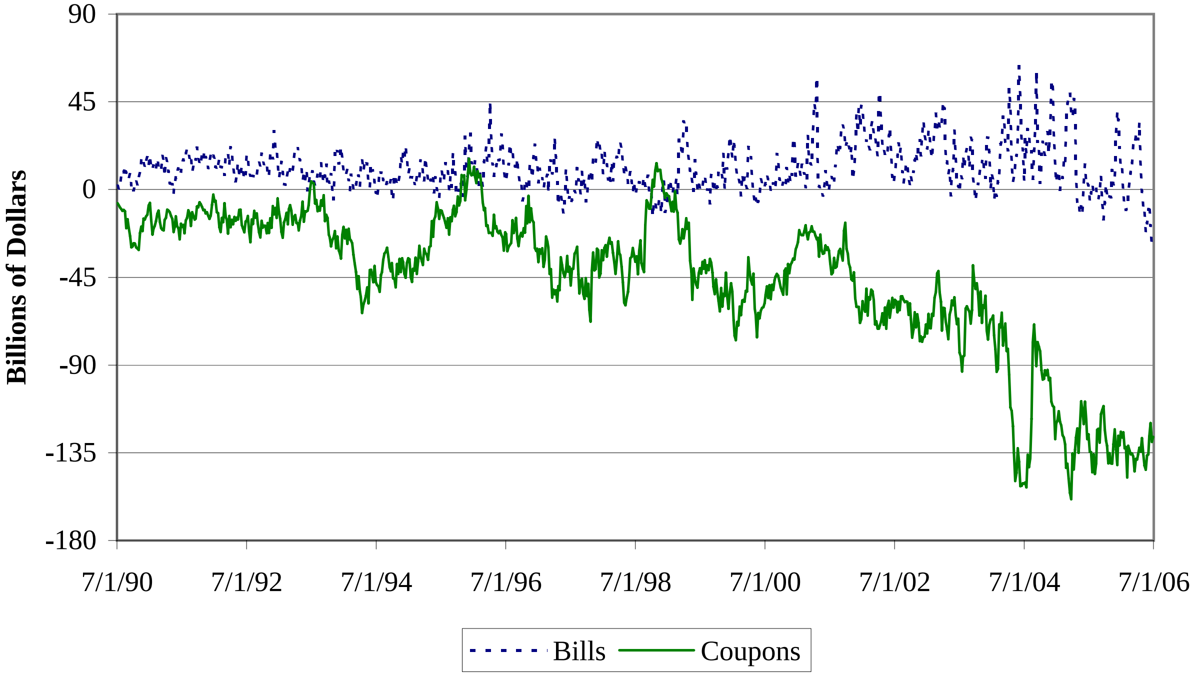
This table reports information on weekly excess Treasury returns for three trading strategies over the July 4, 1990 to June 28, 2006 period. Panel A provides statistics for a strategy of selling if there is going to be an auction of a coupon-bearing security in the coming week, buying if there was an auction the preceding week, and doing nothing if neither or both conditions hold. Panel B provides statistics for a strategy of buying (selling) if the Cochrane-Piazzesi factor is greater than (less than) zero. Panel C provides statistics for a strategy of buying at the beginning of every week. In all cases, positions are closed out at the end of each week. Returns are in basis points.

Panel A: Issuance Strategy			
	2-Year Note	5-Year Note	10-Year Note
Mean return	2.48	9.72	16.97
Standard deviation of returns	23.46	58.33	94.22
Sharpe ratio	0.11	0.17	0.18

Panel B: Cochrane-Piazzesi Strategy			
	2-Year Note	5-Year Note	10-Year Note
Mean return	2.65	4.65	6.45
Standard deviation of returns	23.00	57.96	95.11
Sharpe ratio	0.12	0.08	0.07

Panel C: Long-Only Strategy			
	2-Year Note	5-Year Note	10-Year Note
Mean return	1.18	2.75	4.14
Standard deviation of returns	23.12	58.09	95.21
Sharpe ratio	0.05	0.05	0.04

Figure 1: Dealer Net Treasury Spot Positions



This figure plots primary dealer net spot positions in U.S. Treasury bills and coupon-bearing securities by week from July 4, 1990 to June 28, 2006.

