The Impact of Maturity Financing Choices Made by Primary Bond Dealers on Repo Market Rates*

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Abstract

Testing of the expectation hypothesis (EH) for very short interest rates has provided mixed results. My paper seeks to reconcile conflicting evidence on the EH for the US repo market by exploiting the fact that repo rates are affected by the demand/supply of bonds provided as collateral against repo agreements. My empirical investigation is organized around a theoretical model formulated by Duffie (1996) and Krishnamurthy (2002) on the relative "specialness" of bonds. This model demonstrates how variation in bond prices is related to variation in repo rates on collateralized loans against bonds. I hypothesize that this mechanism also works across different maturities of repo contracts and can explain variation in term repo rates relative to overnight rates. Using NY Fed data, I construct a factor measuring primary dealers' net financing in the overnight repo segment relative to their financing in the term repo segment and demonstrate that this variable was a significant forecaster of the repo market excess returns in the 2001-2008 period. The finding is robust to the inclusion of a Cochrane-Piazzesi factor, change in fed funds futures prices and a measure of dealers' overbidding at Fed's repo auctions.

JEL classification: G12, G14, E43, E58,
Keywords: expectation hypothesis; repo market; short sales.

*The author thanks John Donato, Dimitri Vayanos and participants at the 2011 Annual Meeting of the Midwest Finance Association for useful comments and suggestions. I retain responsibility for any remaining errors.

1 Introduction

Bond market participants use repos for financing long positions in bonds and reverse repos for shorting bonds. If the repurchase transaction is completed on the day after a repo auction is held, the contract is called an overnight repo. If the transaction is completed at a later, specified date, the contract is called a term repo.

In this paper I seek to answer the following question: Does the maturity structure of primary bond dealers' repo positions affect repo market interest rates? In a frictionless market populated by arbitrageurs, the answer should be no. However, there is a growing consensus in academic literature that the bond market is populated by distinguished subgroups of investors whose interaction can help explain certain puzzles of the bond market such as predictability of excess returns. For example, Krishnamurthy (2002) and Greenwood and Vayanos (2010) build models where active arbitrageurs co-exist with investors who have predetermined preferences for liquidity or maturity. Drawing on this line of research, I demonstrate that primary bond dealers' preferences with respect to the maturity of repos predicts the excess returns in the repo market.

More broadly this paper builds upon studies that test the so-called expectations hypothesis (EH) for interest rates. Studies by Cochrane and Piazzessi (2005), Ludvigson and Ng (2009) and Greenwood and Vayanos (2010) overwhelmingly reject the EH for Treasury bond yields and find that factors such as combination of forward rates, macroeconomic fundamentals and bonds supply predict excess returns on the Treasury bond market.

The evidence against EH for the money market is less clear-cut. After the Fed increased transparency of its interest rate policies in the beginning of the 90s, it could be expected that the EH would hold for very short-term interest rates on the money market. Indeed, studies of the fed funds futures market (e.g., Kuttner (2001), Gurkaynak *et al.* (2007), Lange *et al.* (2003)) provide evidence that private market forecasts of policy rates significantly improved in the recent years. However, direct testing of the EH for very short rates has provided mixed results. On the one hand, using repo rates on treasury collateral of different tenor, Longstaff (2000) finds that the EH holds. On the other hand, using an extended data set of repo rates, Della Corte *et al.* (2008) statistically reject the EH, although they find that the economic value of departures from the EH is modest.

In another study that focuses on the fed funds futures market, Piazzessi and Swanson (2008) construct series of excess returns on fed funds futures. They demonstrate that while variations in futures contracts predict upcoming fed funds target rate changes, the excess returns on the futures market are significant and related to business-cycle factors. This finding suggests that, even if market participants correctly forecast future pay-offs, current prices of futures contracts may be affected also by other factors. Using data on market participants' positions, Piazzessi and Swanson show that non-commercial participants are aware of excess returns and exploit this anomaly, while hedgers (primarily banks) have to pay insurance premium.

The findings of these studies encouraged me to try to identify factors that can explain term premium variation in the repo market. In doing so, I exploit the facts that repurchase agreements – unlike other money market agreements – are secured and that repo rates may be affected by demand/supply consideration of bonds provided as collateral against funds. In a seminal paper, Duffie (1996) builds a model that shows that demand for bonds offered against overnight loans also affects the price of loanable funds, i.e. the repo rate. In a situation when a particular bond is in high demand it becomes "on special" and dealers quote "special" overnight repo rates for funds they supply against the bond. This special rate is usually lower than the "general collateral" overnight repo rate. In accordance with this finding, I formulate a hypothesis that relates variations in the demand/supply of bonds put up for repo financing in different maturity sectors of the repo market to variations in repo market excess returns. In order to empirically test this hypothesis, I use data from the New York Fed on repo transactions in treasury collateral involving primary bond dealers. I construct a variable that measures the relative demand of dealers in the overnight and term segments of the repo market, respectively, and demonstrate that this variable is related to excess return on each of the two repo rates.

The New York Fed data on primary bond dealers' repo financing indicates that dealers have a net short position in Treasuries[1]. This implies that variation in repo financing maturity (overnight vs. term repos) is related to variation in the supply/demand of bonds that are shorted in the overnight vs. term horizon. In this respect, my paper also builds on studies that focus on short sale constraints in the equity market and investigate the relationship between the supply of underlying se-

[1]Perli and Sack (2003) show that because dealers were net long agency and mortgage-backed securities they were net short Treasuries for hedging motives.

curities and the cost of financing these securities. For example, Duffie *et al.* (2002) provide a model that explains how the fees for borrowing a stock may push the initial price of the security above the market valuation of its future dividends. Geszy *et al.* (2002) show that short-selling frictions in the equity market could result in stocks being "on special" in the loans market similar to bonds.

A notable contribution on the impact of the supply of bonds and the cost of financing these bonds is Fleming *et al.* (2010). During the recent financial crisis, the private money market imposed high repo rates and hair-cuts on collateralized loans against mortgage and asset backed securities, making it difficult for dealers to finance positions in these asset classes. In order to reduce repo rates on these bonds, Fed introduced the Term Securities Lending Facility (TSLF). The TSLF allows primary bond dealers to swap their holdings of mortgage-backed bonds for Treasury bonds, which can later be used as collateral on the private money market. Fleming *et al.* (2010) use TSLF data to study Fed interventions and find that shifts in the relative supply of Treasury, agency and mortgage-backed bonds had a significant impact on the repo rates charged on these bonds.

2 Institutional Background

2.1 Repo market mechanics

The repo market has gained a lot of attention because of its role in the recent financial crisis (e.g. Gorton and Metrick (2009), Taylor and Williams (2009)).

