# Inflation and Treasury Convenience*

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**Abstract**

We document low-frequency shifts in the relationship between inflation and the convenience yield on US Treasury bonds. Treasury convenience comoves positively with inflation during the inflationary 1970s and 1980s, but negatively in the pre-WWII period and the pre-pandemic 2000s. We explain these changes with an interplay of the "money channel" and the "New Keynesian demand channel" by introducing Treasury convenience yield into a standard New Keynesian model. Exogenous shocks to inflation (such as cost-push shocks) raise nominal interest rates and, by extension, the opportunity cost of holding money and money-like assets, inducing a positive inflation-convenience relationship as observed in the 1970s and 1980s. In contrast, exogenous shocks to liquidity preferences (such as those originating from financial crises and panics) raise the perceived value of Treasuries, lowering consumption demand and inflation, and result in a negative inflation-convenience relationship as seen pre-WWII and post-2000. We argue that the experience of the past century is inconsistent with a direct effect of inflation depressing Treasury convenience.

*Keywords*: Treasury convenience; inflation; demand shocks; money view; New Keynesian models

*JEL classification*: E44, E58, G01, G28

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# 1 Introduction

How is Treasury convenience linked to inflation? The relationship between liquidity, interest rates, and inflation was central to the vigorous macroeconomic debates of the 20th century (Keynes (1937), Friedman (1969)). Today, it is again relevant due to renewed concerns about inflation and the status of US Treasuries. Recent progress in the understanding of Treasury markets indicates that investors value US Treasury securities more highly than assets with the same cash flows, i.e., Treasury bonds have convenience value (Nagel, 2016; Du et al., 2018b; Krishnamurthy and Vissing-Jorgensen, 2012). Besides serving as a significant source of fiscal capacity, Treasury convenience affects monetary policy transmission (Jiang et al., 2020), drives business cycle dynamics during global financial crises (Del Negro et al., 2017; Anzoategui et al., 2019; Li, 2023), and is a critical component of dollar valuation and exchange-rate dynamics (Jiang et al., 2021; Du et al., 2018a).

In this paper, we use a century of US data to document secular shifts in the relationship between Treasury convenience and inflation. Figure 1 illustrates a striking fact: Convenience comoves positively with inflation during the most inflationary episode, but not before or after.[1] In periods typically associated with supply-side shocks, such as the 1970s and 1980s, higher inflation tends to go along with higher – not lower – Treasury convenience. Conversely, in periods with preeminent demand-side shocks, such as financial crises, including the pre-WWII period and the pre-pandemic 2000s, lower inflation tends to coincide with higher Treasury convenience. These shifts are not isolated to historical episodes but remain relevant in today's world. Figure 2 shows that while the correlation between Treasury convenience and market-implied breakeven inflation was strongly negative before the bout of post-pandemic inflation, it turned slightly positive just as inflationary pressures reemerged.

We argue that these findings can be explained by the changing dominance of two channels with a long tradition in the economic debate: the "money channel" and the "New Keynesian (NK) demand channel." The money channel encapsulates the monetarist perspective that the nominal rate of interest is the cost of holding money (Cagan, 1958; Tobin, 1969; Friedman, 1969), augmented with the view that Treasury bonds of all maturities have some money-like qualities (Friedman and

[1] We follow Krishnamurthy and Vissing-Jorgensen (2012) in measuring the convenience value of Treasury bonds with the spread between Aaa-rated corporate bond yields and long-term Treasury bond yields, consistent with the fact that Aaa-rated corporate bonds have never defaulted during our historical period. A higher Aaa-Treasury spread corresponds to a higher value of Treasury convenience.

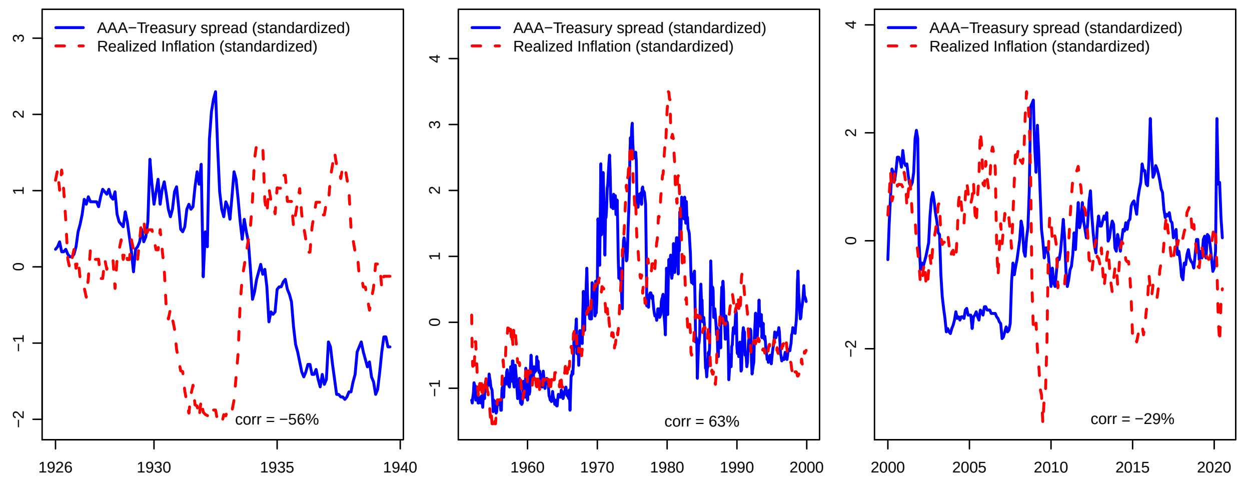



Figure 1: **Historical convenience yield and inflation (standardized).** We plot the Treasury convenience, measured as Aaa-Treasury spread (Krishnamurthy and Vissing-Jorgensen, 2012), and the 12-month change in CPI-U inflation (from Robert Shiller's website). Monthly data runs from January 1926 through July 2020, excluding the WWII period September 1939 – December 1951. The three subperiods shown are January 1929-September 1939, January 1952-December 1999, and January 2000-December 2020. In each subperiod, we normalize both measures to have mean zero and standard deviation of one.

Schwartz, 1982).[2] This channel generates a positive inflation-convenience relationship, as higher inflation expectations increase the cost of holding money and close money substitutes such as Treasuries, increasing the Treasury convenience premium that investors pay in equilibrium. On the other hand, Keynes (1937) considered exogenous variation in liquidity preference as the key determinant of interest rates, business cycles and inflation. Since then, liquidity demand shocks have been argued to be responsible for the Great Depression of the 1930s (Friedman and Schwartz, 1963) and have been incorporated into microfounded New Keynesian models of the Great Recession of 2008–2009 (e.g., Del Negro et al., 2017; Anzoategui et al., 2019). Intuitively, the New Keynesian demand channel views a shock to the demand for liquid stores of wealth as a causal driver of lower aggregate demand, spending and inflation, implying a negative inflation-convenience relationship. As such, the two views have distinct implications for the causal interpretation of the

[2] A long literature has argued that monetary aggregates include not only narrow money but also other liquid assets (Barnett et al., 1984; Lucas and Nicolini, 2015; Ireland, 2009), including Treasury securities that provide liquidity services (Friedman and Schwartz, 1982; Holmström and Tirole, 1998; Longstaff, 2004; Krishnamurthy and Vissing-Jorgensen, 2012; Nagel, 2016; Krishnamurthy and Li, 2023).

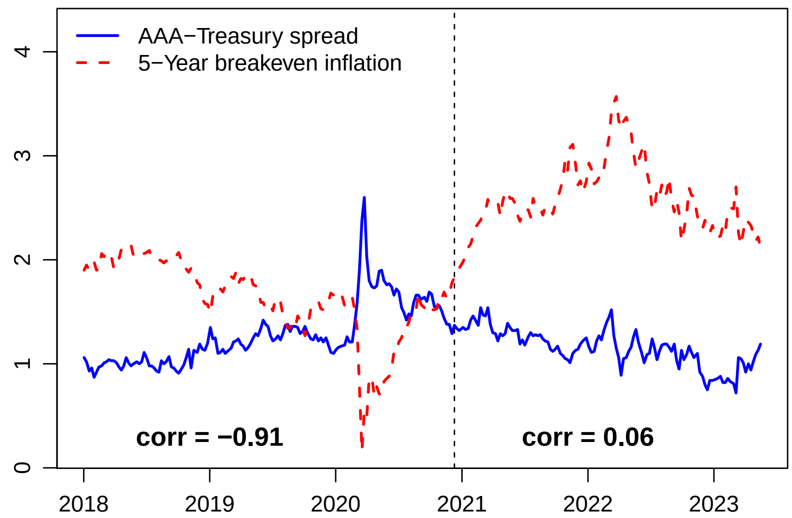



Figure 2: **Weekly time series of convenience yield and 5-year breakeven inflation.** We plot the Treasury convenience, measured as Aaa-Treasury spread (Krishnamurthy and Vissing-Jorgensen, 2012), and 5-year breakeven inflation (denoted as "breakeven") from Bloomberg from January 2018 through May 2023. The vertical line on December 10, 2020 is the break date detected by a QLR break date test for a single unknown break date between January 2018 and May 2023. It tests for a change in the coefficient $b_1$ in the regression $spread_t^{Aaa} = b_0 + b_1 breakeven_t + \varepsilon_t$.

convenience-inflation relationship. In the money channel, higher inflation leads to higher convenience. In the NK demand channel, liquidity shocks revealed via higher convenience lead to disinflation.

