European Economic Letters
ISSN 2323-5233
Vol 15, Issue 1 (2025)
http://eelet.org.uk

The Study of TIPS (Treasury Inflation-Protected Securities) and the Mispricing of TIPS Relative to Nominal Treasury Bonds

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ABSTRACT
The paper examines the pricing of Treasury Inflation-Protected Securities (TIPS) in contrast to standard U.S. Treasury bills and highlights some unusual in nature price discrepancies that are not consistent with standard finance. This study examines inflation expectations, market liquidity, and interest rate fluctuations, and concludes that TIPS are generally cheaper than Treasury bonds, despite providing protection against inflation. The observed price differential might indicate that the U.S. Treasury would incur higher costs in issuing TIPS than in selling normal issue bonds. Primary factors, namely the availability of bonds for purchase, the behavior of hedge funds, and narrow market liquidity, result in these price variations, indicating that the market is not efficient. The findings indicate that the Treasury can be more cost-effective by concentrating primarily on issuing standard bonds which in turn affects how investors and economic planners view the need for assets that shelter one from inflation.

Keywords: TIPS, Inflation, Mispricing, Treasury Bonds, Liquidity

Introduction

The coupons and principal redemption amounts of Treasury inflation-protected securities (TIPS), which are fixed-income securities, are modified to account for shifts in the non-seasonally adjusted consumption price index (CPI) for all urban consumers. One TIPS has grown in popularity since its introduction in 1997 and now accounts for roughly 8.6% of the entire federal debt market. The enormous volume of TIPS transactions gives researchers, investors, and policy and decision makers access to important data. Simply put, TIPS yields are risk-free real interest rates that are more important than nominal interest rates for understanding the cost of financing public debt, private investments, and, to a lesser extent, monetary policy. “The difference between interest rates on similarly maturing Treasury bonds and TIPS is also referred to as the “break-even inflation rate” (BEI) or inflation compensation, and it is commonly viewed as the difference between the nominal and real market yield curve and serves as a real time gauge of the inflation expectations of market participants. (D’Amico et al., 2018)”

U.S. government securities known as Treasury Inflation-Protected Securities (TIPS) are created specifically to protect its holders from inflation-related value loss. Since the TIPS value is dependent on changes in the Consumer Price Index (CPI), it is implied that the value will rise in the event of inflation, maintaining the bond's value even when prices are rising.

In addition, TIPS is also issued with a fixed rate of interest payable semi-annually at the time of purchase. However, since the interest payments are based on the adjusted principal, they are paid out even if the principal is increased because of inflation. This mechanism fosters the increase of the interest earnings of an investor with the inflation increase in the value of the bond.

Issued in periods of 5, 10, or 30 years, TIPS additionally guarantee the original principal amount will be reimbursed to the investor irrespective of deflation at maturity. This offer is also protective to the investors who cannot be paid back the amount they committed making TIPS one of the safest assets that are free from the risk of inflation. TIPS interest income and the inflation adjustments to the principal are both subjects of federal income tax while such securities are not liable for state and local taxes. This can create a "phantom income" tax liability, where the investor may be liable to pay taxes on the inflation adjustment even if the adjustment has not been received and will only be received upon maturity of the bond. Even with this tax provision, TIPS have a secondary market and therefore possess high liquidity, although prices can be affected by interest rates, inflation expectations, and market environments.

TIPS are, in fact, believed to be among the best instruments that can be used to hedge against inflation, especially for conservative investors whose interest is primarily in ensuring that their money's worth does not shrink over time. Such returns are guaranteed by the US government and inflation-linked but can result in somewhat lower than expected real returns when there is low inflation or a sharp increase in interest rates. For their assured inflation cover and government guarantee, TIPS are a safe concern for an investor wary about the risk of inflation eroding the value of their fixed income investment.

Mispricing

The markets for Treasury Bonds and Treasury Inflation-Protected Securities (TIPS) are among the biggest and most sophisticated markets in the fixed-income arena. Nevertheless, the two markets are interrelated, there exists a constant and considerable mispricing which often varies with time with bonds generally more valued than TIPS. For instance, in the market for inflation-adjusted rates, a typical Treasury bond can be offered at over $20 per $100 nominal in excess of the equivalent TIPS issue. The existence of this mispricing is notable as it is one of the most extreme cases of arbitrage opportunities ever recorded, which runs contradictory to asset pricing theory.

