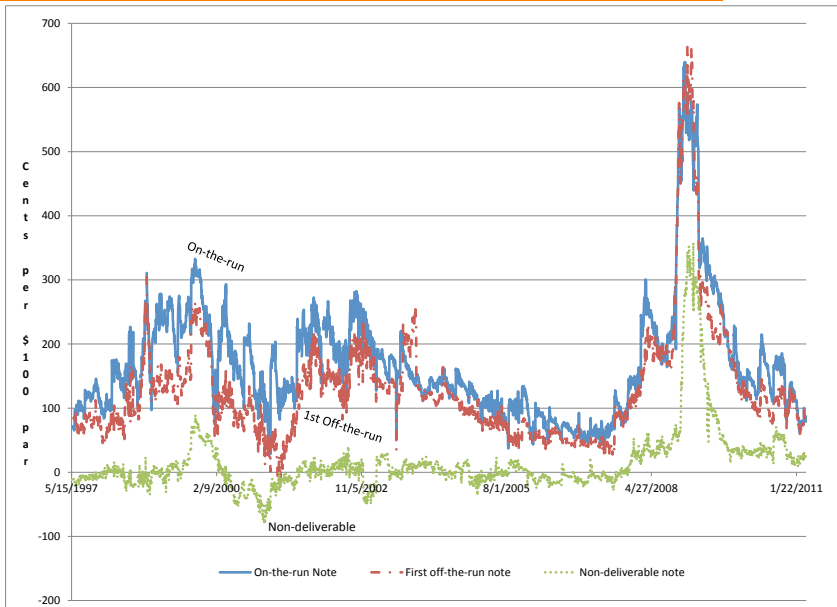# Coupon Spreads, Repo Specials, and Limits to Arbitrage in the 10-Year US Treasury Market
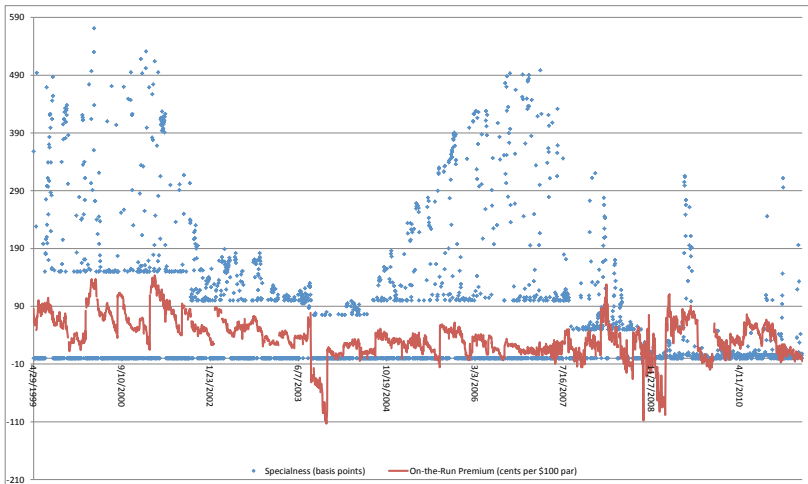
Christopher G. Lamoureux
&
George Theocharides