Figure 2A: Dealer Net Treasury Bill Positions

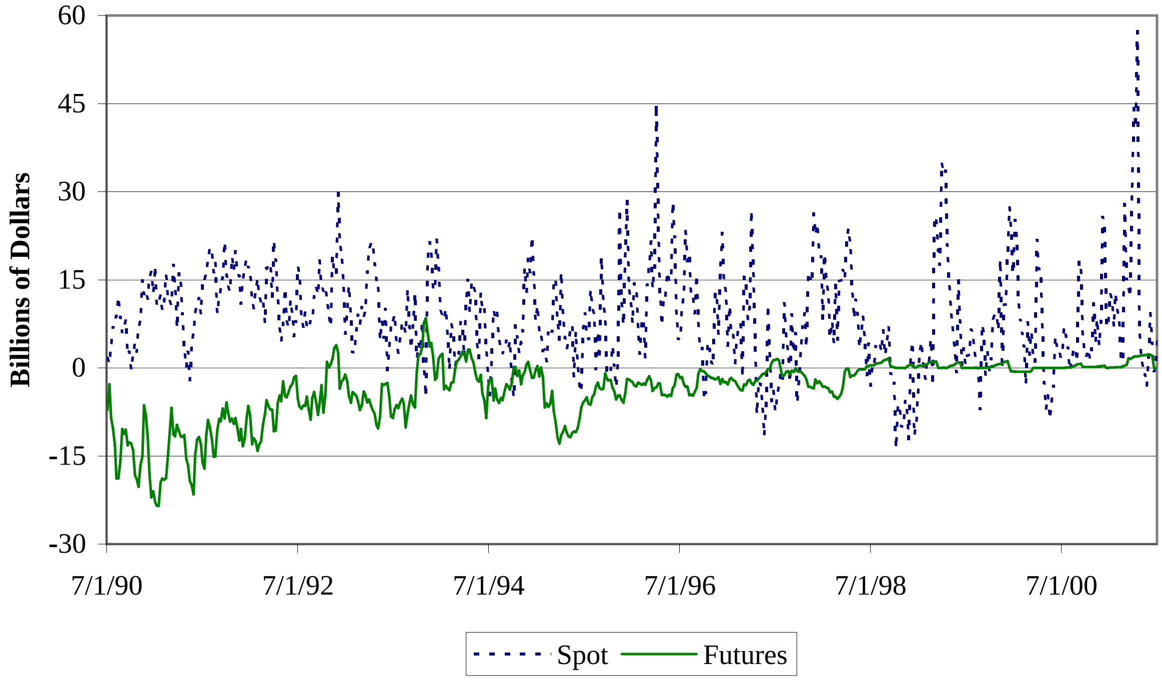
