



Why Does the Treasury Issue TIPS? The TIPS-Treasury Bond Puzzle

Matthias Fleckenstein
Francis A. Longstaff
Hanno Lustig

UCLA Anderson School



Overview

- The T-bond and TIPS markets are two of the largest and most-active fixed income markets in the world.
- Despite this, we find that there is persistent arbitrage on a massive scale across these two markets.
- The price of a T-bond can exceed that of an inflation-swapped TIPS issue exactly replicating the cash flows of the T-bond by more than \$20 per \$100 notional. Average arb is \$2.92.
- T-bonds are almost always rich relative to TIPS.
- To our knowledge, the largest arbitrage ever documented.
- Poses a major puzzle to classical asset-pricing theory.
- Strategy has been successfully implemented by a number of hedge funds (FT, NY Times, CNBC, Bloomberg, etc. articles.)



Asset Pricing Implications

- Why study arbitrage?
- We explore determinants via regression.
 - Driven by Treasury issuance.
 - Driven by disruptions in the financial markets.
 - Supply factors seem to dominate.
- Recent theory stresses role of capital; Duffie (2010), Brunnermeier and Pedersen (2009), Ashcraft, Garleanu, and Pedersen (2010), etc.
 - Implies that arbitrages may be correlated across markets.
- We test this by examining relation between TIPS arb, CDS/corporate arb, and CDX Index/components arb. We also examine the relation between TIPS arb and arb-oriented hedge fund returns.
 - Results provide partial support for the theory, but can't fully explain the results.



Policy Implications

- Should the Treasury issue TIPS? Two arguments against.
 - Issuance of TIPS is very costly. Mispricing has exceeded \$56 billion, or 8% of amount of TIPS outstanding.
 - By issuing indexed debt, Treasury gives up fiscal hedging option.
- Results imply that T-bond/TIPS spreads provide biased estimates of market's inflation expectations.

Table 2

A Specific Example of the Synthetic Treasury Bond Replicating Strategy. This table shows the cash flows associated with the 7.625 percent Treasury bond with maturity date February 15, 2025 and the cash flows from the replicating strategy using the 2.375 percent TIPS issue with the same maturity date that replicates the cash flows of the Treasury bond. The example is based on market prices for December 30, 2008. Cash flows are in dollars per \$100 notional. I_t denotes the realized percentage change in the CPI index from the inception of the strategy to the cash flow date. Date designates the number of the semiannual period in which the corresponding cash flows are paid.

