When do Treasuries Earn the Convenience Yield? — A Hedging Perspective

Viral V. Acharya and Toomas Laarits*

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Abstract

We document that the convenience yield of U.S. Treasuries exhibits properties that are consistent with a hedging perspective of safe assets, i.e., Treasuries are valued highly if they appreciate with poor aggregate shocks. The convenience yield tends to be low when the covariance of Treasury returns with the aggregate stock market returns is high. A decomposition of the aggregate stock-bond covariance into terms corresponding to the convenience yield, the frictionless risk-free rate, and default risk reveals that the covariance between stock returns and the convenience yield itself drives the effect in a substantive capacity. We show the convenience yield is reduced with heightened inflation expectations that erode the hedging properties of U.S. Treasuries and other fixed-income money-like assets, inducing a switch to alternatives such as gold; it is also reduced immediately prior to debt-ceiling standoffs and with increases in Treasury supply.

Keywords: Stock-bond covariance, safety premium, liquidity premium, money premium, exorbitant privilege, safe assets, bubble, inflation, debt ceiling

JEL: G11, G12, G15, E4, E5, F3

*NYU Stern School of Business, 44 West 4th St., New York, NY 10012. Acharya: vva1@stern.nyu.edu; Laarits: tlaarits@stern.nyu.edu. We are grateful to Markus Brunnermeier, Darrell Duffie, Egemen Eren, Urban Jermann, David Lando, Francis Longstaff, Tyler Muir, Stefan Nagel, Stephen Schaefer, and participants at NYU Stern Finance seminar, the London Business School, University of Illinois Urbana-Champaign, the Kansas City Fed, the Federal Reserve Board, the New York Fed, the K Virtual Finance Seminar, and the AEA/IBEFA panel (2023) on "Lessons from the Panedmic: Two Years Out" for helpful comments. We are also grateful to Zhiguo He, Arvind Krishnamurthy, Wenhao Li, Zhaogang Song, Todd Clark, and Will Diamond for sharing data. We thank Cody Wan for excellent research assistance.

The United States (U.S.) Dollar plays a central role in the international monetary system as a reserve currency for settling financial payments and transactions underlying global trade. Relatedly, and likely consequently, dollar and safe dollar-based fixed-income assets, notably the U.S. Treasuries, command a so-called *exorbitant privilege* in their pricing due to heightened demand from international community (central banks, for instance) looking for ways to park its dollar reserves. Increasingly, however, it is being recognized that the U.S. safe assets – and safe assets, more generally – command such a premium in their pricing due not just to an international demand but also to a domestic demand, driven by the hedging properties of these assets.

Distilled to its essence, this "safe assets" or "hedging" perspective relies on the assumption that markets are effectively incomplete. Households, for example, face consumption shocks which would cause severe disutility if not smoothed across states and over time. Corporations face liquidity shocks in their production or financing needs, failure to roll over which would lead to costly asset liquidations. Financial investors may face uninsurable background shocks as well due to exposure to illiquid assets such as housing and private equity. Households, corporations, and financial investors, therefore, have a demand for assets that are safe enough to hedge against the impact of these shocks. Similarly, banks prefer to make inter-bank loans collateralized by pristine quality assets rather than take on each others' counterparty credit risk as credit risk shocks may coincide with own funding shocks.

Important early contributions to the literature offering a safe-assets perspective often assumed by fiat that government bonds have safety and money-like properties and/or there is a built-in preference for such assets in investor or household objective functions.[1] A recent trend, however, is to micro-found these outcomes. It emerges from this latter approach that prices of assets whose financial values and/or liquidity covary inversely with aggregate risk should reflect an excess premium as such assets provide hedging value to investors when unspanned shocks materialize. The premium is magnified if assets provide a hedging benefit not just in a buy-to-hold sense but also from "service flow" or a retrading sense: investors value assets whose secondary market prices rise in times of aggregate risk, as in Brunnermeier et al. (2022), or whose liquidity rises in times of aggregate risk, as in Acharya and Pedersen (2005). The U.S. Treasuries are considered a primary candidate for being such assets, and the premium that accrues to their pricing is referred by the literature with a variety of terms such as "convenience yield", "money premium", or "bubble".

In this paper, we establish that this premium, which, for fixing terminology, we refer to as the *convenience yield* of U.S. Treasuries, exhibits time-series properties that are consistent with the hedging perspective of safe assets.[2] Specifically, the Treasury convenience yield is high when the covariance of returns on Treasuries and the aggregate stock market is low. We find that the

[1]See, e.g., Holmström and Tirole (2001) and Krishnamurthy and Vissing-Jorgensen (2012).

[2]We take a broad definition of the convenience yield: any value of Treasuries above and beyond the present value of the explicit cash-flows could contribute. For instance, extra demand due to regulatory requirements such as the HQLA requirement under Basel III (see Fuhrer et al. (2017)) could contribute to the convenience yield.

convenience yield itself comoves over time with the aggregate equity market returns, contributing to the hedging properties of Treasuries, a result that lends support to the service-flow value of ease of retrading safe assets. We document three sets of findings.

First, we provide a new decomposition of the aggregate stock-bond covariance, separating out the contribution of the convenience yield. In Figure 1 we plot the covariance between the daily returns on 10 year nominal Treasuries and the aggregate stock market in a 30-trading day look-back window. Existing work[3] has found that this covariance exhibits substantial time variation; in particular, note in Figure 1 the periodic large negative spikes in the post-2000 data. To decompose the covariance, we express the 10-year bond yield as the sum of a "frictionless" risk-free rate, the Treasury convenience yield, and a term corresponding to default risk, proxied by the credit default swap (CDS) rate. Our preferred measure of the Treasury convenience yield is the TIPS-Treasury premium which is the yield differential between a Treasury Inflation Protected Security (TIPS) and maturity-matched nominal Treasury, separately accounting for the inflation coupon payment of TIPS by employing traded inflation swap rates.[4]

With this yield decomposition we calculate three covariance terms with stock returns that make up the aggregate stock-bond covariance. We find that both the frictionless risk-free rate component as well as the convenience yield component of the stock-bond covariance contribute in about equal measure to the stock-bond covariance of long maturity bonds. We plot the stock-bond covariance resulting from the convenience yield component of the 10-year yield in Figure 2, illustrating the quantitatively large contribution of convenience yield innovations to the aggregate covariance. What is more, the large negative spikes in the stock-bond covariance such as those around the Global Financial Crisis, the Eurozone crisis, and most recently, the onset of the Covid pandemic, owe in good measure to the convenience yield component.

Second, in our main set of results, we document support for the hedging perspective on safe assets: the convenience yield on Treasuries is high precisely when the covariance between stocks and bonds is low. Employing a large set of convenience yield proxies (beyond the TIPS-Treasury premium) both at the short and long maturities, we find that periods of low aggregate stock-bond covariance see larger convenience yields. We illustrate this relationship for our preferred measure of the Treasury convenience yield – the TIPS-Treasury premium – in Panel A of Figure 3. As we report in Panel A of Table 2, a one standard deviation decrease in the stock-bond covariance (an increase in its hedging properties) corresponds to an increase of six basis points, or close to half standard deviation, in the convenience yield on the 10-year nominal Treasury. We confirm that this result is not driven by extreme realizations of the convenience yield during the Global Financial Crisis, and document that the results does not just represent a volatility effect by controlling for the level of

[3]See Duffee (2022) for a survey.

[4]This measure is based on the work by Fleckenstein et al. (2014) who document that during 2004 to 2010 nominal Treasuries had almost always been more expensive than the synthetic counterparts constructed from TIPS and inflation swaps.

the VIX.

Using the stock-bond covariance decomposition (into terms corresponding to the frictionless risk-free rate, the convenience yield, and default risk), we find that the covariance attributable to convenience yield fluctuations is the most robust in explaining the convenience yield of safe fixed-income assets, with the covariance attributable to the risk-free rate fluctuations playing a meaningful role too. With respect to magnitudes, a one standard deviation drop in the stock-bond covariance estimated with Treasury convenience yields corresponds to a .6 standard deviation increase in the TIPS-Treasury premium. In contrast, the covariance attributable to the CDS premium fluctuations contributes to the convenience yield only with a quantitatively small magnitude. Overall, our result on the relationship between the level of the convenience yield and the hedging properties of the security lends support to the theoretical models in Acharya and Pedersen (2005) and Brunnermeier et al. (2022) regarding a liquidity premium arising from covariance of a security's liquidity with negative aggregate shocks. Put differently, the convenience yield priced at the beginning of a period does not only reflect the expected hedging benefits, but also the feature that in bad aggregate future states the convenience yield (the "service flow") increases.

The strong inverse relationship between Treasury convenience yields and the stock-bond covariance suggests that that the pricing of substitutes to Treasuries should also be affected. We examine the substitutability between U.S. Treasuries and alternate hedging instruments: gold, corporate securities, and other hard currency fixed income securities. With respect to gold we follow Jermann (2021) and construct a measure of convenience yield from the term structure of futures contracts prices. We find that the convenience yield of gold is strongly countercyclical relative to the convenience yield of Treasuries. With respect to corporate securities we document the behavior of 90-day P2-rated commercial paper spread over T-bills, AAA-Treasury spread, and Excess Bond Premium (EBP) of Gilchrist and Zakrajšek (2012) at three different maturities. For all these measures, we find a substantial negative sensitivity to the stock-bond covariance, particularly the covariance term arising from the Treasury convenience yield. With respect to other hard-currency government bonds, we employ two measures from recent literature: i) the measure of relative convenience yield of the U.S. Treasuries over other safe-haven sovereign bonds using the approach of Du et al. (2018), and ii) different currency box rates as constructed in Van Binsbergen et al. (2022) and extended to other currencies in Diamond and Van Tassel (2021). We find that during times of low stock-bond covariance in the U.S. the USD convenience yield over a basket of 10 hard currency bonds opens up.

Thirdly, we examine fundamental drivers of the convenience yield, and by implication, the potential drivers of the stock-bond covariance. We show that inflation expectations are one important contributor though the channel we document is distinct from the one already established in the literature. Prior work, for instance Campbell et al. (2017), has highlighted the role of inflation dynamics, loosely, supply- or demand-driven shocks, in determining the stock-bond covariance. Our results highlight that in addition to the direct effect of inflation surprises on the nominal risk-free rate, there is another channel that operates via the effect of the surprises on the convenience yield.

To demonstrate this channel we again employ the decomposition of aggregate stock-bond covariance into components representing covariance with the frictionless risk-free rate, with the convenience yield, and the CDS rate. Proxying for inflation using either the 5-year inflation swap rate or the 5-year expected inflation series constructed by the Federal Reserve Bank of Cleveland, we find that heightened inflation expectations correspond to more positive stock-bond covariance, and that a substantial part of this positive relationship stems from the covariance term corresponding to convenience yields. This impact of inflation expectations can be seen saliently during the post-Covid-outbreak period of 2021-22 (see Figure 4) during which supply-side frictions and aggregate demand fueled by fiscal and monetary stimulus led to inflation prints rising significantly above the mandated Federal Reserve target and those witnessed over the past two decades, and in turn, resulted in a gradual upward shift in inflation expectations of households and investors.

Furthermore, we provide three sets of event studies to illustrate the link between the hedging properties of U.S. Treasuries and the Treasury convenience yield: policy responses to the Global Financial Crisis and the onset of the Covid pandemic, two debt ceiling standoffs in the United States, and the Eurozone sovereign debt crisis. The common thread through these events is that they illustrate sources of convenience yield variation, either via news about Treasury supply available to the private sector, or news about the default probability, or news about the regulatory environment affecting Treasuries or close substitutes. In the context of the Global Financial Crisis and the Covid pandemic policy responses, we find that announcements of Treasury purchases increase the convenience yield, whereas announcements extending the scope of collateral accepted by emergency programs reduce the specialness of Treasuries, and increase the stock-bond covariance stemming from convenience yield innovations. In the context of two U.S. debt ceiling deals we find that the resolution of the debt ceiling standoffs saw an increase in the Treasury convenience yield as well as a reduction in the stock-bond covariance from the convenience yield component. Case studies around the Eurozone crisis also illustrate the challenges in understanding the convenience yield as it depends on the hedging properties of safe assets for the representative investors in different economies (assuming some market segmentation). The relative U.S. convenience yield also seems to be influenced by unconventional policy measures of central banks in response to advanced-economy sovereign credit risk episodes of the past decade.

Our results hold for a variety of alternative convenience yield proxies. Our main results are documented in the 2005-2022 sample because of the availability of the TIPS-Treasury premium which allows us to carry out a daily yield decomposition into the frictionless rate, the convenience yield, and default risk. In order to extend the time period of our analysis to before 2005 (in some cases to 1972 to span the inflationary episodes that followed) as well as to examine whether the convenience yield of the U.S. Treasuries is also mirrored in other safe fixed-income dollar assets, we turn to six alternate measures of the convenience yield and to other money-like assets.[5] The strength of the relationship between the alternative Treasury convenience yield proxies and the aggregate stock-bond covariance is quantitatively close to what we document for the TIPS-Treasury premium. In all cases, a one standard deviation decrease in the stock-bond covariance corresponds to about a third to two thirds of a standard deviation increase in the convenience yield proxy including the 1991-2022 sample as well as the 1972-2022 sample.

These results have several implications for theoretical and empirical work on safe assets as well as for policy. Observed time-series variation in the covariance of U.S. Treasury returns with the aggregate stock market return, and its linkage to inflation expectations, debt ceiling stand-offs, and Treasury supply implies that the moneyness or safe-asset properties of U.S. Treasuries and fixed-income assets are not a given. Instead, these properties fluctuate over time, and importantly, are tied to macroeconomic and financial developments in the economy. Conversely, as a portion of the safe-asset property of U.S. Treasuries is related to a comovement of the convenience yield itself with aggregate risks, the "good friend" property (in the terminology of Brunnermeier et al. (2022)) can erode swiftly once high inflation outcomes materialize and the anchoring of inflation expectations becomes weaker. In some sense, there is a double whammy when this occurs, as safe assets lose value not only in terms of lower time-value of their nominal cash flows but also due to erosion of convenience yield.

The potentially drastic impact of such a drop in the convenience yield is evident in recent asset market data. In Figure 5, Panel A we show recent returns on the aggregate equity market, the 10-year nominal Treasury bond, an approximately 7-year inflation protected Treasury (represented by the returns on TIP, an exchange traded fund), and gold. While 2021 saw good equity returns in continuation of the recovery from the pandemic-era market trough, the returns in both stocks and bonds were strongly negative in 2022 as higher-than-expected inflation took hold. Only gold provided a slight hedge to poor realized equity returns. The lack of a hedge provided by the 10-year nominal Treasury – in part, we argue, due to the erosion of the convenience yield – is evident in the performance of benchmark diversified portfolios. In Panel B of Figure 5 we show the price performance of the aggregate equity market, the 10-year nominal Treasury, and a 60-40 portfolio of the two. The 60-40 portfolio outperformed the stock market from the pre-pandemic period through to January 2021 but has lost value since then, reflecting the shift in the hedging properties of the long nominal bond.

Last, but not the least, our findings present a complementary rationale for why the U.S. Treasuries may become "inconvenient" to the one offered by Duffie (2020), He et al. (2022) and Haddad et al. (2021). These papers document that during the peak of the market turmoil during the Covid

[5] Specifically, we use the General Collateral Repo rate spread over the 3-month T-bill rate (GC-Tr 3m), the effective Fed funds rate spread over the 3-month T-bill rate (FF-Tr 3m), the negative of the Z-spread, a measure that compares T-bill rates with yields implied by a fitted yield curve (-1*Z), the 30-year LIBOR Swap spread (30y Swap-Tr.), and the Agency mortgage-backed security (MBS) - Treasury spread (FN 30y-Tr.) as alternatives.

outbreak of March 2020, U.S. Treasuries—especially the long-term ones—did not benefit from a flight to quality observed during the global financial crisis (GFC) of 2007-09, and, if anything, they appeared to be experiencing fire sales until the Federal Reserve stepped in to provide liquidity to the market. These authors attribute this outcome to the unwinding of leveraged positions in cash-futures basis market, limited intermediation capacity of dealer banks due to post-GFC reforms, and rollover risk faced by non-bank financial intermediaries. In contrast to this episodic and market-function-linked erosion of convenience yield of the U.S. Treasuries (see also Duffie (2023)), the recent erosion we document is linked to a rise in the covariance of US Treasury returns with aggregate stock returns—partly in response to higher inflation, is more slow-moving, and is similar to that observed also in 1970s and 80s, representing again a present and clear loss of investor ability to hedge aggregate risks using U.S. Treasuries.

1 Measuring the Stock-Bond Covariance and the Convenience Yield

We begin our analysis by documenting high-frequency dynamics of the aggregate stock-bond covariance. We calculate the covariance between the daily CRSP value-weighted stock portfolio arithmetic return and the daily 2-, 5-, and 10-year nominal zero-coupon constant-maturity Treasury bond arithmetic returns in a rolling 30 trading-day look-back window.[6] One potential concern with measuring the conditional covariance in a short look-back window is that times of market stress might see price pressure in either the stock or the bond market, leading to sharp return reversals. In order to mitigate the potential impact of such market illiquidity, our baseline stock-bond covariance measures uses the sum of three most recent daily returns on both the stock and the bond, divided by the square root of three. This approach dampens the impact of potential return outliers while leaving the scaling of the covariance calculation unchanged.[7] (Note that under i.i.d. returns this covariance calculation would be equivalent to using just daily returns.) We then collapse the covariances to a monthly variable by keeping the last available calculation in each calendar month. Zero-coupon nominal bond prices are from the daily fitted yield curve constructed in Gürkaynak et al. (2007). The use of a fitted yield curve ensures that the bond prices involved always correspond to the exact same maturity, and also smooths over the impact of any potential bond-specific demand effects.

The resulting covariances are reported on an annualized basis in percent units. To give an example, if the daily stock return volatility is 2%, daily bond return volatility is .5% and the correlation between the two return series is -.6, the covariance would be reported as $-.6 \times .02 \times .005 \times 252 =$

[6]This short look-back window is in keeping with the approach in Duffee (2022), the rationale being to have each monthly covariance reflect the arrival of recent information.

[7]This approach is similar in spirit to the Dimson (1979) beta, but allows for potential illiquidity in both of the constituent assets.

-1.512%.

We plot the stock-bond covariance using 10-year nominal Treasuries in Figure 1. Both low- and high-frequency changes in the stock-bond covariance are evident in the figure. Over a long time-frame the stock-bond covariance has seen a marked decline from the 1980s through the 2010. Over the shorter time-frames the stock-bond covariance exhibits periodic spikes. In the sample since 1999, in particular, the spikes in the stock-bond covariance tend to be on the negative side: during the 2001 recession, the Global Financial Crisis, the Eurozone crisis, and the onset of the Covid pandemic.

The summary statistics of the aggregate covariance between stocks and the 10-year bond are reported in Table 1 Panel A. (The corresponding statistics using the 5- and 2-year bond are in Appendix Table A1.) In the 2005-2022 sample the 10-year nominal bond return covariance with the stock market is on average negative (-.45) and has standard deviation of .90. As suggested by the negative spikes seen in the post-2005 data in Figure 1, the aggregate stock-bond covariance in this period is left-skewed with the 10th percentile value of -1.33 and the 90th percentile value of .15.

1.1 Convenience Yield Proxy: the TIPS-Treasury Premium

Our main proxy for the Treasury convenience yield is based on the relative pricing of nominal and real Treasury bonds. As shown in Fleckenstein et al. (2014), the prices of nominal Treasuries are consistently above the prices of matched maturity TIPS prices, accounting for the variable inflation coupon payment part via traded inflation swaps. Combining a TIPS, inflation swaps, and Treasury STRIPS allows these authors to construct a "synthetic" nominal Treasury bond with cash-flows identical to a traded nominal Treasury bond. Because these two securities—a nominal bond, and a maturity-matched synthetic nominal bond—have identical cash-flows we interpret the gap in their prices as a proxy for the convenience yield. Our interpretation is consistent with the result in Fleckenstein et al. (2014) that this gap increased substantially during the Global Financial Crisis and has a common component with other proxied of Treasury specialness, namely the on-the-run/off-the-run spread, and the Refcorp-Treasury spread.[8]

Relative to the approach in Fleckenstein et al. (2014) we use a simpler method to construct a high-frequency TIPS-Treasury premium. Instead of comparing the prices of matched pairs of nominal and real Treasuries corresponding to a specific maturity date, we employ the fitted nominal and real yield curves from Gürkaynak et al. (2007) and Gürkaynak et al. (2010), respectively. We use interpolated inflation swap rates to account for the inflation coupon part and then calculate the

[8]See Krishnamurthy (2002) and Longstaff (2004) for more on the on-the-run/off-the-run and Refcorp-Treasury spreads, respectively.