We interpret the experience of the past 100 years through the lens of these competing channels. In the second half of the 20th century, 1970s and 1980s in particular, cost-push shocks or more broadly shocks to the Phillips curve dominate fluctuations (e.g., Justiniano and Primiceri, 2008; Hazell et al., 2022; Pflueger, 2023), driving a positive convenience-inflation relationship via the money channel.[3] In contrast, before WWII and after 2000, as the liquidity shocks are prevalent, the NK demand channel induces a negative convenience-inflation relationship. To the extent that supply shocks gain new importance in the aftermath of the COVID pandemic – potentially due to global supply chain disruptions, labor market frictions, or energy shocks – the reemergence of the

[3]While cost-push shocks are particularly relevant for the 1970s and 1980s, the money channel is not tied to this particular source of inflation fluctuations and more broadly applies to inflation fluctuations not directly driven by demand for liquidity itself.

money channel explains a positive shift in the convenience-inflation comovement as observed in Figure 4.

We start our empirical analysis by estimating the relationship between the Treasury convenience spread and inflation across different historical regimes. Our baseline measure of Treasury convenience is the spread between yields on Aaa-rated corporate bond yields and long-term Treasury yields following Krishnamurthy and Vissing-Jorgensen (2012). Because yields are inversely related to prices, the Treasury-Aaa spread increases with the convenience value of Treasury bonds, or the value that investors attribute to Treasury bonds above and beyond less convenient assets with equivalent cash flows. Our analysis starts in 1926, dictated by the data availability.

We find that a one percentage point increase in inflation is associated with a convenience yield that is 13 bps higher in the second half of the 20th century (1952-1999) compared to the pre-WWII period, a magnitude that is large relative to an average convenience spread of 87bps. In contrast, the coefficients on inflation in the pre-WWII and post-2000 periods are generally negative and typically not statistically significantly distinguishable from each other. These patterns hold true while controlling for the federal funds rate, the quantity of Treasury debt as measured by the Debt/GDP ratio, equity volatility, and the credit spread between Baa and Aaa corporate bond yields. Results for T-bill convenience, measured by the Repo-T-bill spread, display similar shifts, though the level of the federal funds rate now captures a bigger share of the T-bill convenience variation (Nagel (2016)). The results are robust to the exact timing of the start and end dates for the periods, as long as the first shift is dated in the 1950s or 1960s and the second one between 1995 and 2005.

We next present a series of empirical findings that, taken together, support the notion of shifting dominance between the NK demand channel vis-á-vis the money channel of convenience. First, we analyze the lead and lag relationships between inflation and Treasury convenience using predictive regressions. These regressions show that increases in convenience yield tend to be followed by lower inflation similarly across all our subperiods, with the effect peaking between 12 and 24 months. This fact is consistent with a liquidity shock interpretation, whereby a positive shock to the demand for convenient Treasuries reduces real consumption via the NK demand channel. Importantly, however, in the higher-inflation second half of the 20th century, higher inflation tends to also be followed by higher Treasury convenience with a peak effect at roughly 24 months, coinciding with substantial supply-side disturbances during the 1970s and 1980s. This relationship is as expected if higher inflation expectations cause the cost of holding money and other convenient assets to rise via the money channel. Those lead-lag relationships, therefore, indicate that there are stable mechanisms flowing from liquidity to inflation and vice versa, and that the shifts in the contemporaneous inflation-convenience relationships occur because the composition of shock driving the economy – liquidity shocks to Treasury convenience versus direct shocks to inflation – has changed over the past 100 years.

We next explore the different components of inflation for the post-1959 sample. We find that long-term Treasury convenience exhibits a stable positive relationship with core inflation, supporting the notion that persistent inflation tends to raise convenience via the money channel. The correlation between energy inflation and Treasury convenience is much weaker. As such, the money channel tends to manifest in our data when inflationary shocks are longer-lived and pass onto broad measures of core inflation. To explicitly distill the sources of inflation, we employ the decomposition of core CPI inflation into demand and supply drivers as proposed by Shapiro (2022) and available for the post-1990 period.[4] We show that higher long-term Treasury convenience predicts lower demand-driven inflation but not supply-driven inflation, aligning with the NK demand channel dominating fluctuations over the post-1990s period.

To understand the mechanisms behind our empirical findings, we build a framework that encompasses the money and NK demand channels. We combine a parsimonious three-equation New Keynesian model as in Galí (2008), Rotemberg and Woodford (1997), or Clarida et al. (1999), with a model of convenience yield following Nagel (2016).[5] Specifically, the money channel arises from the assumption that Treasuries are substitutes with deposits or even non-interest paying money. Higher inflation drives up the nominal interest rate and raises the opportunity cost of holding money, thus, also the opportunity cost of holding near-money assets, including Treasuries. Consequently, higher inflation leads to higher convenience yield via the money channel. We show in a standard calibration that the money channel is particularly prominent if the economy experiences supply cost-push shocks and average inflation is high, as both of these occurred in the 1970s and 1980s (middle panel of Figure 1), as well as the recent post-pandemic episode. The NK

[4]Shapiro (2022) decomposes inflation into supply- and demand-driven inflation using data on prices and quantities at individual product category level.

[5]For models of banking and money within a New Keynesian economy see also Curdia and Woodford (2010), Gertler and Karadi (2011a), Drechsler et al. (2018), Piazzesi et al. (2019) and Wang (2022). Caballero and Simsek (2020) and Caballero and Simsek (2022b) develop models of optimal monetary policy when broad asset prices matter for aggregate fluctuations, and both financial and non-financial demand shocks are present. Our focus is different, in that we seek to build the most basic model of monetary policy and Treasury convenience that can replicate the changing inflation-convenience relationship that we document in the data.

demand channel, instead, treats the convenience yield as a wedge in the household Euler equation between the risk-free discount rate and the Treasury yield. A positive shock to convenience yield suppresses aggregate demand, which decreases inflation and induces a negative inflation-convenience comovement.[6] This NK demand channel plays an important role when the economy experiences liquidity shocks, such as disruptions in the financial sector, and these are indeed more salient in the 1930s and post-2000 (left and right panel in Figure 1). Taken together, the changing preeminence of the money and the NK demand channels can explain the shifting comovement between Treasury convenience and inflation, as well as their lead-lag relationships.

The model also allows us to explore the hypothesis that high inflation directly depletes the Treasury convenience benefits. Such direct and negative effect of inflation on convenience could arise via several mechanisms highlighted in the literature: (a) Higher inflation means that the monetary authority has less capacity to monetize debt.[7] (b) When inflation is more volatile, Treasuries as safe assets have less stable valuation and therefore the safety premium declines.[8] (c) According to the fiscal theory, higher inflation is driven by an expected expansion of debt supply, which satiates liquidity demand and lowers convenience.[9] (d) Higher inflation increases the cost of financial intermediaries trading Treasury securities and thus reduces Treasury convenience.[10]

We capture this class of mechanisms in our model in reduced form by allowing Treasury convenience to decline directly with higher inflation. Contrary to the data, this assumption implies a more negative convenience-inflation relationship in the 1952–1999 period than during the pre-WWII and post-2000 periods. Intuitively, this alternative assumption implies that Treasuries have little convenience during the high-inflation 1970s and 1980s. Consequently, the money channel, by pushing towards a positive convenience-inflation relationship, should have been especially weak during this period. Our finding of a positive inflation-convenience relationship during the second

[6] Shocks to the convenience of Treasury bonds have been increasingly used to explain a wider range of empirical facts (Anzoategui et al. (2019), Jiang et al. (2020), Itskhoki and Mukhin (2021), Kekre and Lenel (2021), Fukui et al. (2023), Bianchi et al. (2022), Engel and Wu (2023), Abadi et al. (2023).