Date	Treasury	TIPS	Inflation Swaps	STRIPS	Total
0	-169.4793	-101.2249	0	-45.6367	-146.3786
1	3.8125	1.1875 I_1	1.1856 - 1.1875 I_1	2.6269	3.8125
2	3.8125	1.1875 I_2	1.1638 - 1.1875 I_2	2.6487	3.8125
3	3.8125	1.1875 I_3	1.1480 - 1.1875 I_3	2.6645	3.8125
4	3.8125	1.1875 I_4	1.1467 - 1.1875 I_4	2.6658	3.8125
5	3.8125	1.1875 I_5	1.1307 - 1.1875 I_5	2.6818	3.8125
6	3.8125	1.1875 I_6	1.1376 - 1.1875 I_6	2.6749	3.8125
7	3.8125	1.1875 I_7	1.1566 - 1.1875 I_7	2.6559	3.8125
8	3.8125	1.1875 I_8	1.1616 - 1.1875 I_8	2.6509	3.8125
9	3.8125	1.1875 I_9	1.1630 - 1.1875 I_9	2.6495	3.8125
10	3.8125	1.1875 I_{10}	1.1773 - 1.1875 I_{10}	2.6352	3.8125
11	3.8125	1.1875 I_{11}	1.1967 - 1.1875 I_{11}	2.6158	3.8125
12	3.8125	1.1875 I_{12}	1.2095 - 1.1875 I_{12}	2.6030	3.8125
13	3.8125	1.1875 I_{13}	1.2248 - 1.1875 I_{13}	2.5877	3.8125
14	3.8125	1.1875 I_{14}	1.2466 - 1.1875 I_{14}	2.5659	3.8125
15	3.8125	1.1875 I_{15}	1.2683 - 1.1875 I_{15}	2.5442	3.8125
16	3.8125	1.1875 I_{16}	1.2866 - 1.1875 I_{16}	2.5259	3.8125
17	3.8125	1.1875 I_{17}	1.3058 - 1.1875 I_{17}	2.5067	3.8125
18	3.8125	1.1875 I_{18}	1.3304 - 1.1875 I_{18}	2.4821	3.8125
19	3.8125	1.1875 I_{19}	1.3556 - 1.1875 I_{19}	2.4569	3.8125
20	3.8125	1.1875 I_{20}	1.3792 - 1.1875 I_{20}	2.4333	3.8125
21	3.8125	1.1875 I_{21}	1.4009 - 1.1875 I_{21}	2.4116	3.8125
22	3.8125	1.1875 I_{22}	1.4225 - 1.1875 I_{22}	2.3900	3.8125
23	3.8125	1.1875 I_{23}	1.4427 - 1.1875 I_{23}	2.3698	3.8125
24	3.8125	1.1875 I_{24}	1.4635 - 1.1875 I_{24}	2.3490	3.8125
25	3.8125	1.1875 I_{25}	1.4806 - 1.1875 I_{25}	2.3319	3.8125
26	3.8125	1.1875 I_{26}	1.4979 - 1.1875 I_{26}	2.3146	3.8125
27	3.8125	1.1875 I_{27}	1.5126 - 1.1875 I_{27}	2.2999	3.8125
28	3.8125	1.1875 I_{28}	1.5277 - 1.1875 I_{28}	2.2848	3.8125
29	3.8125	1.1875 I_{29}	1.5407 - 1.1875 I_{29}	2.2718	3.8125
30	3.8125	1.1875 I_{30}	1.5548 - 1.1875 I_{30}	2.2577	3.8125
31	3.8125	1.1875 I_{31}	1.5676 - 1.1875 I_{31}	2.2449	3.8125
32	3.8125	1.1875 I_{32}	1.5823 - 1.1875 I_{32}	2.2302	3.8125
33	103.8125	101.1875 I_{33}	135.9861 - 101.1875 I_{33}	-32.1736	103.8125

Table 3

Summary Statistics for TIPS–Treasury Mispricing. This table reports summary statistics for TIPS–Treasury mispricing for the 29 pairs of TIPS and Treasury bonds shown. Days denotes the maturity mismatch of the pair. The left central panel reports summary statistics for the mispricing measured in dollars per \$100. The right central panel reports summary statistics for the mispricing measured in basis points. The sample period is from July 23, 2004 to November 19, 2009.