TIPS-Treasury premium for maturity n on date t as:

$$\text{Premium}_{n,t} = \text{TIPS Yield}_{n,t} + \text{Inflation Swap}_{n,t} - \text{Treasury Yield}_{n,t} \quad (1)$$
$$= \text{Synthetic Treasury Yield}_{n,t} \qquad - \text{Treasury Yield}_{n,t}, \quad (2)$$

where the second equation emphasizes the terminology of "Synthetic Treasury Yield" to refer to the yield on a nominal bond constructed out of TIPS and inflation swaps.

This method results in a day- and maturity-level proxy of the Treasury convenience yield that is not identical, but highly correlated with the measure documented in Fleckenstein et al. (2014) (the correlation between the two calculations is .91 in the 2004-2014 sample). Relative to that proxy, our construction has the advantage that the yield curve estimation smooths over some of the security-specific pricing factors that could add noise to the measure using pairs of securities.

Note that changes in realized or expected inflation should not have any directional impact on this measure of the convenience yield: the dependence of TIPS payouts on the inflation rate is hedged away using swap rate data. Indeed, Fleckenstein et al. (2014) provide evidence against the view that the TIPS-Treasury premium reflects mispricing in the inflation swap market by showing that real and nominal corporate bond prices constructed using identical methodology do not exhibit corresponding price disparities. They also discuss the potential impact of credit risk, tax differences, trading costs, and a bevy of other aspects on the dynamics of the TIPS-Treasury premium.[9]

1.2 Other Measures of the Convenience Yield

In addition to the TIPS-Treasury premium we employ a number of other proxies for the Treasury convenience yield. Our second proxy for Treasury convenience yield is the spread between two-year Treasury yield and the two-year risk-free interest rate implied by put-call parity on options contracts (the "box rate"). We use the USD convenience yield as calculated in Van Binsbergen et al. (2022) as well as the EUR and GBP counterparts constructed in Diamond and Van Tassel (2021).

Our third proxy for the convenience yield is the spread between three month General Collateral (GC) Repo contract rates and the three-month Treasury Bill rate. This measure has been widely

[9] There is a potential bias on the TIPS-Treasury premium that stems from the contractual features of TIPS: these bonds pay a variable inflation coupon, but in the event of deflation the inflation coupon payment is bounded below at zero. This means that TIPS prices incorporate a put premium if the distribution of the price level includes deflationary outcomes. For that reason, a shift away of the probability mass from deflationary outcomes, such as that in 2021 and 2022 would have the impact of reducing TIPS prices, hence increasing TIPS yields and, everything else equal, increasing our proxy of the Treasury convenience yield. As discussed in detail below, directionally this effect goes *against* our findings regarding the relationship between the TIPS-Treasury premium and inflation. Note too that recent work in Dittmar et al. (2019) documents a link between U.S. default risk and the TIPS-Treasury premium, a result we discuss further in Section 3.3.

used in the literature as a proxy for the short-term convenience yield as the GC repo contract is devoid of credit risk but less liquid than Treasury bills, for instance see Gorton et al. (2022).

The fourth proxy for the convenience yield is the spread between the effective Fed funds rate and the three-month Treasury Bill rate.

The fifth proxy is the negative of the Z-spread, constructed after Greenwood et al. (2015). They measure the yield difference of n month maturity Treasury Bills from the fitted yield curve of Gürkaynak et al. (2007) and call the gap the n-month Z-spread. We follow their methodology by calculating the average Z-spread of T-bills with 4 to 26 weeks until maturity. In contrast to these authors we report the negative of the difference between the T-bill rate and the fitted yield curve, so that higher values of the Z-spread correspond to higher levels of convenience. We emphasize this distinction by calling it "-1*Z-spread" or "-1*Z" for short.

Our sixth proxy for the convenience yield is the 30-year LIBOR swap spread. Interest rate swaps are one of the largest derivative markets and the literature has long interpreted the gap between Treasury and swap rates as a proxy for the Treasury convenience yield. In particular, Feldhütter and Lando (2008) decompose swap spreads into a credit risk component, a swap market specific component, and the Treasury convenience yield, with the estimated convenience yield representing the majority of the gap. In recent data, the swap spread has been negative (for instance, see Du et al. (2023)), but we still include it as the variation of the swap spread can still reflect changes in the convenience yield.

The seventh proxy, "FN 30y-Tr.", is the spread between Agency MBS and Treasury yields, based on recent work in He and Song (2022). They construct an MBS convenience yield with respect to AAA corporates, adjusting for both duration mismatch, as well as the value of the prepayment option. For our main analysis we transform the AAA-MBS spread to a MBS-Treasury spread.

These seven proxies are effectively devoid of default risk by employing securities that have implicit or explicit government guarantees, or are fully collateralized. Our preferred measure, the TIPS-Treasury premium, stands apart in that it is available at long maturities, both legs of the construction are backed by the U.S. Treasury, and have the exact same regulatory treatment.

In addition, we use measures of the Treasury convenience yield that employ corporate security prices, described in detail in Section 4. In that section we also describe the construction of the convenience yield on gold, as well as the construction of convenience yields on foreign currency bonds.

2 Decomposition of the Stock-Bond Covariance

Our first main result is a new decomposition of the aggregate stock-bond covariance. To this end, we decompose the nominal Treasury yield into three constituent elements: the convenience yield, proxied by the TIPS-Treasury premium, the default rate, proxied by the the CDS rate,[10] and a residual term, which we call the "frictionless" risk-free rate, meaning the part of the yield not owing to default risk or the convenience yield.

Formally, let Treasury $\text{Yield}_{t,n}$ be the time t, maturity n nominal yield, let $\text{CDS}_{t,n}$ denote the corresponding CDS rate, and let $\text{Premium}_{t,n}$ stand for the TIPS-Treasury Premium, a proxy for the convenience yield. We can then back out the Frictionless $\text{Risk-free}_{t,n}$ term from the following equation[11]:

$$\text{Treasury Yield}_{t,n} = \text{Frictionless Risk-free}_{t,n} + \text{CDS}_{t,n} - \text{Premium}_{t,n}. \tag{3}$$

Decomposing the 10-year nominal yield according to Equation (3), we calculate the stock-bond return covariance with returns implied by each of these constituent parts of the yield. To maintain easy comparability with the benchmark calculation, we transform each of these component yield changes into implied returns:

$$\begin{aligned} R_{t,10}^{\text{Frictionless Risk-free}} &= -\,10 \times \Delta\text{Frictionless Risk-free}_{t,10} \\ R_{t,10}^{\text{CDS}} &= -\,10 \times \Delta\text{CDS}_{t,10} \\ R_{t,10}^{\text{Premium}} &= \quad 10 \times \Delta\text{Premium}_{t,10}. \end{aligned}$$

Note that the change in the premium is multiplied with 10, rather than -10, as that term enters the yield decomposition in Equation (3) with a negative sign. These three implied bond return components in turn allow us to decompose the aggregate stock-bond return covariance (we drop the time and maturity subscripts for ease of reading):

$$\begin{aligned} \text{Cov}(R^{\text{Bonds}}, R^{\text{Stocks}}) = \text{Cov}(R^{\text{Frictionless Risk-free}}, R^{\text{Stocks}}) &+ \text{Cov}(R^{\text{CDS}}, R^{\text{Stocks}}) \\ &+ \text{Cov}(R^{\text{Premium}}, R^{\text{Stocks}}). \end{aligned} \tag{4}$$

Our convention in constructing these three constituent covariances ensures that negative covariance values always mean that returns stemming from that part of the yield reflect a hedge with respect to stock market returns.

Panel A of Table 1 reports summary statistics for these three constituent terms of the aggregate

[10] See Chernov et al. (2020) for a quantitative analysis of U.S. CDS rates.

[11] We report the summary statistics of the 10-year Frictionless Risk-free rate, the 10-year Treasury Yield, and the gap between the two yields in Appendix Table A1. The two rates are quite close in terms of levels with the frictionless rate 6 bps higher on average.

stock-bond covariance in the monthly sample from 2005 to 2022. We find that both the covariance stemming from the frictionless risk-free rate as well as the Treasury premium contribute to the overall hedging properties of the long bond. The averages of the convenience yield and frictionless risk-free rate parts are both negative with means of -.30 and -.20, respectively, and have similar standard deviations of .80 and .91, respectively. The covariance component stemming from innovations to CDS rate has a mean of .05 and contributes much less to the variation of the stock-bond comovement with a standard deviation of .18. The covariance component corresponding to CDS innovations has the expected sign, to the extent increases in default probability coincide with poor stock market realizations.

The time-series of the stock-bond covariance calculated with innovations in the convenience yield is plotted in Figure 2. For comparison we also include the full stock-bond covariance using the 10-year nominal Treasury prices. As the figure shows, a substantial amount of the aggregate variability stems from the convenience yield component: note the substantial spikes during the GFC, during the Eurozone crisis, and most recently, during the onset of the Covid pandemic. Indeed, in November 2008, at the height of the GFC, the hedging properties of the nominal Treasury – summarized in the stock-bond covariance – were entirely accounted for by the convenience yield term, with no contribution from the frictionless risk-free rate.

Nevertheless, for most of the 2005-2022 sample both the covariance terms corresponding to the Treasury convenience yield and the frictionless risk-free rate have contributed to the bond being a hedge to stock market returns. Both components have a positive correlation with the aggregate stock-bond covariance. In Appendix Table A2 Panel A we document that the correlations with the aggregate stock-bond covariance are .65 and .42 respectively for the covariance terms corresponding to the convenience yield and the frictionless risk-free rate. In contrast, the correlation of the term corresponding to CDS innovations with the aggregate covariance is $-.14$. The covariance and the constituent terms show similar amounts of persistence. In Appendix Table A2 Panel B we report that the aggregate covariance and the convenience yield component have the same persistence: .66 in the monthly data.

In all, the descriptive results in this section document that the convenience yield is an important driver of the aggregate stock-bond covariance. It is not a foregone conclusion that the covariance stemming from the convenience yield is substantial, or that it has a negative sign. Indeed, a sizable but stable convenience yield would see no stock-bond covariance emanating from this part of the Treasury yield.

Because the TIPS-Treasury premium is available at different maturities we are able to decompose the stock-bond covariance at various maturities. The summary statistics of aggregate stock-bond covariance with a 5- and 2-year nominal Treasury are reported in Appendix Table A1. We find that the 5- and 2-year calculations are substantially similar to the 10-year calculation, save for the effect of duration on bond returns. The correlation of the 10-year covariance calculation with the

5- and 2-year calculations is .90 and .72, respectively. In other words, the 5-year bond's hedging properties are similar to those of the 10-year bond, except that the 10-year bond has double the return volatility on account of double the duration.

Finally, in our baseline calculation of the stock-bond covariance we use the sum of three most recent daily returns, divided by square root of three, instead of daily returns and a 30 trading-day look-back window. This approach mitigates the potential impact of price pressure during turbulent times. An alternative calculation uses just daily returns in the same 30 trading day look-back window. In Appendix Figure A1 we plot the aggregate stock-bond covariance from both calculations. As the figure shows, the two series overlap tightly for most of the sample. The one exception to this rule is from the early days of the Covid pandemic during which the one-day calculation sees a larger negative spike, consistent with bond market dislocation in this period, as documented in Haddad et al. (2021) and He et al. (2022).

3 Convenience Yield and the Stock-Bond Covariance

In this section we establish our second main result: the level of the convenience yield is high precisely when Treasuries represent a good hedge to stock market returns, as proxied by a low covariance of Treasury and stock market returns.

3.1 Setup

The decomposition in Equation (3) of nominal Treasury yields into a frictionless risk-free rate, default risk, and the convenience yield allows us to illustrate the theoretical framework for our analysis. Let $L_{\text{Treasury}} \cong R_{\text{frictionless}} - R_{\text{Treasury}}$ and $L_{\text{Synthetic}} \cong R_{\text{frictionless}} - R_{\text{Synthetic}}$ correspond to the liquidity premium on the nominal and synthetic nominal Treasury, respectively, where $R_{\text{frictionless}}$ is the risk-free rate, R_{Treasury} is the nominal risk-free rate, and $R_{\text{Synthetic}}$ is the nominal risk-free rate implied by TIPS yields and inflation swaps. In the spirit of Acharya and Pedersen (2005) we can approximate the expected returns on the nominal Treasury, and the synthetic counterpart as:[12]

$$\mathrm{E}[R_{\text{Treasury}}] \cong \lambda \left[\mathrm{Cov}(R_{\text{frictionless}}, R_M) - \mathrm{Cov}(L_{\text{Treasury}}, R_M)\right] \quad (5)$$

$$\mathrm{E}[R_{\text{Synthetic}}] \cong \lambda \left[\mathrm{Cov}(R_{\text{frictionless}}, R_M) - \mathrm{Cov}(L_{\text{Synthetic}}, R_M)\right], \quad (6)$$

where R_M is the stock market return.

Hence the expected Treasury convenience yield, measured as the TIPS-Treasury premium, can be

[12] Note that the approximation leaves out the covariance terms with market liquidity, which typically tend to be smaller in magnitude.

approximated as

$$\implies \mathrm{E}[R_{\text{Synthetic}}] - \mathrm{E}[R_{\text{Treasury}}] \cong -\lambda\,\mathrm{Cov}(L_{\text{Synthetic}} - L_{\text{Treasury}}, R_M) \tag{7}$$

$$\implies \mathrm{E}[\text{Premium}] \cong -\lambda\,\mathrm{Cov}(\text{Premium}, R_M). \tag{8}$$

In words, the expected return premium between nominal Treasuries and the synthetic counterpart is proportional to the gap between the respective covariances, or equivalently, to the covariance of the premium with the stock market return.

This relationship motivates our main empirical analysis—we regress proxies of the Treasury convenience yield on the conditional covariance between the stock market and the Premium component of nominal Treasury returns. This analysis faces two complications. One, existing literature has documented a strong relationship between the level of the risk-free interest rate and the level of the convenience yield, see Nagel (2016). For that reason we include the level of the risk-free interest rate as a control variable in our benchmark specifications. Two, we are able to estimate the high-frequency conditional covariance only in the post 2005 data. For that reason we use the aggregate stock bond covariance as a stand-in in the longer sample, still finding evidence of the relationship between the hedging properties of Treasuries and the level of the convenience yield.

3.2 Baseline results

Our baseline results document a strong association between the level of the Treasury convenience yield and the aggregate stock-bond covariance. In Panel A of Table 2 we report monthly regressions during 2005 to 2022 of seven measures of the convenience yield on the monthly stock-bond covariance using the 10-year zero-coupon nominal Treasury return, controlling for the effective Fed funds rate. In all cases we find a negative relationship, statistically significant at the 5% level for all but one of the specifications.

The estimated effect size is large: a one standard deviation decrease in the aggregate stock-bond covariance (about .95) corresponds to a half standard deviation increase of the 10-year TIPS-Treasury premium. Similar magnitudes obtain for the other six proxies of the Treasury convenience yield. We estimate positive coefficients on the effective Fed funds rate, consistent with the findings of Nagel (2016). In unreported results we confirm the strong negative association between the level of the Treasury convenience yield and the aggregate stock-bond covariance continues to hold without the inclusion of the Fed funds rate.

Panel B of Table 2 repeats the same analysis but extends the sample back to 1991 and to 1972, respectively. Because of the availability of TIPS and inflation swap data we lose the TIPS-Treasury measure in the samples starting before 2005. Likewise, the Box yield is unavailable prior to 2005. In the sample starting in 1972 we also lose the GC repo spread proxy, as well as the Swap rate proxy. The results using the longer samples in Panel B confirm the baseline findings. Just like in the more recent sample, we find a negative relationship between the proxies of the convenience yield and the stock-bond covariance and the coefficient estimates are quantitatively close. With the exception of the Z-spread, all the coefficients in these longer samples are statistically significant at the 5% level.

Our principal empirical finding is reported in Table 3. Here we decompose the aggregate stock-bond covariance into three constituent parts in keeping with Equation (4). The decomposed stock-bond covariance allows us to directly test our hypothesis: the covariance of stock returns with the convenience yield itself contributes to the level of the convenience yield. This is precisely what we find: the first column shows that the strong negative relationship between the TIPS-Treasury spread and stock-bond covariance is mostly on account of the covariance between the Treasury premium and the aggregate stock market. In terms of magnitudes a one standard deviation decrease in the stock-bond covariance estimated from the Treasury premium corresponds to a .6 standard deviation (8 basis points) increase in the 10-year TIPS-Treasury premium. By contrast, the estimated coefficient on the frictionless risk-free rate covariance with the stock market is only .01. The standard deviations of these two main parts of the stock-bond covariance are comparable: .91 and .80 respectively. The impact of the third component, corresponding to the covariance between stock returns and default risk, varies more across specifications. A one standard deviation decrease in the Cov(CDS 10y, St.) term corresponds to a 3.5 basis point drop in the TIPS-Treasury premium.

Regressions estimated with alternative proxies of the Treasury convenience yield convey the same message and confirm the spirit of Equation (8): the negative relationship between the level of the convenience yield and the stock-bond covariance stems primarily from the covariance component stemming from Treasury convenience yield, an effect that is economically and statistically significant for all seven proxies of the convenience yield as the dependent variable.

We motivated this negative relationship with Equation (8): the expected Treasury premium is proportional to the covariance of the market return with the gap in nominal and synthetic Treasury liquidity. What could underlie the negative relationship between convenience yields and the stock-bond covariance term corresponding to the frictionless risk-free rate? Before answering this important question, we examine robustness of our findings to excluding the Global Financial Crisis period and to controlling for market-wide volatility. One answer we explore later is that higher than expected inflation drives up this covariance, as well as cuts into the convenience yield. Further, could the synthetic Treasury price incorporate some measure of convenience yield itself if TIPS are also deemed to be special like nominal Treasuries, which means the stock-bond covariance term corresponding to the frictionless risk-free rate could also capture some of the stock-convenience covariance? We examine these, and several other robustness issues next.

3.3 Robustness

In Table 4 we report the results of two robustness exercises for the main results. In Panel A we include a dummy variable for the the Global Financial Crisis years 2008-09. We do so because all convenience yields—the TIPS-Treasury premium included—were elevated in this period. We find, however, that the positive relationship between the covariance measures and the convenience yield is not driven by this episode alone. The Crisis dummy is in all cases positive and absorbs a good portion of the variation in the convenience yield measures but the stock-bond covariance term corresponding to the convenience yield retains its statistically significant relationship with six of the seven convenience yield proxies at the 5% level, including the TIPS-Treasury premium. Note too the scatterplot in Panel B of Figure 3 that shows this relationship with both the covariance and convenience yield measures winsorized at the 5th and 95th percentiles.

In Panel B we include VIX as a right-hand-side control variable. The goal of this panel is to illustrate that the relationship between the convenience yield and the stock-bond covariance does not just reflect changes in market-wide volatility. We again find that the results are quantitatively close to the estimates reported in Table 3. The stock-bond covariance term corresponding to the convenience yield retains its negative sign, and, in all but one case, is statistically significant at the 5% level. The inclusion of VIX has a somewhat stronger attenuating effect on the estimates of the frictionless risk-free covariance term. Overall, as the the main coefficients of interest on the aggregate stock-bond covariance remain largely unchanged, the table illustrates that results on the relationship between stock-bond covariance and the level of the convenience yield are not capturing an aggregate volatility effect.

In recent work, Dittmar et al. (2019) argue that the TIPS-Treasury premium can be accounted for by default risk. To the extent TIPS and nominal Treasuries represent a different default risk—owing to differential recovery rates, relative pricing of real and nominal payoffs in the default state, or dependence of inflation rates on the default event—the TIPS-Treasury spread could be driven by the creditworthiness of the U.S. Motivated by their findings, in Table 5 we re-estimate the regressions from Table 3, but include the level of the 10-year CDS rate as a control variable. In line with the argument in Dittmar et al. (2019), we find that the CDS rate has a positive relationship with the TIPS-Treasury premium. That said, the strong negative relationship between the covariance term corresponding to the convenience yield and the level of the TIPS-Treasury premium remains intact with a coefficient of -.07, statistically significant at the 1% level. What is more, the corresponding coefficients in regressions estimated with the alternative convenience yield proxies are left virtually unchanged by the inclusion of the CDS rate. We conclude that the negative relationship between the stock-bond covariance and the level of the convenience yield is not a reflection of default risk.