[7] This can be viewed as less "moneyness" of government debt in a model of money and bond substitution as in Nagel (2016) and Krishnamurthy and Li (2023).

[8] For example, in Krishnamurthy and Vissing-Jorgensen (2012), safety premium is an important component of the Treasury convenience that can be driven by return volatility. Recent theories of government debt as insuring against idiosyncratic and aggregate risks also highlight this point (Di Tella, 2020; Brunnermeier et al., 2022b; Liu et al., 2021).

[9] See Cochrane (2023) for a summary of the fiscal theory. Brunnermeier et al. (2022a) embeds the fiscal theory into a model with debt convenience and bubbles.

[10] See Duffie et al. (2007) for a general theory of how intermediation frictions affect asset prices. Du et al. (2023) provide both theory and empirics on how intermediation costs affect Treasury pricing.

half of the 20th century, therefore, points to the persistent feature of US Treasuries as convenient assets at the historically experienced US inflation rates.

Our work relates to the growing literature that studies the determinants and effects of Treasury convenience on the aggregate economy. Nagel (2016) shows that the US monetary policy drives the Treasury convenience yield by changing the opportunity cost of holding money and money-like assets, and Diamond and Van Tassel (2023) provide international evidence. Du et al. (2018b) and Jiang et al. (2021) document that violations of the covered interest parity in foreign exchange markets are correlated with an international view of the US Treasury convenience. Hébert et al. (2023) provide complementary evidence that the gap between the stock market-implied risk-free rate and government rates acts as a shifter in the Euler equation akin to a demand shock. Brunnermeier et al. (2022b) show that the convenience yield is an important determinant of fiscal capacity. Li (2023) presents the convenience yield as a channel of how quantitative easing policies affect the banking sector and financial crises. Complementary to our work, Acharya and Laarits (2023) argue that the hedging properties of Treasury bonds can explain their convenience. They measure covariances at a higher frequency, starting from 2005 and focusing on relatively high-frequency event studies. Our contribution lies in documenting important lower-frequency shifts since the 1920s. Fu et al. (2023) find a negative correlation between Treasury convenience and inflation expectations extracted from long-term Treasury yields. While the main sample of Fu et al. (2023) overlaps with the post-2000 period we consider in our analysis, we interpret the negative inflation-convenience comovement over this period as evidence for the dominant demand channel whereby liquidity shocks lead to lower inflation, in line with much recent research about the Great Recession.

The remainder of the paper is structured as follows. Section 2 describes our empirical results, with data and measurement in Subsection 2.1, our baseline regressions and evidence on the break dates in Subsection 2.2, and a decomposition of the relationship into core versus energy and supply versus demand inflation in 2.4. Section 3 describes the model setup and the calibration, and compares the model results to the data. Finally, Section 4 concludes.

# 2 Empirical Evidence from a Century of Inflation

In this section, we present our main empirical results on the changing relationship between inflation and Treasury convenience. We start with data and measurements.

## 2.1 Data and Measurement

Table 1 presents summary statistics for our key variables using monthly observations from 1926 to 2020, excluding the WWII period defined as September 1939 through December 1951. The start of our sample is determined by the availability of daily stock returns and a measure of stock return volatility. The end of our sample period is dictated by the availability of the GC repo-T-bill spread.

We consider three distinct periods for our empirical analysis: the pre-WWII period from 1926 through 1939, the second half of the 20th century from 1952 through 1999, and the post-2000 period until the start of the pandemic (2000 to 2020). We exclude the WWII period until 1951 due to interest rate controls, which were lifted by the Treasury-Fed accord in 1952. We choose a break date in January 2000, because the literature has found significant changes in the inflation dynamics and their relationship with the real economy around this time (e.g., Campbell et al. (2017), Stock and Watson (2007), Campbell et al. (2020)).

Table 1: **Summary statistics 1926–2020.** This table presents summary statistics for our full sample 1926:01–2020:07, excluding the WWII period 1939:09–1951:12.

| Variable | N | Mean | Std. Dev. | Min | Pctl. 25 | Pctl. 75 | Max |
|---|---|---|---|---|---|---|---|
| Aaa-Treasury Spread | 987 | 0.874 | 0.419 | 0.150 | 0.540 | 1.160 | 2.150 |
| T-bill Liquidity | 987 | 0.437 | 0.484 | −0.292 | 0.133 | 0.576 | 2.842 |
| Inflation | 987 | 0.026 | 0.036 | −0.107 | 0.013 | 0.039 | 0.148 |
| VIX | 987 | 19.663 | 7.871 | 10.905 | 14.977 | 21.076 | 74.457 |
| Debt/GDP | 987 | 0.263 | 0.142 | 0.070 | 0.136 | 0.336 | 0.676 |

We use the consumer price index for all urban consumers from Shiller (2016), who reports the data starting from the late 1800s. We define the inflation rate as the annual percentage change in the consumer price index. As shown by Atkeson and Ohanian (2001) and Stock and Watson (2007), the four-quarter moving average of past inflation is one of the most robust predictors of future inflation, so our measure can also be thought of as a proxy for expected inflation.

In the literature, there are two main measures of the Treasury convenience yield that are available back to the 1920s. Our primary measure is the Aaa-Treasury spread, as in Krishnamurthy and Vissing-Jorgensen (2012).[11] We also construct the T-bill convenience following Nagel (2016) as

[11] We follow Krishnamurthy and Vissing-Jorgensen (2012) in subtracting a matched Treasury bond yield. From 1924 until 1999, we use the average yield on long-term government bonds (LTGVTBD) from the St. Louis Fred. From 2000 onwards, we use the yield on 20-year maturity Treasury bonds (GS20) from the St. Louis Fred. The monthly Moody's seasoned Aaa corporate bond index (AAA) is also from the St. Louis Fred.

the spread between 3-month banker acceptance and 3-month T-bill before 1990, and the spread between 3-month term repo collateralized by Treasuries and 3-month T-bill after 1990. We extend their series forward to 2020 following Krishnamurthy and Li (2023), and call the spliced series "Repo-T-bill spread." The Aaa-Treasury spread reflects the convenience of long-term Treasury bonds, and the Repo-T-bill spread captures the convenience of short-term Treasury bills.

We control for other well-known drivers of Treasury convenience, in particular market volatility, the total government debt supply, and monetary policy. For market volatility, we use the VIX index. The VIX data are only available since 1990. For the period before 1990, we use a linear projection of VIX on realized volatility of the S&P 500 index, where the projection coefficients are estimated on the post-1990 data. For government debt supply, we use the total quantity of Treasury debt, at par value, excluding intra-governmental holdings, but including bank and Federal Reserve holdings. The data construction follows Krishnamurthy and Li (2023). For monetary policy, we use the end-of-month effective federal funds rate, available from the flow of funds data. We also occasionally control for credit conditions using the difference between Moody's seasoned Baa minus Aaa yields available from the St. Louis FRED. Daily data on the Aaa-Treasury spread (Aaa10Y) and 5-year breakeven inflation (T5YIE) are also obtained from the St. Louis FRED.

## 2.2 The Changing Treasury Convenience-Inflation Relationship

In this section, we show that the relation between inflation and the Treasury convenience spread has changed in a quantitative and statistically significant manner over the three periods we consider. To visualize these shifts, Figure 3 juxtaposes the Aaa-Treasury spread against the realized inflation over the past century. The correlation between inflation and the spread changes from negative $-0.55$ pre-WWII to positive 0.63 in the second half of the 20th century, and back to negative $-0.28$ post-2000. The average inflation is 4% in the middle period that encompasses the high-inflation 1970s and 1980s, but much lower in the other periods.