TIPS		Trsy		Days	Mean	SDev	Min	Max	ρ	Mean	SDev	Min	Max	ρ	<i>N</i>
Jan-15-07	3.375	Dec-31-06	3.000	15	0.18	0.39	-0.76	1.10	0.97	34.57	92.03	-255.56	357.23	0.98	506
Jan-15-08	3.625	Dec-31-07	4.375	15	0.34	0.34	-0.25	1.26	0.96	53.82	66.57	-80.99	270.41	0.96	502
Jan-15-09	3.875	Jan-15-09	3.250	0	0.67	0.46	-0.34	2.56	0.95	72.54	135.34	-25.55	723.29	0.98	1109
Jan-15-10	4.250	Jan-15-10	3.625	0	0.85	0.59	-1.05	4.69	0.91	55.14	71.91	-64.47	420.39	0.97	1215
Apr-15-10	0.875	Apr-15-10	4.000	0	1.09	0.65	-1.18	4.51	0.93	58.25	57.84	-69.20	316.69	0.96	1161
Jan-15-11	3.500	Jan-15-11	4.250	0	1.32	0.71	-0.03	4.94	0.92	50.24	33.67	-1.07	231.07	0.94	971
Apr-15-11	2.375	Mar-31-11	4.750	15	1.67	0.70	-0.37	5.03	0.91	56.13	33.04	-15.24	213.25	0.94	736
Jan-15-12	3.375	Jan-15-12	1.125	0	1.84	0.75	0.79	4.64	0.96	72.32	24.20	31.10	163.04	0.95	215
Apr-15-12	2.000	Apr-15-12	1.375	0	1.42	0.41	0.62	2.32	0.91	54.11	14.90	21.83	90.97	0.90	154
Jul-15-12	3.000	Jul-15-12	1.500	0	1.66	0.37	0.94	2.89	0.86	60.25	12.44	35.72	104.19	0.83	91
Apr-15-13	0.625	Mar-31-12	2.500	15	2.19	1.18	-1.07	6.37	0.95	55.44	28.02	-24.54	156.69	0.95	395
Jul-15-13	1.875	Jun-30-13	3.375	15	4.02	1.83	1.77	9.36	0.98	96.27	39.99	49.04	212.92	0.97	353
Jan-15-14	2.000	Dec-31-13	1.500	15	4.38	1.50	2.30	7.86	0.98	103.66	30.32	59.34	173.67	0.97	225
Apr-15-14	1.250	Mar-31-14	1.750	15	1.76	0.30	1.07	2.58	0.85	41.24	6.97	23.77	56.82	0.85	143
Jul-15-14	2.000	Jun-30-14	2.625	15	3.01	0.48	2.04	4.04	0.95	67.20	9.76	46.45	88.47	0.93	101
Jan-15-15	1.625	Feb-15-15	4.000	31	3.36	2.04	1.22	12.52	0.99	55.48	37.53	15.62	214.11	0.99	1204
Jul-15-15	1.875	Aug-15-15	4.250	31	3.61	2.18	1.54	13.24	0.99	56.39	36.45	22.68	207.57	0.99	1079
Jan-15-16	2.000	Feb-15-16	4.500	31	4.01	2.29	1.63	13.14	0.99	59.66	35.41	22.46	206.56	0.99	950
Jul-15-16	2.500	Jun-30-16	3.250	15	3.76	0.59	2.46	4.99	0.98	62.34	9.63	40.75	82.58	0.98	101
Jan-15-17	2.375	Feb-15-17	4.625	31	4.27	2.35	1.51	12.56	0.98	58.22	31.97	18.92	166.06	0.98	698
Jul-15-17	2.625	Aug-15-17	4.750	31	4.43	2.34	1.70	11.20	0.97	57.29	29.83	20.51	143.82	0.97	573
Jan-15-18	1.625	Feb-25-18	3.500	31	5.00	2.51	2.13	12.05	0.98	65.33	31.57	26.99	147.04	0.97	446
Jul-15-18	1.375	Aug-15-18	4.000	31	5.38	2.62	1.78	12.31	0.98	65.78	29.84	21.72	137.22	0.97	320
Jan-15-19	2.125	Feb-15-19	2.750	31	5.32	2.08	2.56	10.14	0.99	68.36	24.60	33.66	123.37	0.99	194
Jul-15-19	1.875	Aug-15-19	3.625	31	3.94	0.78	2.40	5.09	0.99	47.98	9.44	29.05	62.51	0.99	68
Jan-15-25	2.375	Feb-15-25	7.625	31	4.27	3.57	-0.89	23.06	0.98	29.40	23.45	-5.51	138.97	0.98	1342
Jan-15-26	2.000	Feb-15-26	6.000	31	4.90	3.16	-0.06	18.49	0.97	36.85	21.96	-0.50	118.59	0.96	961
Jan-15-27	2.375	Feb-15-27	6.625	31	5.30	3.46	0.54	18.53	0.97	36.42	22.03	3.70	108.12	0.96	709
Jan-15-29	2.500	Feb-15-29	5.250	31	6.84	3.49	1.68	15.22	0.98	48.43	23.69	12.22	103.74	0.98	205