The Online Appendix contains a number of additional robustness exercises. In Appendix Tables A3 and A4 we repeat the main analysis, but lag the covariance measures by one period with respect to the convenience yield proxies. In both tables we find that the strong negative relationship between the covariance measures and the convenience yield stays intact which is expected given the persistence of the covariance measures. In Appendix Table A5 Panel A we use the alternative yield curve of Liu and Wu (2021) instead of Gürkaynak et al. (2007) yield curve to calculate the stock-bond covariance. We mirror the structure of the tables reporting our benchmark results and find coefficient estimates very close to those reported in Tables 2 and 3. In Panel B of Table A5 we repeat the analysis but calculate the stock-bond covariance using the MSCI World Index return. Again we find negative coefficients on the covariance for all the convenience yield proxies, suggesting that the hedging properties of the U.S. Treasury against global equity risk are also likely to drive some of this effect.

In Appendix Table A6 Panels A and B we replace the stock-bond covariance with the stock-bond correlation and stock market beta of the Treasury bond, respectively. Our main analysis focuses on the covariance because that term contributes to the variance of a portfolio invested in stocks and bonds. However, we find that the negative relationship between the stock-bond comovements and the level of the convenience yield holds when employing correlation or stock market betas as the right-hand-side variable. In Panel A of Table A6 we use the Treasury beta with respect to the stock market, again focusing on the three separate terms corresponding to the convenience yield, the frictionless risk-free rate, and the CDS innovations. Across the seven convenience yield proxies we consistently find a negative relationship with the beta corresponding to the convenience yield. The statistical significance varies across specifications, with the TIPS-Treasury premium significant at the 10% level. In Panel B of Table A6 we repeat the analysis with correlation coefficients corresponding to the three constituent parts of the 10-year yield. We find that the correlation term stemming from convenience yield innovations has a negative relationship with the level of the convenience for six of the seven yield proxies. The statistical significance of this relationship is weaker than in our benchmark results, but this is to be expected given that the correlation measure does not distinguish between periods of high and low volatility in the stock and bond markets.

In Appendix Table A7 we document the benchmark results using different maturity stock-bond covariance calculations, as well as different maturity convenience yield proxies. In Panel A we document that the benchmark result holds with the stock-bond covariance employing a 5-year nominal Treasury bond. In large part this result reflects the finding, discussed in Section 2, that the 5- and 10-year stock-bond covariances are highly correlated. In Panel B we explore our main result but with different maturity TIPS-Treasury spreads on the left hand side. We find that the 10-year covariance term has equally strong explanatory power over the variation in shorter maturity covariance terms. This suggests a strong factor structure in the TIPS-Treasury premium across different maturities, consistent with the argument in Jiang and Richmond (2022) that the entire terms structure reflects the convenience yield. The 5- and 2-year covariance terms also have explanatory power over the TIPS-Treasury premia. Interestingly, the 5-year covariance term explains slightly more variation in the 5-year TIPS-Treasury premium than the 10-year covariance, indicative of some maturity-specific effects as well.

Our preferred proxy of the convenience yield – the TIPS-Treasury premium – is a measure of relative convenience between two securities issued by the U.S. Treasury. There is a possibility that TIPS prices themselves reflect some amount of convenience, which would make our proxy an underestimate of the total convenience afforded by nominal Treasuries. To explore this magnitude of this potential convenience yield we compare the "synthetic" nominal Treasury yield, constructed from TIPS and inflation swaps, with the AAA-rated corporate bond yield. We find that in the 2005-2022 sample, the 10-year "synthetic" nominal Treasury yield is 12 bps lower than the Bank of America AAA-rated corporate bond index yield, consistent with a convenience yield on TIPS itself (for reference, the level of the 10-year TIPS-Treasury premium in this period is 29 bps.) That said, there are prolonged periods during which either of the rates is higher. Indeed, since 2015 the AAA yield has been lower than the the 10-year "synthetic" nominal rate. We conclude that there is some evidence for the convenience yield of TIPS but it is not as robust as the TIPS-Treasury premium which is positive in every month of the sample.

Another driver of the TIPS-Treasury premium could be variation in the relative supply of the two types of securities. In Appendix Figure A2 we plot the total amount of nominal and real Treasuries outstanding. Two aspects are worth noting: one, the TIPS supply is an order of magnitude smaller than nominal supply, with yearly issuance representing about 5-10% of the total Treasury supply; two, the TIPS supply grows at a steady rate. These two observations suggest to us that fluctuations in TIPS supply are not major drivers of the TIPS-Treasury premium.

3.4 Sectoral Treasury Holdings

Our main results document that a substantial amount of the aggregate stock-bond covariance corresponds to innovations in the convenience yield. Such convenience yield is a service-flow benefit that accrues to the investor holding the Treasury. As different types of investors might value this aspect of Treasuries to a different degree, the time-variation in the stock-bond covariance should be evident in the sectoral holdings of Treasuries.

We confirm this prediction by employing data on holdings of Treasuries. Specifically, we use sectoral holdings as a share of the total outstanding based on quarterly data from *Financial Accounts of the U.S.*, Table L.210 (formerly the *Flow of Funds* data). In particular, holdings are reported for "sectors" such as Broker-Dealers (B-D), Depository Institutions (Depos.), Households (HH), Insurers (Insur.), Money Market Mutual Funds (MMF), Mutual funds (Mutual), Closed-end Funds and ETFs (Funds), the Federal Reserve (Monet.), Pension Funds (Pension), and Rest-of-the World (ROW). Unfortunately this data does not break out holdings of nominal and inflation-protected Treasuries but, as shown above, TIPS issuance is typically in the 5-10% range of the total issuance in this time period, so the vast majority of Treasuries in this data are nominal.

In Table 6 we estimate regressions of sectoral holdings, quoted as a percent of total Treasuries outstanding, on the stock-bond covariance, controlling again for the level of the risk-free interest rates. Using the aggregate stock-bond covariance, we find that Pension funds, Insurers, and Rest-of-the-World tend to increase their holdings when the stock-bond covariance is low. In other words, when the hedging properties of Treasuries are good, Pension funds, Insurers, and ROW investors increase their holdings. The Fed, Depository institutions, and Funds (meaning closed-end funds and ETFs), in contrast, take the opposite side and increase their holdings when the hedging value of Treasuries is low. Because these different sectors of Treasury investors could be investing at different maturities these regressions all include a control variable for the 10-year term premium estimated in Kim and Wright (2005).

In Panel B of Table 6 we repeat the same analysis but break the stock-bond covariance measure into the three constituent elements. The pattern of coefficients from the aggregate stock-bond covariance is in large part reflected in the covariance components corresponding to the convenience yield, and (to an extent) the frictionless risk-free rate, with the covariance component due to the convenience yield typically being the one with more explanatory power. We find that the holdings of money market funds, pension funds, and ROW are strongly negatively related to the stock-bond covariance term corresponding to the convenience yield. Depository institutions and Funds again act as the holders of last resort with respect to the covariance term stemming from the convenience yield, suggesting that these investors benefit the least from the non-pecuniary services afforded by Treasuries.

The differences in Treasury holdings are likely to translate into differences in average returns from Treasury portfolios as well. Investors that hold Treasuries in times of negative stock-bond covariance are likely to see lower average return, reflecting the higher hedging qualities of the portfolio.

4 Treasury Substitutes

Treasuries enjoy the convenience yield because they often, if not always, appreciate in poor aggregate states. Of course, other investments could fulfill a similar role. As we have seen a substantial time-series variation in the convenience yield earned by Treasuries, we would expect the relative convenience yield of substitute assets to move in the opposite direction, as their relative attractiveness as safe assets likely moves inversely to that of Treasuries. This is precisely what we find in the case of three sets of assets: gold, corporate securities, and foreign government bonds.

To study the convenience yield on gold we follow Jermann (2021) and employ the term structure of futures prices to back out a convenience yield from the cash-and-carry formula. Specifically, we use the 7-month futures price, the 1-month futures price in place of the spot price, and the Gürkaynak et al. (2007) fitted yield curve as the risk-free interest rate to calculate a monthly estimate of gold convenience yield.[13] In Table 7 we regress this convenience yield of gold on our measure of stock-bond covariance, as well as the Treasury convenience yield directly, in both cases controlling for the level of the Fed funds rate. We find that periods of high Treasury covariance with the stock market, and periods of low Treasury convenience yields see higher convenience yields on Gold.

Certain corporate securities can likewise serve as a safe haven asset. In Table 8 we document the dependence of various corporate spreads over Treasuries as a function of the stock-bond covariance. Our first measure is the 90-day P2-rated commercial paper spread to Treasury bills, as constructed in Krishnamurthy and Li (forthcoming). The second one is the long-term AAA-rated corporate bond spread over long-term Treasuries. Our final corporate measure is the Excess Bond Premium (EBP) first constructed in Gilchrist and Zakrajšek (2012) and updated in Gilchrist et al. (2021). Reflecting the data in Gilchrist et al. (2021), we use three versions of the EBP: short (up to two years remaining to maturity), medium (two to five years remaining), and long (above five years remaining). The EBP is a measure of corporate bond yield premium that is cleansed of duration mismatch, and that controls for, among other features, prepayment optionality and default risk. This measure, then, seeks to capture the corporate bond yield premium that is not due to default risk. The first two measures, however, do contain some measure of default spread.

In Table 8, we find that when the Treasury convenience yield covariance with stock returns is low, the gap between corporate and Treasury yields opens up. Both the covariance terms corresponding to the convenience yield and the frictionless risk-free rate contribute to this relationship, with the convenience yield part being the dominant channel. A one standard deviation increase in the convenience yield covariance term corresponds to about 85% standard deviation decrease in the P2 spread, and a 40% standard deviation decrease in the AAA-Treasury spread. Similarly, the estimated relationship with the three different maturity EBP measures is strong: a one standard deviation increase in the stock-bond covariance term corresponding to the convenience yield corresponds to approximately half standard deviation drop in the excess bond premium.

Finally, we document the relationship between the Treasury-stock covariance and foreign safe assets. Here we rely on two recent papers to construct convenience yields of foreign currency bonds. Firstly, we follow Du et al. (2018) and construct measures of foreign currency sovereign bond convenience yields with respect to U.S. Treasuries. This measure is a close analogue to the convenience yield approximated as the TIPS-Treasury premium: it measures the yield on foreign safe bonds, with the cash-flows swapped into USD, relative to the yield on U.S. Treasuries. Specifically, Du et al. (2018) show that in frictionless markets the relative convenience yield on U.S. Treasuries with respect to a foreign sovereign bond is equal to the foreign yield minus the U.S. yield, minus the forward

[13] The futures (F) and spot (P) prices satisfy $F = P\exp\{r - c\}$ where r is the interest rate and c is the convenience yield.

premium for hedging the foreign currency against the U.S. Dollar.[14] The resulting measure, USD premium, is an equal-weighted average of the U.S. convenience yield over a basket of ten foreign currencies (AUD, CAD, CHF, DKK, EUR, GBP, JPY, NOK, NZD, SEK). We also use the EUR and GBP relative convenience yields directly. Secondly, we follow Van Binsbergen et al. (2022) and Diamond and Van Tassel (2021) and use the box rates constructed in various currencies to estimate a local currency convenience yield. Specifically, we use the USD, GBP, and EUR box yields, all at the 2-year maturities.

The first column of Table 9 documents a strong negative relationship between the stock-bond covariance term corresponding to the convenience yield, and the U.S. premium over foreign currencies. A one standard deviation increase in the convenience yield covariance term corresponds to about a fifth of a standard deviation decrease in the U.S. premium. The second and third columns show, however, that this relationship is not driven by EUR and GBP premium, as the U.S. premium over these currency safe bonds (German Bunds in the case of EUR) does not have a similar relationship with the covariance term. That said, using the EUR and GBP box rate as the foreign currency convenience yield proxy reveals that times of high U.S. covariance see a lowering of these foreign convenience yields. In Panel B of Table 9 we confirm the results by using the TIPS-Treasury premium directly as an explanatory variable in place of the covariance. We find a strong relationship between the TIPS-Treasury measure of the convenience yield and the U.S. relative convenience yield over 10 foreign currency bonds, as well as positive relationship between the U.S. and German convenience yields, measured in USD and EUR terms, respectively.

5 The Role of Inflation Expectations

Our finding that the time-variation in the convenience yield can materially contribute to the hedging properties of Treasuries additionally suggests a novel channel via which inflation can affect the stock-bond covariance. Prior literature has extensively studied the link between realized and expected inflation shocks and the stock-bond covariance, and has attributed the long-term shift from positive to negative stock-bond covariance to changes in inflation dynamics, for instance, see Campbell et al. (2017). Our results open the possibility, however, that inflation also affects the stock-bond covariance via its impact on the convenience yield. To the extent high inflation, or the possibility of high inflation, erodes the convenience yield, and simultaneously lowers the stock market valuation (especially via the valuation of long-duration assets), it can also dampen the hedging properties of Treasury bonds.

We test this hypothesis in Table 10 with the help of two proxies for expected inflation: the five-year inflation swap rate, and the Federal Reserve Bank of Cleveland five-year expected inflation series

[14] Du et al. (2018) consider a number of alternative calculations. We follow their calculation that estimates the forward premium using interest rate swaps and basis swaps, see Equation (9) in that paper.

that combines both survey and market data.

In Panel A we report regressions of the stock-bond covariance, as well as the three constituent parts, as dependent variables with proxies for expected inflation as the explanatory variables, over the period 2005-2022. First, we find that the stock-bond covariance is larger in times when expected inflation is higher. This accords with existing work,[15] but our decomposition of the stock-bond covariance into three constituent parts reveals that almost all of this relationship stems from the stock-bond covariance stemming from the convenience yield. Hence these regressions support the view that expected inflation affects the stock-bond covariance via the convenience yield, in addition to via the frictionless risk-free rate. In the last column of the panel, we provide further validation of this effect by estimating a direct regression of the TIPS-Treasury premium on the inflation swap rate. We find a strong negative relationship, in line with the view that inflation innovations are a potentially important source of convenience yield innovations, consistent with the findings in Li et al. (2022) who document a negative relationship between inflation expectations and the AAA-Treasury spread as well as the Treasury-Refcorp spread.

The first five columns of Panel B repeat the above analysis except using the Cleveland Fed expected inflation series as the explanatory variable. We again find a positive relationship between the aggregate stock-bond covariance and expected inflation, consistent with prior work. With this alternative proxy for expected inflation, we again find that the correlation term corresponding to the convenience yield contributes materially to this relationship. In the sixth column we use the full time-series of available inflation expectations data (1982-2022) to demonstrate the link between inflation and the aggregate stock-bond covariance (we are unable to use the decomposed covariances here due to the unavailability of the TIPS-Treasury premium). Finally, in the seventh column we provide evidence that the relationship between expected inflation and the stock-bond covariance holds in an even longer sample starting in 1972. Here we use the measure of long-run inflation expectations (PTR) used in the FRB/US model maintained by the Fed Board.[16] Again we find a strong positive relationship: high expected inflation periods see larger stock-bond covariance.

The dynamics of convenience yield and stock-bond covariance that we propose and these panels evince are particularly evident in the recent inflation bout starting in early 2021. In Panel A of Figure 4 we plot the expected inflation series, as well as the 10-year TIPS-Treasury premium. As inflation expectations took off starting in early 2021, the Treasury specialness proxy saw a drop of more than 20 bps (recall its monthly standard deviation is only 14 basis points). As Panel B of Figure 4 shows, the stock-bond covariance and Treasury convenience yield had a negative relationship in this period: a one standard deviation change in the stock-bond covariance in this period corresponds to about a quarter standard deviation drop in the 10-year TIPS-Treasury premium.

[15] See Campbell et al. (2017) and Pflueger (2023).

[16] See Chan et al. (2018) for details on the construction of PTR. We are grateful to Todd Clark for sharing the measure with us and explaining its construction. We are also grateful to Marco Del Negro of New York Fed for putting us in touch with Todd Clark.

Note too that this drop in the convenience yield is not limited to the TIPS-Treasury premium and is also evident in the other long-term convenience yield proxies, such as the Agency MBS-Treasury spread.

Overall, our findings establish a novel channel via which inflation can affect the hedging properties of Treasuries. Higher-than-expected inflation can then cut into the hedging properties of nominal bonds in two different ways: by its effect on nominal rates and by its effect on the convenience yield. Prior work in Duffee (2018) has argued that inflation volatility can explain only a small part of long-term nominal yield volatility and, more recently, Duffee (2022) has argued that inflation news have historically not been volatile enough to justify the role inflation has been given in accounting for the stock-bond covariance. The importance of the convenience yield channel suggests a way in which inflation expectations can have larger impact on the stock-bond covariance than might at first seem.[17]

6 Event Studies: Credit Risk and Treasury Supply

Besides inflation expectations, two other prime contributors to the convenience yield are the availability of Treasuries, and their perceived safety. In this section we revisit a number of events from recent history that have seen large increases or drops in the US Treasury convenience yield, either because of news on default probability, or because of sharp supply changes. We also examine events around the Eurozone sovereign debt crisis to understand the behavior of U.S. Treasury convenience yield relative to other government safe bonds.

6.1 Financial Crisis and Covid

Our first set of event studies employs the central bank policy responses to the Global Financial Crisis (GFC) as well as the Covid pandemic. These periods provide a number of sharp event dates with substantial news about the future supply of Treasuries and GSE securities (bonds and MBS) was altered by the pace of central bank purchases. We document the behavior of the convenience yield as well as the stock-bond covariance on these event days.

In Table 11A we document the behavior of the TIPS-Treasury premium and the stock-bond covariance corresponding to the convenience yield around seven event dates during the GFC that saw

[17] To see this explicitly note the Campbell and Ammer (1993) decomposition of long yields into expected inflation, expected short-term real yields, and expected excess returns:
$y_t^m = \frac{1}{m}\sum_{i=1}^m \mathrm{E}_t[\pi_{t+i}] + \frac{1}{m}\sum_{i=1}^m \mathrm{E}_t[r_{t+i-1}] + \frac{1}{m}\sum_{i=1}^m \mathrm{E}[ex_{t+i}^{m-i+1}]$.
Even if the volatility of the first term (expected inflation) is small relative to overall yield volatility, to the extent expected inflation innovations drive excess returns via the convenience yield component, there is an additional channel via which inflation news contribute to nominal yield volatility.

large changes in the expected amount of Treasury securities outstanding. Panel A of Table 11A lists the events as well as the predicted impact on Treasury supply. Six of the events are about increasing the expected amount of Treasury, GSE or Agency MBS purchases. Because these policy actions see a reduction in the aggregate amount of safe assets available to the private sector, we predict that on these days the Treasury convenience yield increases, and the stock-bond covariance stemming from the convenience component decreases. The one outlier is the August 12, 2009 event date when the Fed announced it will slow the pace of Treasury purchases and we predict a decrease in the Treasury convenience yield.

Panel B of Table 11A shows that in all but one case, the TIPS-Treasury premium innovation on the event days is in the predicted direction. For instance, the November 11, 2008 announcement of purchases of GSE debt and Agency MBS securities saw a nearly five basis point increase in the Treasury convenience yield. The March 18, 2009 announcement that the Fed will, for the first time, buy Treasuries saw a whopping 20 basis point increase in the TIPS-Treasury premium in the three-day event window. In contrast, the August 12, 2009 announcement that Treasury purchases will be slowed saw a drop of 13 basis points in this proxy of the Treasury convenience yield. The innovations to the stock-bond covariance on these event days are typically in the opposite direction of the convenience yield innovation, consistent with our finding that the level of the convenience yield reflects in part the covariance of convenience yields with aggregate equity risk.

In Table 11B and Figure 6A we carry out a similar analysis around four event days during the onset of the Covid pandemic. We employ four event days (see Table 11B Panel A) that pertain to Treasuries from the dates studied in Haddad et al. (2021). The first of these events, an announced purchase of USD 500 billion of Treasuries by the Federal Reserve on March 15, 2020 reduced the amount of Treasuries outstanding and is predicted to increase Treasury convenience yields. The third event day, March 31 2020 saw the Fed allow certain foreign counterparties to directly repo Treasuries with the Fed and is predicted to make Treasuries more appealing to foreign investors, hence increasing Treasury convenience yields. The other two events are predicted to reduce Treasury convenience yield: on March 23, 2020 the Fed increased the range of collateral accepted at emergency facilities, hence providing more substitutes to Treasuries. On April 1, 2020 the Fed excluded Treasuries from leverage ratio calculations, in the hope of making intermediation of fixed income securities more economical for banks.