In brief, a repurchase (repo) transaction[2] means borrowing funds against bonds as collateral. It involves two parties: 1) a *cash-taker (collateral-provider)* and 2) a *cash-provider (collateral-taker)*. The transaction parties may be motivated by either a) funding or b) collateral considerations.

a) *Cash-takers (collateral-providers)* are motivated by cash considerations when they seek to obtain short-term funding against a long-term bond, which is in their possession, in order to relend the funds at a higher interest rate on the money market. Among actors that typically enter the repo market with such motives are bond mutual funds and banks. *Cash-providers (collateral-takers)* are motivated by cash considera-

[2]For a detailed description of repo transactions, please see Stigum and Crescenzi (2007), Buraschi and Menini (2002), Jordan and Jordan (1997).

tions when they seek to lend excess funds on a short-term basis and reduce the credit risk of the loan because of the collateralized nature of the transaction. Examples of actors driven by such motives include municipal governments, large corporations, Fannie Mae, Freddie Mac and other institutions that have excess funds but can not invest them on the inter-bank money market.

b) *Cash-takers (collateral-providers)* are motivated by collateral considerations when they seek to establish a long position with a view to benefiting from an appreciation in the bond price. As cash-takers remain entitled to bond coupons and capital gains after putting bonds up as collateral for repos, they can gain higher leverage by rolling-over repos on a continuous basis through their investment horizon[3]. *Cash-providers (collateral-takers)* are driven by collateral considerations when they seek to establish a short position in a bond. As described in Stigum and Crescenzi (2007), most bond short sales are organized through reverse repos. Actors motivated by collateral considerations either on the long or short side of the market are arbitrageurs betting on bond price movements.

2.2 Repo specialness

In case a particular bond is in high demand it becomes "on special", which means that the convenience yield on holding it is high. This could be due to either the fact that it is a cheapest-to-deliver against the futures contract or that traders need this bond for covering short positions. Jordan and Jordan (1997) document that about 64% of newly issued Treasury bonds in the US are on special. Duffie (1996) demonstrates that such bonds are traded at a premium relative to general collateral (GC) bonds while "special" repo rates on such bonds are below GC repo rates.

From a repo market view point "specialness" is beneficial for collateral-providers, but disadvantageous for cash-providers. Cash-providers are typically willing to supply funds at a special repo rate below the market rate for GC[4].

[3]See Adrian and Shin (2009) for a study of explosive repo market growth as a tool for obtaining leverage in the period prior to the recent liquidity crisis and Gorton and Metrick (2009) for a description of a repo market run similar to the classic bank run.

[4]Krishnamurthy (2002) demonstrates that, when accounting for the specialness of repo rates, the strategy of shorting an expensive newly issued bond and going long the non-special old bond does not yield excess returns.

3 Data description

3.1 Primary Dealers' Financing

Data on primary bond dealers' repo financing is reported by the New York Fed[5]. It covers weekly averages of the total value of *bonds in* under reverse repo transactions and the total value of *bonds out* under repo transactions for all primary bond dealers. Both variables are provided for both overnight and term segments of the repo market, as well as for different types of collateral: treasury, agency, corporate and mortgage-backed bonds.

I use data for the period July 2001-September 2008. The starting date is the date from which data is available, while end date corresponds to the time of the collapse of the Lehman Brothers, which sent global money markets into a disarray[6].

In order to avoid the issue of credit and liquidity premia, I focus solely on repo financing of treasury collateral. Statistics on primary dealers' financing in different maturity segments is reported in Table A1. Similarly as in Fleming and Adrian (2005), I determine dealers' net financing as the value of Treasury *bonds out* minus the value of Treasury *bonds in.* However, I do this separately for the overnight and term financing segments. The variable obtained gauges the amount of funds that primary dealers borrow/lend through repurchase transactions in each of the maturity segments. From the descriptive statistics and graphical illustrations contained in Figure A1 and A2, one can see that the value of *bonds in* exceeded the value of *bonds out* during most of the sample period. This implies that primary bond dealers on average were *cash-providers (collateral-takers)*, i.e. they were net short Treasuries.

The dynamics of dealers' financing in overnight and term segments illustrated in Figure A2 reveals that the two variables are negatively correlated. This suggests that dealers choose between overnight and term horizon of their Treasuries repo financing.

The key variable in my study is the ratio of dealers' net financing in the overnight (O/N) repo segment relative to the term repo segment: $\Delta\frac{\text{Net O/N financing}}{\text{Net term financing}}$. From the view point of the bond market, this variable measures the relative size of short Treasuries positions held overnight relative to short Treasuries positions held for a certain

[5] For a detailed description of this data, see Fleming and Adrian (2005).

[6] When Henry Paulson was asked to define the worst moment of the crisis, his reply was: "...September 17, 2008 when the capital market froze, when there started to be the run on the money markets, banks stopped to lend to each other..." (Wessel (2010))

term period by all dealers. Summary statistics for this variable are provided in Table A1 in Appendix A.

3.2 Repo Excess Returns

Data on general collateral repo rates is available from *Bloomberg* at a daily frequency. It has previously been used by Longstaff (2000) and Della Corte *et al.* (2008). Following Longstaff (2000), and using common terminology, I construct excess return series for repo rates as the difference between the currently observed term repo rate $r_t^{(n)}$ where n is the term period of the contract and the average overnight rate r_t^1 computed over $t+n$ horizon:

$$rx_t^{(n)} = r_t^{(n)} - (\tfrac{1}{n}) \textstyle\sum_{t=0}^{n} r_t^1 \tag{1}$$

Since data on primary bond dealers' repo financing is averaged by the Fed on a weekly basis, I use weekly averages of daily excess returns in order to match both series.

I calculate repo market excess returns according to formula (1) and report summary statistics in Table A3. The statistics are nearly identical to the ones reported in Longstaff (2000), suggesting that the relationship between term and overnight rates did not change over time.

Figure A3 plots the dynamics of $\Delta\frac{\text{Net O/N financing}}{\text{Net term financing}}$ against 1-month excess repo returns. The visual examination of the figure suggests that the two series co-move together and could be casually related. Another data series used in my empirical analysis is the slope of the repo market term-structure: $r_t^{(n)} - r_t^1$ series plotted in Figure A4.

3.3 Control Variables

In order to control for other factors related to the repo market, I use several control variables. These include: 1) The Cochrane-Piazzesi (CP) factor, which has been found to be a significant predictor of bond market excess returns[7]; 2) the price of fed funds futures, which is the best available measure of market expectations about the future

[7] I follow the approach used by Fleming and Rosenberg (2007) by constructing the CP factor from GSW data on zero-coupon bonds (Gurkaynak *et al.* (2006))

course of fed fund target rates (e.g., Hamilton (2009)), 3) overbidding by primary dealers during Fed open market operations measured as bid-to-cover ratio; 4) Merrill Lynch Option Volatility Estimate (MOVE) Index, which is a yield curve weighted index of the normalized implied volatility on 1-month Treasury options which are weighted on the 2, 5, 10, and 30 year contracts.

4 Maturity Structure of Primary Dealers' Financing and Repo Market Returns

Preliminary evidence on the dynamics of the money market term premium can be drawn from Figures A3-A4 in the Appendix, which plot overnight and 2-week LIBOR and repo rates for the 2004-2006 period of monetary policy tightening. It could be expected that the money market term spreads would widen prior to target rate hikes during this period, since Fed was transparent regarding its interest rate policy. As can be seen from the dynamics of the LIBOR term spread in Figure A3, this is indeed the case for all 17 episodes of target rate increases. On the contrary, the dynamics of the repo market term spread in Figure A4 show that the 2-week repo rate closely tracked the overnight rate in most cases, irrespective of expected target rate hikes. Moreover, although this was a police tightening cycle, the 2-week term repo rate went below the overnight rate on several occasions. This suggests that the repo market term spread may be affected by factors other than the expected path of overnight rates. My hypothesis is that variation in the demand/supply of bonds provided as collateral against repo financing could be such a factor.