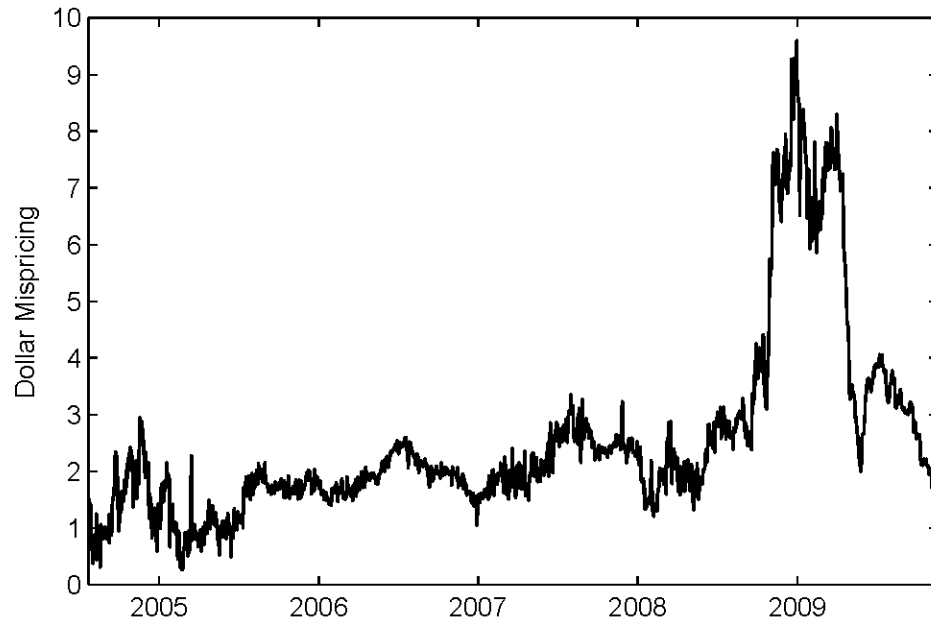


Figure 1. TIPS–Treasury Mispricing. This figure plots the time series of the weighted-average TIPS–Treasury mispricing, expressed in units of dollars per \$100 notional, across the pairs included in the sample, where the average is weighted by the notional amount of the TIPS issue.

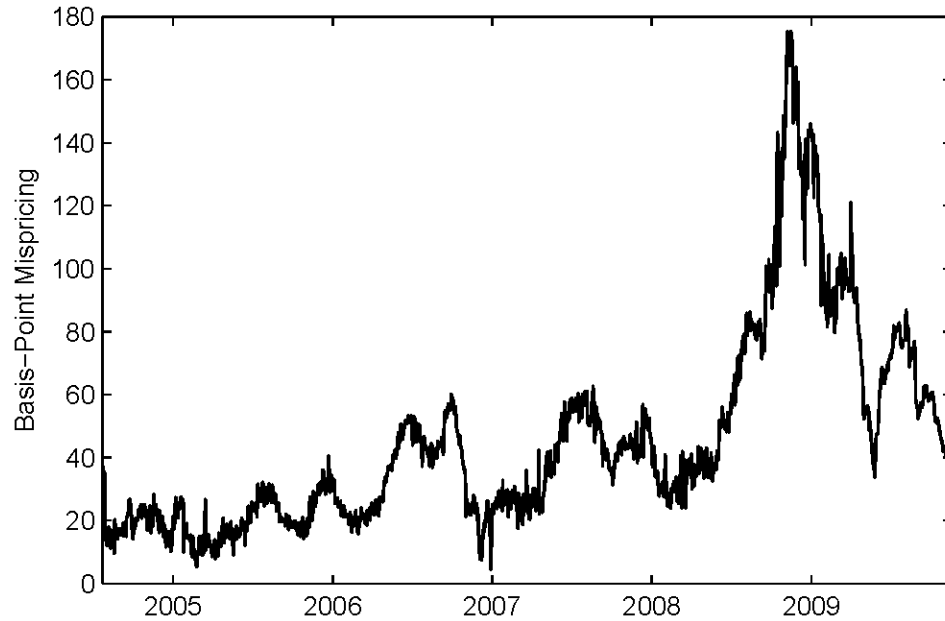


Figure 2. Weighted Average TIPS–Treasury Mispricing in Basis Points. This figure plots the time series of the average TIPS–Treasury mispricing, measured in basis points, across the pairs included in the sample, where the average is weighted by the notional amount of the TIPS issue.