As the first column of Panel B of Table 11B shows, three events see the convenience yield move in the predicted direction. For instance, the announcement of collateral eligibility rules on March 23 saw a 13 basis point drop in the TIPS-Treasury premium. The only event that does not follow the predicted pattern is the announcement of foreign direct repo. Note, though, that this event came right before the announcement that Treasuries are to be excluded from leverage ratio calculations and the event window overlaps with the subsequent announcement. The one-day change after the March 31 announcement was a positive 11 basis points.

One potential concern with these event studies is that the Fed purchases of assets preference either nominal or real Treasuries, which could directly impact the TIPS-Treasury premium. An outsize position in, say, real Treasuries would drive up TIPS prices and potentially cut into the TIPS-Treasury premium. We explore this possibility in Appendix Figure A3. In Panel A we show the dollar amount of nominal and real Treasuries held by the Fed. The Figure shows that the Fed tends to adjust its portfolio size with nominal Treasuries, with the small overall share of TIPS being much more stable. In Panel B we plot the share of total nominal and real Treasuries outstanding held by the Fed, as well as the TIPS-Treasury premium, again highlighting the Fed's tendency to adjust its portfolio size with nominal Treasuries. Of particular note in Panel B is the large increase in holdings share in early 2020 at the onset of the Covid pandemic, with a jump in the share of real bonds held. Note, however, that this event did not coincide with the drop in the TIPS-Treasury premium that occurred in 2021. Note too that the highest level of the TIPS-Treasury premium occurred during the Global Financial Crisis, a period during which the Fed's holdings of nominal Treasuries were at a low point, again cutting against the view that Fed holdings are driving the TIPS-Treasury premium.

6.2 Debt Ceiling Standoffs

Our second event study considers two debt ceiling standoffs in the U.S. First, we consider the debt ceiling crisis of Summer of 2011 that was resolved on August 1, 2011 with the passage of a debt ceiling bill in the House of Representatives. As shown in Figure 6B, leading up to the event date, the covariance of U.S. Treasuries and aggregate stock return was high and the convenience yield declined. These patterns reversed sharply soon after a default was averted. As reported in Panel A of Table 11C, in a 60 trading-day window around the August 1, 2011 resolution date we find that the TIPS-Treasury premium was higher by 6.5 basis points after the resolution, and the covariance term corresponding to the convenience yield was lower by .37 percentage points. Both estimated effects are statistically significant at the 5% level. As also shown in Figure 6B, despite a rise in the U.S. CDS premium in build-up to the crisis date, especially at the short maturity of one year, its covariance with aggregate stock returns is quantitatively too small to explain the pre-resolution fall in the convenience yield.

Similar dynamics obtain around the debt ceiling standoff of Spring 2023 that was resolved with congressional action on May 31, 2023. In Figure A4 we show the TIPS-Treasury premium and the stock-bond covariance around this date. The Treasury convenience yield dropped earlier in the year around the regional banking crisis, and saw a dip of close to ten basis points just prior to the debt ceiling deal. As we confirm in Table 11C Panel B, the TIPS-Treasury premium was higher after the debt ceiling resolution, and correspondingly the stock-bond covariance stemming from the convenience term was lower.

Overall, we conclude from these case studies that besides inflation expectations, Treasury bond supply and sovereign credit risk are important determinants of the hedging properties of Treasuries. The stock-bond covariance and Treasury convenience yield appear to be "catch-all" economic measures proxying for these characteristics.

6.3 Eurozone Sovereign Debt Crisis

Finally, the Eurozone Sovereign Debt crisis of 2010-2012 presents an occasion to study the interplay of U.S. and foreign currency convenience yields. Specifically, we examine the convenience yield of the U.S. Treasuries relative to the German Bunds in response to events that ignited or amplified sovereign bond stress in the Eurozone, as well as policy actions by the ECB.

In Figure A5 we plot the TIPS-Treasury premium, and the relative convenience yield of the U.S. Treasury relative to Germany government bonds (EUR premium). Panel A shows the early part of the crisis, January 2010 to July 2011, which included the Greek debt downgrade, as well as the introduction of the Securities Market Programme (SMP) by the ECB which provided short-term funding to banks against eligible collateral (sovereign debt securities). Panel B shows the second half of the crisis, up to January 2013, including the introduction of the Long-Term Refinancing Operation (LTRO) in Dec 2012 which expanded both eligible collateral as well as extended the tenor of financing to three years, the Greek default of March 2013, and the introduction of the Outright Monetary Transactions (OMT) during July-Sep 2013 under which the ECB pledged to do "whatever it takes" via purchases of Eurozone sovereign bonds in open market operations in order to preserve the Euro. The corresponding event dates are listed in Table A8 Panel A. Panel B of the same table lists the averages of the U.S. TIPS-Treasury premium and the relative premium of Treasuries over German bunds across the different event periods.

First, Panel A of Figure A5 illustrates the need for joint understanding of the hedging properties of the two bonds. In particular, vulnerability of the Eurozone (periphery countries, specifically) following the Greek downgrade sees the absolute convenience yield of the U.S. Treasuries to rise but that relative to the German Bunds to fall due to a flight-to-safety premium in the latter; stabilization measures by the European Central Bank (ECB) such as the SMP restore the relative convenience yield of the U.S. Treasuries as they dampen the flight-to-safety to German Bunds

Second, Panel B of Figure A5 highlights that the evolution of this relationship was highly complex. While the ECB's Long-Term Refinancing Operation (LTRO) of December 2012 saw the reduction of the specialness of German bunds causing the relative U.S. Treasury premium to rise even as Treasuries remained less special at an absolute level, the Greek default of March 2013 saw both relative and absolute U.S. Treasury premium to rise over the subsequent months. At that point, ECB's Outright Monetary Transactions program (OMT), announced in July 2012 and finalized in September 2012, brought both premia eventually to lower levels.

Overall, these event studies help recognize that the linkage between the hedging properties of safe assets and their convenience yield that we discovered in monthly regressions employed over long time-periods are at work even at a microscopic daily level around specific events that alter the credit risk or the safe-asset supply of government bonds globally.

7 Related Literature

Our paper brings together two large literatures: one on the stock-bond comovement and the other on the convenience yield on Treasury securities.

The literature on the aggregate stock-bond comovement extends back to the work in Shiller and Beltratti (1992) and Campbell and Ammer (1993). An important part of this literature has studied stock and bond returns jointly in affine economies, for instance Bekaert and Grenadier (1999), Bekaert et al. (2010), and Lettau and Wachter (2011). Recent work in Cieslak and Pang (2021) uses sign-restriction identification to decompose stock and bond returns. Further work studying stock-bond comovements, including nonlinearities and the term strucure, includes Connolly et al. (2005), Baele et al. (2010), Adrian et al. (2015), Koijen et al. (2017), Xu (2017), Backus et al. (2018), Chang et al. (2021), Ermolov (2022).

The recent literature on this topic has focused on the sign shift in the aggregate stock-bond comovement in the early 2000s. Campbell et al. (2017) study the risk exposures of nominal bonds and attributes the changing covariance to a shift in the covariance between nominal interest rate and the real economy while Campbell et al. (2018) study the impact of monetary policy rules. Other recent work such as Laarits (2021), Choi et al. (2022), Jones and Pyun (2022), Kozak (2022), and Chernov et al. (2023) explore non-inflation accounts of stock-bond comovement, in line with the argument in Duffee (2022) that inflation innovations have not been the main driver of the time-varying stock-bond comovement. Quantitatively, Laarits (2021) shows that the variability of the aggregate stock-bond covariance can be captured using a price of risk process calibrated to match moments of the equity market. In particular, he finds that the real bond-stock covariance is well captured by a frictionless model of price of risk, while the nominal bond-stock covariance exhibits additional volatility, a finding in line with the argument here on the important role of convenience yields. On the empirical side, Laarits (2021) documents that the stock-bond covariance is co-moves with credit spreads, predicts returns on corporate bonds, and captures risk-neutral moments of Treasury returns as well as aggregate issuance of safe assets. Hu et al. (2023) use intraday data to measure the conditional correlation between stocks and bonds. They show that days with substantial negative stock-bond correlations see poor equity market returns, appreciation of Treasuries, appreciation of the Yen with respect to USD, spikes in implied volatility, and widening of Treasury specialness, in line with the findings here. Also part of this literature has studied the relationship between aggregate stock-bond covariance and the cross-section of stock and bond returns, for instance see Baker and Wurgler (2012).

The literature on Treasury convenience yield goes back to Duffee (1996) and Longstaff (2004). Fleckenstein and Longstaff (Forthcoming) provide a recent overview and re-evaluation of absolute Treasury convenience using the term structure of repo swap rates. Krishnamurthy and Vissing-Jorgensen (2012) document a strong relationship between the aggregate supply of Treasuries and the spread between safe corporate bonds and Treasury yields while He et al. (2019) model the determination of the safe asset in a model of two sovereigns. The relationship between Treasury supply and the convenience yield is explored in Greenwood et al. (2015) while Sunderam (2015) studies private market response to Treasury scarcity. Di Tella et al. (2023) estimate zero-beta rates from risky asset returns and interpret the difference between zero-beta and risk-free assets as the convenience yield. Krishnamurthy and Li (forthcoming) study the substitutability between different types of money and money-like claims, while Eren et al. (2023) estimate a demand system for Treasury securities. d'Avernas and Vandeweyer (2021), Stein and Wallen (2023), and Doerr et al. (2023) study intermediation frictions pertaining to the near end of the yield curve.

Two other recent papers study the relationship between convenience yields and inflation. Li et al. (2022) study this link using a model of fiscal policy in which deficit shocks lead to both higher expected inflation, as well as lower convenience yields from additional future issuance. Cieslak et al. (2023) document two specific regimes in the inflation-convenience yield relationship: a "money channel" regime in which high inflation corresponds to high convenience yields, and a "New Keynesian" regime in which shocks to liquid stores of wealth drive aggregate demand and inflation, resulting in a negative stock-bond covariance. Relative to these two papers we emphasize the importance of the covariance of Treasury convenience with aggregate shocks as an important driver of the level of the convenience yield and emphasize that one channel via which inflation affects the convenience yield is through its impact on this covariance.

Finally, the convenience yield of Treasuries also relies on the proper functioning of the associated markets, for instance see Amihud and Mendelson (1991). Adrian et al. (2017) construct a daily measure of Treasury market liquidity and contrast with existing measures of market liquidity, such as Hu et al. (2013). In contrast to existing measures they find higher illiquidity at the onset of the Covid pandemic in March 2020. A recent literature has studied these dislocations in the Treasury market in that tumultuous period, see He et al. (2022), Haddad et al. (2021), as well as Duffie (2020). Other market microstructure issues can be important, such as specific Treasury securities being cheapest-to-deliver into futures contracts, or going on special in the repo market, as illustrated and analyzed in Duffie (1996), and Jappelli et al. (2022).

Relative to the existing literature on the convenience yield, our novelty lies in the focus on the dynamics of this part of Treasury yields, particularly with respect to aggregate equity market movements.

8 Conclusion

We argue—and empirically establish—that the hedging perspective for safe assets is a quantitatively important channel to capture the time-variation in the Treasury convenience yield: we document that times when the aggregate stock-bond covariance is large and negative see a widening of Treasury convenience yields. In a decomposition of the aggregate stock-bond covariance into terms corresponding to the frictionless risk-free rate, default risk, and the convenience yield, we find that the convenience yield component contributes most robustly to the aggregate hedging properties of the Treasury, particularly during times of market stress. These results lend strong support to the view that investors pay for the convenience yield they enjoy from holding safe assets in a service-flow or an ease-of-retrading sense.

We additionally show that heightened inflation expectations erode the convenience yield, and by extension, reduce the hedging properties of Treasuries. Default risk and Treasury bond supply also erode Treasury hedging properties. These results further imply that that the safe asset properties of U.S. Treasuries are not to be taken as given, but need to be ensured via prudent macroeconomic outcomes. In particular, they underscore the importance of inflation-targeting framework and the attainment of its goals by the Federal Reserve for keeping secure the safe-asset properties of U.S. Treasuries and the demand for them, and in turn, for keeping contained the government borrowing costs. In other words, the convenience yield of government bonds must be "earned" by the central bank and the government by ensuring bonds retain their hedging properties for unspanned shocks faced by households, investors, financial firms, and corporations.

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9 Tables

Panel A.

	mean	p1	p10	p50	p90	p99	sd	count
Cov(Tr 10y, St.)	-0.45	-4.23	-1.33	-0.25	0.15	1.23	0.90	216
Cov(Prem. 10y, St.)	-0.21	-4.60	-0.32	-0.05	0.08	0.36	0.91	216
Cov(Rf 10y, St.)	-0.29	-3.18	-1.01	-0.20	0.24	2.25	0.79	216
Cov(CDS 10y, St.)	0.05	-0.17	-0.05	0.00	0.16	0.68	0.18	216

Panel B.

	mean	p1	p10	p50	p90	p99	sd	count
10y TIPS-Tr	0.29	0.02	0.17	0.28	0.37	1.04	0.14	216
2y Box USD	0.35	0.11	0.18	0.29	0.66	1.30	0.22	179
GC-Tr 3m	0.14	-0.03	0.03	0.10	0.29	0.63	0.13	216
FF-Tr 3m	0.09	-0.64	-0.08	0.05	0.30	1.22	0.27	216
-1*Z-spr.	0.14	-0.07	0.01	0.12	0.23	0.59	0.13	216
30y Sw-Tr	-0.05	-0.59	-0.48	-0.15	0.65	0.84	0.40	216
FN 30y-Tr	0.32	-0.11	0.10	0.26	0.66	1.07	0.25	216
Eff. Fed Funds	1.31	0.05	0.07	0.22	4.52	5.33	1.69	216
5-year E[Inflation]	1.82	1.01	1.34	1.74	2.46	2.68	0.41	216
5-year Inf. Swap Rate	2.18	0.56	1.59	2.18	2.91	3.27	0.55	216
PTR	2.07	1.85	2.00	2.10	2.20	2.30	0.10	216
KW Term Premium	0.17	-0.87	-0.45	0.16	0.86	1.23	0.50	216

Panel C.

	mean	p1	p10	p50	p90	p99	sd	count
6m. GC Conv.	-2.36	-6.17	-5.25	-1.84	-0.55	-0.09	1.69	216
P2-Tr.	0.59	0.13	0.23	0.42	1.23	5.21	0.72	216
AAA-Tr.	1.00	0.49	0.60	0.99	1.38	1.83	0.29	216
EBP LT	0.14	-0.66	-0.31	-0.09	0.79	3.79	0.72	189
EBP MT	0.17	-0.67	-0.46	-0.14	1.06	4.94	0.97	189
EBP ST	0.20	-0.53	-0.39	-0.19	1.38	5.53	1.12	189
US prem.	-15.24	-53.03	-32.47	-15.52	5.59	14.30	14.84	216
-EUR prem.	-10.42	-81.16	-33.80	-11.14	27.39	34.95	24.54	216
-GBP prem.	-5.24	-41.35	-29.56	-4.53	15.74	27.40	15.89	159
2y Box EUR	0.24	-0.02	0.09	0.23	0.42	0.70	0.13	187
2y Box GBP	0.32	0.03	0.09	0.32	0.51	0.89	0.17	76

Table 1: Summary Statistics. Monthly data 2005-2022. Panel A: the stock-bond covariance calculated using 10-year constant maturity Treasury returns and the CRSP value-weighted stock market return in a 30 trading-day look-back window, collapsed to a monthly variable by keeping the last available calculation in each month. Stock-bond covariance calculated separately using the TIPS-Treasury premium, the frictionless risk-free rate, and the CDS rate. Panel B: various proxies of the Treasury convenience yield (described in Section 1.2), Cleveland Fed five year expected inflation, Five year inflation swap rate, and PTR, a measure of inflation expectations. Panel C: six month convenience yield on gold (GC), convenience yield proxies using corporate securities, U.S. Treasury convenience yield relative to other government bonds, EUR and GBP Box spreads.

Panel A.

	2005-2022						
	10y TIPS-Tr	2y Box USD	GC-Tr 3m	FF-Tr 3m	-1*Z-spr.	30y Sw-Tr	FN 30y-Tr
Cov(Tr 10y, St.)	-0.069**	-0.129***	-0.051***	-0.099**	-0.048	-0.074**	-0.102***
	(-2.21)	(-2.96)	(-2.68)	(-2.12)	(-1.32)	(-2.02)	(-3.98)
Eff. Fed Funds	0.011	0.059***	0.028**	0.069***	0.006	0.179***	0.043***
	(1.62)	(5.84)	(2.45)	(2.65)	(0.69)	(8.30)	(3.01)
Constant	0.240***	0.202***	0.078***	-0.043	0.107***	-0.316***	0.222***
	(10.98)	(10.47)	(4.01)	(-1.29)	(5.73)	(-5.66)	(5.23)
Observations	216	179	216	216	216	216	216
R^2	0.184	0.418	0.210	0.243	0.113	0.551	0.182

Panel B.

	1991-2022				1972-2022	
	GC-Tr 3m	FF-Tr 3m	-1*Z-spr.	FF-Tr 3m	-1*Z-spr.	30y Sw-Tr
Cov(Tr 10y, St.)	-0.044**	-0.097***	-0.044	-0.114**	-0.019	-0.069**
	(-2.46)	(-2.84)	(-1.60)	(-2.43)	(-0.78)	(-2.17)
Eff. Fed Funds	0.032***	0.054***	-0.017***	0.144***	-0.037***	0.177***
	(5.24)	(5.47)	(-3.84)	(9.55)	(-6.97)	(10.84)
Constant	0.057***	-0.057**	0.111***	-0.241***	0.175***	-0.254***
	(3.18)	(-2.02)	(6.56)	(-4.22)	(8.13)	(-4.47)
Observations	380	384	384	612	612	319
R^2	0.197	0.231	0.247	0.588	0.389	0.636

Table 2: Stock-Bond Covariance and Proxies of the Treasury Convenience Yield. Left-hand-side variables are proxies of the convenience yield. The selection of left-hand-side variables in each panel reflects their availability in the indicated time period. Right-hand-side variables are the monthly stock-bond covariance and the effective Fed Funds rate. Monthly data 2005-2022. Heteroskedasticity and autocorrelation robust t statistics in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

	2005-2022						
	10y TIPS-Tr	2y Box USD	GC-Tr 3m	FF-Tr 3m	-1*Z-spr.	30y Sw-Tr	FN 30y-Tr
Cov(Prem. 10y, St.)	-0.090***	-0.153***	-0.064***	-0.085***	-0.083***	-0.072**	-0.095***
	(-5.68)	(-9.11)	(-5.30)	(-2.62)	(-7.98)	(-2.56)	(-6.60)
Cov(Rf 10y, St.)	-0.013	-0.058*	-0.029	-0.121*	0.017	-0.078	-0.085**
	(-0.62)	(-1.91)	(-1.44)	(-1.90)	(0.94)	(-1.42)	(-2.36)
Cov(CDS 10y, St.)	0.225**	-0.033	-0.071*	-0.154	-0.006	-0.092	0.306***
	(2.17)	(-0.43)	(-1.76)	(-1.48)	(-0.18)	(-0.85)	(3.93)
Eff. Fed Funds	0.014**	0.059***	0.027**	0.046*	0.004	0.179***	0.048***
	(2.45)	(5.33)	(2.28)	(1.82)	(0.53)	(8.24)	(3.46)
Constant	0.236***	0.217***	0.084***	-0.039	0.118***	-0.316***	0.203***
	(12.98)	(11.10)	(4.14)	(-1.15)	(7.69)	(-5.54)	(5.17)
Observations	216	179	216	216	216	216	216
R^2	0.403	0.515	0.248	0.182	0.412	0.551	0.260

Table 3: Stock-Bond Covariance and Proxies of the Treasury Convenience Yield. Left-hand-side variables are proxies of the convenience yield. The right-hand-side variables are components of the aggregate stock-bond covariance, corresponding to the convenience yield, the frictionless risk-free rate, and the CDS rate according to Equation (4). Monthly data 2005-2022. Heteroskedasticity and autocorrelation robust t statistics in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

Panel A.