Krishnamurthy (2002) demonstrates that, if the supply of bonds is fixed, variation in the demand for bonds has an impact on the price of loanable funds against these bonds. Accordingly, it can be assumed that variation in the maturity structure of dealers' short positions in Treasury bonds also may be associated with variation in the repo rates for overnight and term horizon.

As can be seen in Figures A1 and A2, primary dealers are net short treasuries in both the overnight (O/N) and the term maturity segments of the repo market. This implies that growth of the ratio $\Delta\frac{\text{Net O/N financing}}{\text{Net term financing}}$ occurs when primary dealers establish relatively more short positions for the overnight horizon, which results in that the overnight segment of the repo market becomes more "special" than the term segment. This, again, can be expected to press down the overnight repo rate in relation to the term repo rate and, thus, positively impact repo market excess returns.

On the opposite, a decline of the ratio $\Delta\frac{\text{Net O/N financing}}{\text{Net term financing}}$ occurs when there is a high demand for bond collateral by cash-providers (collateral-takers) in the term segment of the repo market, which can be expected to press down the term repo rate in relation to the overnight rate. In other words, excess supply of cash offered for term collateral could render the term segment of the repo market more "special" than the overnight segment.

In accordance with the logic just discussed, it can be expected that repo market excess returns as defined in (1) are affected by variation in the maturity structure of primary dealers' repo financing.

Another testable hypothesis concerns the slope of the repo market term-structure: $r_t^{(n)} - r_t^1$. The mechanism of relative demand/supply pressures in the overnight and term repo market segments outlined above can also be expected to affect the currently observed slope of the repo market term structure.

Let me now sum up my working hypotheses:

Hypothesis 1: Growth in the ratio of primary dealers' overnight repo financing in relation to their term repo financing is positively associated with repo market excess returns.

Hypothesis 2: Growth in the ratio of primary bond dealers' overnight repo financing in relation to their term repo financing is positively associated with an increase in the slope of the repo market term-structure.

5 Empirical results

5.1 Baseline Specification

Data on the key variable of my study - the maturity structure of primary bond dealers' financing – is available at weekly frequency. All other data I have is daily, but I use weekly averages to ensure consistency. I calculate the level of excess return according to (1) and run a regression, which is similar to specifications used by Piazzesi and

Swanson (2008) for the fed funds futures market and by Greenwood and Vayanos (2010) for the bond market.

$$rx_t^{(n)} = \alpha + \beta X_t + u_{t+n} \tag{2}$$

where X_t is the ratio $\Delta \frac{\text{Net O/N financing}}{\text{Net term financing}}$. The results for the baseline specification are reported in Panel A of Table B1 and are presented for two samples: the first one covers the non-crisis period in July 2001-August 2007; the second one additionally covers the year preceding the Lehman Brothers collapse and, thus, concerns the period July 2001 - September 2008. All reported standard errors are computed using the Newey-West correction with 4 weekly lags. This correction makes coefficient estimates robust to possible serial correlation of residuals. The results demonstrate that the coefficients for 2-week, 3-week and 1-month excess returns are strongly statistically significant and a positive sign obtained is consistent with Hypothesis 1. The regression coefficients increase as the forecast horizon increases. For example, for the non-crisis period the 0.049 coefficient obtained from regressing the 2-week excess return on X_t, doubles to 0.099 for the 1-month excess return.

Next I turn to the results for the repo term-structure slop regression.

$$r_t^{(n)} - r_t^1 = \alpha + \beta X_t + u_t \tag{3}$$

The baseline results for the coefficient β are reported in Panel B of Table B1. All estimates are insignificant, which means that variation in the maturity structure of primary bond dealers' financing is not related to variations in the slope of the repo market yield curve. Thus, Hypothesis 2 is rejected.

These findings are consistent with Fama's and Bliss' (1987) rejection of the EH for the term structure of interest rates on the bond market. In a seminal study they show that contrary to what the EH would suggest, bond market excess returns are predictable, while bond market yield curve slopes are not. My estimates for repo market rates reveal a similar pattern with respect to factor X_t.

5.2 Robustness Checks

A possible concern regarding my analysis is that other factors may have a significant impact on repo market interest rates given the Fed's transparency regarding its interest rate policies. I now turn to multivariate tests and report the results in Table B2.

$$rx_t^{(n)} = \alpha + \beta X_t + \gamma Z_t + u_{t+n} \quad (4)$$

$$r_t^{(n)} - r_t^1 = \alpha + \beta X_t + \gamma Z_t + u_t \quad (5)$$

where Z_t represents a vector of control variables, which includes: 1) the tent-shaped Cochrane-Piazzesi factor; 2) price change of the nearby fed funds futures contract; 3) the Merill Lynch MOVE Bond volatility index; 4) a measure of primary dealers' overbidding during Fed open market operations (OMO). All of these variables are forward-looking measures of market expectations regarding interest rate dynamics and are observed at time period t.

The key result is that coefficients β on a factor X_t are robust to the inclusion of control variables for all samples and for all repo contract tenors. We can not reject Hypothesis 1, while Hypothesis 2 is rejected. Inclusion of the control variables also increases the predictive power of the regression. For example, in the non-crisis sample, the R-squared in the same regressions increases from 5% to 10%.

The estimates of coefficient γ also provide an interesting insight into repo market predictability. The second rows in both panels of Table B2 demonstrate that the coefficients on the *CP factors* are positive but only marginally significant for specifications with 1-month term repo rates. This means that information embedded in bond market forward rates and captured by the *CP factor* does not predict money market excess returns over weekly horizons, even though the *CP factor* is found to be a strong predictor of bond market excess returns over long horizons.

As can be seen from the third line of Panel A, the coefficient on the Δ*FF Futures* variable is strongly significant and has a negative sign. This means that positive innovations to the price of the fed funds futures can predict an upcoming increase in overnight rates, thus driving down repo market excess returns. The estimates for the extended sample, which also includes the liquidity crisis period, are not statistically significant. This result suggests that fed funds futures do not predict overnight rates well if a period of increased money market volatility is included. Estimates for the term structure slope reported in the second row of Panel B suggest that positive innovations to current fed funds futures prices are associated with a widening of the repo market yield curve slope, however, the results are not uniformly significant.

The Merill Lynch MOVE index is constructed from implied volatility quotes on bond options and represents a forward looking measure of bond market volatility. The MOVE index is analogous to the CBOE stock market volatility index (VIX). As can be seen from the third lines of panels A and B, innovations to the MOVE index do not predict repo market excess returns, but are strongly negatively associated with variations in the repo market term-structure slopes across all specifications. This finding suggests that the slope narrowing observed during periods of higher bond market volatility is due to an increase in overnight rates.

The last control variable employed in my study is the ratio between overbidding in the overnight segment of Fed open market operations (OMO) and overbidding in the term segment of its operations $\frac{OMO\ O/N\ overbid}{OMO\ term\ overbid}$[8]. Data on Fed OMOs is available at daily frequency, but as in the case of all other variables in my study, I use weekly averages.

The inclusion of this variable is motivated by an argument made by Duffie (1996) regarding primary bond dealers' behavior at Treasury auctions. He notes that if the auction is tight, unsuccessful bidders create a large demand for bonds on the secondary market, which results in collateral scarcity and "specialness" of the repo market. Jordan and Jordan (1997) construct a bid-to-cover ratio (BTC) for Treasury auctions and find that this variable has a significant impact on repo rates.