March 8, 2013
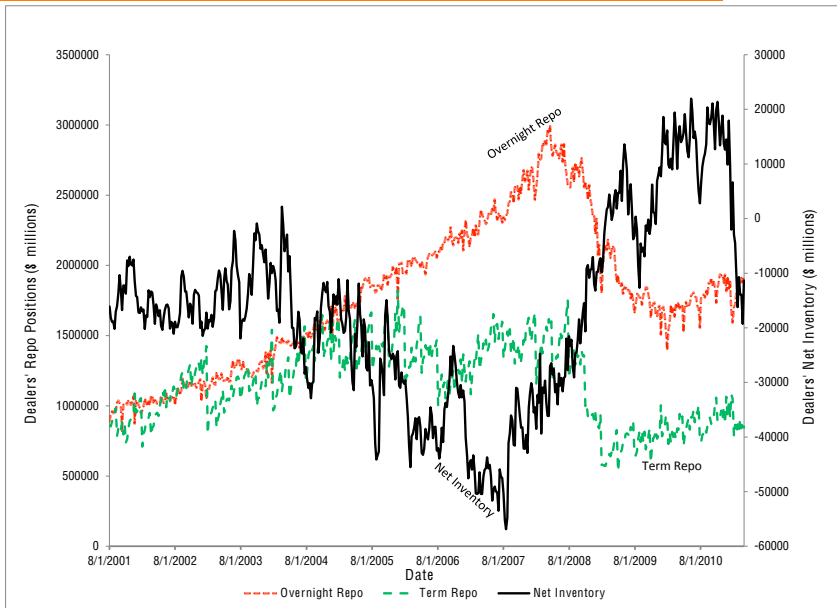
Coupon Spreads

Specialness (basis points) ♦ On-the-Run Premium (cents per $100 par)

Balance Sheets

Auction & Formats

- Generally quarterly issuances: Feb, . . . cycle.
- Structurally missing data in our panel from the July and October 2006 notes.
- No format prior to September 2003.
- Prior to this no off-cycle reopenings and arbitrary on-cycle reopenings.
- Aug 2003 – Sept 2008:
    - New note each quarter.
    - Reopening in following month.
- November 2008 – Present:
    - New note each quarter.
    - Reopening in each of next two months.

Sub-periods

We split our data into 3 subperiods:

1. May 1997 - December 2002 (Pre-Electronic)
2. January 2003 - June 2008 (Increased Risk Capital)
3. July 2008 - March 2011 (Crisis)

Per./Form.	% Dlr.	% Foreign.	Size ($b.)
1/O	78	7	14
1/R	82	6	11
2/O	61	20	17
2/R	84	6	9
3/O	54	24	25
3/R	60	19	20

Limits to Arbitrage –1.

Repo specialness leads to violations of the Law of One Price.
–Also risk of call to cover.

- ▶ Duffie (1996).
- ▶ Storied 3Com / Palm episode.
- ▶ Krishnamurthy (2002); Nashikkar (2007).

Sluggish adjustment of Risk Capital:

- ▶ Duffie (2010).
- ▶ Price pressure (microstructure); Grossman & Miller (1988).
- ▶ Nagel (2011).

Note that the effects of more risk capital are not unambiguous, suggesting the need to explore multiple dimensions of coupon spread dynamics.

Limits to Arbitrage –2.

The turmoil in the wholesale funding markets, which started in 2007, is a rich source of data relating to limits to arbitrage (*optical arbitrage*):

1. August 2007 - September Euro/$ Covered Interest Parity Violation (Baba, Packer, Nagano (2008): $ shortage).

2. Convertible Bond Arbitrage (Mitchell and Pulvino (2011)).

3. CDS-Bond Basis:
   - US Corporate Bonds (Bai and Collin-Dufresne (2010), Mitchell and Pulvino (2011).
   - European Sovereign Debt (Foley-Fisher (2010).

4. 30-year swap rates 50 bp lower than 30-year US Treasury in late November 2008.

5. Buraschi, Sener, and Menguturk (2012) Sovereign debt in different currencies: August 9, 2007 – March 31, 2009.

Limits to Arbitrage –3.

▶ Also, Mitchell & Pulvino (2011) document a high correlation between *arbitrage errors* in the CDS/Bond basis and convertible bonds, which is normally 0, is 91% during the crisis.

▶ Why? Lack of Risk Capital and collapse of repo market (two sides of the same coin).

▶ We add to the mix evidence from 10-year US Treasury market, including the effects of Fed policy.

▶ We complement other examples, since coupon spreads are true arbitrage trades.

Limits to Arbitrage –4.

Important Related paper:

- Hu, Pan, and Wang (2012) – $Noise_t$ –deviations of all Treasury securities maximal 10 year terms. –Argue that this captures the liquidity or level of risky capital in markets (One-dimensional).

  - Hu, Pan, and Wang claim that their $Noise_t$ measure is a summary of the liquidity in the overall market, which is the level of arbitrage capital. However, they have no direct evidence of this.