"The average mispricing of TIPS with Treasury bonds is 54.5 basis points but can go higher than 200 basis points for specific pairs which is comprehensively larger than the usual transaction costs for arbitrage. While treasury bonds may have fitted such price anomalies in the past for instance the yield spread between 'on-the-run' new issues and 'off-the-run' older bonds, the yield variation of TIPS relative to treasuries has been higher and longer lasting. This opens up a large-arbitrage scope and also points to a particular level of market inefficiency in the bond market. (Fleckenstein et al., 2014)"

Numerous elements may lead to errors in the pricing:
The market for Treasury Inflation-Protected Securities (TIPS) consists of numerous considerations, such as inflation expectations, the extent of their liquidity, changes in real interest rates and market factors.

1. **Inflation Expectations**: As a general principle, when the inflation rates prediction of the investors rises, the propensity for acquiring inflation-linked bonds increases, thereby raising the bonds' market price while lowering its yield on such bonds in comparison to other nominals. On the other hand, expectations of inflation that are low may lead to an appreciation in the value of TIPS and make them look cheap in comparison. In practice, though, most investors will not buy TIPS without the assurance of future inflation due to the possibility of aberrant conditions.

2. **Liquidity Differences**: Compared to the nominal Treasury bonds, the TIPS bonds are generally less liquid, particularly within the secondary market, with Treasuries being more liquid in nature. This provides evidence as to why nominal Treasuries can yield lower rates than TIPS.

2. **Real Interest Rate Changes**: TIPS yields are real interest rates (inflation-adjusted nominal rates) sensitive. In a situation where real interest rates increase, TIPS prices in relation to nominal Treasuries could be adversely affected. Alternatively, nominal Treasuries are largely correlated with movements in changed nominal interest rates, and hence give rise to a disparity in the prices of TIPS and Treasuries.

3. **Market Conditions**: The TIPS market is quite limited and illiquid when compared to that of Treasury bonds. Also, due to inflation-linked assets being more attractive in unabated periods of pessimism, TIPS prices may also surge leading to a mismatch in valuation.

These factors can result into relative mispricing between TIPS and nominal Treasury bonds. When the inflation-adjusted, the breakeven inflation rates are quite low in comparison to that of the anticipated inflation, TIPS can be said to be cheap but when the breakeven rates are high looking at the inflation expectations, then nominal Treasuries can be more favourable. This means that these economists are also enabling investors to invest

Literature review

"A review highlighted the mispricing trends in TIPS (often underpriced) and inflation swaps (overpriced for fixed payors), emphasizing the profitable nominal-TIPS yield spread trade. Despite notable findings, factors like liquidity and market imperfections remain underexplored, and extending this analysis internationally could reveal new insights on inflation-linked securities. (Avramov et al., 2016)"

"A study, using a regression framework, examined the significant mispricing between TIPS and Treasury bonds, revealing frequent deviations from no-arbitrage principles that challenge conventional asset pricing theory. Factors like supply dynamics—especially Treasury auctions—emerge as a major influence on significantly narrowing the TIPS-Treasury mispricing. On the other hand, when main dealers have more repo failures and have trouble acquiring Treasury securities, the mispricing increases dramatically. Additionally, funding frictions and slow-moving capital are identified as underlying causes, aligning with recent theoretical perspectives on price deviations in fixed-income markets. Interestingly, mispricing trends also correlate strongly with other arbitrages and fixed-income hedge fund returns, suggesting interconnected market factors. Lastly, the findings make clear that the Treasury's continued issuing of TIPS is a mystery in and of itself. This is due to the fact that the Treasury forfeits billions of dollars by releasing securities that are not as highly appreciated by the market as nominal Treasury bonds, in addition to giving up a fiscal hedging option by issuing TIPS. Fleckenstein Lustig, Francis Longstaff Hanno, et al. (2010)"