I conjecture that a similar mechanism should be at work during the New York Fed's open market operations[9], which are organized as refinancing auctions for primary bond dealers. Using the value of bonds submitted for refinancing by primary dealers and the value of bonds accepted for refinancing, I construct overbidding ratios for Fed open market operations. Bonds that are not refinanced at Fed auctions are put up for refinancing in the private repo market. This is likely to create an excess demand for funds and affect repo rates. The Fed organizes separate repo auctions for different maturity segments. On a given day it may conduct an auction for overnight financing

[8] Overbidding is measured as value of bonds submited for refinancing minus value of bond accepted for refinancing at Fed's open market operations.

[9] Open market operations in the US are organized as repo auction among primary dealers, which take place daily at fixed time intervals. When the Fed intends to intervene on a particular day, it makes an announcement and invites refinancing bids from primary dealers. Dealers indicate both the bond issue they want to refinance and the repo rate they are willing to pay to the Fed for the provided funds. The Fed ranks dealers' offers and chooses the most attractive ones within the amount of reserves it wants to inject into the system. This is a discriminatory (pay-your-bid) pricing rule auction, under which, the market is cleared from the highest submitted bid (the repo rate a dealer is willing to pay) downward until the desired supply is exhausted. All winning bidders pay the repo rates they quoted.

and for term financing of different maturities (up to 28 business days). Using data on outcomes of OMOs of different maturity, I construct a variable that measures the ratio between overbidding at overnight OMOs and overbidding at term OMOs at a weekly frequency. This ratio measures the relative excess demand caused by Fed interventions in the two maturity segments of the private repo market. Inclusion of this variable into the specification should control for the demand pressure effect. As can be seen from the last row of Table B2, it does not predict repo market excess returns but is positively related to the term-structure slope at longer maturities. The positive sign of the coefficients means that, in a situation where there are more unfunded bonds at overnight than at term OMOs, the term repo rates will rise relative to the overnight repo rates. An unexpectedly large demand for bonds in the overnight segment will render overnight rates more "special" than term repo rates, which results in a widening of the term-structure slope. The insignificant estimates for excess returns specification in Panel A suggest that this repo market "specialness" effect is transitory.

5.3 Maturity Structure of Primary Dealers' Financing and Other Money Market Rates

The economic mechanism behind the $\Delta\frac{\text{Net O/N financing}}{\text{Net term financing}}$ factor is based on the collateralized nature of repurchase agreements. As discussed above, I hypothesize that variation in the maturity structure of dealers' short positions on Treasury bonds, which have been pledged as collateral against repos, is associated with variation in the repo rates of both the overnight and term horizon. To further test this hypothesis I run specifications (4) and (5) on a number of other money market rates, including LIBOR, US cash deposit rates, and AA financial commercial paper rates. All series are obtained from *Datastream* and averaged at weekly frequency. In order to save space I report only coefficients β in Table B3. Across all samples and specifications, both Hypothesis 1 and 2 are rejected. This means that the maturity structure of primary dealers' financing does not have an impact on unsecured interest rates and price pressure effects are present only on the collateralized market.

6 Conclusion

In the introduction, I set out the following question to be addressed in this paper: does the maturity structure of primary bond dealers' repo positions affect repo market interest rates? This question is motivated by conflicting evidence on EH tests for very short-term interest rates.

I organized my empirical investigation around a theoretical model formulated by Duffie (1996) and Krishnamurthy (2002) on the relative "specialness" of bonds. This model demonstrates how variation in bond prices is related to variation in repo rates on collateralized loans against these bonds. I hypothesized that this mechanism also works across different maturities of repo contracts and can explain variation in term repo rates relative to overnight repo rates. In order to empirically test my hypothesis I constructed a factor measuring primary dealers' net financing in the overnight repo segment relative to the term repo segment and demonstrate that this variable is significantly associated with repo market excess returns in the whole 2001-2008 period.

I interpret the results as follows: as primary bond dealers were consistently short Treasuries during the period of investigation, their choice of holding short positions for either an overnight or a term horizon created a relative excess demand/supply pressure in the repo market at the corresponding horizons. The model presented by Duffie (1996) and Krishnamurthy (2002) would suggest that term repo rates would vary relative to overnight repo rates in such an environment. My empirical results demonstrate that the impact of this factor on excess returns is strong, of an expected sign and that the coefficient is robust to the inclusion of forward-looking variables, thus controlling for market expectations regarding future interest rates dynamics.

7 Appendix A

Figure A1. Dynamics of primary bond dealers'
Net positions and Net total financing in Treasuries

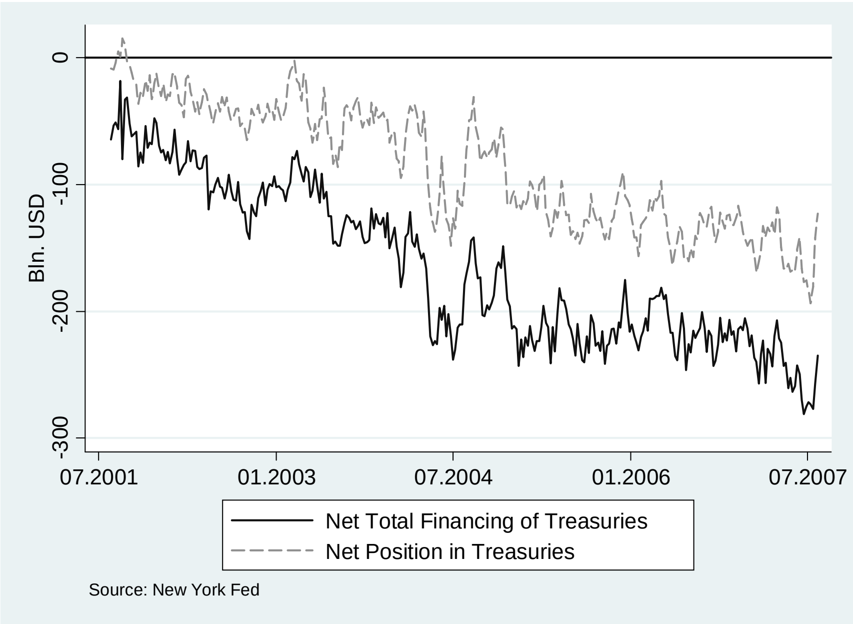

Figure A2. Dynamics of primary bond dealers'
Net term and Net overnight financing of Treasuries

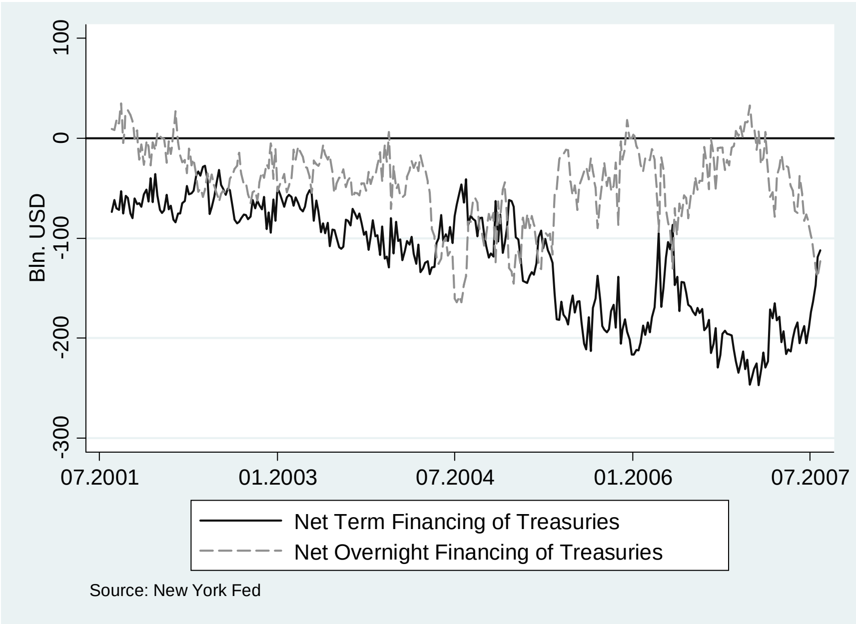

Figure A3. Dynamics of repo 1-month excess returns and ratio of net Net overnight to Net term primary bond dealers' repo financing