Coupon Spreads: Periods 1 & 2
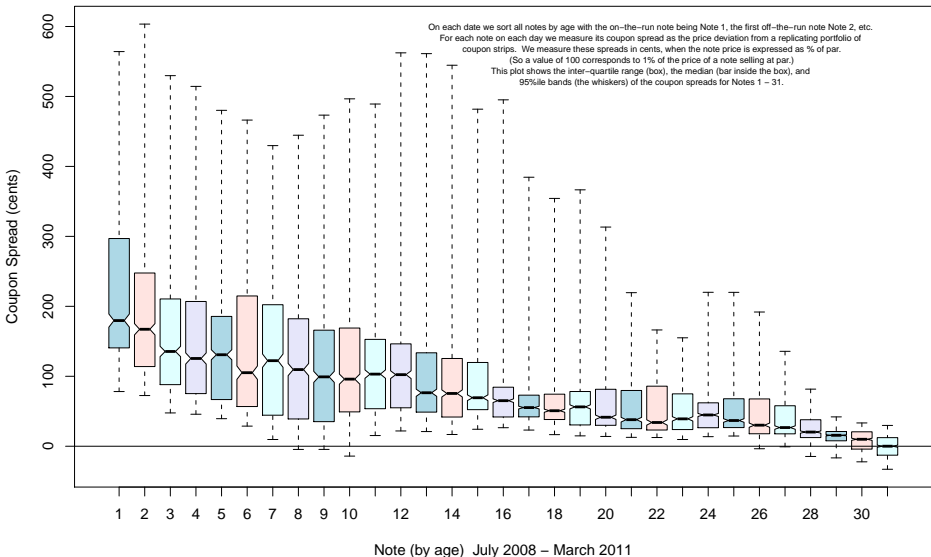

On each date we sort all notes by age with the on–the–run note being Note 1, the first off–the–run note Note 2, etc.
For each note on each day we measure its coupon spread as the price deviation from a replicating portfolio of coupon STRIPS.
We measure these spreads in cents, when the note price is expressed as % of par.
(So a value of 100 corresponds to 1% of the price of a note selling at par.)
This plot shows the inter–quartile range (box), the median (bar inside the box), and 95%ile bands (the whiskers)
of the coupon spreads for Notes 1 – 31.

Note (by age) May 1997 – December 2002

Note (by age) January 2003 – June 2008

On each date we sort all notes by age with the on–the–run note being Note 1, the first off–the–run note Note 2, etc.
For each note on each day we measure its coupon spread as the price deviation from a replicating portfolio of coupon strips. We measure these spreads in cents, when the note is expressed as % of par.
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Coupon Spread (cents)

Note (by age) July 2008 – March 2011

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Principal Components Analysis

We use the Gibbs sampler to integrate over the uncertainty in the first two moments and missing data.

Consider that the coupon spread for Note j on day t is missing. Then $x_{j,t} \sim \mathcal{N}(\hat{\mu}_j, \hat{\sigma}_j^2)$.

$$\hat{\mu}_j = \mu_j + \Sigma_{12}\Sigma_{22}^{-1}(X_{t,-j} - \mu_{-j}) \qquad (1)$$

$$\hat{\sigma}_j^2 = \Sigma_{11} - \Sigma_{12}\Sigma_{22}^{-1}\Sigma_{21} \qquad (2)$$

Here, μ_j is the unconditional mean of the jth coupon spread.

$$\mu | \Sigma \sim N(\bar{x}, \, T^{-1}\Sigma) \qquad (3)$$

$$\Sigma | \mu \sim IG(\hat{\Sigma}, \, T) \qquad (4)$$

Here $\hat{\Sigma}$ is the maximum likelihood estimator of Σ (which is conditional on μ), and $\bar{x}$ is the sample mean. IG refers to the inverse gamma distribution.

Principal Components Analysis –2.

- ▶ Once we have a draw from Σ, we form the correlation matrix, and its eigenvalues and eigenvectors.
- ▶ Armed with these, we form the PC scores.
- ▶ Identification (Aliasing Problems):
    - ▶ Switching rank of eigenvalues from one draw to the next.
    - ▶ Change in sign of eigenvector from one draw to the next.