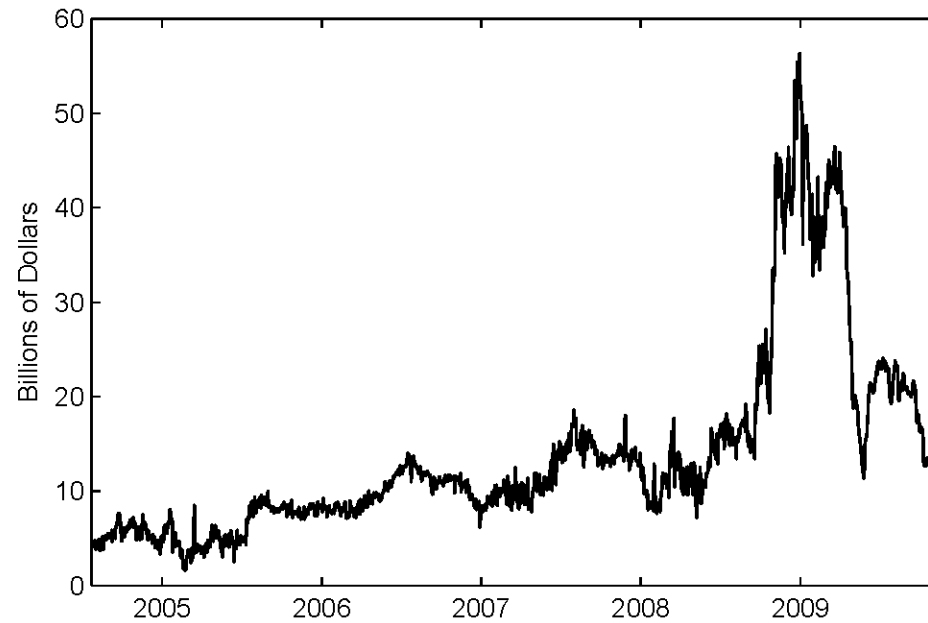


Figure 3. Total Dollar Amount of TIPS-Treasury Mispricing. This figure plots the total dollar amount in billions of TIPS-Treasury mispricing, where the total is calculated using all 33 pairs of TIPS issues outstanding during some portion of the sample period and the corresponding matching-maturity Treasury bonds.