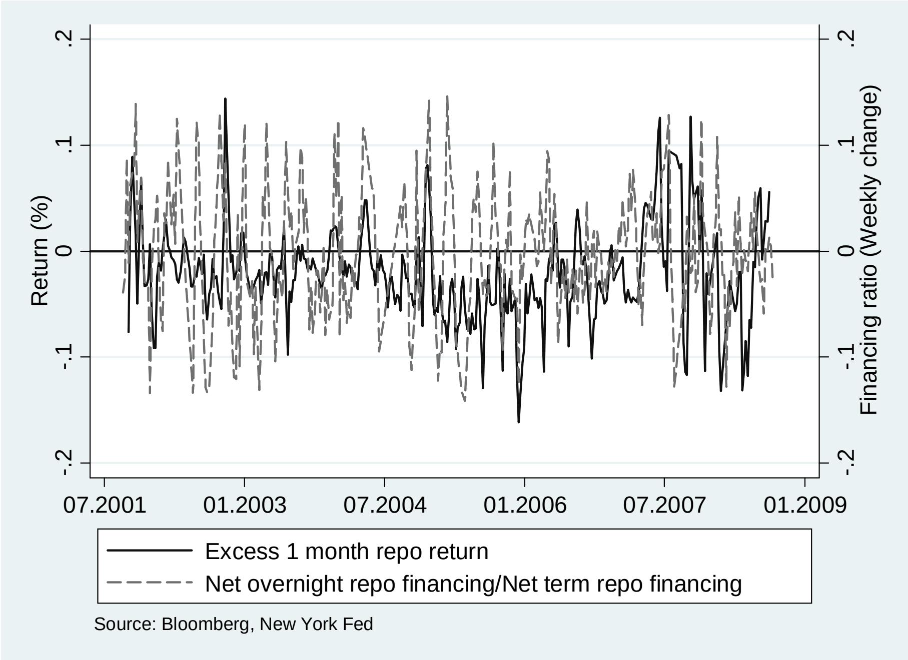

Figure A4. Dynamics of repo market 1-month slope and Net overnight to Net term primary bond dealers' repo financing

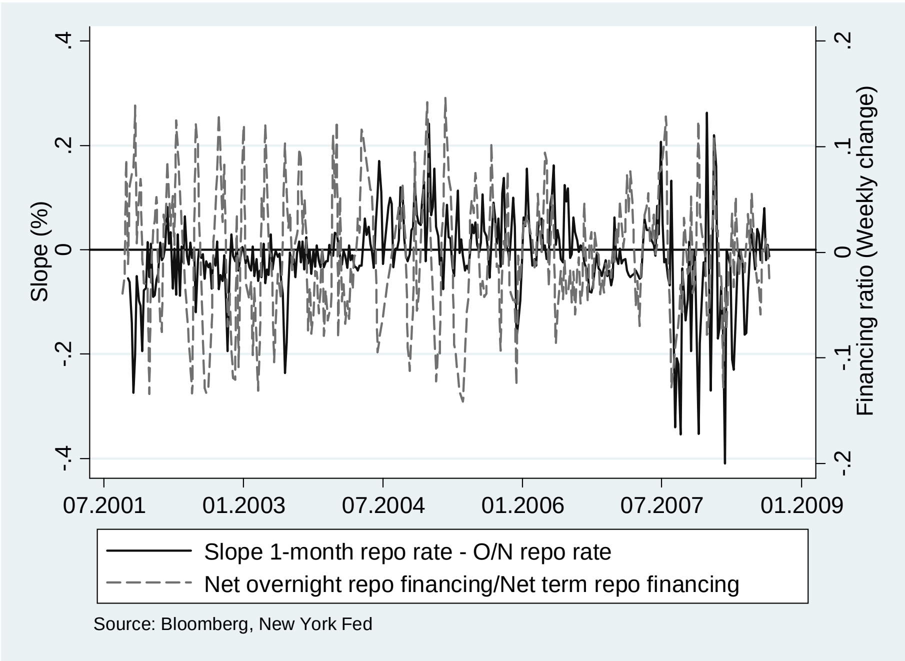

Figure A5. Dynamics of overnight and 2-week LIBOR rates during the episode of policy tightening (07.2004-09-2006)

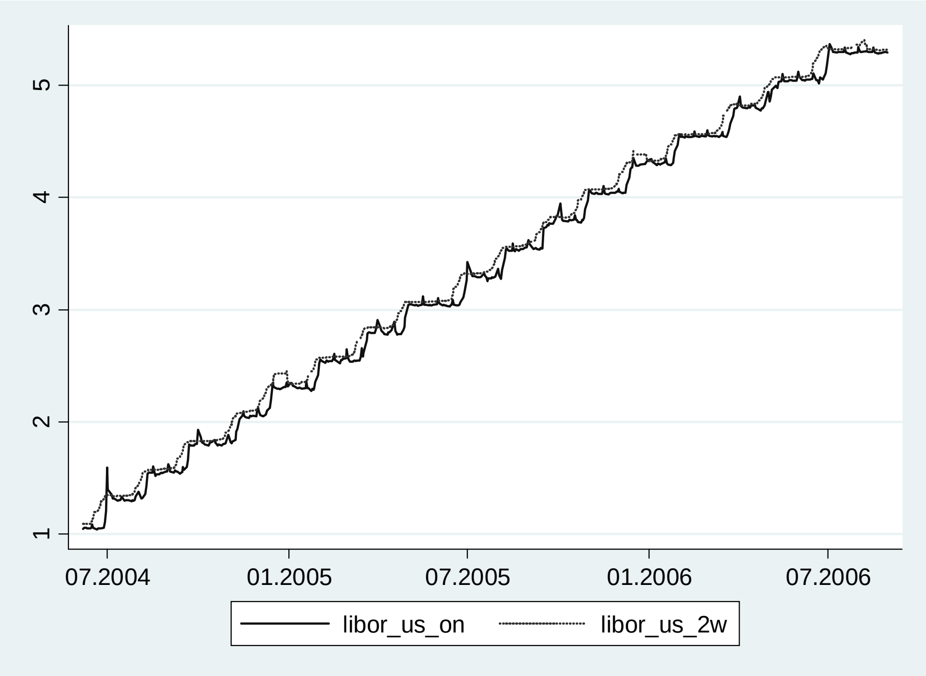

Figure A6. Dynamics of overnight and 2-week GC repo rates during the episode of policy tightening (07.2004-09-2006)