To assess the statistical and economic significance of those changes, we estimate the following baseline regression at a monthly frequency:

$$spread_t^{Aaa} = b_0 + b_1\pi_t + b_2\pi_t \times I_{1952--1999,t} + b_3\pi_t \times I_{\geq 2000,t} + \Gamma X_t + \varepsilon_t, \tag{1}$$

where we interact inflation with period-specific dummy variables. The interaction coefficients are interpreted relative to the pre-WWII period 1926-1939 (the omitted category). $\pi_t$ is the inflation

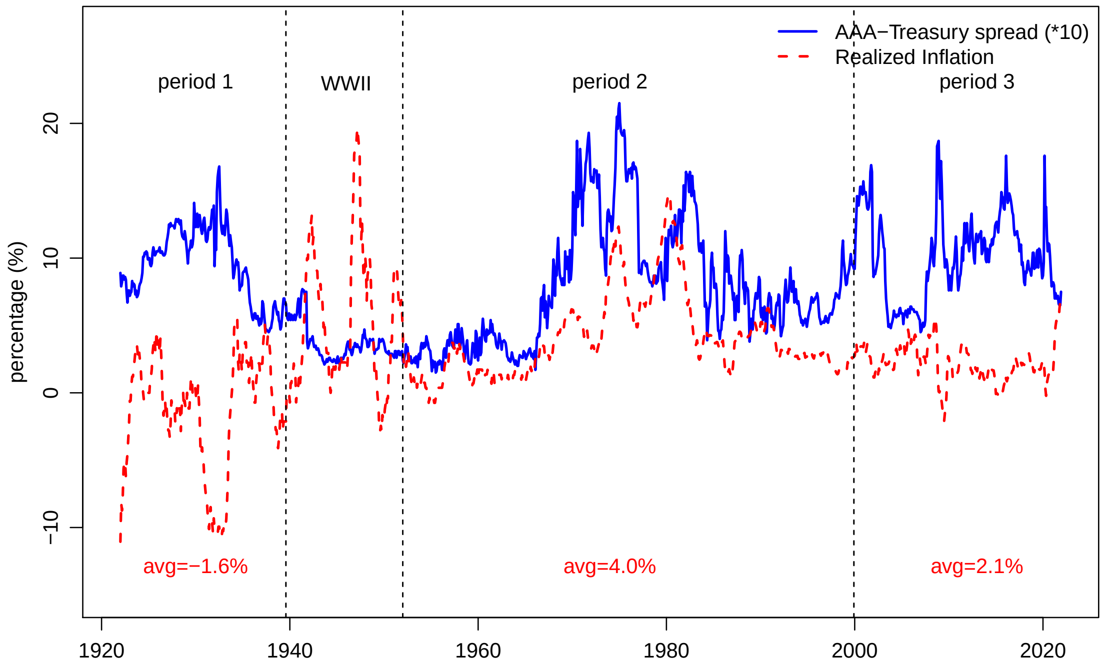



Figure 3: **Time series of Aaa-Treasury spread and inflation.** This figure shows the measures of inflation and the Aaa-Treasury spread used for our main analysis. Horizontal lines indicate the subperiods used, with the WWII period excluded from our analysis.

rate over the 12 months prior to time $t$. The vector $X_t$ captures controls.

Table 2 shows a consistently negative baseline coefficient on inflation, a positive interaction coefficient on $\pi_t \times Period_{2,t}$, and a negative though not always significant interaction coefficient on $\pi_t \times Period_{3,t}$. The positive interaction with the 1952–1999 dummy is particularly revealing, as it indicates that the relationship between inflation the Aaa-Treasury spread is significantly more positive over this period – which includes the Great Inflation of the 1970s and 1980s – than over other periods. The coefficients in column (1) imply that a one percentage point increase in inflation is associated with a 13 bps higher Aaa-Treasury spread in the 1952–1999 period compared to pre-WWII. This magnitude is large compared to an average Aaa-spread of 87 bps reported in Table 1.

The negative baseline coefficient on inflation means that a one percentage point increase in inflation tends to be associated with a four bps *de*crease in the Aaa spread before WWII. The relationship is similar or even more negative during 2000s. These results hold controlling for

Table 2: **Shifts in long-term Treasury convenience-inflation relationship.** Monthly data runs from 1926:01 through 2020:07, excluding the WWII period 1939:09–1951:12. The three subperiods shown are 1929:01–1939:08, 1952:01–1999:12, and 2000:01–2020:07, with the first period being the omitted period. Newey-West standard errors with 12 lags are shown in parentheses.

| | Aaa-Tsy spread | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Inflation | -0.038*** | -0.038*** | -0.025*** | -0.016 |
| | (-5.25) | (-5.40) | (-2.61) | (-1.24) |
| Inflation x $I_{1952-1999}$, | 0.13*** | 0.12*** | 0.095*** | 0.080*** |
| | (6.64) | (3.98) | (3.38) | (2.75) |
| Inflation x $I_{\geq 2000}$ | -0.035 | -0.050 | -0.089** | -0.085** |
| | (-0.99) | (-1.38) | (-2.29) | (-2.13) |
| FFR | | 0.016 | 0.0093 | 0.0084 |
| | | (0.87) | (0.49) | (0.46) |
| Debt/GDP | | | -0.68 | -0.66 |
| | | | (-1.49) | (-1.48) |
| VIX | | | 0.0090*** | 0.0056* |
| | | | (2.76) | (1.72) |
| Baa-Aaa spread | | | | 0.099* |
| | | | | (1.66) |
| $I_{1952-1999}$ | -0.52*** | -0.51*** | -0.29** | -0.21 |
| | (-5.28) | (-5.47) | (-2.00) | (-1.21) |
| $I_{\geq 2000}$ | 0.27*** | 0.31*** | 0.62*** | 0.65*** |
| | (2.80) | (2.97) | (2.98) | (3.01) |
| Constant | 0.92*** | 0.88*** | 0.74*** | 0.65*** |
| | (13.65) | (10.88) | (5.18) | (3.85) |
| $\bar{R}^2$ | 0.39 | 0.39 | 0.43 | 0.44 |
| N | 987 | 987 | 987 | 987 |

potential other drivers of the Treasury convenience, such as the government debt-to-GDP ratio, equity volatility, and even the credit spread, underscoring that the switch in the inflation-spread relationship is specific to the liquidity premium in Treasuries, as distinct from how inflation affects credit risk (e.g. Kang and Pflueger (2015), Brunnermeier et al. (2023), Bhamra et al. (2023)).

Table 3: **Shifts in T-bill convenience-inflation relationship.** Monthly data runs from 1926:01 through 2020:07, excluding the WWII period 1939:09–1951:12. The three subperiods shown are 1929:01–1939:08, 1952:01–1999:12, and 2000:01–2020:07, with the first period being the omitted period. Newey-West standard errors with 12 lags are shown in parentheses. The Repo-T-bill spread is measured as the spread between 3-month banker acceptance and 3-month T-bill before 1990, and the spread between 3-month term repo and 3-month T-bill after 1990.

| | Repo-T-bill spread | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Inflation | -0.029*** | -0.027*** | -0.013** | -0.016*** |
| | (-4.79) | (-6.10) | (-2.37) | (-2.60) |
| Inflation x $I_{1952-1999}$ | 0.15*** | 0.077*** | 0.060*** | 0.066*** |
| | (9.08) | (3.76) | (3.21) | (2.94) |
| Inflation x $I_{\geq 2000}$ | 0.079*** | 0.0093 | -0.0041 | -0.0058 |
| | (4.24) | (0.41) | (-0.19) | (-0.26) |
| FFR | | 0.080*** | 0.079*** | 0.079*** |
| | | (6.67) | (6.42) | (6.50) |
| Debt/GDP | | | -0.046 | -0.055 |
| | | | (-0.22) | (-0.26) |
| VIX | | | 0.011*** | 0.012*** |
| | | | (4.31) | (3.60) |
| Baa-Aaa spread | | | | -0.043 |
| | | | | (-0.83) |
| $I_{52-99}$ | -0.15** | -0.15** | -0.033 | -0.069 |
| | (-2.15) | (-2.16) | (-0.45) | (-0.72) |
| $I_{\geq 2000}$ | -0.18*** | 0.023 | 0.089 | 0.078 |
| | (-3.07) | (0.37) | (0.88) | (0.78) |
| Constant | 0.24*** | 0.033 | -0.23** | -0.19* |
| | (4.97) | (0.66) | (-2.49) | (-1.95) |
| $\bar{R}^2$ | 0.51 | 0.61 | 0.63 | 0.63 |
| N | 987 | 987 | 987 | 987 |

Table 3 estimates analogous regressions with the T-bill convenience as the dependent variable. Column (1) indicates that secular shifts have also occurred in the relationship between inflation and short-term Treasury convenience. However, different from the long-term spread, columns (2) through (4) of Table 3 show that the fed funds rate enters significantly, reducing the economic significance of the relationship between short-term convenience and inflation. This subtle difference between long-term and short-term convenience suggests that while the inflation-convenience relationship exhibits similar patterns across Treasury maturities, the role of monetary policy in the transmission differs. We explain these differences in our model in Section 3, where the money channel links short-term convenience to the short-term nominal interest rate, but long-term convenience to the persistent component in inflation and nominal rates.