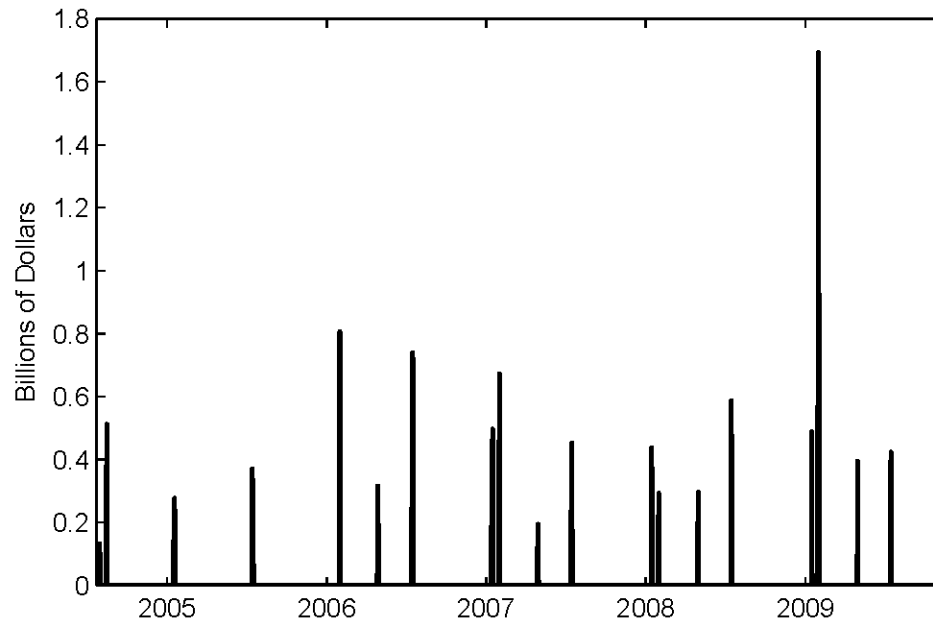


Figure 4. Total Cost to the Treasury from Issuing TIPS Rather than Treasury Bonds. This figure plots the total cost to the Treasury (measured in billions of dollars) of issuing TIPS rather Treasury bonds for each of the TIPS auctions during the sample period.



Additional Factors

- Tax differences.
- Credit risk.
- Bid-ask spreads.
- Deflation floor.
- Repo financing.
- Collateral value.
- Eligibility for STRIPS.
- Futures.
- Foreign ownership.
- Institutional ownership.
- Microstructure.
- Supply.
- TIPS liquidity.
- Costs of shorting.
- Counterparty credit risk.
- Mispricing in inflation swaps market—The corporate axe.

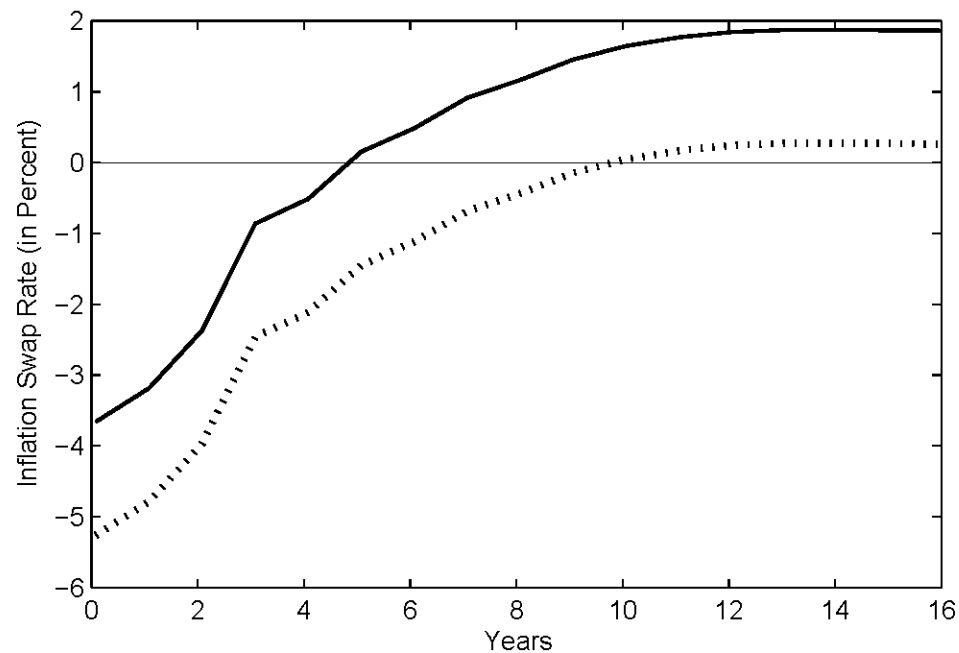


Figure 5. Implied Inflation Swap Curve that Reconciles TIPS–Treasury Mispricing. This figure plots the actual inflation swap curve for December 30, 2008 (solid curve) and the implied inflation swap curve (dotted curve) for the same date that would reconcile the pricing of the Treasury bond with maturity date February 15, 2025 and the corresponding TIPS issue.