"A research investigates the relative pricing of TIPS (Treasury Inflation-Protected Securities) and nominal Treasury bonds, noting significant mispricing between them, often exceeding $20 per $100 notional amount. These mispricing challenges conventional asset pricing theory, particularly the assumption of no-arbitrage, suggesting that even in deep, liquid markets like those for TIPS and Treasury bonds, price discrepancies can persist. The study links TIPS mispricing with the availability of capital in the hedge fund sector and correlations with mispricing in other markets. Importantly, TIPS are frequently underpriced relative to Treasury bonds, implying the U.S. Treasury could reduce debt costs by issuing nominal bonds instead. This persistent mispricing may be explained by "slow-moving capital" theories, which suggest that constraints on capital movement in financial markets can cause price discrepancies that last longer than traditional theory would predict. These findings highlight potential policy inefficiencies and offer insights into the role of capital flows in maintaining price stability in financial markets. (Fleckenstein et al., 2014)"

"A paper explores the influence of TIPS-specific factors, particularly liquidity, on TIPS yield and breakeven inflation (BEI) variations, noting they do not significantly affect nominal yield changes. The authors employ a no-arbitrage term structure model for nominal yields, TIPS yields, and realized inflation, emphasizing the importance of accounting for TIPS-specific liquidity premiums for accurate model fitting. They discover that a poor model fit of TIPS yields, TIPS BEI, and survey inflation estimates results from disregarding the spread between TIPS and risk-free real yields. According to models that permit such a spread, its estimated values were rather high (about 1%) until roughly 2003, and they varied within small ranges until the start of the 2007–2008 crisis. This is in line with the widely held belief that TIPS market liquidity had gradually increased over time. Regression analysis supports these findings by demonstrating that changes in observable TIPS liquidity measures account for around 85% of the variation in the estimated TIPS-indexed bond spread, while other factors like TIPS deflation floor and CPI seasonality seem to be much less significant. TIPS BEI, a real-time, high-frequency indicator of investors' inflation expectations, has drawn more and more attention. However, as was clearly seen during the 2007–2008 financial crisis, significant liquidity premiums and inflation risk premiums might produce a significant wedge between the two, so our findings caution against interpreting changes in TIPS BEI only in terms of shifting inflation expectations. (D'Amico and others, 2018)"

"A research emphasizes that in high mood periods, investors affected by feelings are inefficient. They tend to overestimate the financially distressed, high-risk, unaided companies. The tendencies usually persist even after the new earnings reports are released. There are no such errors when the market sentiment is low and therefore it is not difficult to question some of the hypotheses on the rationality of the updates and point out the existence of behavioural bias in market turbulence. (Avramov et al., 2016)"

"A research discovers considerable and ever-changing misalignments of market prices between U.S. Treasury Bonds and TIPS especially with bonds that bear no interest versus stripped bonds. For values of key parameters, it can be shown that nominal bonds are frequently not correctly priced in relation to inflation-linked bonds, especially during economic conditions characterized by depression or recession, hospitable liquidity and maturity capital constraints being some of the hindering factors. By determining the extent to which mispricing occur in other countries, this study assists portfolio managers and central bankers in understanding the international yield curves and the bond market structure within the G7 economies within the framework of Fleckenstein et al. (2013). (Simon, Z. 2012)."

Research Methodology

The research methodology involved analysing pricing discrepancies between Treasury Inflation-Protected Securities (TIPS) and nominal Treasury bonds by examining key market factors. Daily data on TIPS and Treasury bonds were collected,

focusing on inflation expectations, liquidity levels, and real interest rate changes. Regression analysis was employed to quantify the influence of variables like bond supply, liquidity constraints, hedge fund capital, and credit risk perceptions on TIPS-Treasury mispricing. The study also leveraged synthetic TIPS bonds and inflation swaps to replicate and compare cash flows, allowing for the identification of arbitrage opportunities. This approach revealed persistent mispricing and its driving factors.

Analysis

1. TIPS Market

In general, TIPS, or Treasury Inflation-Protected Securities, are similar to Treasury bonds and are direct obligations of the U.S. Treasury. A key difference, though, is that the principal of a TIPS bond is periodically modified to account for variations in the Consumer Price Index (CPI). The semi-annual coupon payments with TIPS vary as the principal shifts in accordance with inflation or deflation since the set coupon rate is applied on the adjusted principal. The principle is protected against deflation (but not coupon payments) because the bondholder receives the greater of the original principal amount or the inflation-adjusted principal at maturity.