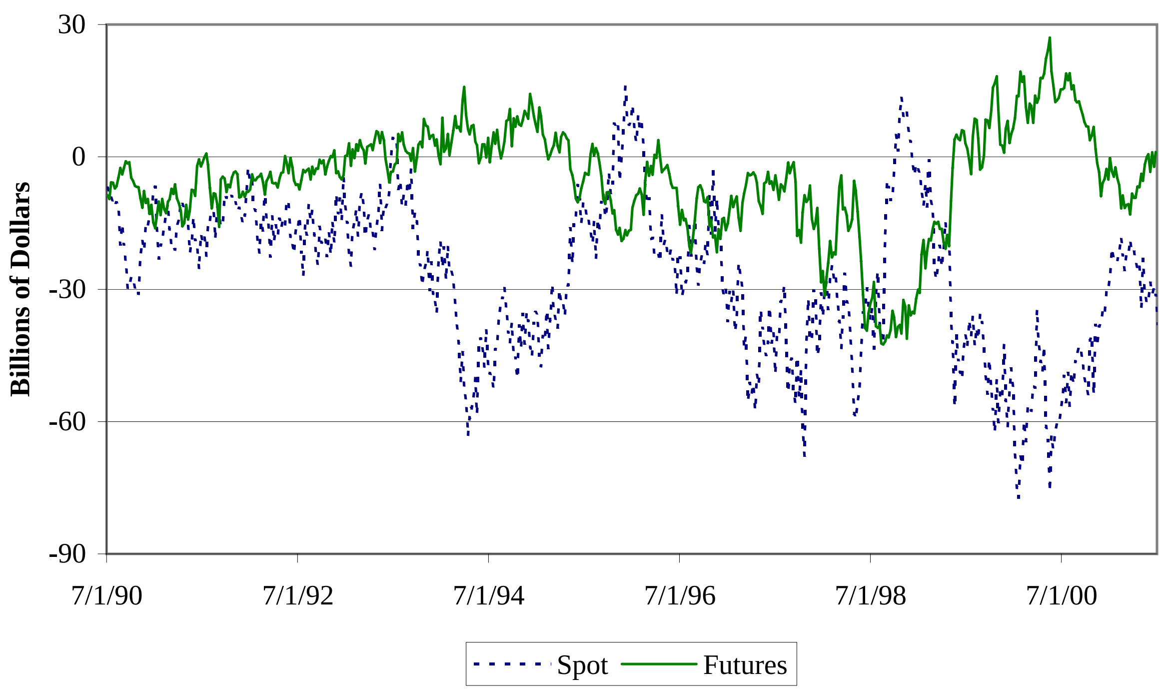
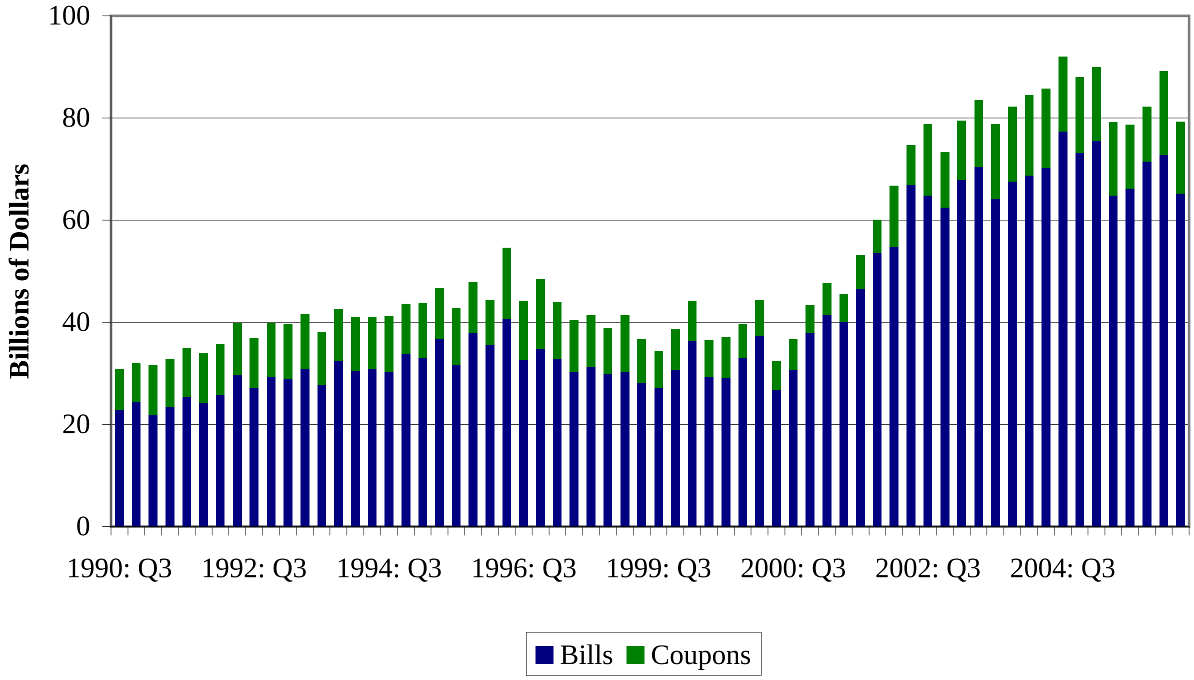