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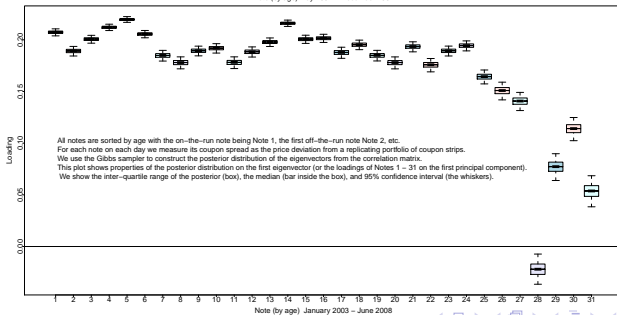
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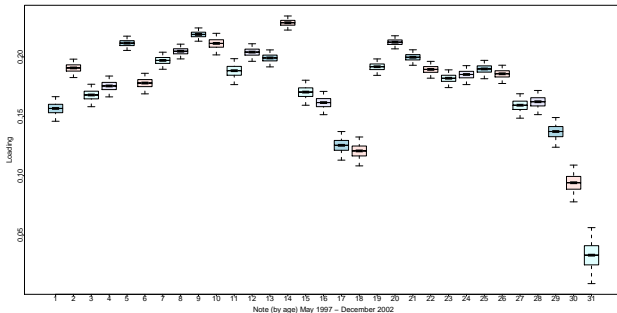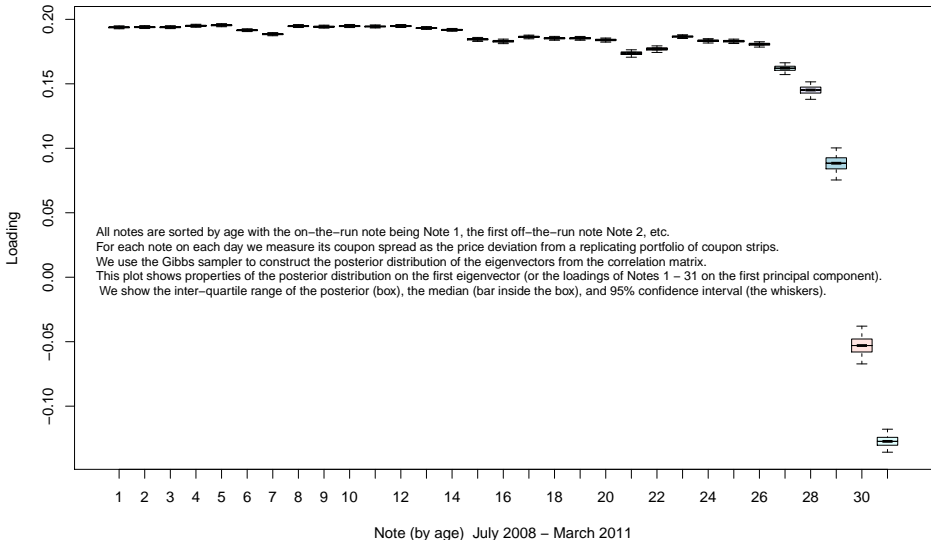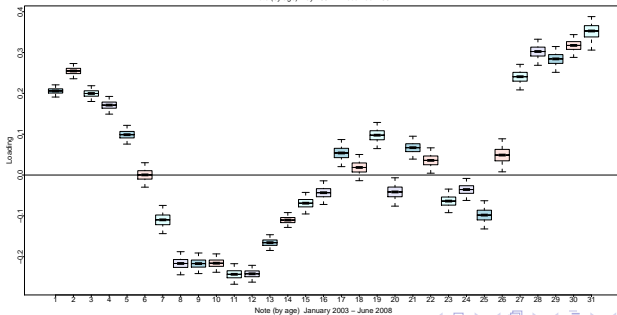 Scores

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First eigenvector

All notes are sorted by age with the on–the–run note being Note 1, the first off–the–run note Note 2, etc.
For each note on each day we measure its coupon spread as the price deviation from a replicating portfolio of coupon strips.
We use the Gibbs sampler to construct the posterior distribution of the eigenvectors from the correlation matrix.
This plot shows properties of the posterior distribution on the first eigenvector (or the loadings of Notes 1 – 31 on the first principal component).
We show the inter–quartile range of the posterior (box), the median (bar inside the box), and 95% confidence interval (the whiskers).