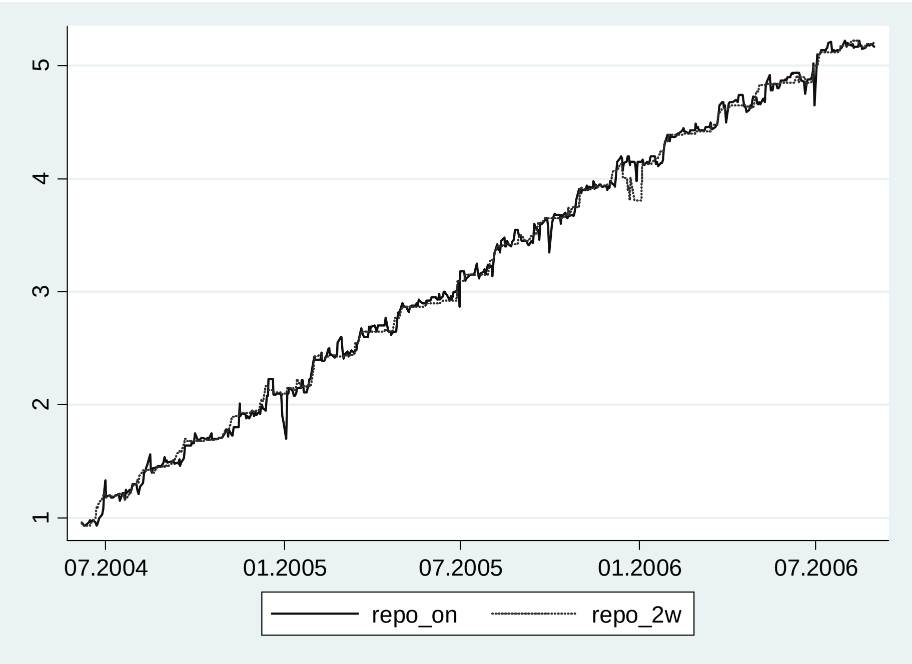

Table A1. Summary statistics of primary bond dealers' financing
Sample period: 11.07.2001 - 15.09.2008

	Mean	**Std.Dev**	**Max**	**Min**	**N**	$\boldsymbol{\rho}^b$
Net O/N[c] financing	-35356	47170	167644	-164025	357[a]	0.8873
Net term financing	-134323	62929	-27547	-335221	357	0.9596
$\frac{\text{Net O/N financing}}{\text{Net term financing}}$	0.4025	0.5417	3.533	-0.6578	357	0.8192
ΔNet O/N financing	415.5	22181	83959	-77300	357	-0.3387
ΔNet term financing	-693.4	18368	55866	-74085	357	-0.2959
$\Delta\frac{\text{Net O/N financing}}{\text{Net term financing}}$	-0.0013	0.3255	1.366	-2.401	357	-0.3582

Note: [a] Weekly observations; [b] Autocorrelation coefficient; [c] Overnight

Table A2. Summary statistics of GC[a] Treasury repo rates
Sample period: 11.07.2001 - 15.09.2008

	Mean	**Std.Dev**	**Max**	**Min**	**N**	$\boldsymbol{\rho}$
Repo O/N	2.6528	1.5728	5.2540	0.0333	357	0.9920
Repo 1-week	2.6558	1.5580	5.2100	0.0700	357	0.9950
Repo 2-week	2.6517	1.5531	5.2100	0.1200	357	0.9960
Repo 3-week	2.6501	1.5568	5.2120	0.1400	357	0.9970
Repo 1-month	2.6544	1.5527	5.2200	0.1500	357	0.9972
ΔRepo O/N	-0.0093	0.1989	1.4100	-1.4220	357	-0.0476
ΔRepo 1-week	-0.0091	0.1559	0.9800	-1.0950	357	0.0266
ΔRepo 2-week	-0.0088	0.1387	0.9500	-0.8450	357	0.0882
ΔRepo 3-week	-0.0065	0.1217	0.8700	-0.8075	357	0.1320
ΔRepo 1-month	-0.0089	0.1165	0.7200	-0.6900	357	0.2046

Note: [a] General collateral

Table A3. Summary statistics of GC Treasury excess returns and term structure slopes (11.07.2001 - 15.09.2008)

	Mean	**Std.Dev**	**Max**	**Min**	**N**	ρ
Excess returns						
rx^{1week}	0.0069	0.1520	1.2160	-0.9532	357	0.1636
rx^{2week}	0.0075	0.1776	1.1972	-1.0342	357	0.4735
rx^{3week}	0.0108	0.1850	1.2768	-0.9249	357	0.6601
rx^{1month}	0.0202	0.1878	1.2355	-0.7411	357	0.7727
Term structure slopes						
$r^{1week} - r^{o/n}$	0.0030	0.1065	1.1300	-0.5000	357	0.2325
$r^{2week} - r^{o/n}$	-0.0011	0.1218	1.1300	-0.5200	357	0.3545
$r^{3week} - r^{o/n}$	-0.0030	0.1381	1.2140	-0.4400	357	0.3967
$r^{1month} - r^{o/n}$	0.0016	0.1474	1.1900	-0.5360	357	0.4522

Table A4. Summary statistics of control variables

	Mean	**Std.Dev**	**Max**	**Min**	**N**	ρ
Cochrane-Piazessi Factor	0.0233	0.0150	0.0631	-0.0005	357	0.9834
Fed funds futures rate	2.7903	1.6231	5.3720	0.8730	357	0.9993
ΔFed funds futures rate	0.0011	0.0157	0.0575	-0.1330	357	0.1071
Merill Lynch MOVE index	94.4900	25.0008	161.2480	52.1000	357	0.9711
ΔMerill Lynch MOVE index	-0.0002	0.0167	0.0724	-0.0466	357	-0.2324

Table A5. Summary statistics of Fed's open market opeartions

	Mean	**Std.Dev**	**Max**	**Min**	**N**	ρ
Financing Submitted O/N OMO[a]	14.4930	7.4581	55.2700	0.0000	357	0.4359
Financing Accepted O/N OMO	3.5768	3.4244	54.5100	0.0000	357	0.1575
Overbid[b] O/N OMO	10.9162	5.8050	29.8200	0.0000	357	0.4866
Financing Submitted Term OMO	10.2621	4.8460	27.7250	0.0000	357	0.0259
Financing Accepted Term OMO	1.9581	1.2747	6.4098	0.0000	357	0.0259
Overbid Term OMO	8.3040	3.9600	22.4340	0.0000	357	0.0520
$\frac{\text{Overbid O/N OMO}}{\text{Overbid term OMO}}$	1.8004	1.9371	17.9068	0.0000	357	-0.0433

Note: [a] OMO - open market operations; [b] Overbid=Submitted-Accepted;

Table A6. Cross-correlations. Sample period (11.07.2001 - 15.09.2008)