Figure 2B: Dealer Net Treasury Coupon Positions



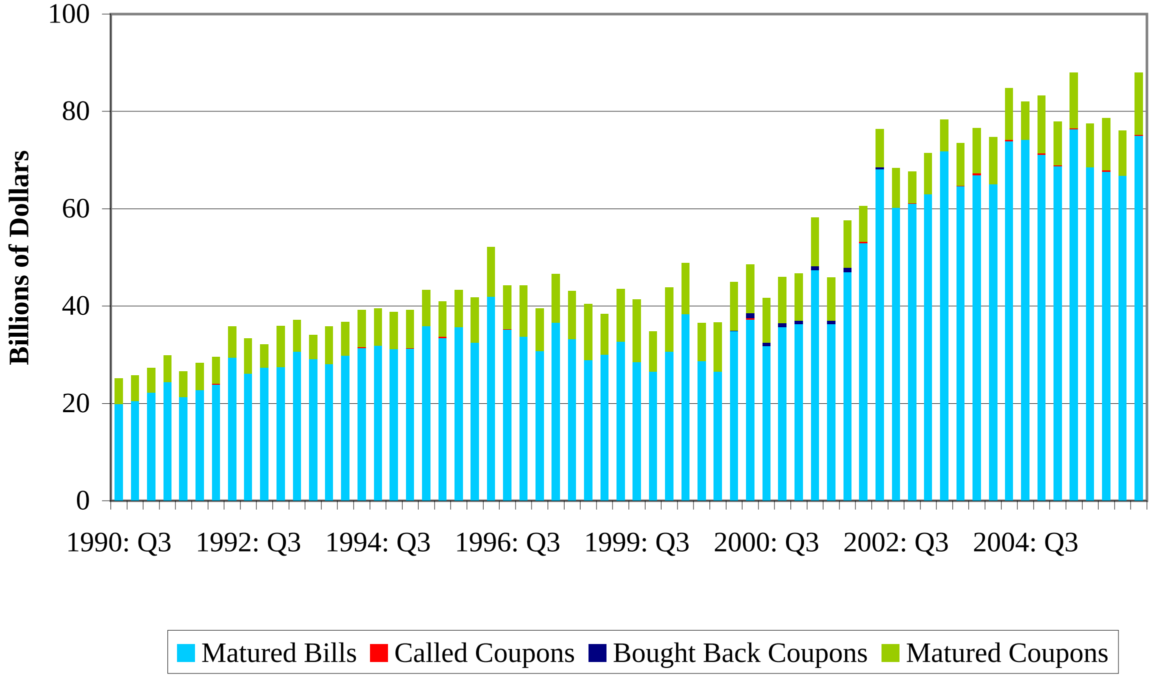
This figure plots primary dealer net spot and futures positions in U.S. Treasury bills (Panel A) and coupon-bearing securities (Panel B) by week from July 4, 1990 to June 27, 2001.

Figure 3: Treasury Issuance



This figure plots average weekly auction amounts of U.S. Treasury bills and coupon-bearing securities by quarter for the weeks ending July 4, 1990 to June 28, 2006.

Figure 4: Treasury Redemptions



This figure plots average weekly redemptions of U.S. Treasury bills and coupon-bearing securities by quarter for the weeks ending July 4, 1990 to June 28, 2006.