	2005-2022						
	10y TIPS-Tr	2y Box USD	GC-Tr 3m	FF-Tr 3m	-1*Z-spr.	30y Sw-Tr	FN 30y-Tr
Cov(Prem. 10y, St.)	-0.073***	-0.106***	-0.056***	-0.055**	-0.079***	-0.029	-0.069***
	(-6.30)	(-7.39)	(-4.39)	(-2.12)	(-6.72)	(-1.18)	(-3.26)
Cov(Rf 10y, St.)	-0.007	-0.041***	-0.025	-0.109**	0.018	-0.061	-0.075**
	(-0.39)	(-3.00)	(-1.47)	(-2.03)	(1.04)	(-1.23)	(-2.13)
Cov(CDS 10y, St.)	0.204**	-0.090***	-0.082**	-0.192*	-0.010	-0.146	0.274***
	(2.57)	(-2.72)	(-2.28)	(-1.92)	(-0.29)	(-1.43)	(3.76)
Crisis	0.117	0.333***	0.058	0.208*	0.021	0.300***	0.178
	(1.42)	(3.55)	(1.16)	(1.73)	(0.32)	(4.19)	(1.53)
Eff. Fed Funds	0.013**	0.058***	0.027**	0.046*	0.004	0.178***	0.047***
	(2.21)	(6.88)	(2.30)	(1.85)	(0.53)	(8.14)	(3.70)
Constant	0.230***	0.194***	0.081***	-0.050	0.117***	-0.332***	0.194***
	(12.90)	(11.21)	(3.89)	(-1.37)	(7.82)	(-5.75)	(4.84)
Observations	216	179	216	216	216	216	216
R^2	0.459	0.746	0.265	0.237	0.414	0.597	0.303

Panel B.

	2005-2022						
	10y TIPS-Tr	2y Box USD	GC-Tr 3m	FF-Tr 3m	-1*Z-spr.	30y Sw-Tr	FN 30y-Tr
Cov(Prem. 10y, St.)	-0.076***	-0.090***	-0.064***	-0.099**	-0.066***	-0.103**	-0.029
	(-4.71)	(-3.23)	(-4.59)	(-2.29)	(-4.02)	(-2.11)	(-1.13)
Cov(Rf 10y, St.)	-0.008	-0.019	-0.029	-0.126*	0.024	-0.090	-0.058**
	(-0.37)	(-0.71)	(-1.53)	(-1.96)	(1.33)	(-1.58)	(-2.03)
Cov(CDS 10y, St.)	0.202**	-0.116	-0.071*	-0.130	-0.035	-0.039	0.192***
	(2.25)	(-1.60)	(-1.66)	(-1.17)	(-1.30)	(-0.42)	(2.60)
VIX	0.229	0.930*	0.003	-0.238	0.289	-0.528	1.142***
	(0.80)	(1.93)	(0.02)	(-0.50)	(1.36)	(-0.80)	(2.96)
Eff. Fed Funds	0.015***	0.063***	0.027**	0.045	0.006	0.175***	0.055***
	(2.73)	(5.95)	(2.20)	(1.62)	(0.76)	(7.41)	(4.53)
Constant	0.194***	0.067	0.083**	0.005	0.066*	-0.220	-0.005
	(3.78)	(0.91)	(2.01)	(0.05)	(1.69)	(-1.59)	(-0.08)
Observations	216	179	216	216	216	216	216
R^2	0.414	0.572	0.248	0.185	0.433	0.558	0.345

Table 4: Stock-Bond Covariance and Proxies of the Treasury Convenience Yield. In Panel A, the left-hand-side variables are various proxies of the convenience yield and the right-hand-side variables are components of the aggregate stock-bond covariance, corresponding to the convenience yield, the frictionless risk-free rate, and the CDS rate, as well as the effective Fed funds rate, and an indicator variable for the Global Financial Crisis. In Panel B, the left-hand-side variables are as in Panel A, and the right-hand-side variables are as in Panel A, except for the GFC indicator variable is replaced by VIX. Monthly data 2005-2022. Heteroskedasticity and autocorrelation robust t statistics in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

	2005-2022						
	10y TIPS-Tr	2y Box USD	GC-Tr 3m	FF-Tr 3m	-1*Z-spr.	30y Sw-Tr	FN 30y-Tr
Cov(Prem. 10y, St.)	-0.070***	-0.146***	-0.061***	-0.094**	-0.073***	-0.078**	-0.097***
	(-6.71)	(-7.62)	(-4.69)	(-2.48)	(-5.74)	(-2.06)	(-4.77)
Cov(Rf 10y, St.)	-0.003	-0.054*	-0.026	-0.122*	0.022	-0.080	-0.086**
	(-0.17)	(-1.73)	(-1.28)	(-1.88)	(1.24)	(-1.36)	(-2.22)
Cov(CDS 10y, St.)	0.153*	-0.053	-0.078**	-0.115	-0.040*	-0.066	0.311***
	(1.80)	(-0.89)	(-1.98)	(-1.34)	(-1.74)	(-0.75)	(3.30)
CDS 10y	0.454***	0.187	0.053	-0.225	0.217**	-0.149	-0.030
	(2.69)	(0.84)	(0.60)	(-1.06)	(2.26)	(-0.45)	(-0.09)
Eff. Fed Funds	0.038***	0.071***	0.028**	0.031	0.016	0.169***	0.046*
	(3.89)	(4.77)	(2.44)	(1.25)	(1.48)	(5.56)	(1.72)
Constant	0.101**	0.154**	0.069**	0.031	0.054**	-0.271***	0.212*
	(1.97)	(2.09)	(2.08)	(0.55)	(2.08)	(-2.63)	(1.77)
Observations	215	178	215	215	215	215	215
R^2	0.529	0.517	0.242	0.181	0.451	0.543	0.258

Table 5: Stock-Bond Covariance and Proxies of the Treasury Convenience Yield, Controlling for the Level of CDS Rate. The left-hand-side variables are various proxies of the convenience yield and the right-hand-side variables are components of the aggregate stock-bond covariance, corresponding to the convenience yield, the frictionless risk-free rate, and the CDS rate, as well as the effective Fed funds rate, and the level of the 10-year U.S. CDS rate. Monthly data 2005-2022. Heteroskedasticity and autocorrelation robust t statistics in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

Panel A.

	B-D	Depos.	HH	Insur.	MMF	Mutual	Funds	Monet.	Pension	ROW
Cov(Tr 10y, St.)	-0.055	0.472***	0.036	-0.043	-0.311	0.309***	0.056	1.773***	-0.453***	-1.250**
	(-0.95)	(2.83)	(0.13)	(-0.67)	(-0.88)	(3.62)	(1.23)	(4.52)	(-3.13)	(-2.41)
KW Term Premium	-0.610***	-1.410***	-0.379	0.639***	-1.876***	-1.711***	-0.406***	-4.557***	2.902***	4.665***
	(-4.83)	(-8.21)	(-0.68)	(7.64)	(-3.92)	(-8.01)	(-7.93)	(-5.51)	(8.66)	(5.59)
Eff. Fed Funds	-0.375***	-0.147**	-0.713***	0.214***	-0.493***	-0.165***	-0.019	-0.422**	1.281***	-0.663***
	(-8.90)	(-2.38)	(-4.21)	(6.43)	(-5.57)	(-3.54)	(-1.04)	(-2.26)	(15.93)	(-3.43)
Constant	0.910***	3.219***	6.326***	1.998***	5.383***	5.258***	0.817***	17.445***	12.077***	38.111***
	(12.69)	(16.42)	(19.07)	(35.61)	(15.83)	(37.05)	(16.75)	(33.61)	(68.93)	(56.09)
Observations	74	74	74	74	74	74	74	74	74	74
R^2	0.678	0.479	0.245	0.625	0.401	0.584	0.427	0.519	0.834	0.425

Panel B.

	B-D	Depos.	HH	Insur.	MMF	Mutual	Funds	Monet.	Pension	ROW
Cov(Prem. 10y, St.)	-0.101*	0.385***	0.344	0.011	-0.903***	0.317***	0.019	2.048***	-0.609***	-0.761***
	(-1.75)	(4.34)	(1.40)	(0.25)	(-4.12)	(6.44)	(0.77)	(7.07)	(-4.69)	(-2.70)
Cov(Rf 10y, St.)	-0.008	0.527**	-0.224	-0.091	0.191	0.291**	0.085	1.481**	-0.313	-1.600**
	(-0.10)	(2.02)	(-0.67)	(-1.14)	(0.56)	(2.31)	(1.30)	(2.06)	(-1.41)	(-2.28)
Cov(CDS 10y, St.)	0.194	-0.395	1.550*	0.111	-0.143	-0.413**	0.010	-1.769	0.069	0.846
	(1.43)	(-1.31)	(1.95)	(1.49)	(-0.19)	(-2.64)	(0.15)	(-1.41)	(0.19)	(1.00)
KW Term Premium	-0.627***	-1.380***	-0.416	0.637***	-1.955***	-1.676***	-0.408***	-4.358***	2.859***	4.628***
	(-4.88)	(-8.56)	(-0.75)	(7.40)	(-3.86)	(-8.01)	(-7.79)	(-5.50)	(8.55)	(5.56)
Eff. Fed Funds	-0.369***	-0.168***	-0.678***	0.218***	-0.484***	-0.182***	-0.020	-0.511***	1.295***	-0.615***
	(-8.50)	(-2.67)	(-3.91)	(6.39)	(-5.36)	(-3.98)	(-1.05)	(-2.83)	(15.97)	(-3.06)
Constant	0.892***	3.289***	6.189***	1.983***	5.386***	5.315***	0.821***	17.717***	12.040***	37.939***
	(12.03)	(16.74)	(18.39)	(35.30)	(15.99)	(37.77)	(16.38)	(34.49)	(66.77)	(54.60)
Observations	74	74	74	74	74	74	74	74	74	74
R^2	0.686	0.505	0.276	0.633	0.456	0.604	0.435	0.568	0.839	0.444

Table 6: Stock-Bond Covariance and Sectoral Holdings of Treasuries. The left-hand-side variables in both panels are share of total outstanding Treasuries held by the sector. Sectors included: Broker-Dealers (B-D), Depository Institutions (Depos.), Households (HH), Insurers (Insur.), Money Market Mutual Funds (MMF), Mutual funds (Mutual), Closed-end Funds and ETFs (Funds), the Federal Reserve (Monet.), Pension Funds (Pension), and Rest-of-the World (ROW). In Panel A the right-hand-side variables are the aggregate stock-bond covariance, the 10-year Kim and Wright (2005) term premium, as well as the effective Fed funds rate. In Panel B the right-hand-side variables are as in Panel A, except we include the components of the aggregate stock-bond covariance corresponding to the convenience yield, the frictionless risk-free rate, and the CDS rate. Quarterly data 2004-2022. Heteroskedasticity and autocorrelation robust standard errors in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

Panel A.

	6m Gold Conv.		
Cov(Prem. 10y, St.)		0.099***	
		(3.36)	
10y TIPS-Tr			-0.520***
			(-2.59)
Eff. Fed Funds	-0.923***	-0.929***	-0.921***
	(-20.77)	(-20.47)	(-20.78)
Constant	-1.150***	-1.121***	-1.004***
	(-8.70)	(-8.23)	(-6.98)
Observations	216	216	216
R^2	0.856	0.859	0.858

Table 7: Gold Convenience Yield and the Treasury Convenience Yield. Left-hand-side variable is the 6-month convenience yield in Gold prices, estimated from the term structure of futures prices. Right-hand-side variables are the stock-bond covariance term corresponding to the convenience yield, the 10-year TIPS-Treasury premium, and the effective Fed funds rate. Monthly data 2005-2022. Heteroskedasticity and autocorrelation robust t statistics in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

Panel A.

	2005-2022				
	P2-Tr.	AAA-Tr.	EBP ST	EBP MT	EBP LT
Cov(Tr 10y, St.)	-0.488**	-0.097***	-0.658***	-0.569***	-0.409**
	(-2.25)	(-2.97)	(-2.64)	(-2.61)	(-2.45)
Eff. Fed Funds	0.080***	-0.097***	-0.003	-0.025	-0.004
	(2.71)	(-6.87)	(-0.05)	(-0.62)	(-0.14)
Constant	0.268***	1.080***	-0.143	-0.102	-0.077
	(4.71)	(22.25)	(-0.93)	(-0.80)	(-0.79)
Observations	216	216	189	189	189
R^2	0.365	0.475	0.279	0.288	0.263

Panel B.

	2005-2022				
	P2-Tr.	AAA-Tr.	EBP ST	EBP MT	EBP LT
Cov(Prem. 10y, St.)	-0.675***	-0.122***	-0.794***	-0.687***	-0.509***
	(-10.24)	(-7.52)	(-6.92)	(-7.22)	(-7.76)
Cov(Rf 10y, St.)	-0.139	-0.043	-0.163	-0.147	-0.072
	(-1.39)	(-1.50)	(-0.76)	(-0.80)	(-0.59)
Cov(CDS 10y, St.)	-0.340	0.095	1.297**	1.076*	0.826*
	(-1.58)	(0.78)	(2.00)	(1.86)	(1.71)
Eff. Fed Funds	0.073**	-0.095***	0.017	-0.009	0.008
	(2.13)	(-6.62)	(0.35)	(-0.24)	(0.30)
Constant	0.333***	1.081***	-0.130	-0.089	-0.062
	(6.73)	(21.85)	(-1.05)	(-0.86)	(-0.79)
Observations	216	216	189	189	189
R^2	0.633	0.518	0.492	0.493	0.500

Table 8: Corporate Spreads and the Stock-bond Covariance. Left-hand-side variables are proxies of the Treasury convenience yield employing corporate security prices. Right-hand-side variables in Panel A are the aggregate stock-bond covariance and the effective Fed funds rate. Right-hand-side variables in Panel B are the components of the aggregate stock-bond covariance corresponding to the convenience yield, the frictionless risk-free rate, and the CDS rate, as well as the effective Fed funds rate. Monthly data 2005-2022. Heteroskedasticity and autocorrelation robust t statistics in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

Panel A.

	2008-2022					
	US prem.	-EUR prem.	-GBP prem.	2y Box USD	2y Box EUR	2y Box GBP
Cov(Prem. 10y, St.)	-2.694***	0.795	-0.758	-0.130***	-0.053***	-0.075
	(-6.76)	(1.10)	(-0.19)	(-15.20)	(-5.97)	(-0.58)
Eff. Fed Funds	-6.464***	-8.115*	-10.666***	0.080	0.072***	0.032
	(-3.08)	(-1.70)	(-4.15)	(1.43)	(2.87)	(1.02)
Constant	-15.144***	-12.406***	1.257	0.234***	0.190***	0.282***
	(-7.01)	(-4.41)	(0.41)	(10.61)	(8.26)	(4.99)
Observations	180	180	159	151	151	74
R^2	0.263	0.158	0.357	0.464	0.334	0.034

Panel B.

	2008-2022					
	US prem.	-EUR prem.	-GBP prem.	2y Box USD	2y Box EUR	2y Box GBP
10y TIPS-Tr	34.388***	8.635	34.689	0.788***	0.164	-0.194
	(5.44)	(0.58)	(1.64)	(4.73)	(1.56)	(-0.39)
Eff. Fed Funds	-6.602***	-8.026*	-11.301***	0.087	0.070***	0.027
	(-2.98)	(-1.67)	(-4.82)	(1.49)	(2.70)	(0.75)
Constant	-24.155***	-15.109***	-7.127	0.027	0.156***	0.347*
	(-8.86)	(-2.62)	(-1.14)	(0.56)	(3.89)	(1.96)
Observations	180	180	159	151	151	74
R^2	0.382	0.161	0.387	0.360	0.197	0.026

Table 9: Stock-Bond Covariance and Proxies of U.S. Treasury Premium. In Panel A the right-hand-side variables are the stock-bond covariance component corresponding too the convenience yield and the effective Fed funds a rate. In Panel B the right-hand-side variables are the 10-year TIPS-Treasury premium, and the effective Fed funds rate. In the first three columns the left-hand-side variables are a proxy of relative U.S. Treasury convenience yield over a basket of foreign currency denominated bonds, and proxies for the relative US Treasury convenience yield over the indicated foreign currency bond. In the second set of three columns the left hand side variables are estimates of convenience yields using the option-implied risk-free rate in the indicated currency. Monthly data 2008-2022. Heteroskedasticity and autocorrelation robust t statistics in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

Panel A.

	2005-2022				
	Cov(Tr, St.)	Cov(Prem., St.)	Cov(Rf, St.)	Cov(CDS, St.)	10y TIPS-Tr
5-year Inf. Swap Rate	0.721***	0.693	0.077	-0.047	-0.136**
	(2.77)	(1.54)	(0.31)	(-1.63)	(-2.45)
Constant	-2.026***	-1.720	-0.459	0.147**	0.584***
	(-3.29)	(-1.62)	(-0.80)	(2.01)	(4.38)
Observations	216	216	216	216	216
R^2	0.195	0.178	0.003	0.021	0.277

Panel B.

	2005-2022					1982-2022	1972-2022
	Cov(Tr, St.)	Cov(Prem., St.)	Cov(Rf, St.)	Cov(CDS, St.)	10y TIPS-Tr	Cov(Tr, St.)	Cov(Tr, St.)
5-year E[Inflation]	0.493**	0.168*	0.401**	-0.078**	-0.014	0.428***	
	(2.48)	(1.74)	(2.21)	(-2.04)	(-0.33)	(7.46)	
PTR							0.281***
							(8.06)
Constant	-1.348***	-0.512**	-1.021***	0.188**	0.312***	-1.217***	-0.876***
	(-3.26)	(-2.06)	(-2.81)	(2.23)	(3.27)	(-6.46)	(-5.94)
Observations	216	216	216	216	216	492	612
R^2	0.050	0.006	0.043	0.032	0.002	0.299	0.233

Table 10: Stock-Bond Covariance and Expected Inflation. In both panels the left-hand-side variables are the aggregate stock-bond covariance, as well as its components corresponding to the convenience yield, the frictionless risk-free rate, and the CDS rate. In Panel A the right-hand-side variable is the five-year inflation swap rate. In Panel B the right-hand-side variable is the five year expected inflation rate constructed by the Cleveland Fed, and, in the last column, PTR, a measure of inflation expectations used in the FRB/US model maintained by the Fed Board. Monthly data in the indicated date range. Heteroskedasticity and autocorrelation robust t statistics in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

Panel A.

Date	Description	Abbreviation	Conv. pred.
11/25/2008	Fed to purchase up to 100 billion GSE and 500 billion MBS	QE, #1	+
12/1/2008	Ben Bernanke states that the Federal Reserve could purchase longer-term Treasury or agency securities...in substantial quantities"	QE, #2	+
3/18/2009	The FOMC will a purchase "up to an additional 750 billion of agency mortgage-backed securities,"up to 100 billion" in agency debt, and "up to 300 billion of longer-term Treasury securities over the next six months."	QE, #3	+
8/12/2009	The FOMC "decided to gradually slow the pace" of Treasury purchases	QE, #4	–
8/10/2010	The FOMC will reinvest "principal payments from agency debt and agency mortgage-backed securities in longer-term Treasury securities."	QEII, #1	+
11/3/2010	The FOMC "intends to purchase a further 600 billion of longer-term Treasury securities"	QEII, #2	+
9/21/2011	The FOMC intends to purchase 400 billion of long-term Treasuries, sell equivalent amount of short-term Treasuries.	OT	+
9/13/2012	The FOMC "will increase the Committees holdings of longer-term securities by about 85 billion each month through the end of the year,	QEIII	+

Panel B.

	10y TIPS-Treasury Prem.	Cov(Prem. 10y, St.)
QE, #1	0.046***	-3.842***
	(19.20)	(-374.18)
QE, #2	-0.186***	1.227***
	(-77.28)	(119.53)
QE, #3	0.202***	-0.175***
	(83.96)	(-17.09)
QE, #4	-0.131***	0.141***
	(-54.51)	(13.73)
QEII, #1	0.063***	0.017*
	(26.03)	(1.69)
QEII, #2	0.040***	0.192***
	(16.55)	(18.65)
OT	0.108***	-0.637***
	(44.81)	(-62.07)
QEIII	0.030***	-0.019*
	(12.34)	(-1.86)
Constant	-0.000	0.002
	(-0.15)	(0.22)
Observations	1299	1299
R^2	0.012	0.088

Table 11A: Event Study around Global Financial Crisis Event Days. Panel A lists the event dates. Panel B shows three-day changes in the TIPS-Treasury premium and the stock-bond covariance component corresponding to the convenience yield. Daily sample from July 2007 to November 2011. Heteroskedasticity robust t statistics in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

Panel A.

Date	Description	Abbreviation	Conv. pred.
3/15/2020	Purchase 500 billion of Treasuries, and 200 billion of Agency MBS.	Purchases	+
3/23/2020	Extend the range of accepted collateral at emergency facilities.	Collateral	–
3/31/2020	Allow certain foreign counterparties to repo Treasuries with the Fed directly.	Foreign	+
4/1/2020	Exclude Treasuries and deposits from leverage calculations for bank holding companies.	Exclude	–

Panel B.