Variables	$r^{1w} - r^{o/n}$	$r^{2w} - r^{o/n}$	$r^{3w} - r^{o/n}$	$r^{1m} - r^{o/n}$	rx^{1w}	rx^{2w}	rx^{3w}	rx^{1m}	$\Delta Fin.$	CP	ΔFF	$\Delta MOVE$	$Overbid$
$r^{1week} - r^{o/n}$	1.000												
$r^{2week} - r^{o/n}$	0.843*[a]	1.000											
$r^{3week} - r^{o/n}$	0.759*	0.915*	1.000										
$r^{1month} - r^{o/n}$	0.632*	0.782*	0.916*	1.000									
rx^{1week}	0.537*	0.305*	0.196*	0.059	1.000								
rx^{2week}	0.407*	0.408*	0.198*	-0.011	0.760*	1.000							
rx^{3week}	0.392*	0.371*	0.288*	0.036	0.641*	0.855*	1.000						
rx^{1month}	0.300*	0.281*	0.244*	0.139*	0.467*	0.631*	0.823*	1.000					
$\Delta \frac{O/N\ Financing}{Term\ Financing}$	0.004	0.032	0.063	0.034	0.050	0.120*	0.227*	0.259*	1.000				
CP factor	0.027	0.015	-0.040	-0.057	0.081	0.112	0.088	0.082	0.115*	1.000			
Δ*FF Futures*	0.010	0.086	0.144*	0.229*	-0.269*	-0.226*	-0.201*	-0.150*	-0.023	-0.042	1.000		
Δ*MOVE Vol*	-0.210*	-0.175*	-0.141*	-0.136*	-0.070	-0.014	0.004	0.061	0.007	-0.043	0.134*	1.000	
$\frac{Overbid\ O/N\ OMO}{Overbid\ term\ OMO}$	0.062	0.104	0.172*	0.196*	-0.019	-0.023	0.015	0.015	-0.179*	-0.402*	0.079	0.024	1.000

Note: * Denotes significance at 5%

8 Appendix B

Table B1. Baseline spesification

I run $rx_{t+n}^{(n)} = \alpha + \beta X_t + u_{t+n}$ and $r_t^{(n)} - r_t^1 = \alpha + \beta X_t + \gamma Z_t + u_t$ regressions where X_t is the growth of ratio of dealers' net financing in the overnight (O/N) repo segment relative to the term repo segment $\Delta \frac{\text{Net O/N financing}}{\text{Net term financing}}$

	A. No crisis sample (July 2001 - August 2007) 305 weekly obervations			**B. The whole sample** (July 2001 - Sept. 2008) 357 weekly observations		
	β	$s.e$	R^2	β	$s.e$	R^2
Panel A. Repo excess return:						
rx^{1week}	0.015	(0.016)^a	0.003	0.012	(0.018)	0.001
rx^{2week}	0.049**	(0.021)	0.014	0.049**	(0.022)	0.007
rx^{3week}	0.093***	(0.027)	0.052	0.135***	(0.055)	0.032
rx^{1month}	0.099***	(0.026)	0.067	0.130***	(0.042)	0.037
Panel B. Repo term structure slope:						
$r^{1week} - r^{o/n}$	0.001	(0.013)	0.000	0.001	(0.015)	0.001
$r^{2week} - r^{o/n}$	0.014	(0.026)	0.001	0.008	(0.029)	0.001
$r^{3week} - r^{o/n}$	0.033	(0.040)	0.001	0.050	(0.052)	0.004
$r^{1month} - r^{o/n}$	0.021	(0.049)	0.001	0.040	(0.062)	0.002

Note: [a] Newey-West standard errors. *** Denotes significance at 1%;
** Denotes significance at 5%; * Denotes significance at 10%

Table B2. Repo excess returns, term-structure slope and maturity of dealers' financing

	A. No crisis sample (July 2001 - August 2007)				**B. The whole sample (July 2001 - Sept. 2008)**			
	Panel A. Repo excess return: $rx_{t+n}^{(n)} = \alpha + \beta X_t + \gamma Z_t + u_{t+n}$							
	rx^{1week}	rx^{2week}	rx^{3week}	rx^{1month}	rx^{1week}	rx^{2week}	rx^{3week}	rx^{1month}
$\Delta \frac{O/N\ Financing}{Term\ Financing}$	0.012	0.045**	0.094***	0.100***	0.006	0.045**	0.135***	0.129***
	(0.016)	(0.021)	(0.029)	(0.027)	(0.020)	(0.023)	(0.056)	(0.044)
CP factor	0.171	0.312	0.282	0.244	0.255	0.256	0.604*	0.559*
	(0.152)	(0.214)	(0.246)	(0.223)	(0.208)	(0.232)	(0.368)	(0.338)
$\Delta FF\ Futures$	-0.675***	-0.810***	-0.707***	-0.514***	-0.271	-0.101	-0.358	-0.451
	(0.175)	(0.271)	(0.224)	(0.150)	(0.289)	(0.381)	(0.503)	(0.330)
$\Delta MOVE\ Vol$	-0.062	0.035	-0.083	0.199*	-0.216	-0.045	0.175	0.295
	(0.104)	(0.119)	(0.126)	(0.119)	(0.161)	(0.194)	(0.210)	(0.205)
$\frac{OMO\ O/N\ BTC^b}{OMO\ Term\ BTC}$	0.001	0.002	0.005	0.005	0.002	0.001	0.006	0.006
	(0.003)	(0.004)	(0.005)	(0.004)	(0.003)	(0.004)	(0.006)	(0.005)
R^2	0.081	0.084	0.104	0.107	0.021	0.011	0.046	0.048
	Panel B. Repo term structure slope: $r_t^{(n)} - r_t^1 = \alpha + \beta X_t + \gamma Z_t + u_t$							
	$Slope^{1week}$	$Slope^{2week}$	$Slope^{3week}$	$Slope^{1month}$	$Slope^{1week}$	$Slope^{2week}$	$Slope^{3week}$	$Slope^{1month}$
$\Delta \frac{O/N\ Financing}{Term\ Financing}$	0.004	0.023	0.053	0.047	0.001	0.008	0.059	0.050
	(0.013)[a]	(0.025)	(0.039)	(0.049)	(0.014)	(0.029)	(0.037)	(0.061)
CP factor	0.107	0.177	0.089	0.076	0.058	0.372	0.657	0.807*
	(0.147)	(0.225)	(0.276)	(0.335)	(0.161)	(0.249)	(0.257)	(0.469)
$\Delta FF\ Futures$	0.083	0.388	0.691*	1.273***	-0.191	0.074	0.324	0.930*
	(0.198)	(0.351)	(0.224)	(0.410)	(0.254)	(0.351)	(0.269)	(0.495)
$\Delta MOVE\ Vol$	-0.395***	-0.527***	-0.559***	-0.692***	-0.299***	-0.445***	-0.397**	-0.642***
	(0.105)	(0.139)	(0.154)	(0.184)	(0.115)	(0.179)	(0.215)	(0.262)
$\frac{OMO\ O/N\ BTC^b}{OMO\ Term\ BTC}$	0.003	0.007*	0.012**	0.015**	0.001	0.005	0.012**	0.016**
	(0.002)	(0.004)	(0.005)	(0.006)	(0.002)	(0.004)	(0.005)	(0.007)
R^2	0.053	0.059	0.084	0.119	0.027	0.034	0.048	0.075
Num.obs.	305	305	305	305	357	356	353	349

Note: [a] Newey-West standard errors. *** Denotes significance at 1%;** Denotes significance at 5%;* Denotes significance at 10%

Table B3. Money market rates and maturity of dealers' financing
I run multivariate specifications but report only coeffients for factor X_t