When exactly did the inflation-convenience relationship shift? Our main results are robust to varying the cutoff dates that define our subperiods. Figure 4 plots the t-statistics for the interaction coefficients from the baseline regression (1) over a range of dates demarcating the starts of the second and third periods, $start2$ and $start3$. The specification is identical to column (1) of Table 2, except that we vary the start of the second period between 1952 and 1975 and the start of the third period between 1990 and 2005. The left panel shows that the $\pi_t \times I_{start2-start3,t}$ loading is positive and significant for a broad range of start dates for the second period, and almost completely insensitive to the start of the third period. The right panel shows that the $\pi_t \times I_{\geq start3,t}$ loading is negative with a t-statistic exceeding $-2$ in absolute value, if we allow the second period to start in the 1950s or 1960s and the third period to start any time between 1995 and 2005. We conclude that the economic mechanism driving the inflation-convenience relationship changed once sometime in the middle of the 20th century, and then again around 2000.

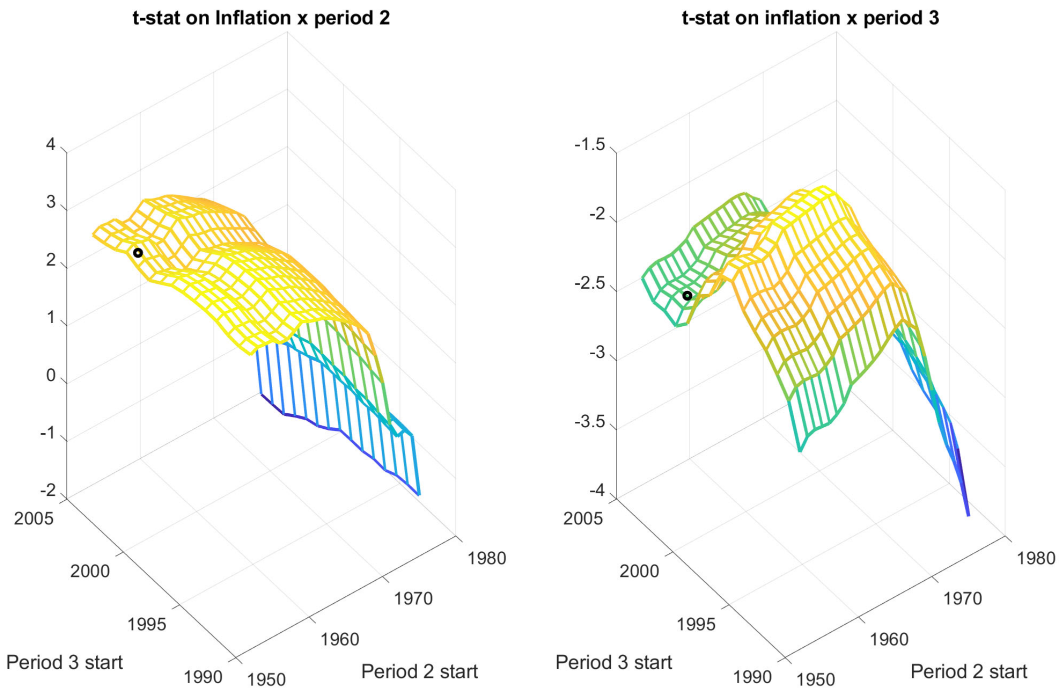
## 2.3 Lead-Lag Relationships Between Inflation and Treasury Bond Convenience

To better understand these distinct regimes, we investigate the lead-lag relationship between inflation and convenience. We predict future changes in the annual inflation rate from month $t$ to $t+h$ with a one-month change in the AAA-Treasury spread from month $t-1$ to $t$, and vice versa. We interpret the results in the spirit of Granger causality. Specifically, we estimate forecasting regressions of the form:

$$\pi_{t+h} - \pi_t = a_h + b_h \Delta spread_t + \gamma_h \Delta FFR_t + \varepsilon_{t+h} \tag{2}$$

$$spread^{Aaa}_{t+h} - spread^{Aaa}_t = c_h + d_h \Delta \pi_t + \delta_h \Delta FFR_t + \epsilon_{t+h} \tag{3}$$

Figure 4: **T-statistics for different period start dates.** This figure reports results for the baseline regression in column (1) of Table 2 using different start dates for periods 2 and 3. The first break date (period 2 start) ranges from 1952 to 1975 and is shown on the x-axis. The second break date (period 3 start) ranges from 1990 to 2005 and is shown on the y-axis. Our baseline break dates – 1st break in 1952 and 2nd break in 2000– are indicated with black circles. The t-statistics for the interaction coefficients between period dummies with inflation are shown on the z-axis and are based on Newey-West standard errors with 12 lags.




and plot the coefficients $b_h$ and $d_h$ for different $h$ up to 60 months in Figure 5. Table 2 documents a significantly more positive inflation-convenience relationship in the second half of the 20th century than either before or after. To understand how these lead-lag relationships illuminate the shifting inflation-convenience relationships, we estimate them separately for the second half of the 20th century (1952–1999) and for a sample combining the pre-WWII and post-2000 periods.[12] We include the change in the fed funds rate to control for the direct effect of the short rate on inflation and the spread.

Figure 5 shows that convenience spreads and inflation are significantly associated with each

[12]Formally, the estimates in Panel A treat the observations between 1939.09 and 1999.12 as missing.

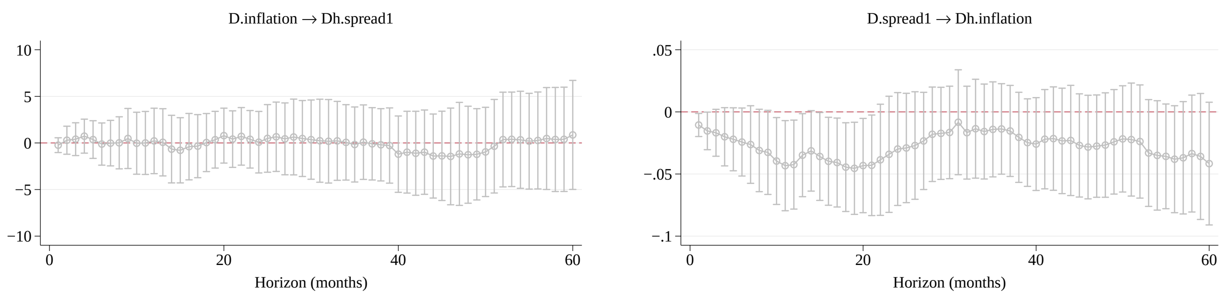
other at leads and lags. A positive inflation-convenience relationship tends to run from Treasury convenience to inflation, a consistent pattern visible across both subsamples. By contrast, to the extent that a negative inflation-convenience relationship is present, it tends to run from inflation to convenience spreads. The right panels in Figure 5 suggest that increases in the Aaa-Treasury spread tend to be followed by declines in inflation and these declines are statistically significant in both subsamples. The right panels show that inflation tends to be followed by an increase in the Aaa-Treasury spread, but this relationship is statistically significant only in the 1952–1999 sample.

To interpret these lead-lag relationships causally, it would be necessary to assume that inflation does not respond immediately to the convenience yield and vice versa, in the spirit of Sims (1980). One threat to this interpretation would arise if spreads are forward-looking and inflation expectations respond instantaneously. In that case, inflation or any other predictor of future inflation should not be able to predict changes in spreads, in line with our empirical evidence for the 1926-1939+2000-2020 sample in Panel A, but in contrast to the evidence for the 1952–1999 period in Panel B. Another concern might arise if spreads simply anticipate lower inflation but do not cause it. However, such an alternative story could not explain why higher convenience spreads predicted lower inflation during 1952–1999 even though they were positively contemporaneously correlated with the best-known inflation predictor, namely inflation itself. While the evidence in the left panels is therefore potentially subject to different interpretations and might require some sluggishness in the updating of inflation expectations, the results in the right panels are strongly suggestive of the NK demand channel whereby shocks to the demand for Treasury convenience cause lower inflation. In the appendix, we further confirm that these lead-lag relationships are robust to estimating via a VAR local projection impulse responses to identify inflation shocks and convenience shocks.