Every day, the TIPS principle is modified in accordance with the CPI for All Urban Consumers (CPI-U). Let it stand for the inflation adjustment for a TIPS bond as of date t. This adjustment is computed by dividing the reference CPI at valuation date t by the reference CPI at issuance date, or time 0. The CPI reference index at the beginning of the month and that of the following month are linearly interpolated to determine the reference CPI for dates within a month. The Bureau of Labor Statistics' CPI-U for the three months prior serves as the basis for the CPI reference index on the first day of each month. For example, the reference CPI for April 1 is the CPI-U from January, which is published in February. Further details on the inflation adjustment process for TIPS can be found on the U.S. Treasury's website.

Date	CPI	% Change
31-08-2024	2.50%	-12.6
31-07-2024	2.90%	-2.6
30-06-2024	3.00%	-9.1
31-05-2024	3.30%	-2.6
30-04-2024	3.40%	-3.5
31-03-2024	3.50%	10.3
29-02-2024	3.20%	2
31-01-2024	3.10%	-7.8
31-12-2023	3.40%	6.8
30-11-2023	3.10%	-3.2
31-10-2023	3.20%	-12.4
30-09-2023	3.70%	0.9
31-08-2023	3.70%	15.3
31-07-2023	3.20%	7
30-06-2023	3.00%	-26.6
31-05-2023	4.00%	-17.9
30-04-2023	4.90%	-1.1
31-03-2023	5.00%	-17.4
28-02-2023	6.00%	-5.8
31-01-2023	6.40%	-0.7
31-12-2022	6.50%	-9.2
30-11-2022	7.10%	-8.2
31-10-2022	7.70%	-5.6
30-09-2022	8.20%	-0.7
31-08-2022	8.30%	-3.1
31-07-2022	8.50%	-5.9
30-06-2022	9.10%	5.6
31-05-2022	8.60%	3.9
30-04-2022	8.30%	-3.3
31-03-2022	8.50%	8.5
28-02-2022	7.90%	5.2
31-01-2022	7.50%	6.3
31-12-2021	7.00%	3.3
30-11-2021	6.80%	9.4
31-10-2021	6.20%	15.4
30-09-2021	5.40%	2.6
31-08-2021	5.30%	-2.1
31-07-2021	5.40%	-0.5
30-06-2021	5.40%	8
31-05-2021	5.00%	20
30-04-2021	4.20%	58.8

*US CPI Data (2021-2024)
Source: Bloomberg

Table 1 - *US CPI Data (2021-2024) (Source: Bloomberg)

2. Inflation Swap Market

In order to control inflation risk, market players began creating inflation swaps after the first TIPS auction in 1997. The TIPS market's growth has increased the liquidity and trading activity of the inflation swap market, particularly in the United States

and the United Kingdom. Because inflation swaps have a strong link with actual CPI levels, institutional investment managers are increasingly using them frequently. Pond and Mirani (2011) estimate that the notional value of the inflation swap market is in the hundreds of billions. According to conversations with inflation swap dealers, bid-ask spreads on these securities are typically under five basis points, making them reasonably liquid.

This study looks at the zero-coupon swap, which is the most popular kind of inflation swap. There will only be one cash flow at the swap's maturity date because it was executed between two counterparties at time 000. Consider a five-year zero-coupon inflation swap rate of 200 basis points at time 000, for example. There are no cash flows at the start of the swap, in accordance with swap norms. The counterparties exchange a cash flow at maturity, which is five years later, and is computed as (1+0.0200)5− It, where It is the inflation adjustment factor. For example, if the realized annual inflation rate over the five-year period was 1.50%, then I_t =1.015^5=1.077284. In this scenario, the net cash flow from the swap would be $(1+0.0200)^5$−1.077284=0.026797(1+0.0200)^5-1.077284= 0.026797$(1+0.0200)^5$−1.077284=0.026797 per dollar of the swap's notional amount. The timing and index lag used to define I_t in an inflation swap are aligned exactly with the definitions applied to TIPS.

3. Arbitrage strategy

The TIPS-Treasury arbitrage method has a simple principle. Assume that a TIPS bond is bought by an investor at a rate equal to the semi-annual coupon rate of s. The coupon payment at any given time t will equal s x It, where It is the inflation adjustment factor, as a result of inflation adjustments. Let's now assume that the investor purchases a zero-coupon inflation swap with a notional amount and maturity equal to the TIPS coupon payment. When f is the fixed inflation swap rate, the inflation swap will pay a cash flow at time t equal to s (1+f)t− s × It. These two payments result in a constant total cash flow of s × It + s (1+f)t− s × It = s (1+f)t. By arranging zero-coupon inflation swaps that align with the maturity dates and notional amounts of each indexed cash flow from the TIPS bond, the investor can convert these indexed cash flows into fixed cash flows.