Note (by age) July 2008 – March 2011

Second eigenvector
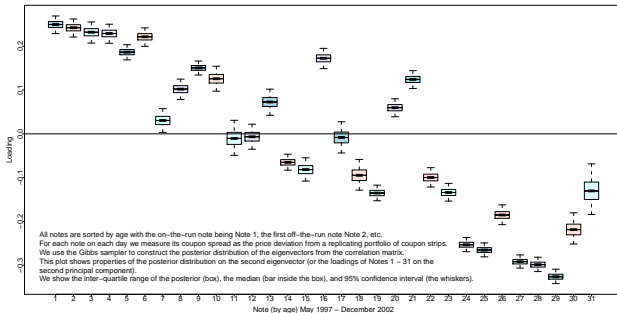
Second eigenvector –Period 3.
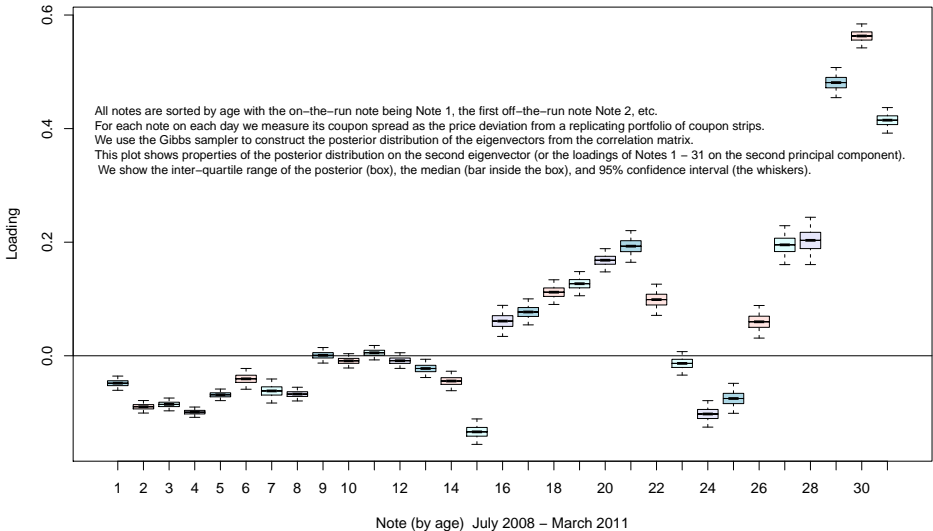
All notes are sorted by age with the on–the–run note being Note 1, the first off–the–run note Note 2, etc.
For each note on each day we measure its coupon spread as the price deviation from a replicating portfolio of coupon strips.
We use the Gibbs sampler to construct the posterior distribution of the eigenvectors from the correlation matrix.
This plot shows properties of the posterior distribution on the second eigenvector (or the loadings of Notes 1 – 31 on the second principal component).
We show the inter–quartile range of the posterior (box), the median (bar inside the box), and 95% confidence interval (the whiskers).

Loading

Note (by age) July 2008 – March 2011

Cumulative % Explained

Component	Period 1	Period 2	Period 3
1	43.1	52.6	81.0
	(0.9)	(0.9)	(0.06)
2	59.3	62.9	88.8
	(0.8)	(0.8)	(0.05)
3	68.1	68.6	91.7
	(0.6)	(0.7)	(0.04)
3F	71.6	79.0	96.3
	(0.3)	(0.2)	(0.04)

It appears that the slope factor is unique to the first period.

Correlation with Hu, Pan and Wang's Noise

Component	Period 1	Period 2	Period 3
1	30.8	83.4	94.0
	(0.4)	(0.1)	(0.04)
2	-40.0	1.6	-22.5
	(1.2)	(2.5)	(3.8)
3	-1.9	-27.2	NI
	(3.4)	(2.3)	(−)
R^2	25.7	77.1	94.7
	(0.6)	(0.5)	(0.7)
F-1	50.8	74.4	95.0
	(0.6)	(0.6)	(0.2)

Correlation with on-the-run premia

Component	Period 1	Period 2	Period 3
1	-18.1	15.5	-22.2
	(0.4)	(0.3)	(0.1)
2	-8.8	-17.6	28.8
	(0.9)	(1.4)	(1.3)
3	7.4	8.9	NI
	(1.9)	(1.2)	(−)
R^2	4.7	8.9	19.2
	(0.3)	(1.2)	(6.4)
F-1	-10.0	-1.4	-23.4
	(0.8)	(0.6)	(0.5)

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Non-On-the-Run Specials

Little – if anything– is known about specials for
non-on-the-run notes.