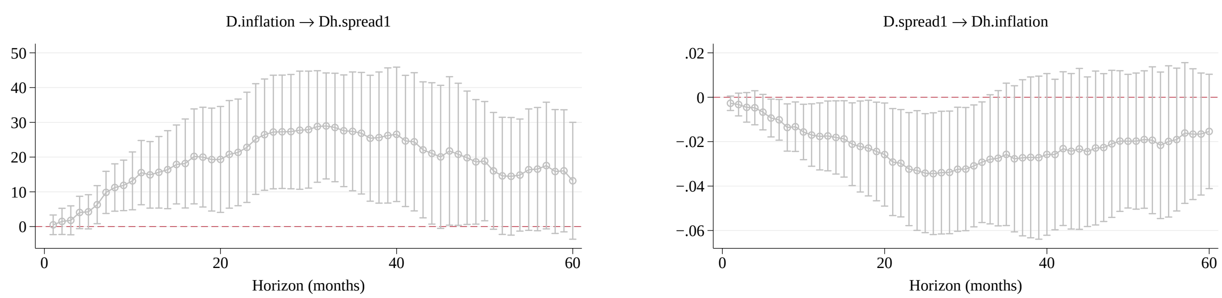
Overall, the evidence suggests that distinct mechanisms are at play generating positive versus negative inflation-convenience relationships. Forces that move inflation first tend to induce a positive inflation-convenience relationship, dominating the relationship in the 1952–1999 period. Conversely, forces that move convenience first tend to induce a negative inflation-convenience spread relationship, dominating the overall relationship pre-WWII and again during the post-2000 period.

Figure 5: **Predictive regressions.** This figure presents coefficients from regressions (2) and (3). The left panels plot $b_h$ as a function of horizon $h$. The right panels plot $d_h$ as a function of horizon $h$. The top two panels use the combined sample of the pre-WWII and post-2000 periods (1926–1939 and 2000–2020). The bottom panels use the post-WWII sample (1952–1999). The spikes mark the 95% confidence intervals based on Newey-West standard errors with $h$ lags.

**Panel A:** 1926–1939 and 2000–2020




**Panel B:** 1952–1999



## 2.4 Inflation Components and Treasury Bond Convenience

So far, evidence from headline inflation and its leads and lags points to secular changes in inflation-Treasury convenience relationship. To better understand these patterns in the context of underlying inflation properties, we use the decomposition of headline inflation into core and energy components. Although simple, this decomposition has the advantage of being available in real-time without forward-looking bias of most econometric models. It also reflects the way the Fed thinks about different components of inflation, where core inflation is often viewed to capture the more persistent component and fluctuations around core, driven by food and energy prices, are viewed as more transitory.[13] If the headline inflation-Treasury convenience relationship changed because the dominant drivers of inflation changed, we would expect more stable relationships between Treasury convenience and inflation components. In particular, if core inflation is linked to relatively more persistent supply shocks, it should raise the long-term convenience via the "money channel," as we argue using our model below, and we would thus expect a consistently positive core inflation-convenience relationship across periods.

This is indeed what we find in Table 4. Table 4 starts in Panel A by re-estimating our baseline regression (1) for headline inflation over a more limited sample starting in 1959 dictated by the availability of core and energy inflation series.[14] Table 4, Panel B separates headline inflation into core and energy and shows that these components have more stable relationships with Treasury convenience, as indicated by the insignificant interaction coefficients with the post-2000 dummy. We see that Treasury convenience is consistently positively related with core inflation, for both the pre- and post-2000 samples. Energy inflation enters with a coefficient that is significantly smaller than the coefficient on core inflation for both the Aaa-Treasury spread and the Repo-T-bill spread. For the Aaa-Treasury spread, the relationship with energy inflation is statistically indistinguishable from zero.[15] The results from this decomposition therefore deepen the puzzle if

[13]For example, Fed Chair Jerome Powell stated in his 2023 Jackson Hole speech "Food and energy prices are influenced by global factors that remain volatile, and can provide a misleading signal of where inflation is headed. In my remaining comments, I will focus on core inflation, which omits the food and energy components." (August 25, 2023, speech by Fed Chair Jerome Powell). While it is well known that energy inflation can reflect both supply and demand shocks, demand shocks have been important for energy prices since at least the early 1990s. For prominent decompositions of energy prices see Kilian (2009) and Baumeister et al. (2022).

[14]It thus encompasses most of the second half of the 20th century and the entire post-2000 period in our previous analysis. Due to the shorter sample, the 1959-1999 period now serves as the omitted period. We find that the overall message and magnitudes are similar to Tables 2 and 3, in that headline inflation exhibits a significantly more positive relationship with convenience before 1999 than post-2000.

[15]In column (4), the federal funds rate subsumes the otherwise positive coefficient on core inflation. This relation-

Table 4: **Relationship between convenience yield and inflation components.** The table reports regressions of convenience spreads on headline inflation in Panel A. Panel B decomposes headline CPI inflation into core and energy inflation components. $I_{\geq 2000}$ is a dummy variable equal to one from 2000 onward. The sample period is 1959:01–2020:07.

**Panel A**: Headline inflation

| | Aaa-Tsy spread | | Repo-T-bill spread | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Infl (head) | 0.089*** | 0.090*** | 0.12*** | 0.049** |
| | (4.38) | (3.29) | (7.23) | (2.38) |
| Infl (head) x $I_{\geq 2000}$ | -0.17*** | -0.18*** | -0.072*** | -0.066** |
| | (-3.99) | (-4.40) | (-2.87) | (-2.51) |
| FFR | | -0.021 | | 0.080*** |
| | | (-1.01) | | (5.73) |
| VIX | | 0.017*** | | 0.014*** |
| | | (4.73) | | (3.72) |
| Debt/GDP | | -0.60 | | -0.0058 |
| | | (-1.39) | | (-0.03) |
| $I_{\geq 2000}$ | 0.72*** | 0.71*** | -0.053 | 0.12 |
| | (6.43) | (5.23) | (-0.73) | (1.29) |
| Constant | 0.48*** | 0.45** | 0.10* | -0.35*** |
| | (5.50) | (2.03) | (1.68) | (-2.64) |
| $\bar{R}^2$ | 0.31 | 0.39 | 0.52 | 0.65 |
| N | 739 | 739 | 739 | 739 |

**Panel B**: Core and energy inflation components

| | Aaa-Tsy spread | | Repo-T-bill spread | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| Infl (core) | 0.12*** | 0.14*** | 0.095*** | -0.0021 |
| | (5.93) | (5.14) | (4.11) | (-0.10) |
| Infl (eng) | -0.0076 | -0.0087 | 0.015* | 0.015** |
| | (-1.19) | (-1.46) | (1.70) | (2.33) |
| Infl (core) x $I_{\geq 2000}$ | 0.017 | 0.0067 | 0.039 | -0.14*** |
| | (0.14) | (0.06) | (0.92) | (-2.62) |
| Infl (eng) x $I_{\geq 2000}$ | -0.0029 | -0.00040 | -0.013 | -0.016** |
| | (-0.42) | (-0.06) | (-1.39) | (-2.53) |
| FFR | | -0.037** | | 0.096*** |
| | | (-2.12) | | (6.52) |
| VIX | | 0.016*** | | 0.014*** |
| | | (4.77) | | (3.83) |
| Debt/GDP | | -0.55 | | -0.080 |
| | | (-1.31) | | (-0.38) |
| $I_{\geq 2000}$ | 0.44* | 0.38 | -0.27*** | 0.29** |
| | (1.81) | (1.49) | (-2.80) | (2.15) |
| Constant | 0.35*** | 0.35* | 0.15** | -0.27** |
| | (3.91) | (1.69) | (2.02) | (-2.35) |
| $\bar{R}^2$ | 0.38 | 0.46 | 0.49 | 0.65 |
| N | 739 | 739 | 739 | 739 |

one expected higher long-term inflation to diminish the value of Treasury convenience. Instead, the results in Table 4 are in line with an interpretation where the inflation-Treasury convenience relationship reflects changing dominant components, each of which has a stable inflation-Treasury convenience relationship.

We next supplement the core-energy decomposition with an explicit decomposition of core CPI inflation into its demand- versus supply-driven components from Shapiro (2022). This decomposition relies on micro data on quantities and prices to separate demand from supply shocks at individual product category level and then aggregates them to obtain demand- and supply-driven inflation. This decomposition is only available starting in 1990, so we are constrained to a shorter sample primarily covering the post-2000 sample from our main analysis.

Table 5 regresses the demand component of core inflation onto our measure of long-term Treasury convenience at different lags (up to 24 months) and finds a strongly negative relationship, which becomes larger and more significant as the horizon expands. While this is not a direct test of causality, it does suggest that convenience may have a direct negative effect on inflation that accumulates over time. Conversely, the loading of the supply-driven inflation on the spread is statistically insignificant, as one might expect if convenience yield fluctuations mainly reflect demand side of the economy.

Finally, we estimate quantile regressions and report the results in Table 6. The regressions describe the relationship between core inflation and quantiles of the convenience spread distribution. It is clear that no negative core inflation-convenience relationship emerges across different convenience quantiles. The coefficient on core inflation remains positive and relatively steady when convenience is at the 25th, the 50th (median), and the 75th percentile. It weakens (albeit remains significantly positive) only at the top 90th percentile.