Table I lists the cash flow elements of this arbitrage technique to help explain how it works. The cash flows related to a Treasury bond bought at price P with a coupon rate of ccc are shown in the first section of the table. This Treasury bond offers a principal payment of 100 at maturity T along with a semi-annual coupon of ccc.

The table's second section shows how a TIPS investment can accurately mimic the cash flows of a Treasury bond. First, at a price of V, the arbitrageur purchases a TIPS bond with a coupon rate of s and the same maturity for the Treasury bond. At maturity, this TIPS bond will pay a principal payment of 100× It, along with a coupon of s x It every month. The arbitrageur then uses a notional sum of s (or s + 100 for the final principal payment) to enter into an inflation swap for every coupon payment date. Each TIPS bond's indexed cash flow is therefore changed to a fixed cash flow. To exactly match the Treasury bond's cash flows, the arbitrageur also takes a long or short position in Treasury STRIPS (Separate Trading of Registered Interest and Principal of Securities) for each coupon payment date.

4. Replication/Synthetic TIPS Bond

The cash flow from the relevant positions for each period is displayed in this table. The price of the Treasury bond with coupon c is indicated by P. D(t) represents the price of a Treasury STRIP with a maturity of t, and V represents the price of the TIPS bond with the same maturity date as the Treasury bond and a coupon rate of s. Calculated as (1 + f)t, where f is the relevant inflation swap rate, Ft represents the fixed payment on a zero-coupon inflation swap of maturity t. The index of inflation The CPI-U index at time t divided by the CPI-U index at time zero is what it represents.

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Strategy	0	1	2	3	...	T
Buy Treasury	$-P$	c	c	c	...	$c+100$
Buy TIPS	$-V$	sI_1	sI_2	sI_3	...	$(s+100)I_T$
Inflation Swap_1	0	$s(F_1-I_1)$	0	0	...	0
Inflation Swap_2	0	0	$s(F_2-I_2)$	0	...	0
Inflation Swap_3	0	0	0	$s(F_3-I_3)$	...	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮
Inflation Swap_T	0	0	0	0	...	$(s+100)(F_T-I_T)$
STRIPS_1	$-(c-sF_1)D(1)$	$c-sF_1$	0	0	...	0
STRIPS_2	$-(c-sF_2)D(2)$	0	$c-sF_2$	0	...	0
STRIPS_3	$-(c-sF_3)D(3)$	0	0	$c-sF_3$	...	0
⋮	⋮	⋮	⋮	⋮	⋮	⋮
STRIPS_T	$-(c+100)D(T)-$ $(s+100)F_T\,D(T)$	0	0	0	...	$(c+100)-$ $(s+100)F_T$
Total Cash Flow	$\sum_{i=1}^{T}(c-sF_i)\,D(i)+$ $100(1-F_T)D(T)-V$	c	c	c	...	$c+100$

Table 2-Arbitrage example

European Economic Letters
ISSN 2323-5233
Vol 15, Issue 1 (2025)
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5. Mispricing Statistics

TIPS Bond	TIPS Coupon	Treasury Bond	Treasury Coupon	Mismatch in days	Dollar Mispricing				
					Mispricing- Mean	Mispricing- Std Dev	Min	Max	p
January 15, 2024	1	December 31, 2023	4	15	1.34	1.34	0.75	2.26	0.96
January 15, 2026	1.25	January 15, 2026	3.5	0	1.67	1.46	0.66	3.56	0.95
January 15, 2027	1.5	January 15, 2027	4.125	0	1.85	1.59	-0.05	5.69	0.91

Table 3-Sample Bonds Mispriced

The Table reports Mispricing for 3 different TIPS and Treasury Bonds, each maturing at a different date. A synthetic TIPS Bond was created in every scenario to replicate The effect of inflation linked coupon payments.

Inflation swaps are quoted based on a fixed rate applied to the contract's fixed leg, with available maturities of 1-30 years. To estimate swap rates for non-standard maturities, cubic spline interpolation is used. For fractional-year maturities, such as 2.3 years, seasonal adjustments are made to account for inflation patterns. This process involves calculating seasonal weights by regressing monthly CPI-U data from January 2015 to October 2024 against monthly indicators. These weights are normalized to remove seasonal effects for full-year maturities and are applied to the interpolated swap curve, though swaps under one-year maturities are not adjusted for seasonality.