	10y TIPS-Treasury Prem.	Cov(Prem. 10y, St.)
Purchases	0.036***	-0.467***
	(4.83)	(-13.26)
Collateral	-0.127***	-0.668***
	(-17.13)	(-19.00)
Foreign	-0.059***	0.064*
	(-7.87)	(1.82)
Exclude	-0.097***	-0.248***
	(-13.03)	(-7.06)
Constant	0.004	0.016
	(0.55)	(0.46)
Observations	104	104
R^2	0.053	0.057

Table 11B: Event Study around the Onset of Covid Pandemic Event Days. Panel A lists the event dates. Panel B shows three-day changes in the TIPS-Treasury premium and the stock-bond covariance component corresponding to the convenience yield. Daily sample from March 2020 to August 2020. Heteroskedasticity robust t statistics in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

Panel A. 2011 debt crisis. Cutoff August 1, 2011

	10y TIPS-Tr	Cov(Tr 10y, St.)	Cov(Prem. 10y, St.)
Cutoff	0.065***	-2.582***	-0.366***
	(3.36)	(-6.57)	(-5.97)
Constant	0.254***	-0.734***	-0.121***
	(21.84)	(-3.78)	(-3.56)
Observations	66	66	66
R^2	0.263	0.798	0.691

Panel B. 2023 debt crisis. Cutoff May 31, 2023

	10y TIPS-Tr	Cov(Tr 10y, St.)	Cov(Prem. 10y, St.)
Cutoff	0.039***	0.240**	-0.175**
	(3.66)	(2.04)	(-2.36)
Constant	0.297***	-0.741***	0.132*
	(32.61)	(-10.58)	(1.76)
Observations	54	53	53
R^2	0.237	0.184	0.141

Table 11C: Convenience Yields and Stock-Bond Covariances Around Two Debt Ceiling Deals. Daily data. 2011 debt ceiling standoff sample from June to September 2011; 2023 debt ceiling sample from April to June 2023. Heteroskedasticity and autocorrelation robust t statistics. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

10 Figures

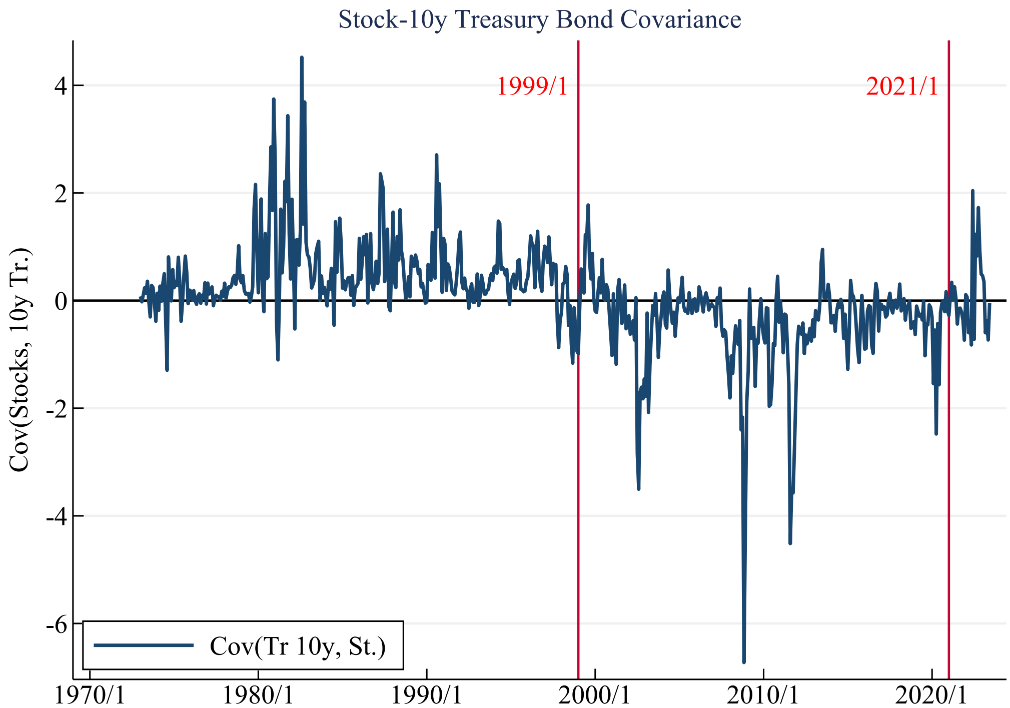


Figure 1: Aggregate Stock-Bond Covariance. Nominal 10-year constant maturity bond. Covariances with the market calculated using a 30 trading day rolling window. Plot shows end of month values. Monthly data 1973-2022.

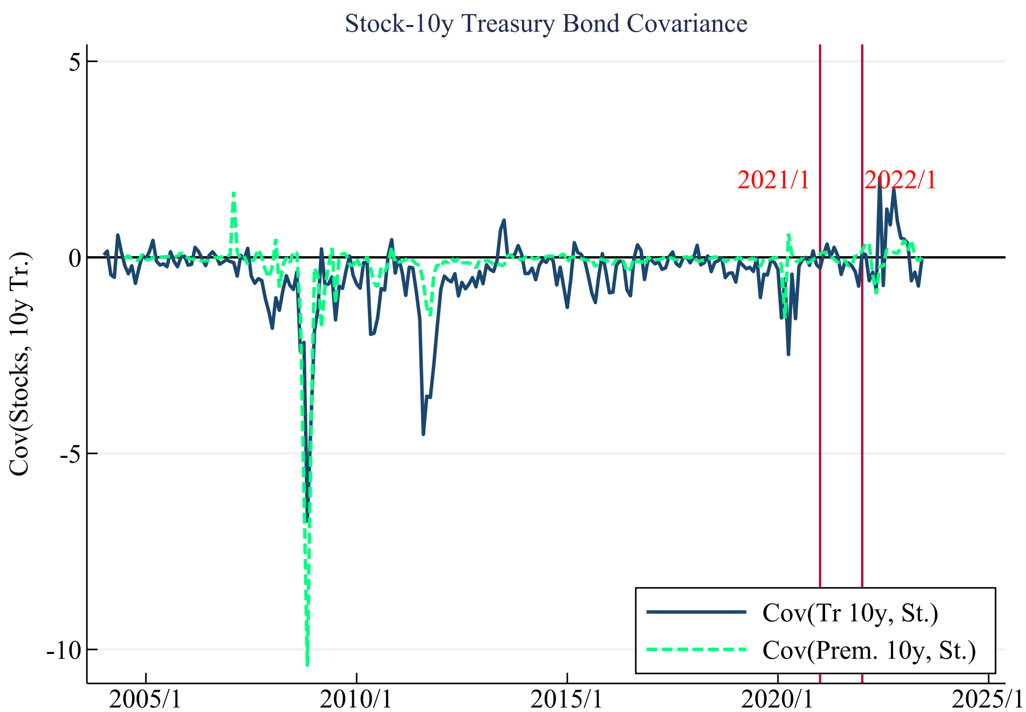


Figure 2: Stock-Bond Covariance Using the TIPS-Treasury Premium. Two calculations of the stock-bond covariance in a 30 trading-day rolling window. The blue solid shows the aggregate stock-bond covariance using the 10-year Treasury yield. The neon dashed line shows the component of the aggregate stock-bond covariance calculation corresponding to the convenience yield. Plot shows end of month values. Monthly data 2005-2022.

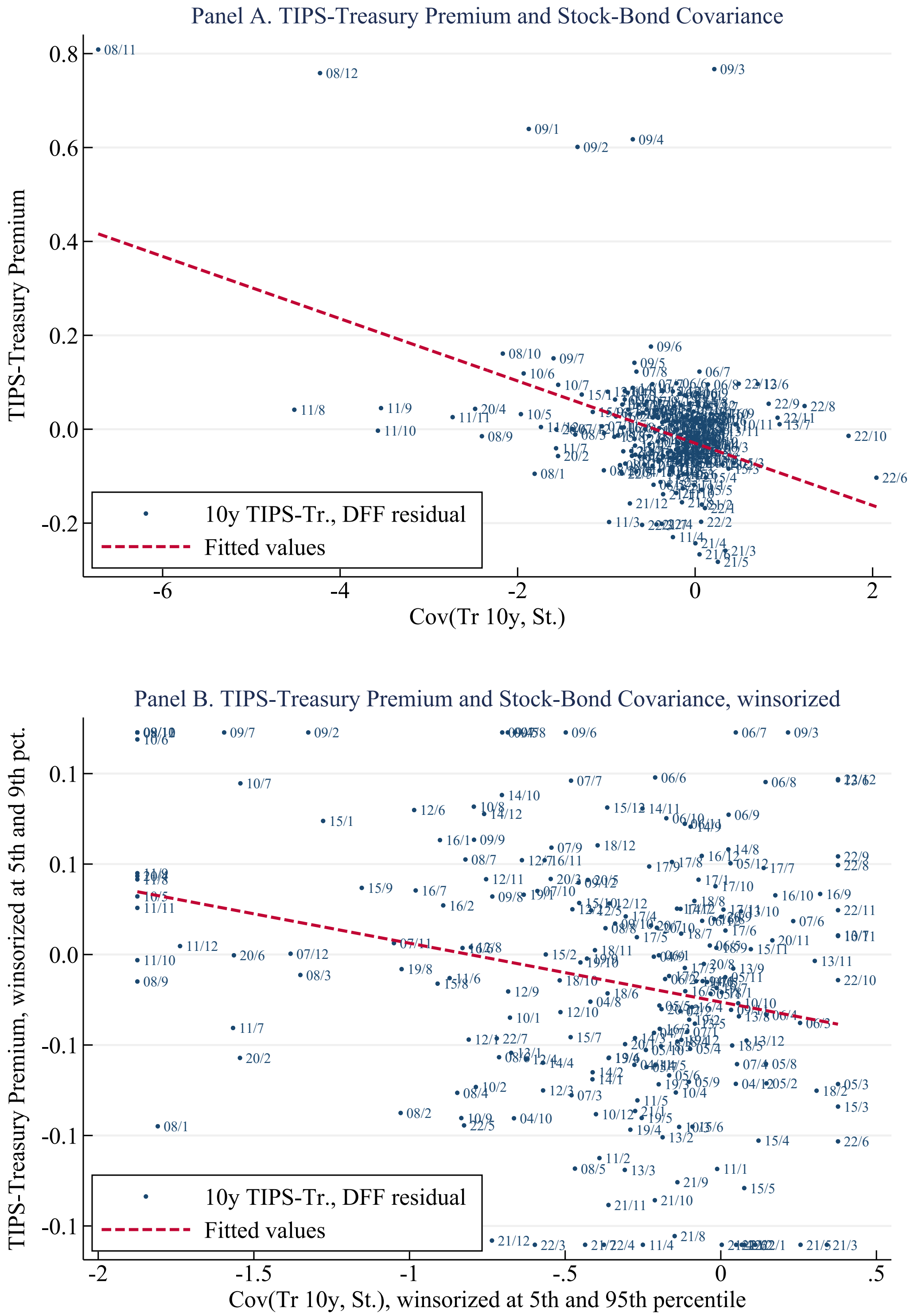


Figure 3: Treasury Convenience Yield and the Stock-Bond Covariance. Panel A is a scatterplot of the 10-year TIPS-Treasury premium and the aggregate stock-bond covariance. Monthly data 2005-2022. TIPS-Treasury premium residualized with respect to the effective Fed funds rate. Panel B reports the same data, except the stock-bond covariance measure is winsorized at the 5th and 95th percentiles.

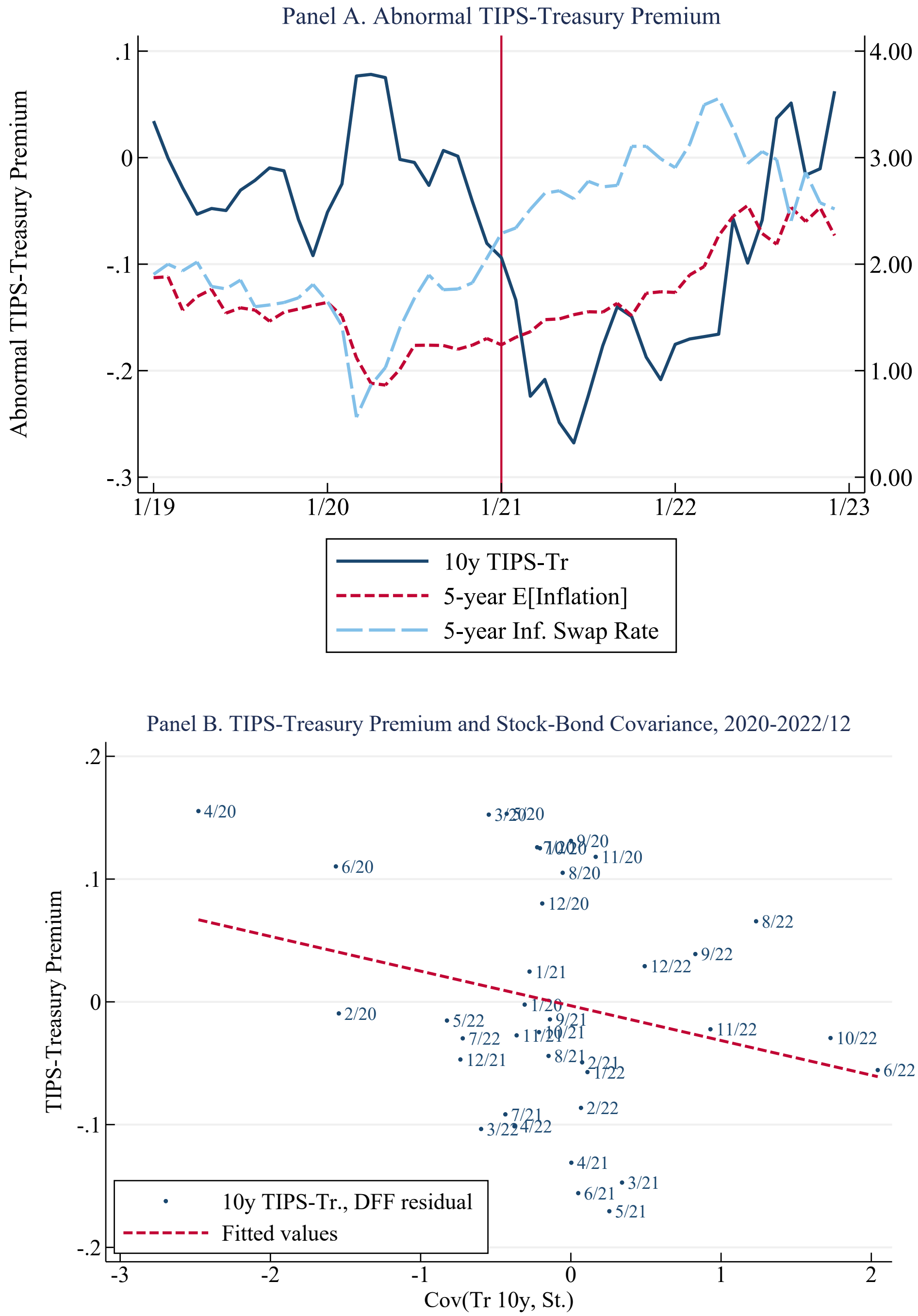


Figure 4: TIPS-Treasury Premium and the Stock-Bond Covariance. Panel A shows the level of the 10-year TIPS-Treasury premium, as well as the five-year expected inflation, and the five-year inflation swap rate. Panel B shows a scatterplot of the TIPS-Treasury premium and stock-bond covariance. TIPS-Treasury premium residualized with respect to effective Fed Funds rate.

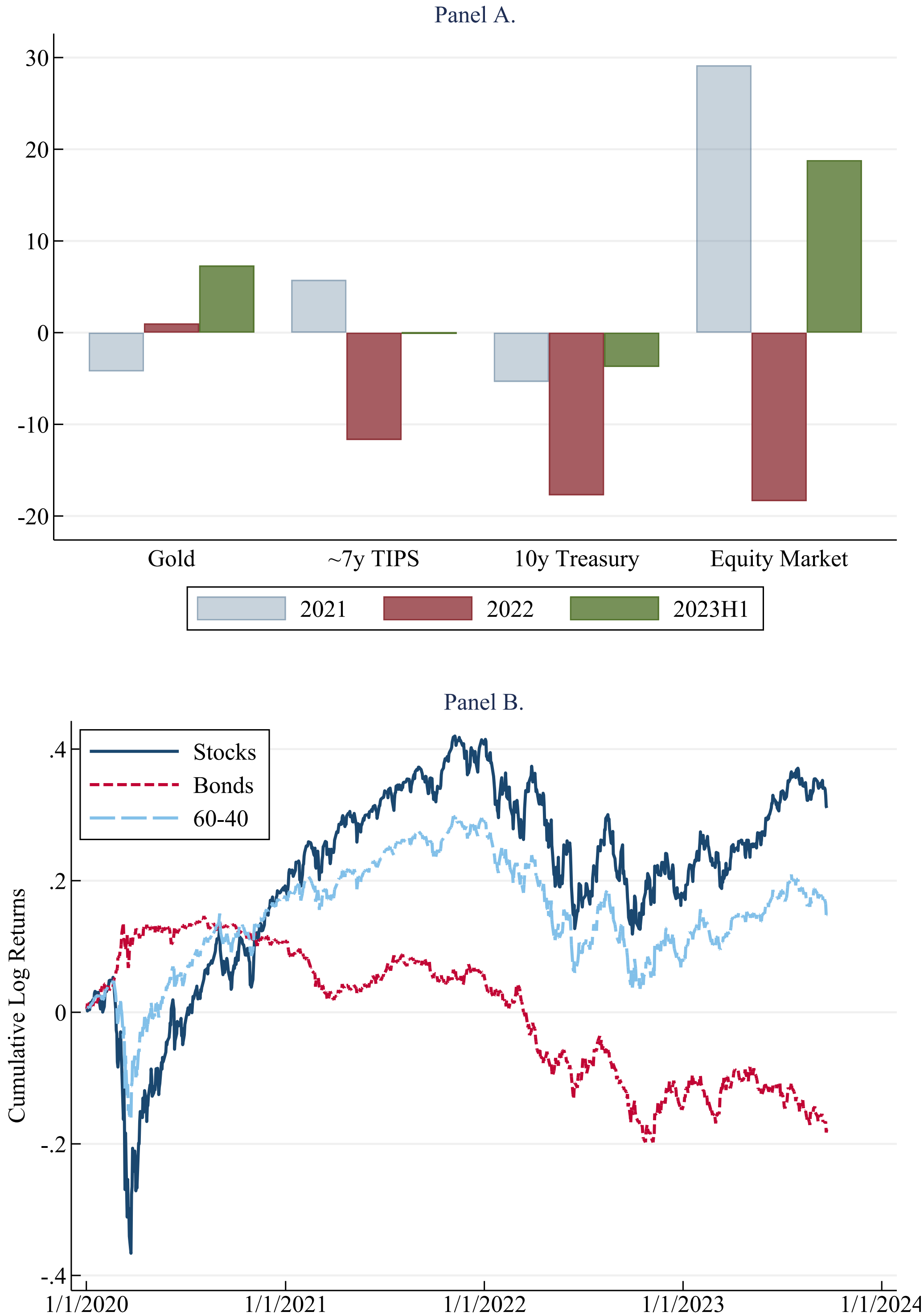
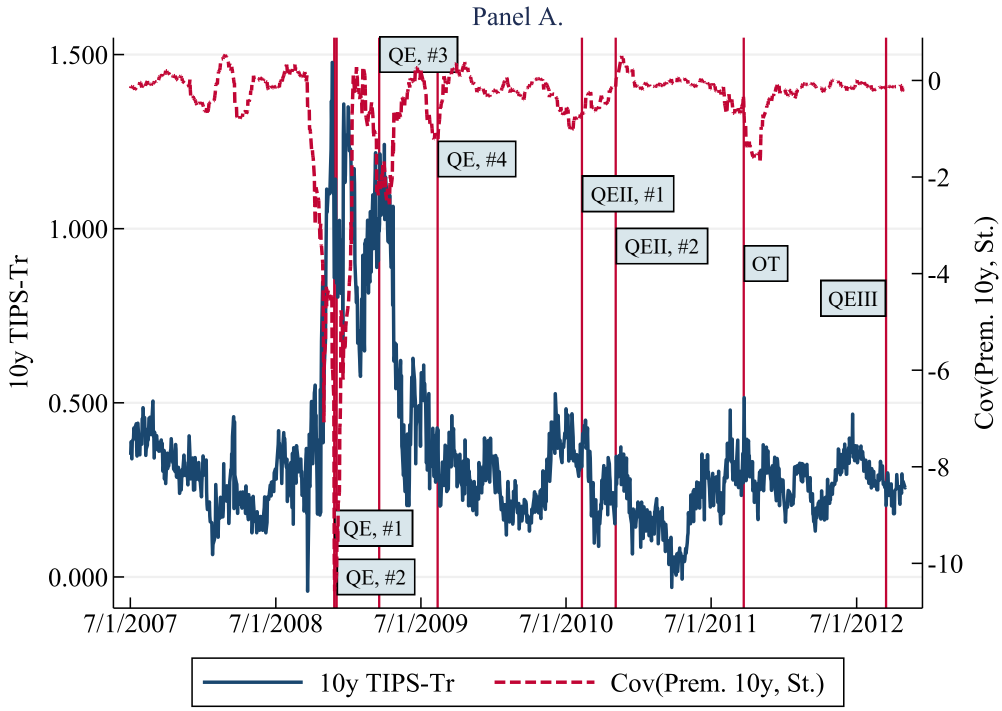


Figure 5: Returns in 2021, 2022, and first half of 2023. Stocks, 10-year Treasuries, and the 60-40 Portfolio. Return on TIPS proxied by the return on TIP, a TIPS ETF with duration of approximately 7 years.