Overall, the evidence from almost a century of data suggest that higher inflation has generally led to an increase, not decrease, in Treasury convenience, while higher Treasury convenience has led to lower inflation. Further, the relative contributions of these mechanisms for the macroeconomy and Treasury convenience appear to have shifted over time, implying a positive inflation-convenience relationship during the high-inflation second half of the 20th century, but a negative inflation-convenience relationship pre-WWII and post-2000. To understand the mechanisms and potential causal links behind the empirical patterns, we next turn to a New Keynesian model of

ship is captured in our model if the money channel at the short end is intermediated by monetary policy, but long-term convenience is more closely linked to long-term inflation expectations.

Table 5: **Relationship between convenience yield and demand- vs. supply-driven components of inflation in post-1990s sample.** The table reports projections of demand and supply components of core inflation onto the Aaa-Treasury spread, its lag, and controls. Projections are estimated for horizons ranging from one month ahead to 24 months ahead. The controls include current and lagged values of the following variables: FFR, VIX, Debt/GDP ratio, as well as the current and lagged value of the dependent variable. The coefficients on controls are suppressed. The dependent and explanatory variables are standardized to have one unit standard deviation. The inflation decomposition into the contributions of demand and supply components is obtained from Shapiro (2022). The sample of the explanatory variables spans the period from 1990:01 to 2020:07, with the longest forecast predicting the dependent variable as of 2022:07. Newey-West standard errors with $h$ lags are reported in parentheses.

**Panel A**. Dependent variable: Demand-driven component of core inflation

| | $h = 1$ | $h = 3$ | $h = 6$ | $h = 9$ | $h = 12$ | $h = 18$ | $h = 24$ |
|---|---|---|---|---|---|---|---|
| AAA-Tsy spread | -0.042 | -0.204* | -0.122 | -0.552*** | -0.591*** | -0.651** | -0.496** |
| | (-0.48) | (-1.82) | (-0.89) | (-3.29) | (-3.18) | (-2.47) | (-2.31) |
| L.AAA-Tsy spread | -0.011 | 0.037 | -0.175 | 0.114 | 0.056 | 0.167 | 0.168 |
| | (-0.12) | (0.34) | (-1.38) | (0.88) | (0.31) | (0.98) | (1.19) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $\bar{R}^2$ | 0.93 | 0.77 | 0.58 | 0.40 | 0.20 | 0.12 | 0.12 |
| N | 366 | 366 | 366 | 366 | 366 | 366 | 366 |

**Panel B**. Dependent variable: Supply-driven component of core inflation

| | $h = 1$ | $h = 3$ | $h = 6$ | $h = 9$ | $h = 12$ | $h = 18$ | $h = 24$ |
|---|---|---|---|---|---|---|---|
| AAA-Tsy spread | 0.009 | 0.114 | 0.104 | 0.115 | 0.145 | 0.041 | -0.086 |
| | (0.18) | (1.29) | (0.96) | (0.85) | (0.75) | (0.14) | (-0.30) |
| L.AAA-Tsy spread | 0.008 | -0.039 | 0.015 | 0.055 | 0.006 | 0.018 | 0.039 |
| | (0.16) | (-0.47) | (0.16) | (0.41) | (0.04) | (0.08) | (0.29) |
| Controls | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| $\bar{R}^2$ | 0.94 | 0.86 | 0.74 | 0.62 | 0.43 | 0.22 | 0.046 |
| N | 366 | 366 | 366 | 366 | 366 | 366 | 366 |

monetary policy with Treasury convenience.

Table 6: **Quantile regressions.** The table presents estimates of quintile regressions of AAA-Treasury spread on annual core and energy inflation components and additional controls. The columns report results for predicting the 25th, 50th, 75th and 90th percentiles of the spread distribution. The sample period is 1959:01–2020:07. T-statistics using standard errors robust to heteroskedasticity and clustered over 24-month windows are in parentheses.

| | Dependent variable: Aaa-Tsy spread | | | |
|---|---|---|---|---|
| | (1) | (2) | (3) | (4) |
| | q=0.25 | q=0.5 | q=0.75 | q=0.90 |
| Infl (core) | 0.15*** | 0.18*** | 0.18** | 0.10*** |
| | (4.05) | (4.83) | (2.01) | (3.14) |
| Infl (eng) | -0.0042 | -0.0040 | -0.0044 | -0.0080** |
| | (-1.40) | (-0.91) | (-0.83) | (-1.98) |
| FFR | -0.060*** | -0.062*** | -0.067* | -0.049*** |
| | (-2.98) | (-3.35) | (-1.68) | (-3.26) |
| VIX | 0.017* | 0.025*** | 0.023 | 0.017** |
| | (1.92) | (3.46) | (1.49) | (2.13) |
| Debt/GDP | 0.80*** | 0.77** | 0.066 | -0.84 |
| | (2.61) | (2.32) | (0.06) | (-1.47) |
| Constant | -0.088 | -0.16 | 0.38 | 1.22*** |
| | (-0.62) | (-0.85) | (0.40) | (2.84) |
| N | 744 | 744 | 744 | 744 |

# 3 Model of Convenience Yields and Inflation Drivers

This section provides a simple formalization of the two views of Treasury convenience, i.e., the "money view" and the "New Keynesian view." Our model combines two standard components – a simple three-equation New Keynesian model of inflation and monetary policy (e.g., Galí (2008)) and block with money-like assets in the utility and Treasury bonds and money-like assets being substitutes (Sidrauski (1967),Friedman (1969), Nagel (2016)). We focus on the new implications for the changing relationship between inflation and convenience yields.[16] We solve for log-linear dynamics for inflation, the output gap, interest rates, and importantly the convenience spread between illiquid loans and liquid bond rates in the model. We illustrate the effects of cost-push and liquidity shocks on convenience yields and inflation via impulse responses.

There are three different short-term interest rates in our model, that correspond to different rates in practice. We use $I_t^l$ to denote the interest rate on illiquid loans. In practice, households and firms cannot directly borrow and lend T-bill rates, instead relying on less liquid bank loans, credit cards, student loans, mortgages etc. In order to capture lower liquidity inherent in these markets we proxy for $I_t^l$ using high-grade corporate bond yields or GC repo rates in our empirical analysis. We denote $I_t^b$ as the interest rate on liquid Treasury bonds, such as T-bills and Treasury bonds that are highly liquid and that have many regulatory and liquidity benefits. Finally, $I_t^d$ denotes the interest rate on liquid deposits, representing the interest rate that consumers and households can earn by depositing their money with a bank, i.e. the most liquid and money-like asset in this model. Deposits collapse to cash in the special case where the deposit rate is set zero. Each of these interest rates are available at various maturities and we denote the $n$-period zero-coupon interest rates by $I_{n,t}^l$, $I_{n,t}^b$, $I_{n,t}^b$. Log interest rates are related to level interest rates via $i_t^l = \log\left(1 + I_t^l\right)$ etc. We use lowercase letters to denote logs throughout.

## 3.1 Preferences, Consumption, and Liquidity

A representative household has preferences over consumption, leisure, and liquidity services and maximizes

$$E_0 \sum_{t=0}^{\infty} \beta^t U\left(C_t, Q_t, H_t, N_t, \Theta_t\right), \tag{4}$$

$$\tag{5}$$

where

$$U\left(C_t, Q_t, H_t, N_t, \Theta_t\right) = \frac{\Theta_t \left(C_t - H_t\right)^{1-\gamma}}{1-\gamma} + \alpha \log Q_t - \chi \frac{N_t^{1+\eta}}{1+\eta}. \tag{6}$$

[16] Bianchi et al. (2022) also feature a convenience yield shock as a driver of business cycles and asset prices but do not focus on the changing inflation-convenience relationship, which we have documented in Section 2.

Different from the basic New Keynesian model, households have direct preferences over liquidity, similar to money in the utility function (Sidrauski (1967)) and the seminal work by Krishnamurthy and Vissing-Jorgensen (2012). We assume that $Q_t$ is a composite of deposits and convenient government bonds

$$Q_t \quad = \quad (1-\lambda_t)D_t + \lambda_t B_t. \tag{7}$$

Here, $D_t = D_{1,t}+D_{2,t}+...$ and $B_t = B_{1,t}+B_{2,t}+B_{3,t}+...$ denote real balances of zero-coupon bank deposits and Treasury bonds of various maturities. We consider perfect substitutability between Treasury bonds and deposits for simplicity.[17] The parameter $\lambda_t$ controls the relative contribution of government bonds to the liquidity aggregate. A spike in $\lambda_t$ can be interpreted as heightened uncertainty in the economy (Caballero and Krishnamurthy (2008)), tightened collateral constraints (Del Negro et al. (2017)), or a liquidity shock in the financial sector (Li (2023)), all of which would increase the preference for government debt. We refer to $\lambda_t$ as Treasury liquidity.