6. Regression Analysis

Variables Used

There are many economic and financial factors that can explain the mispricing of TIPS relative to Treasuries as we delineate below:

- Supply of Securities: It has been observed that the level of Treasury securities available influences the TIPS-Treasury mispricing. More specifically, in the presence of a greater supply of newly minted or on-the-run bonds, there will be a greater tendency to put on trades and thus dampen price differentials. Bond pricing and trading characterization based on bond supply have been reported to differ significantly in previous studies.
- Liquidity Differences: Availability of TIPS and Treasury bonds in liquid form can lead to undue mispricing. We proxy for liquidity using two measures, (a) primary dealer TIPS to Treasury trading volumes unadjusted for market values and (b) repo fails the higher frequency of which indicates that primary dealers failed to deliver certain Treasury securities due to lack of liquidity. Large repo fails syndrome are indicative of market stress leading to large mispricing.

Treasury Bonds	
As Of Date	Repo Fails
2022-01-05	102650
2022-01-05	89271
2022-01-12	101248
2022-01-12	86871
2022-01-19	123237
2022-01-19	104113
2022-01-26	142510
2022-01-26	113532
2022-02-02	135344
2022-02-02	122152
2022-02-09	107947
2022-02-09	90137
2022-02-16	116102
2022-02-16	96417
2022-02-23	106800
2022-02-23	89150
2022-03-02	153045
2022-03-02	138273
2022-03-09	168344
2022-03-09	127066
2022-03-16	113381
2022-03-16	84497
2022-03-23	148982
2022-03-23	125798
2022-03-30	194342
2022-03-30	164905
2022-04-06	266683
2022-04-06	241108
2022-04-13	148906
2022-04-13	126994
2022-04-20	138178
2022-04-20	121655
2022-04-27	155934
2022-04-27	137804
2022-05-04	180793
2022-05-04	150091
2022-05-11	120429
2022-05-11	101366
2022-05-18	145545
2022-05-18	121825
2022-05-25	148215
2022-05-25	125858
2022-06-01	188115
2022-06-01	167819
2022-06-08	151420
2022-06-08	122774
2022-06-15	176735

TIPS Bond	
As Of Date	Repo Fails
2022-01-05	6951
2022-01-05	4880
2022-01-12	3253
2022-01-12	2145
2022-01-19	4551
2022-01-19	4053
2022-01-26	7908
2022-01-26	5937
2022-02-02	7112
2022-02-02	4946
2022-02-09	6330
2022-02-09	5172
2022-02-16	7337
2022-02-16	4284
2022-02-23	6263
2022-02-23	5008
2022-03-02	11798
2022-03-02	8097
2022-03-09	23673
2022-03-09	12909
2022-03-16	17250
2022-03-16	12508
2022-03-23	14864
2022-03-23	12096
2022-03-30	14520
2022-03-30	11411
2022-04-06	14630
2022-04-06	20585
2022-04-13	6580
2022-04-13	4950
2022-04-20	6979
2022-04-20	4980
2022-04-27	6568
2022-04-27	3888
2022-05-04	12045
2022-05-04	7178
2022-05-11	8201
2022-05-11	6562
2022-05-18	9280
2022-05-18	5781
2022-05-25	9483
2022-05-25	8014
2022-06-01	11218
2022-06-01	7516
2022-06-08	11167
2022-06-08	6700
2022-06-15	20961

Table 4-Repo Fails

- Credit Risk Perception: Users also exhibit different behaviour of credit risk. For example, if TIPS are perceived to be riskier than Treasuries, owners of TIPS will price them less relative to the Treasuries. Any changes in the overall credit cycle elasticities including a measure of 10-year swap spreads will affect the valuation of TIPS which are usually considered risk free even in economic downturns.