Table 4

Results from Regression of Monthly Changes in Average Basis-Point Mispricing on Systemic, Credit, Confidence, Supply, and Liquidity Factors. This table reports the Newey-West *t*-statistics for the coefficients in the indicated regressions. VIX denotes the change in the VIX index. Super Senior denotes the change in the spread of the on-the-run 15–30 CDX index tranche. CDX denotes the change in the on-the-run CDX Investment Grade Index. Conf denotes the change in the Consumer Confidence Index. Flows denotes the change in the total assets held by money market mutual funds. TIPS Issue denotes the total notional amount of TIPS issued during the month. Trsy Issue denotes the total notional amount of Treasury notes and bonds issued during the month. Trade Ratio denotes the ratio of total monthly TIPS trading volume by primary dealers to total monthly Treasury note and bond trading volume by primary dealers. Fails denotes the total notional amount of repo failures reported by primary dealers. The superscript ** denotes significance at the five-percent level; the superscript * denotes significance at the ten-percent level. The sample period is June 2004 to November 2009.

Systemic		Credit		Confidence		Supply		Liquidity		\bar{R}^2
VIX	Super Senior	Swap Spread	CDX	Conf	Flows	TIPS Issue	Trsy Issue	Trade Ratio	Fails	
1.97*		0.95		-0.16		-1.86*	-1.80*	0.33	2.86**	0.135
1.78*		0.95			-0.83	-1.86*	-1.93*	0.37	4.02**	0.138
0.95			0.30	-0.32		-1.90*	-2.00**	0.38	2.05**	0.124
0.84			0.42		-0.59	-1.89*	-2.11**	0.38	3.07**	0.124
	1.21	1.57		-0.17		-1.58	-1.52	0.14	4.82**	0.151
	1.28	1.55			-1.00	-1.64	-1.72*	0.23	5.77**	0.161
	0.81		0.20	-0.42		-1.81*	-1.97*	0.28	3.31**	0.121
	0.75		0.41		-0.78	-1.80*	-2.16**	0.27	8.28**	0.121

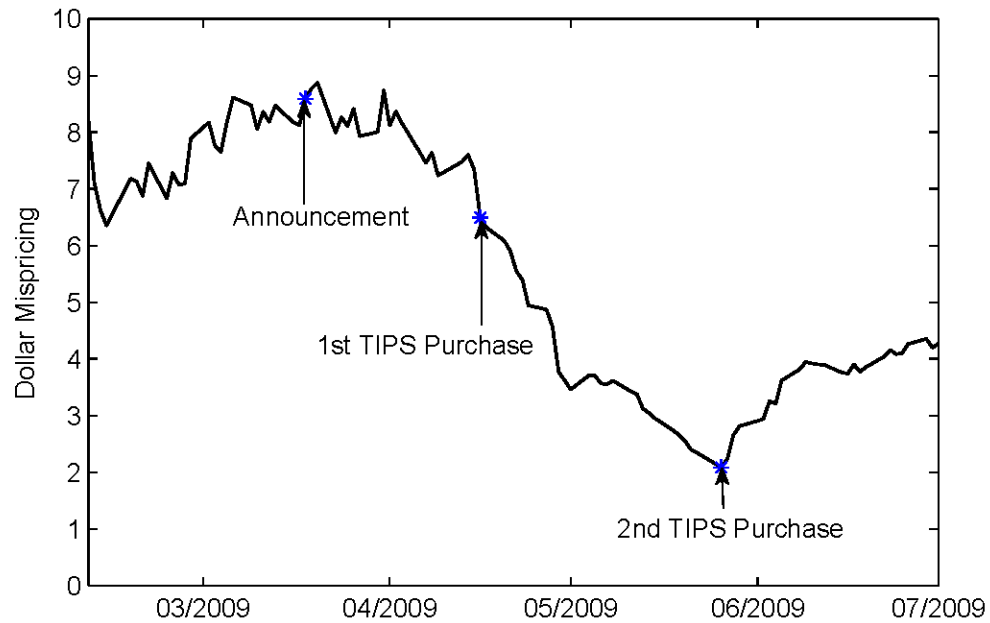


Figure 6. Treasury Purchase Program and TIPS–Treasury Mispricing. This figure plots key dates in the Treasury Purchase Program along with the weighted-average TIPS–Treasury mispricing measured in units of dollars per \$100 notional.