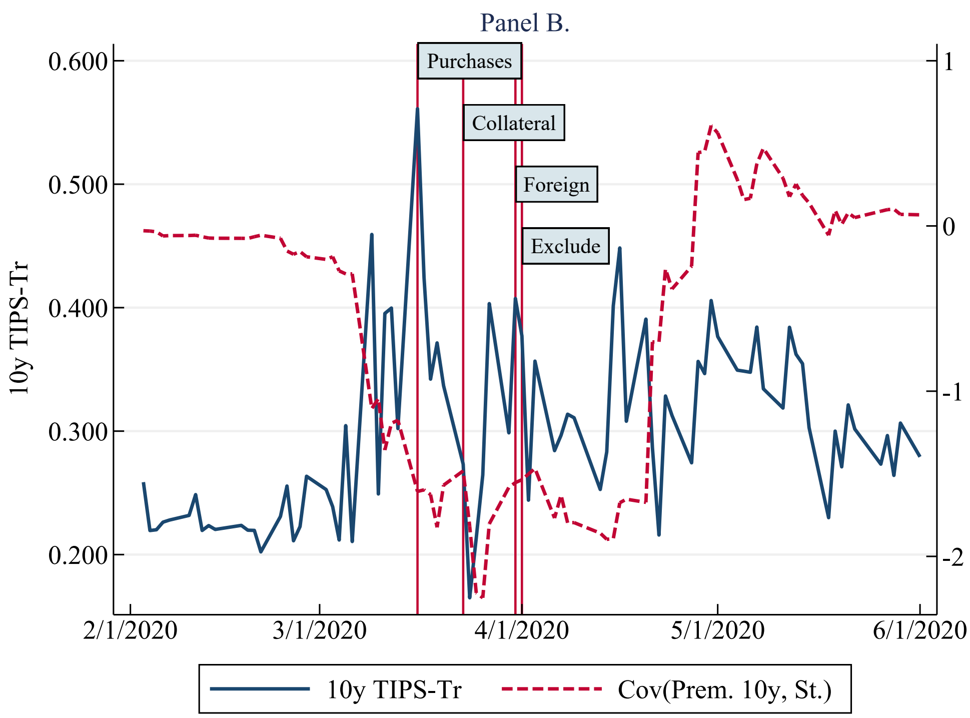
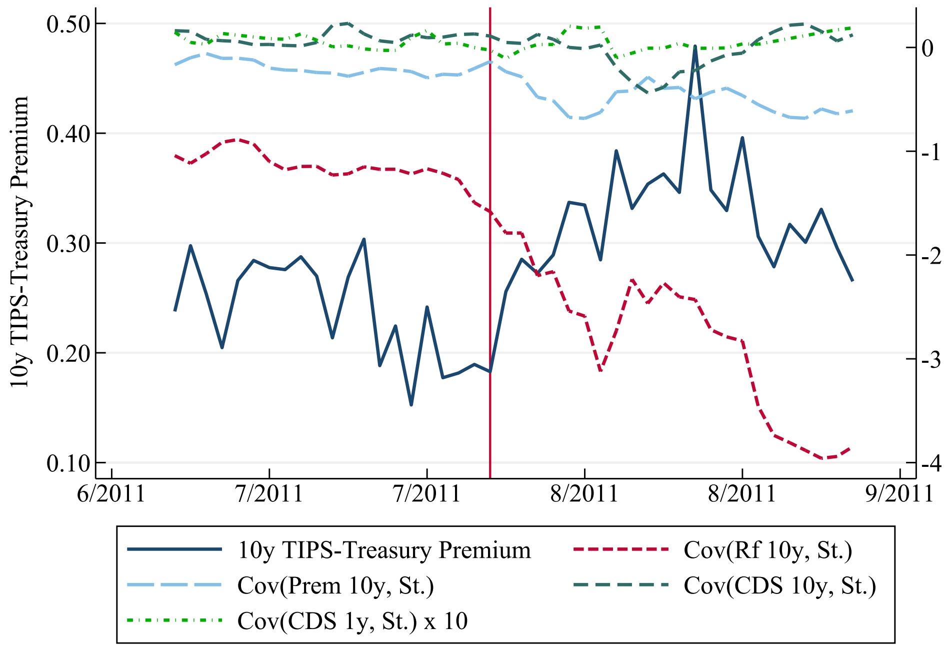


Figure 6A: TIPS-Treasury Premium and Stock-Bond Covariance during the Financial Crisis and Covid Era. Vertical lines correspond to event days described in Table 11A Panel A, and Table 11B Panel A.

Panel A.



Panel B.

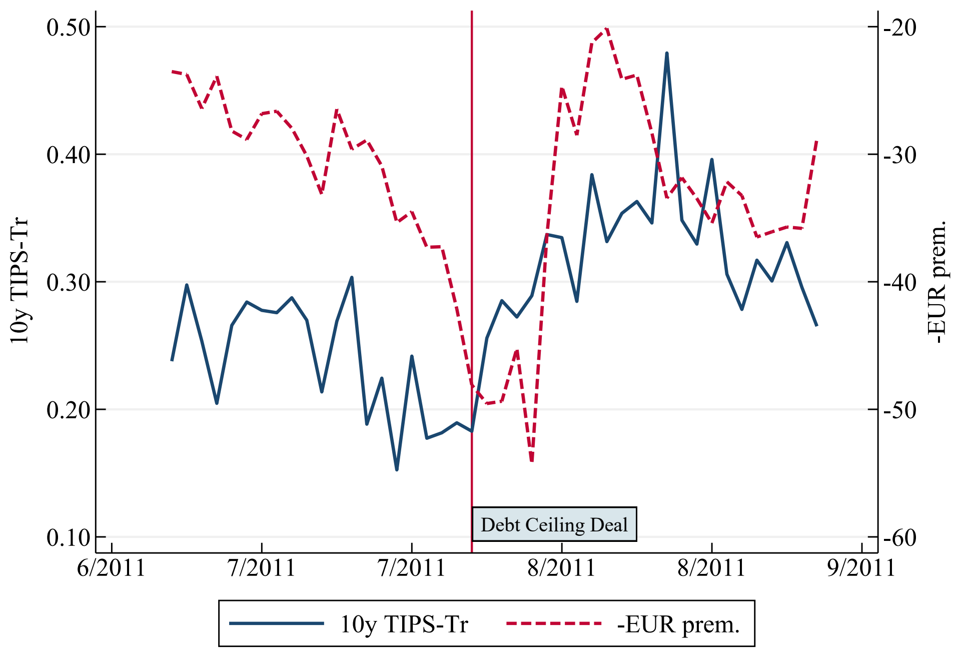


Figure 6B: TIPS-Treasury Premium and the Stock-Bond Covariance around the 2011 Debt Ceiling Crisis. Relative Treasury Convenience Yield over German Bunds. Panel A shows the TIPS-Treasury premium and the aggregate stock-bond covariance, as well as the components of the stock-bond covariance corresponding to the convenience yield, the frictionless risk-free rate, and the CDS rate. Panel B shows the relative convenience yield of U.S. Treasuries over German Bunds, as well as the aggregate stock-bond covariance. Red vertical lines indicate August 1, 2011, the date of the debt ceiling standoff resolution.

A Online Appendix

Panel A.

	mean	p1	p10	p50	p90	p99	sd	count
Corr(Tr 10y, St.)	-0.29	-0.85	-0.74	-0.36	0.29	0.57	0.37	216
Corr(Prem. 10y, St.)	-0.15	-0.64	-0.48	-0.16	0.16	0.34	0.24	216
Corr(Rf 10y, St.)	-0.22	-0.74	-0.62	-0.29	0.28	0.61	0.34	216
Corr(CDS 10y, St.)	0.06	-0.59	-0.29	0.05	0.41	0.67	0.29	216
St. Beta Tr 10y	-0.17	-0.72	-0.45	-0.20	0.15	0.55	0.25	216
St. Beta Prem. 10y	-0.05	-0.25	-0.16	-0.04	0.05	0.14	0.08	216
St. Beta Rf 10y	-0.14	-0.66	-0.41	-0.17	0.20	0.57	0.24	216
St. Beta CDS 10y	0.02	-0.13	-0.02	0.00	0.10	0.22	0.06	216
5y TIPS-Tr	0.28	0.02	0.10	0.24	0.47	1.05	0.20	216
2y TIPS-Tr	0.26	-0.13	0.02	0.26	0.44	1.45	0.26	216
Cov(Tr 5y, St.)	-0.19	-1.67	-0.62	-0.11	0.08	0.64	0.38	216
Cov(Prem. 5y, St.)	-0.10	-2.24	-0.22	-0.03	0.05	0.24	0.36	216
Cov(Tr 2y, St.)	-0.05	-0.54	-0.16	-0.03	0.02	0.35	0.14	216
Cov(Prem. 2y, St.)	-0.03	-0.43	-0.12	-0.01	0.04	0.15	0.11	216
Frictionless 10y Yield	2.94	0.83	1.55	2.71	4.87	5.44	1.22	216
Nominal 10y Yield	2.88	0.68	1.55	2.71	4.60	5.11	1.15	216
Nominal-Frictionless 10y	-0.06	-0.58	-0.32	-0.05	0.22	0.40	0.22	216

Table A1: Additional Summary Statistics. Correlation with the stock market and stock market beta of the 10-year Treasury bond, separated into terms corresponding to the three constituent elements of the 10-year yield. TIPS-Treasury premium at the 5- and 2-year maturity and the stock-bond covariance using the 5- and 2-year Treasury returns. “Frictionless” and nominal 10-year Treasury rates, as well as the gap between nominal and frictionless. Monthly data 2005-2022.

Panel A. Correlation matrix.

	Cov(Tr 10y, St.)	Cov(Prem. 10y, St.)	Cov(Rf 10y, St.)	Cov(CDS 10y, St.)
Cov(Tr 10y, St.)	1.000			
Cov(Prem. 10y, St.)	0.649***	1.000		
Cov(Rf 10y, St.)	0.427***	-0.388***	1.000	
Cov(CDS 10y, St.)	-0.145**	-0.080	-0.298***	1.000

Panel B. Autocorrelations.

	2005-2022			
	Cov(Tr 10y, St.)	Cov(Prem. 10y, St.)	Cov(Rf 10y, St.)	Cov(CDS 10y, St.)
L.Cov(Tr 10y, St.)	0.658***			
	(12.72)			
L.Cov(Prem. 10y, St.)		0.665***		
		(12.98)		
L.Cov(Rf 10y, St.)			0.529***	
			(9.09)	
L.Cov(CDS 10y, St.)				0.355***
				(5.54)
Constant	-0.153***	-0.068	-0.138***	0.030**
	(-2.94)	(-1.44)	(-2.81)	(2.50)
Observations	215	215	215	215
R^2	0.432	0.442	0.279	0.126

Table A2: Correlation coefficients. Autocorrelation coefficients of the Stock-Bond Covariance Components. Panel A shows the correlation matrix of the aggregate stock-bond covariance and its components corresponding to the convenience yield, the risk-free rate, and the CDS rate. Panel B reports the autocorrelation coefficients of the four stock-bond covariance measures. Monthly data 2005-2022. Heteroskedasticity robust t statistics in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

Panel A.

	2005-2022						
	F.10y TIPS-Tr	F.2y Box USD	F.GC-Tr 3m	F.FF-Tr 3m	F.-1*Z-spr.	F.30y Sw-Tr	F.FN 30y-Tr
Cov(Tr 10y, St.)	-0.071**	-0.115***	-0.040***	-0.091*	-0.034	-0.057	-0.105***
	(-2.11)	(-3.19)	(-3.08)	(-1.90)	(-1.40)	(-1.60)	(-3.37)
Eff. Fed Funds	0.013*	0.063***	0.030**	0.077***	0.006	0.178***	0.047***
	(1.89)	(5.37)	(2.43)	(2.82)	(0.74)	(8.17)	(3.34)
Constant	0.238***	0.204***	0.079***	-0.051	0.113***	-0.311***	0.216***
	(11.89)	(11.48)	(4.02)	(-1.33)	(6.88)	(-5.63)	(5.28)
Observations	216	179	216	216	215	216	216
R^2	0.196	0.390	0.187	0.266	0.058	0.544	0.204

Panel B.

	1991-2022			1972-2022	
	F.GC-Tr 3m	F.FF-Tr 3m	F.-1*Z-spr.	F.FF-Tr 3m	F.-1*Z-spr.
Cov(Tr 10y, St.)	-0.038***	-0.097***	-0.035*	-0.103**	-0.014
	(-2.62)	(-2.71)	(-1.78)	(-2.35)	(-0.82)
Eff. Fed Funds	0.033***	0.056***	-0.019***	0.146***	-0.037***
	(5.24)	(5.23)	(-4.26)	(9.71)	(-7.74)
Constant	0.055***	-0.065**	0.117***	-0.251***	0.171***
	(2.97)	(-2.05)	(7.34)	(-4.31)	(8.48)
Observations	381	384	383	612	611
R^2	0.205	0.246	0.216	0.611	0.367

Table A3: Stock-Bond Covariance and Proxies of the Treasury Convenience Yield. Left-hand-side variables are proxies of the convenience yield. The right-hand-side variables are the aggregate stock-bond covariance and the effective Fed funds rate. Right-hand-side variables lagged by one month. Monthly data 2005-2022. Heteroskedasticity and autocorrelation robust t statistics in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

	2005-2022						
	F.10y TIPS-Tr	F.2y Box USD	F.GC-Tr 3m	F.FF-Tr 3m	F.-1*Z-spr.	F.30y Sw-Tr	F.FN 30y-Tr
Cov(Prem. 10y, St.)	-0.101***	-0.135***	-0.046***	-0.070**	-0.057***	-0.053**	-0.094***
	(-9.40)	(-8.30)	(-4.31)	(-2.33)	(-4.40)	(-1.98)	(-5.30)
Cov(Rf 10y, St.)	-0.003	-0.052*	-0.033*	-0.131**	0.007	-0.062	-0.104**
	(-0.22)	(-1.81)	(-1.95)	(-2.04)	(0.46)	(-1.13)	(-2.57)
Cov(CDS 10y, St.)	0.144*	0.003	-0.095*	-0.180	-0.020	-0.021	0.186***
	(1.78)	(0.06)	(-1.88)	(-1.57)	(-0.55)	(-0.21)	(2.73)
Eff. Fed Funds	0.014**	0.063***	0.029**	0.077***	0.005	0.178***	0.051***
	(2.40)	(4.97)	(2.31)	(2.87)	(0.61)	(8.16)	(3.69)
Constant	0.240***	0.215***	0.084***	-0.055	0.120***	-0.314***	0.200***
	(12.87)	(11.50)	(4.06)	(-1.39)	(7.63)	(-5.57)	(5.16)
Observations	216	179	216	216	215	216	216
R^2	0.445	0.465	0.199	0.290	0.184	0.545	0.246

Table A4: Stock-Bond Covariance and Proxies of the Treasury Convenience Yield. Left-hand-side variables are proxies of the convenience yield. The right-hand-side variables are components of the aggregate stock-bond covariance, corresponding to the convenience yield, the frictionless risk-free rate, and the CDS rate. Right-hand-side variables lagged by one month. Monthly data 2005-2022. Heteroskedasticity and autocorrelation robust t statistics in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

Panel A.

	2005-2022						
	10y TIPS-Tr	2y Box USD	GC-Tr 3m	FF-Tr 3m	-1*Z-spr.	30y Sw-Tr	FN 30y-Tr
Cov(Tr 10y LW, St.)	-0.070***	-0.120***	-0.046***	-0.048	-0.070***	-0.020	-0.116***
	(-2.84)	(-3.72)	(-2.96)	(-1.64)	(-2.82)	(-0.73)	(-3.82)
Eff. Fed Funds	0.010	0.059***	0.026**	0.063**	0.007	0.173***	0.042***
	(1.41)	(5.80)	(2.33)	(2.22)	(0.87)	(7.16)	(3.22)
Constant	0.235***	0.203***	0.078***	-0.017	0.089***	-0.286***	0.205***
	(10.61)	(11.35)	(3.95)	(-0.65)	(5.27)	(-5.41)	(5.02)
Observations	216	179	216	216	216	216	216
R^2	0.217	0.449	0.199	0.165	0.275	0.526	0.247

Panel B.

	2005-2022						
	10y TIPS-Tr	2y Box USD	GC-Tr 3m	FF-Tr 3m	-1*Z-spr.	30y Sw-Tr	FN 30y-Tr
Cov(Tr 10y, St. MSCI)	-0.053*	-0.123**	-0.051**	-0.105**	-0.043	-0.081**	-0.092***
	(-1.82)	(-2.39)	(-2.16)	(-2.19)	(-1.07)	(-1.98)	(-3.60)
Eff. Fed Funds	0.009	0.057***	0.027**	0.069***	0.005	0.179***	0.041***
	(1.22)	(5.44)	(2.41)	(2.65)	(0.58)	(8.35)	(2.79)
Constant	0.252***	0.214***	0.080***	-0.042	0.112***	-0.316***	0.232***
	(10.24)	(10.11)	(4.16)	(-1.28)	(6.22)	(-5.61)	(5.14)
Observations	216	179	216	216	216	216	216
R^2	0.100	0.364	0.197	0.243	0.080	0.553	0.147

Table A5: Stock-Bond Covariance and Proxies of the Treasury Convenience Yield. Panel A repeats the main analysis, but uses the Liu and Wu (2021) yield curve to calculate the stock-bond covariance. Panel B repeats the main analysis, but uses the MSCI World Index (Ticker: MXWO) to calculate the stock-bond covariance. Left-hand-side variables are proxies of the convenience yield. Right-hand-side variables are the monthly stock-bond covariance and the effective Fed funds rate. Heteroskedasticity and autocorrelation robust t statistics in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

Panel A.

	2005-2022						
	10y TIPS-Tr	2y Box USD	GC-Tr 3m	FF-Tr 3m	-1*Z-spr.	30y Sw-Tr	FN 30y-Tr
St. Beta Prem. 10y	-0.231	-0.450	-0.440**	-0.675**	-0.302	-0.049	-0.080
	(-1.17)	(-1.28)	(-2.46)	(-2.37)	(-1.23)	(-0.14)	(-0.32)
St. Beta Rf 10y	0.017	-0.015	-0.041	-0.243**	0.059	-0.150	-0.082
	(0.37)	(-0.24)	(-0.91)	(-1.99)	(1.32)	(-1.08)	(-1.01)
St. Beta CDS 10y	0.116	-0.269	-0.174	-0.209	-0.107	0.036	0.046
	(0.72)	(-1.22)	(-1.56)	(-1.02)	(-0.77)	(0.10)	(0.19)
Eff. Fed Funds	0.007	0.050***	0.028**	0.048*	0.003	0.175***	0.035**
	(0.92)	(3.95)	(2.28)	(1.82)	(0.33)	(8.00)	(2.05)
Constant	0.266***	0.266***	0.078***	-0.056	0.128***	-0.301***	0.262***
	(8.62)	(8.85)	(3.61)	(-1.35)	(7.28)	(-5.20)	(4.66)
Observations	216	179	216	216	216	216	216
R^2	0.024	0.165	0.158	0.141	0.056	0.532	0.056

Panel B.