	A. No crisis sample			**B. The whole sample**		
	β	$s.e$	R^2	β	$s.e$	R^2
Panel A. LIBOR rates						
	LIBOR excess return:					
rx_{LIBOR}^{1week}	0.002	(0.013)	0.032	-0.007	(0.023)	0.017
rx_{LIBOR}^{2week}	0.001	(0.021)	0.041	-0.002	(0.031)	0.037
rx_{LIBOR}^{1month}	0.009	(0.029)	0.038	0.001	(0.058)	0.052
	LIBOR term structure slope:					
$i^{1week} - i^{o/n}$	0.001	(0.027)	0.036	-0.020	(0.033)	0.019
$i^{2week} - i^{o/n}$	0.011	(0.042)	0.045	-0.012	(0.046)	0.023
$i^{1month} - i^{o/n}$	0.005	(0.064)	0.075	-0.018	(0.068)	0.043
Panel B. Bank deposit rates						
	Deposit rates excess return:					
$rx_{Deposit}^{1week}$	-0.001	(0.015)[a]	0.050	-0.013	(0.032)	0.056
$rx_{Deposit}^{2week}$	0.011	(0.022)	0.011	-0.002	(0.042)	0.063
$rx_{Deposit}^{1month}$	0.039*	(0.024)	0.050	-0.002	(0.074)	0.072
	Deposit rates term structure slope:					
$d^{1week} - d^{o/n}$	0.009	(0.018)	0.081	-0.013	(0.031)	0.048
$d^{2week} - d^{o/n}$	0.020	(0.036)	0.062	-0.001	(0.044)	0.046
$d^{1month} - d^{o/n}$	0.022	(0.055)	0.098	-0.017	(0.065)	0.046
Panel C. Commercial paper AA rates						
	Commercial paper rates excess return:					
rx_{CP}^{1week}	-0.008	(0.013)	0.038	-0.055	(0.034)	0.034
rx_{CP}^{2week}	-0.006	(0.019)	0.049	-0.054	(0.051)	0.037
rx_{CP}^{1month}	0.018	(0.027)	0.058	-0.019	(0.082)	0.049
	Commercial paper rates term structure slope:					
$c^{1week} - c^{o/n}$	-0.001	(0.015)	0.071	-0.049	(0.033)	0.018
$c^{2week} - c^{o/n}$	0.006	(0.035)	0.062	-0.039	(0.050)	0.022
$c^{1month} - c^{o/n}$	0.017	(0.059)	0.082	-0.001	(0.065)	0.039

Note: [a] Newey-West standard errors. *** Denotes significance at 1%; ** Denotes significance at 5%;* Denotes significance at 10%

References

[1] Adrian, T., and Fleming, M. (2005). "What Financing Data Reveal about Dealer Leverage." *Federal Reserve Bank of New York Current Issues in Economics and Finance,* 11(3).

[2] Adrian, T., and Shin, H. (2009). "Liquidity and Leverage." *Federal Reserve Bank of New York Stuff Report 328.*

[3] Buraschi, A., and Menini, D. (2002). "Liquidity Risk and Specialness." *Journal of Financial Economics*, Vol. 64 pp. 243-284.

[4] Campbell, J., and Shiller R. (1991). "Yield Spreads and Interest Rate Movements: A Bird's Eye View." *Review* of *Economic Studies 58,* pp. 495-514.

[5] Carpenter, S., and Demiralp, S. (2006). "Anticipation of Monetary Policy and Open Market Operations." *International Journal of Central Banking* 2(2) pp. 25-63.

[6] Cochrane, J., and Piazzesi, M. (2005). "Bond Risk Premia." *American Economic Review* 95(1), pp. 138-60.

[7] Della Corte, P., Sarno, L., and Thornton, D. (2008). "The Expectation Hypothesis of the Term structure of Very Short-term Rates: Statistical Tests and Economic Value." *Journal of Financial Economics* 89, iss. 1, pp. 158-74.

[8] Duffie, D. (1996). "Special Repo Rates." *The Journal of Finance*, Vol. LI, No. 2, pp. 493-526.

[9] Duffie, D., Garleanu, N., and Pedersen, L. (2002). "Securities Lending, shorting, and Pricing." *Journal of Financial Economics*, Vol. 66 pp. 307-339.

[10] Fama, E., and Bliss, R. (1987). "The Information in Long-Maturity Forward Rates," *American Economic Review* 77, pp. 680-92.

[11] Fleming, M., and Garbade, K. (2007). "Dealer Behavior in the Specials Market for US Treasury Securities." *Journal of Financial Intermediation* 16, pp. 204-28.

[12] Fleming, M., Hrung, W., and Keane, F. (2010). "Repo Market Effects of the Term Securities Lending Facility." *American Economic Review*, 100(2): 591–96.

[13] Fleming, M., and Rosenberg, J. (2007). "How do Treasury Dealer Manage their Positions?." *Staff Report 299,* Federal Reserve Bank of New York.

[14] Geczy, C., Musto, D., and Reed, A. (2002). "Stocks are Special Too:An Analysis of the Equity Lending Market." *Journal of Financial Economics*, Vol. 66 pp. 241-269.

[15] Greenwood, R., and Vayanos, D. (2010). "Bond Supply and Excess Bond Returns." *mimeo.*

[16] Gorton, G., and Metrick, A. (2009). "Securitized Banking and the Run on Repo." NBER Working Paper 15223.

[17] Gurkaynak, R., Sack, B., and Swanson, E. (2007). "Market-based Measures of Monetary Policy Expectations." *Journal of Business and Economic Statistics*, 25(2), pp. 201-12.

[18] Gurkaynak, R., Sack, B., and Wright, J. (2006). "The U.S. Treasury Yield Curve: 1961 to the Present," Manuscript, Federal Reserve Board of Governors

[19] Hamilton, J. (2009). " Daily Changes in Fed Funds Futures Prices." *Journal of Money, Credit, and Banking*, Vol. 41, iss. 4, pp. 567-82.

[20] Jordan, B., and Jordan, S. (1997). "Special Repo Rates: An Empirical Analysis," *The Journal of Finance*, Vol. LII, No. 5, pp. 2051-2072.

[21] Krishnamurthy, A. (2002). "The Bond/Old-Bond Spread." *Journal of Financial Economics*, Vol. 66 pp. 463-506.

[22] Kuttner, K. (2001). "Monetary Policy Surprises and Interest Rates: Evidence from the Federal funds Futures Market." *Journal of Monetary Economics* 47, pp. 523-44.

[23] Lange, J., Sack, B., and Whitesell, W. (2003). "Anticipation of Monetary Policy in Financial Markets." *Journal of Money, Credit, and Banking* 35(6), pp. 889-909.

[24] Longstaff, F. (2000). "The Term Structure of very Short-term Rates: New Evidence for the Expectation Hypothesis." *Journal of Financial Economics 58,* pp. 397-415.

[25] Ludvigson, S., and Ng, S. (2009). "Macro Factors in Bond Risk Premia, " *Review of Financial Studies* 22, pp. 5027-5067.

[26] Perli, R., and Sack, B. (2003). "Does Morgage Hedging Amplify Movements in Long-term Interest Rates?" *Journal of Fixed Income* 12, 7-17.

[27] Piazzesi, M., and Swanson, E. (2008). "Futures Price as Risk-adjusted Forecast of Monetary Policy", *Journal of Monetary Economics* 55, pp. 677-91.

[28] Stigum, M., and Crescenzi, A. (2007). *The Stigum's Money Market*, McGraw-Hill.

[29] Taylor, J., and Williams, J. (2009) "A Black Swan in the Money Market," *American Economic Journal: Macroeconomics*, American Economic Association, vol. 1(1), pp. 58-83.

[30] Wessel, D. (2010). *In FED We Trust: Ben Bernanke's War on the Great Panic,*Crown Business