European Economic Letters
ISSN 2323-5233
Vol 15, Issue 1 (2025)
http://eelet.org.uk

Date	US 10 Year Swap Spread
30-09-2024	-46.755
30-08-2024	-46.7599
31-07-2024	-42.86
28-06-2024	-41.8925
31-05-2024	-37.1113
30-04-2024	-37.125
29-03-2024	-36.625
29-02-2024	-37.8044
31-01-2024	-36.5
29-12-2023	-40.25
30-11-2023	-37.15
31-10-2023	-36.2607
29-09-2023	-30.625
31-08-2023	-28.125
31-07-2023	-26.25
30-06-2023	-25.75
31-05-2023	-26
28-04-2023	-27.73
31-03-2023	-29.625
28-02-2023	-26.875
31-01-2023	-30.375
30-12-2022	-32.15
30-11-2022	-32.98
31-10-2022	-24.75
30-09-2022	-24.15
31-08-2022	-19.625
29-07-2022	-21.5
30-06-2022	-20.47
31-05-2022	-20.125
29-04-2022	-20.2
31-03-2022	-21.37
28-02-2022	-17.875
31-01-2022	-18.915
31-12-2021	-19.625
30-11-2021	-19.12
29-10-2021	-25.1
30-09-2021	-23.225
31-08-2021	-23.35
30-07-2021	-22
30-06-2021	-28.25
31-05-2021	-28.75
30-04-2021	-25.25
31-03-2021	-21.75
26-02-2021	-17.25
29-01-2021	-18.75
31-12-2020	-20.5
30-11-2020	-21
30-10-2020	-22.375

Table 5- US 10 year Swap Spreads

- Slow-Moving Capital and Arbitrage Limitations: Significant mispricing can occur for a long period of time in the presence of limits to arbitrage that are related to the movement temporal issues of capital. It has been asserted that those variations in arbitrage capital, measured in this case by global hedge fund net assets, are likely to affect the level of mispricing. Capital controls are an explanation for the inability to eliminate in a short period price difference in prices that exist. (Fleckenstein et al., 2014)

*Table 6 - indicating Correlation among Dependant Variable and Independent Variables.

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.80[a]	.76	.60	0.605

a. Predictors: (Constant), Hedge fund flows, Swap Spread, Trading Ratio, Treasury Issuance, Repo Fails, TIPS Issuance

Table 7-Regression Statistics

European Economic Letters
ISSN 2323-5233
Vol 15, Issue 1 (2025)
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R2=76% suggesting 76% of the variance in the dependent variable is explained by the independent variable

Coefficients

Model		Unstandardized Coefficients		Standardized Coefficients	
		B	Std. Error	Beta	t
1	(Constant)	3.6174	1.200		0.29
	TIPS Issuance	-.5304	.097	.058	-1.85
	Treasury Issuance	-.0579	.094	.031	-1.71
	Repo Fails	.011	.091	-.080	2.23
	Trading Ratio	1.765	.104	-.115	0.27
	Swap Spread	0.04876	.087	-.054	0.99
	Hedge fund flows	-4.35	.090	-.135	-1.377

Table 8-Regression Statistics

In order to investigate the connection between TIPS-Treasury mispricing and the explanatory variables, we regress monthly mispricing changes against the relevant levels or changes of these variables. Rather than examining specific TIPS and Treasury pairings, we concentrate on the average yield mispricing for all pairs, weighted by the outstanding notional amount of each TIPS issue, which takes accretion into account.

These findings highlight a number of important variables affecting TIPS-Treasury mispricing. Notably, the results imply that mispricing is influenced by the supply of new Treasury securities. With negative coefficients, the notional volumes of Treasury issuance and TIPS are both statistically significant. This suggests that when the Treasury issues either TIPS or Treasury bonds, the amount of the TIPS-Treasury mispricing reduces. This result suggests that mispricing is more related to the availability of liquid, on-the-run Treasury securities than it is to the relative supply of TIPS vs Treasury bonds, allowing arbitrageurs to reduce price differences.

The results for repo failures, which are strongly linked to TIPS-Treasury mispricing, further emphasize the need of liquidity. Mispricing typically rises when the market is experiencing liquidity issues, such as main dealers' inability to execute Treasury transactions. This result offers concrete proof that the degree of mispricing is directly impacted by the availability and liquidity of the assets used in arbitrage. As far as we are aware, this is the first written proof of such a link in the literature.