% of possible times on special

Note(s)	Period 1	Period 2	Period 3
1	42.5	43.2	57.6
2	15.8	20.4	22.1
3	2.9	10.3	10.6
4	2.1	8.2	9.3
All Del.	8.4	12.3	19.6
All Non-del.	1.7	5.2	17.4

–From Period 1 to 2: Consistent with flattening out of the
on-the-run premium seen in Slide 11.

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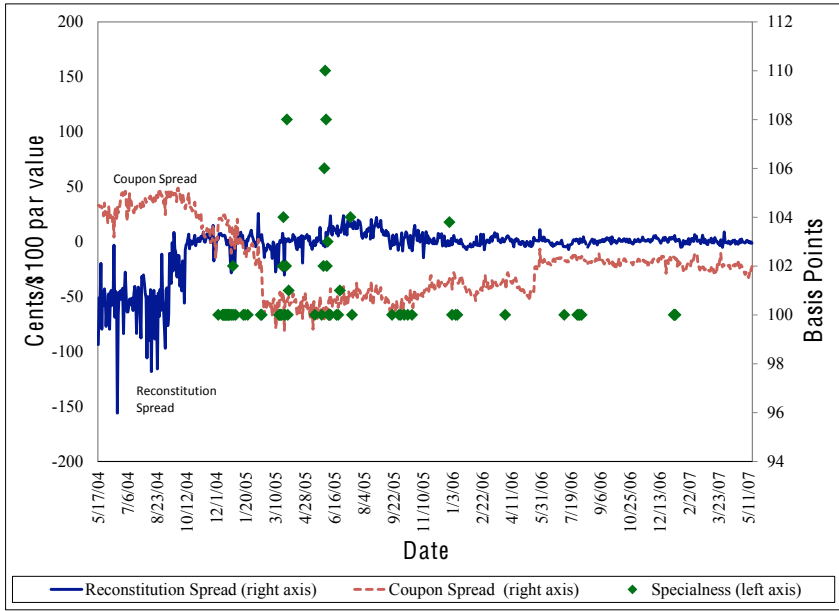Eigenvectors
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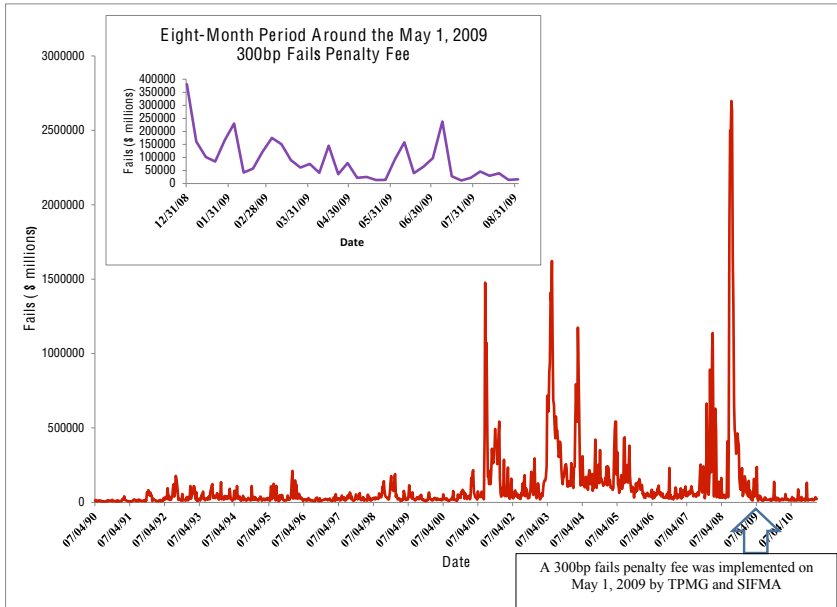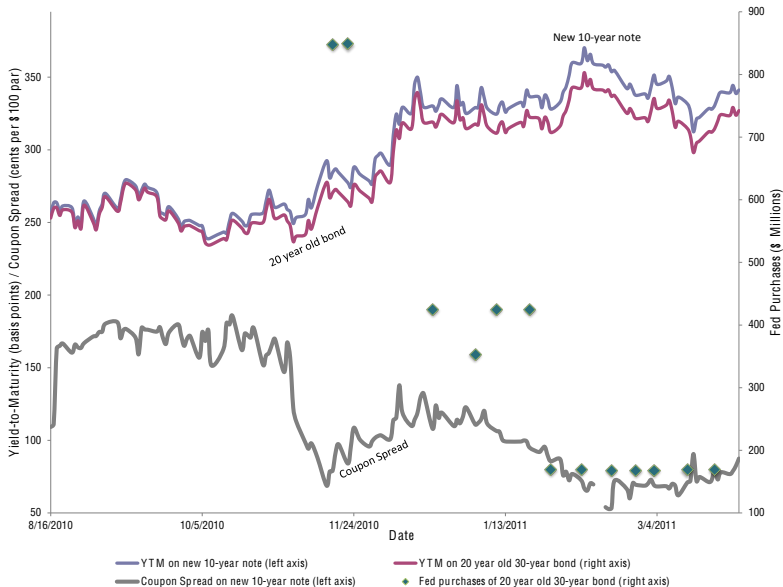Policy
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Non-On-the-Run Specials 2.