	2005-2022						
	10y TIPS-Tr	2y Box USD	GC-Tr 3m	FF-Tr 3m	-1*Z-spr.	30y Sw-Tr	FN 30y-Tr
Corr(Prem. 10y, St.)	-0.082	-0.077	-0.152***	-0.207**	-0.084	0.045	-0.036
	(-1.46)	(-0.81)	(-2.91)	(-2.32)	(-1.18)	(0.35)	(-0.40)
Corr(Rf 10y, St.)	0.012	0.008	-0.032	-0.198*	0.065	-0.104	-0.099
	(0.31)	(0.11)	(-0.86)	(-1.93)	(1.50)	(-0.92)	(-1.51)
Corr(CDS 10y, St.)	0.064	-0.006	-0.020	-0.016	0.019	-0.074	0.133**
	(1.64)	(-0.19)	(-0.65)	(-0.25)	(0.65)	(-0.97)	(2.11)
Eff. Fed Funds	0.008	0.049***	0.028**	0.049*	0.002	0.171***	0.039**
	(0.93)	(3.51)	(2.38)	(1.87)	(0.26)	(7.81)	(2.57)
Constant	0.263***	0.277***	0.072***	-0.070	0.134***	-0.284***	0.238***
	(7.57)	(6.82)	(3.34)	(-1.47)	(6.24)	(-4.54)	(4.89)
Observations	216	179	216	216	216	216	216
R^2	0.039	0.143	0.163	0.157	0.056	0.534	0.098

Table A6: Stock-Bond Correlation, Stock Beta of Bonds, and Proxies of the Treasury Convenience Yield. Left-hand-side variables are proxies of the convenience yield. The selection of left-hand-side variables in each panel reflects their availability in the indicated time period. In Panel A the right-hand-side variables are stock betas of the bond returns, separately corresponding to the convenience yield, the frictionless risk-free rate, and the CDS rate, as well as the effective Fed funsd rate. In Panel B the right-hand-side variables are stock-bond correlation coefficients, corresponding to the convenience yield, the frictionless risk-free rate, and the CDS rate, as well as the effective Fed funds rate. Heteroskedasticity and autocorrelation robust t statistics in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

Panel A.

	2005-2022						
	10y TIPS-Tr	2y Box USD	GC-Tr 3m	FF-Tr 3m	-1*Z-spr.	30y Sw-Tr	FN 30y-Tr
Cov(Prem. 5y, St.)	-0.264***	-0.360***	-0.134***	-0.096**	-0.221***	-0.109***	-0.147***
	(-5.00)	(-13.49)	(-6.56)	(-2.21)	(-7.90)	(-3.63)	(-2.95)
Eff. Fed Funds	0.012**	0.058***	0.026**	0.061**	0.007	0.174***	0.036**
	(2.03)	(5.29)	(2.27)	(2.24)	(0.85)	(7.51)	(2.25)
Constant	0.244***	0.235***	0.089***	0.001	0.104***	-0.288***	0.261***
	(13.99)	(12.41)	(4.99)	(0.07)	(7.24)	(-5.98)	(5.31)
Observations	216	179	216	216	216	216	216
R^2	0.433	0.539	0.225	0.153	0.392	0.533	0.094

Panel B.

	2005-2022					
	10y TIPS-Tr	10y TIPS-Tr	5y TIPS-Tr	5y TIPS-Tr	2y TIPS-Tr	2y TIPS-Tr
Cov(Prem. 10y, St.)			-0.148***		-0.203***	
			(-15.63)		(-16.02)	
Cov(Prem. 5y, St.)	-0.256***			-0.415***		
	(-4.86)			(-12.08)		
Cov(Prem. 2y, St.)		-0.284				-0.386*
		(-1.28)				(-1.67)
Constant	0.260***	0.277***	0.252***	0.240***	0.222***	0.252***
	(21.10)	(14.67)	(10.73)	(11.59)	(9.60)	(6.56)
Observations	216	216	216	216	216	216
R^2	0.414	0.052	0.438	0.536	0.481	0.028

Table A7: Stock-Bond Covariance and Proxies of the Treasury Convenience Yield. Alternative maturity bond returns. Left-hand-side variables are proxies of the convenience yield. Right-hand-side variables are the monthly stock-bond covariance corresponding to the convenience yield, calculated using the 10-, 5-, and 2-year Treasury returns, as well as the effective Fed Funds rate. Heteroskedasticity and autocorrelation robust t statistics in parentheses. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

Panel A.

Date	Description	Abbreviation
5/10/2010	Securities Market Programme (SMP) introduction	SMP, #1
8/6/2010	SMP expansion	SMP, #2
12/1/2011	Long Term Refinancing Operations (LTRO)	LTRO, #1
12/8/2011	LTRO official introduction	LTRO, #2
3/9/2012	Greek default	Greece
7/26/2012	Outright Monetary Transactions (OMT), "whatever it takes" speech	OMT , #1
8/2/2012	OMT announcement	OMT, #2
9/6/2012	OMT official introduction	OMT, #3

Panel B.

	10y TIPS-Tr	Cov(Prem. 10y, St.)	EUR prem.
SMP, #1	0.157***	-0.430***	0.123***
	(8.88)	(-4.67)	(5.88)
SMP, #2	0.016	-0.160**	0.134***
	(0.99)	(-2.34)	(6.87)
LTRO, #1	0.094***	-0.175***	-0.030
	(10.36)	(-4.78)	(-1.05)
LTRO, #2	0.058***	-0.042	-0.045*
	(3.97)	(-0.99)	(-1.83)
Greece	0.076***	0.040	-0.019
	(3.74)	(1.09)	(-0.60)
OMT, #1	0.073***	0.027	-0.001
	(7.81)	(0.78)	(-0.05)
OMT, #2	0.075***	-0.014	-0.100***
	(6.46)	(-0.40)	(-3.90)
OMT, #3	0.070***	-0.036	-0.079***
	(4.87)	(-0.93)	(-3.31)
Constant	0.212***	-0.143***	0.120***
	(24.07)	(-4.21)	(7.00)
Observations	727	727	727
R^2	0.248	0.150	0.582

Table A8: TIPS-Treasury Premium, Stock-bond Covariance, and the EUR Convenience Yield During Periods of the Eurozone Crisis. Daily data from January 2010 to December 2012. Indicator variables run from start dates indicated in Panel A to the next start date. Heteroskedasticity and autocorrelation robust t statistics. ***, **, and * denote significance at the 1%, 5%, and 10% levels.

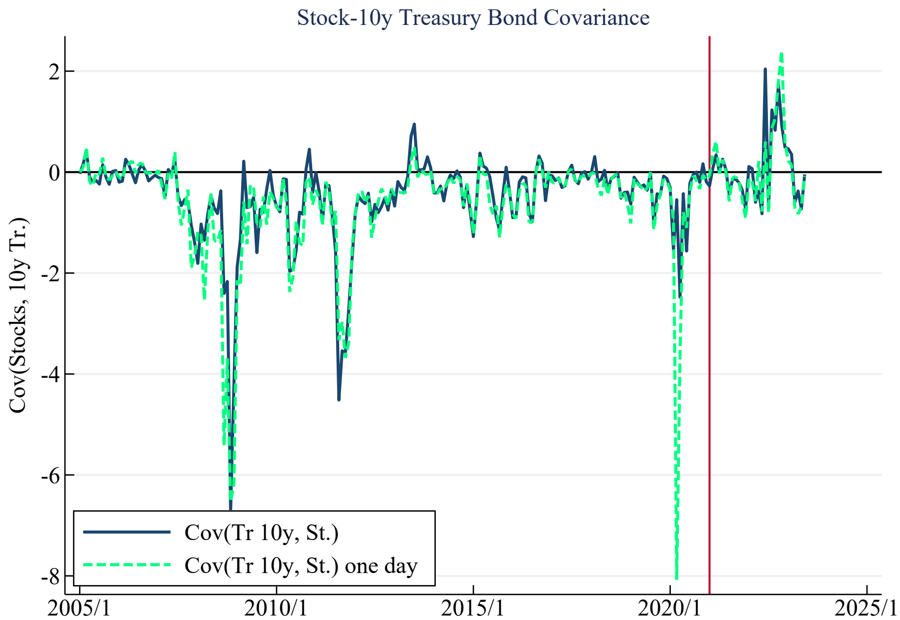


Figure A1: Stock-bond Covariance. Calculation with three daily returns in blue, calculation with single daily returns in dashed neon green. Monthly data from 2005 to 2022. Vertical line indicates 1/2021.

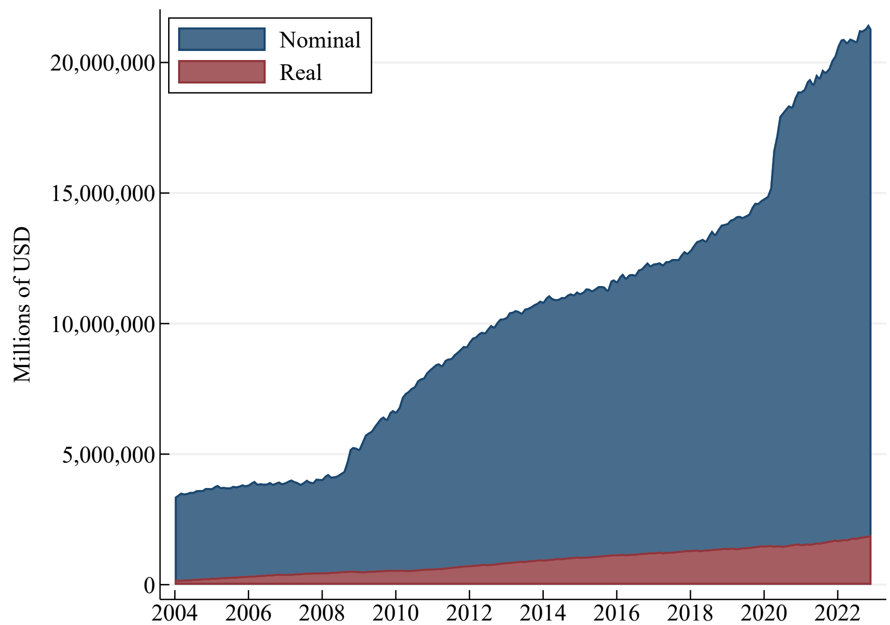


Figure A2: Nominal and Real Treasuries Outstanding. Dollar value of Treasuries held by the private sector. Monthly calculation.

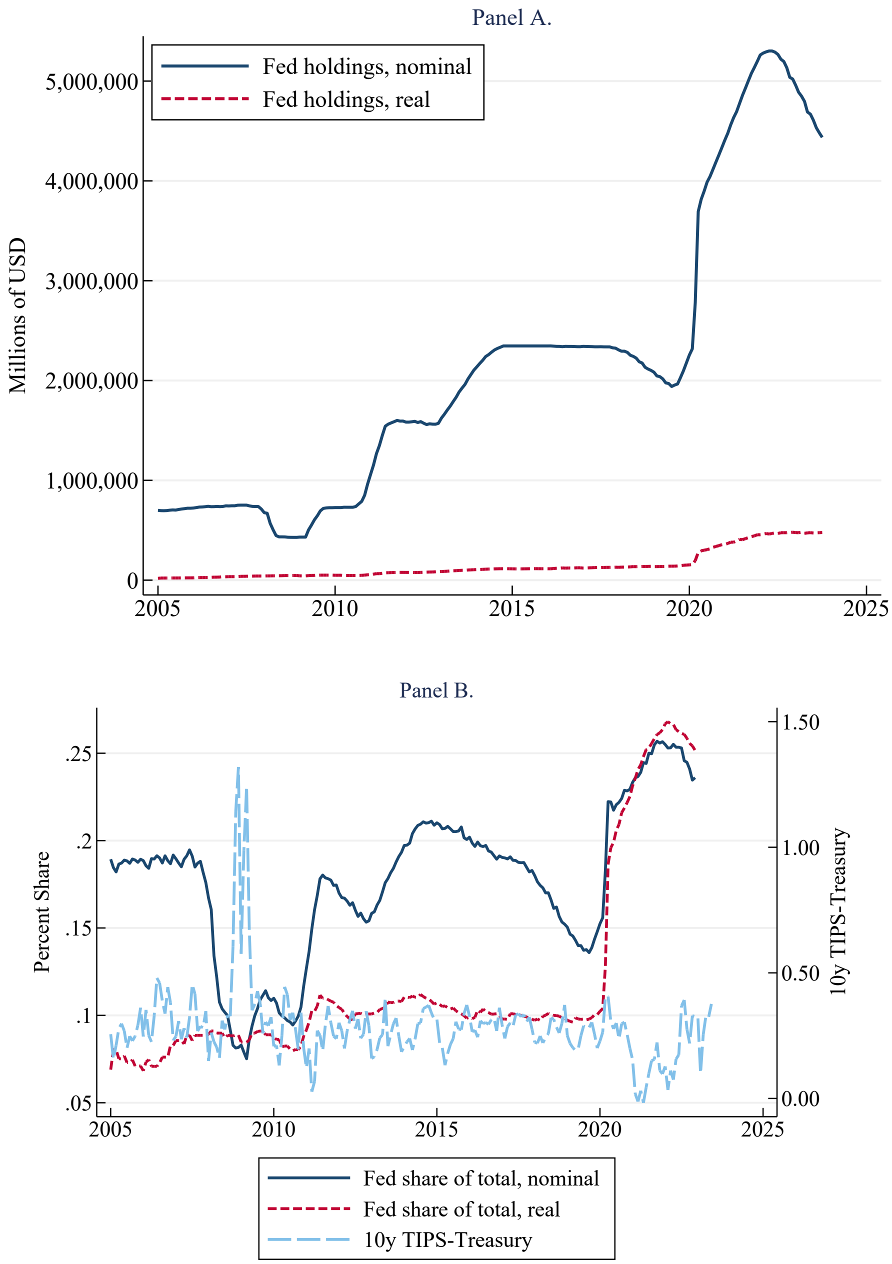


Figure A3: Nominal and Real Treasuries Held by the Fed. Panel A shows the dollar value of Treasuries held by the Fed. Panel B shows the share of the total held by the Fed, as well as the 10-year TIPS-Treasury premium. Monthly calculation.

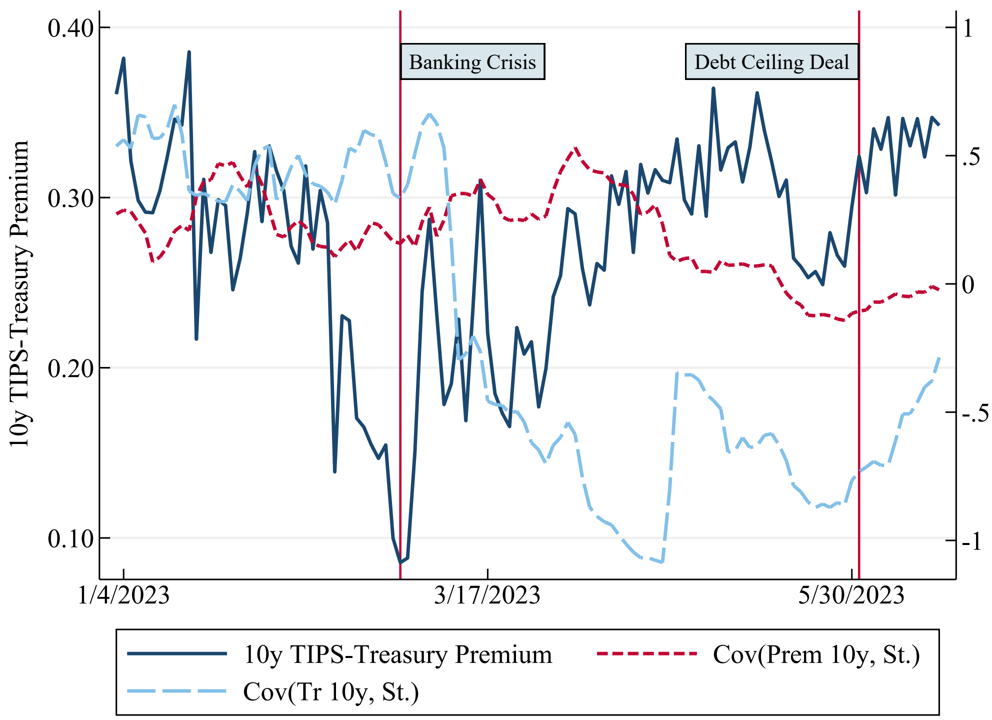


Figure A4: TIPS-Treasury Premium and Stock-Bond Covariance During the 2023 Debt Ceiling Standoff. The 10-year TIPS-Treasury premium, aggregate stock-bond covariance, as well as the stock-bond covariance component corresponding to the convenience yield. Vertical lines indicate March 1, 2023, denoting the regional banking crisis, and May 31, 2023, the date of the debt ceiling standoff resolution.

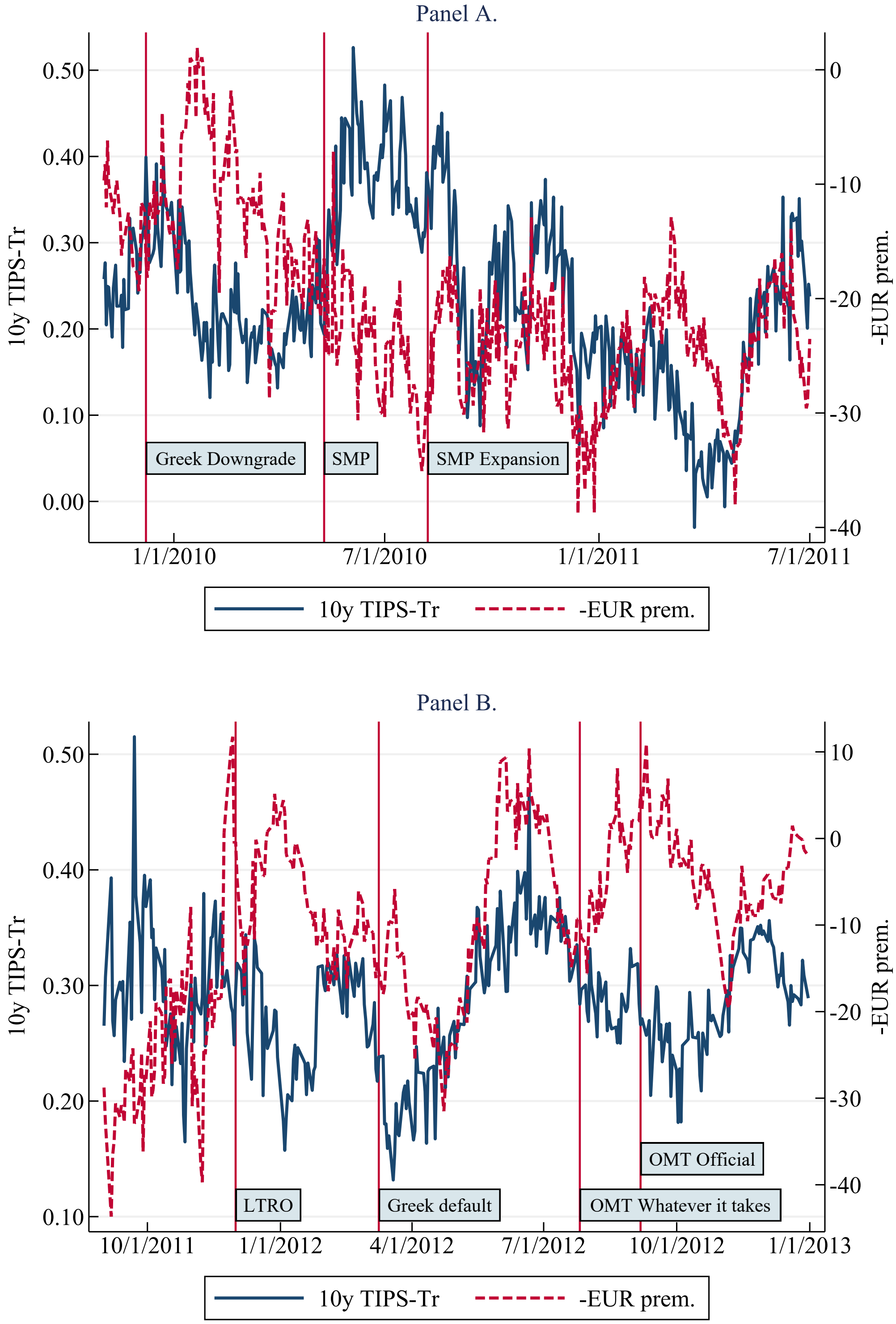


Figure A5: TIPS-Treasury Premium and Relative Treasury Convenience Yield of German Bunds. Vertical lines correspond to event days described in Table 11A, Panel A.