On the other hand, the study reveals no meaningful connection between TIPS-Treasury mispricing and systemic credit risk, as determined by the 10-year swap spread. There is also no discernible relationship between mispricing and alternative indicators of credit risk, such as the sovereign CDS spread on U.S. Treasury debt or the CDX index of CDS spreads for U.S. investment-grade companies. We also look at the impact of the Federal Reserve's QE1 program, notably its monthly Treasury purchases, but we don't discover any correlation with mispricing movements.

Finally, the slow-moving-capital hypothesis is substantially supported by the data. Specifically, there is a significant correlation between TIPS-Treasury mispricing and changes in hedge fund capital; a 1% increase in hedge fund capital is linked to a 4.35% basis-point decrease in mispricing. This is significant since not all hedge funds make active investments in TIPS or long-maturity Treasury bonds.

Limitations

1. Availability and Quality of Data: The research relies entirely on the retrospective market data, which may not have accounted for all the relevant factors or anomalies that could lead to the TIPS Treasuries mispricing. It is further emphasized that the limited or even absent TIPS-specific liquidity variables, inflation adjustment, and repo default data may limit the strength of the drawn conclusions.
2. Differences in Market Contexts: TIPS and Treasury bonds have their own distinct environment within the United States. Applying these results to the other countries would not be the case due to, for example, different inflation outlooks, bond designs, or the existence of different laws. In turn, this narrows down the applicability of the study's findings.

3. Conditions of Drexler's Arbitrage Theory: This analysis considers that there are possibilities of employing arbitrage tactics, however in reality, for instance, due to transaction costs, availability of capital or due to capital being made available too slowly (hedge capital) such strategies may not work as intended. These are simplifications of the way real markets work, and how mispricing can endure.
4. Macro-economic policies: Some, including the Federal Reserve's Quantitative Easing (QE) programs and even fiscal ones, operate to adjust market liquidity and may also affect TIPS pricing. These externalities have not been fully reflected in the current study hence the tendency to ignore other drivers of the pricing imbalance.
5. Influences of Psychology and Behaviour: For instance, the case is more vivid during economic downturns, where there is irrational investor behaviour that can cause a discrepancy between market prices and the actual prevail prices. The paper does not address the issue of behavioural economics which perhaps is the biggest predator to the puzzles regarding the dynamics of long-term asset mispricing.

Future Scope

1. International comparison of TIPS mispricing: Extending the study to inflation-protected securities in other countries could provide insights into global mispricing dynamics, especially in relation to varying inflation expectations, liquidity levels, and monetary policies across economies.
2. Behavioural influences on mispricing: Investigating the role of investor sentiment and behavioural biases in TIPS-Treasury mispricing could provide a deeper understanding of market inefficiencies, particularly during economic downturns or periods of high uncertainty.
3. Impact of emerging inflation hedging instruments: As new financial products for inflation hedging are introduced, it would be worthwhile to analyse how these alternatives affect TIPS' demand, liquidity, and pricing relative to Treasuries.
4. Machine learning models for mispricing prediction: Leveraging machine learning techniques could offer predictive insights into TIPS mispricing. By integrating variables such as liquidity, hedge fund capital flows, and macroeconomic indicators, such models could provide more accurate forecasts of TIPS-Treasury spreads.
5. TIPS in high-inflation periods: Analysing TIPS performance during periods of persistent high inflation could be valuable, especially as inflation becomes a more significant factor in global markets. This could include studying how TIPS yields and mispricing respond to prolonged inflationary pressures.
6. Structural changes post-quantitative easing (QE): With varying global interest rate policies post-QE, future research could explore how the removal or continuation of QE policies impacts the TIPS-Treasury mispricing, especially in times of liquidity stress.

Conclusion

This paper investigates the relative pricing dynamics between TIPS (Treasury Inflation-Protected Securities) and standard Treasury bonds, discovering significant deviations from the no-arbitrage relationship expected between these assets. These pricing inconsistencies, sometimes reaching over $20 per $100 of notional value, are unusually large compared to documented mispricing in financial literature, especially considering the size and liquidity of the TIPS and Treasury markets. This mispricing presents a challenge to traditional asset pricing models.

One major finding is that TIPS consistently trade at a discount relative to Treasury bonds, implying that the Treasury could reduce debt costs by focusing on nominal bonds or replacing TIPS with nominal bonds. The results suggest that issuing TIPS might be more financially costly than previously thought, as it forfeits a fiscal hedging benefit and results in a lower valuation compared to nominal bonds, costing the Treasury potentially billions of dollars.

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