Little – if anything– is known about specials for
non-on-the-run notes.

Mean Spreads above Minimum Lending Fee (bps)

Note(s)	Period 1	Period 2	Period 3
1	89	73	20
2	77	42	2
3	56	20	9
4	18	25	3
All Del.	77	37	6
All Non-del.	2	2	2

Interesting general decline in special rates, even during the
crisis, and after fails penalty imposition.

$5\frac{3}{4}$% August 2010 Note; May 2004 – May 2007
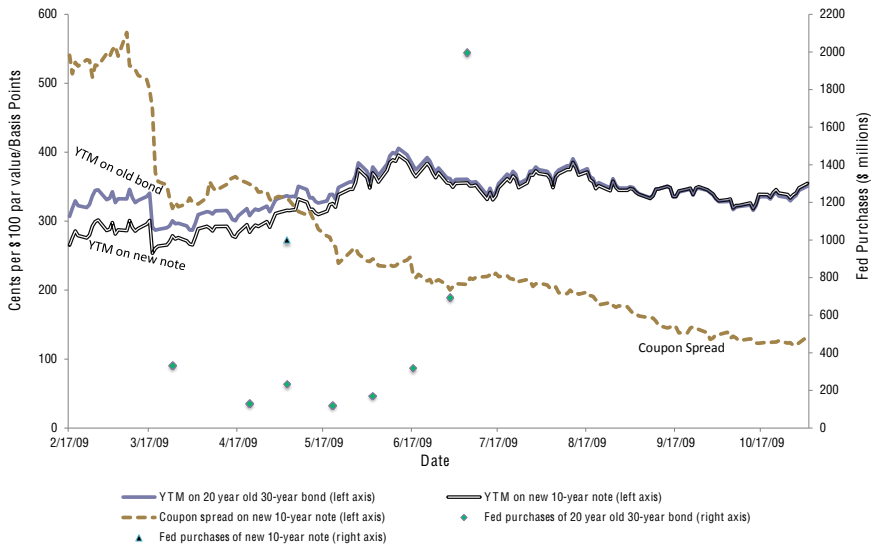
Eight-Month Period Around the May 1, 2009
300bp Fails Penalty Fee

A 300bp fails penalty fee was implemented on
May 1, 2009 by TPMG and SIFMA

The Speed of Capital

- ▶ The spike in the on-the-run note's coupon spread on the announcement on March 18 (it was 491 on 3/17, and 370 on 3/19), is relevant to understanding the speed of arbitrage capital. This convergence was not the result of gradual restoration of risky balance sheets. The Fed's announcement changed the risk profile and capital moved in.

- ▶ And the effect occurred before the Fed bought a single US Treasury security.

- ▶ Most significant effect of QE-I as the effect on coupon spreads is permanent.

What's Next?

- ▶ I like Buraschi, Sener, and Menguturk (2012). Studies spreads between Mexican, Brazilian, and Turkish sovereign debt in $ and euro. These spreads also explode during the financial crisis.

- ▶ They regress the spreads on proxies for risk factors that might drive the financial frictions.

- ▶ Like Mitchell & Pulvino they find strong correlations between their empirical measure of Limits to Arbitrage during the crisis and usual suspects.

- ▶ They infer e.g.: "Closed End Fund Discount risk ... accounts for a majority of the explanation."