Table 5

Results from the Regression of Monthly Changes in the Absolute Value of TIPS–Treasury Mispricing on Monthly Changes in the Absolute Value of Alternative Arbitrages. This table reports the coefficients and Newey–West *t*-Statistics from the regression of the monthly changes in the absolute value of TIPS–Treasury mispricing on the lagging, contemporaneous, and leading changes in the indicated explanatory variables. The superscript ** denotes significance at the five-percent level; the superscript * denotes significance at the ten-percent level. The sample period is June 2004 to November 2009.

$$\Delta \text{ Mispricing} = \alpha + \sum_{i=t-2}^{t+2} \beta_i \text{ Arb}_i + \epsilon.$$

Explanatory Variable	Coefficient						<i>t</i> -Statistic						\bar{R}^2
	α	Arb _{<i>t</i>-2}	Arb _{<i>t</i>-1}	Arb _{<i>t</i>}	Arb _{<i>t</i>+1}	Arb _{<i>t</i>+2}	α	Arb _{<i>t</i>-2}	Arb _{<i>t</i>-1}	Arb _{<i>t</i>}	Arb _{<i>t</i>+1}	Arb _{<i>t</i>+2}	
CDS Arbitrage	0.7018	-0.0621	-0.0952	0.3270	0.0004	-0.0371	0.44	-1.34	-1.25	3.64**	0.00	-0.55	0.386
CDX Arbitrage	0.8579	-0.4227	0.4362	0.2662	-0.0439	0.2325	0.59	-2.74**	1.98*	1.90*	-0.18	1.11	0.289

Table 6

Results from the Regression of Monthly Changes in TIPS–Treasury Mispricing on Monthly Hedge Fund Index Returns. This table reports the coefficients and Newey–West *t*-statistics from the regression of monthly changes in TIPS–Treasury mispricing on the lagging, contemporaneous, and leading monthly returns on the indicated hedge fund indexes. The superscript ** denotes significance at the five-percent level; the superscript * denotes significance at the ten-percent level. The sample period is June 2004 to November 2009.

$$\Delta \text{ Mispricing} = \alpha + \sum_{i=t-2}^{t+2} \beta_i \text{ Return}_i + \epsilon.$$

Hedge Fund Index	Coefficient						<i>t</i> -Statistic						\bar{R}^2
	α	Ret _{<i>t</i>-2}	Ret _{<i>t</i>-1}	Ret _{<i>t</i>}	Ret _{<i>t</i>+1}	Ret _{<i>t</i>+2}	α	Ret _{<i>t</i>-2}	Ret _{<i>t</i>-1}	Ret _{<i>t</i>}	Ret _{<i>t</i>+1}	Ret _{<i>t</i>+2}	
Fixed Income Arb Return	0.0102	1.9364	-0.5506	-2.2664	-0.6103	0.0279	0.66	1.93*	-0.50	-3.62**	-0.52	0.04	0.141
Convertible Arb Return	0.0149	1.1255	0.1022	-3.0779	0.3795	-0.1268	0.96	1.90*	0.11	-2.80**	0.61	-0.15	0.182
Merger Arb Return	0.0465	2.6145	-5.8550	-0.5706	-3.8181	0.4253	3.47**	1.30	-1.79*	-0.26	-1.51	-0.24	0.141



Conclusion

- Large and persistent arbitrage in two of our largest and most active markets.
- Arbitrage driven by supply flows and liquidity in the fixed income markets.
- Slow-moving capital may explain some portion, but arbitrages that don't involve balance sheet are related to those that do.