The rest of the household specification is standard. Here, $N_t$ denotes market labor supplied outside the home, and $H_t = hC_{t-1}$ denotes external consumption habit (Fuhrer (2000), Christiano et al. (2005)), i.e., consumers do not internalize the effects of their choices on future habit. External habit $H_t$ serves to generate a backward-looking term in the Euler equation and slows down the output response to monetary policy.[18] The shifter $\Theta_t$ represents a taste shock that increases the utility that households derive from consumption today vs. tomorrow.

The representative household's budget constraint can then be written as

$$\begin{aligned}
& D_t + B_t - L_t + C_t \\
= \quad & \frac{W_t}{P_t}N_t + \Pi_t + \frac{P_{t-1}}{P_t}D_{1,t-1}(1+I^d_{t-1}) + \frac{P_{t-1}}{P_t}B_{1,t-1}(1+I^b_{t-1}) - \frac{P_{t-1}}{P_t}L_{1,t-1}(1+I^l_{t-1}) \\
& + \frac{P_{t-1}}{P_t}\sum_{i=2}^{\infty}\left(B_{i,t-1}(1+R^b_{i,t}) + D_{i,t-1}(1+R^d_{i,t}) - L_{i,t-1}(1+R^l_{i,t})]\right),
\end{aligned} \tag{8}$$

[17]The assumption of perfect substitutability makes the model as simple as possible while illustrating our main points. If deposits and bonds are not perfectly substitutable, the quantity of Treasury debt outstanding also matters for Treasury convenience (Krishnamurthy and Li (2023)). We include measures of Treasury debt quantities to control for this possibility throughout our empirical analysis.

[18]We follow the macroeconomics literature in our specification of habit because we are not solving for risk premia here. Campbell et al. (2020) show that a somewhat more complicated habit specification can also explain salient features of asset prices while preserving the same macroeconomic equilibrium as the simpler preferences considered here.

where $P_t$ is the aggregate price level in the economy at time $t$, $L_{i,t}$ denotes the real quantity of zero-coupon loans of maturity $i$, $L_t = \sum_{i=1}^{\infty} L_{i,t}$ is the total real quantity of loans, $\Pi_t$ is the sum of firm and bank profits remitted to the household sector, and $R^b_{i,t}$, $R^d_{i,t}$ and $R^l_{i,t}$ denote the nominal returns from buying an $i$-period bond, deposit or loan at time $t-1$ and selling it again at time $t$.

## 3.2 Deposits and Monetary Policy

Following Nagel (2016), we assume that the deposit rate $I^d_t$ equals a fraction of the illiquid loan rate $I^l_t$:

$$I^d_t = \delta I^l_t, \tag{9}$$

where the constant $\delta$ is generally less than $1$ to reflect banks' market power and ability to keep raise deposit rates less than one-for-one with market rates.[19] In the corner case where $\delta = 0$, deposits in the model can be interpreted as cash that carries a liquid benefit but earns no interest. The Fed implements policy by affecting the liquid bond rate, $I^b_t$. Intuitively, the Fed is not allowed to operate directly through private loan markets, as deciding which borrower is creditworthy would be considered fiscal policy and hence outside the purview of the central bank. We assume that the target policy rate follows a log-linear Taylor (1993)-type rule. Theoretical and empirical research has documented the relevance of interest-rate smoothing and policy inertia (Woodford (2003b), Taylor and Williams (2010), Bernanke (2004), Stein and Sunderam (2018)). Therefore, we include an inertial term in the policy rule:

$$i^b_t \;\; = \;\; (1-\rho^i)\left(\gamma^x x_t + \gamma^\pi \pi_t\right) + \rho^i i^b_{t-1} + v_{i,t}, \tag{10}$$

where the monetary policy shock $v_{i,t}$ is assumed to be iid, $i^b_t$ is the one-period log liquid bond rate, $\pi_t$ is log inflation, and $x_t$ is the log output gap, or the difference between log real output and its natural level in the absence of price-setting frictions. Specifying monetary policy in terms of an interest rate target is consistent with how monetary policy was conducted throughout almost all of our sample.[20] We assume that the central bank conducts monetary policy by choosing an interest rate target and then setting the amount of deposits to the implicit value satisfying households'

[19] A long-standing and growing literature has documented the role of bank market power, see e.g. Barro and Santomero (1972); Startz (1979); Drechsler et al. (2017, 2021); Egan et al. (2022); Wang et al. (2022).

[20] The short 1979-1982 monetarist experiment provides an exception, though interest rates featured prominently in the Federal Reserve's considerations even during this episode.

money demand function to ensure the interest rate target is met.[21] The rule (10) says that the central bank raises the policy rate when the output gap or inflation are higher, though it does so gradually over time as captured by the parameter $\rho^i$. A higher inertia parameter $\rho^i$ also implies that monetary policy may raise interest rates slowly in response to an increase in inflation, as the short-term response to inflation $(1-\rho^i)\gamma^\pi$ may be substantially smaller than the long-term response $\gamma^\pi$.

## 3.3 Firms

The supply side of the economy is standard and we relegate the details to the Appendix. Partially monopolistic firms are assumed set product prices but can adjust their product prices only in some periods according to Calvo (1983) with inflation indexation (Christiano et al., 2005). Such a setup generates a standard log-linearized Phillips curve with an extra backward-looking term. Since the model does not have real investment, the aggregate resource constraint implies that consumption equals output, $C_t = Y_t$. Details are in Appendix B.

## 3.4 Shock Processes

In our baseline model, we assume that the liquidity shock $\lambda_t$ follows a simple AR(1) process, similar to Anzoategui et al. (2019). We also consider an extension where Treasury liquidity is allowed to depend directly on inflation. Encompassing both of these cases, liquidity dynamics can be written as:

$$\lambda_t = \bar{u} - b\pi_t + u_t \tag{11}$$

$$u_t = \rho^\lambda u_{t-1} + v_{\lambda,t}. \tag{12}$$

Here, $\rho^\lambda$ is the persistence of Treasury liquidity. Our baseline analysis sets $b=0$, so inflation does not have a direct effect on Treasury liquidity. We also consider the case with $b>0$, which captures the intuition that low and stable inflation may be important for the safety and convenience of nominal Treasury bonds as discussed in the introduction. The steady-state Treasury bond liquidity

[21] If banks face a constant reserve requirement, the implicit rule for deposits can then be met by increasing or decreasing the amount of federal funds in the system, similarly to how the Fed operated for much of our sample period until the global financial crisis of 2008-2009.

weight equals $\bar{\lambda} = \bar{u} - b\bar{\pi}$, where $\bar{\pi}$ is steady-state log inflation. To allow for a clear comparison between liquidity and taste shocks, we assume that the log taste shifter $\theta_t \equiv \log \Theta_t$ is also normally distributed and follows and AR(1) process with the same autocorrelation coefficient $rho^{\lambda}$. The cost-push shock, which formally arises as a markup shock to firms' market power over the variety they produce, is assumed to be log-normal and iid.

## 3.5 Asset Pricing Euler Equations

Let the nominal consumption-based stochastic discount factor be denoted by

$$M_{t+1}^{\$} \;\; = \;\; \beta \frac{U_c\left(C_{t+1}, Q_{t+1}, H_{t+1}, N_{t+1}, \Theta_{t+1}\right)}{U_c\left(C_t, Q_t, H_t, N_t, \Theta_t\right)} \frac{P_t}{P_{t+1}}, \tag{13}$$

where $\beta$ is the time discount rate. This stochastic discount factor prices all nominal assets that have no special liquidity benefits, such as illiquid loans, giving the standard asset pricing Euler equation for the one-period loan rate

$$E_t\left[M_{t+1}^{\$}\left(1+I_t^l\right)\right] \;\; = \;\; 1. \tag{14}$$

In equilibrium, the representative household must be indifferent between marginally increasing Treasury bond holdings while decreasing consumption subject to the budget constraint (8), giving the Treasury bond Euler equation

$$E_t\left[M_{t+1}^{\$}\left(1+I_t^b\right)\right] \;\; = \;\; 1 - \underbrace{\frac{\frac{\alpha}{Q_t}\lambda_t}{U_c\left(C_t, Q_t, H_t, N_t, \Theta_t\right)}}_{\zeta_t^b}. \tag{15}$$

Note that the Euler equation (15) for liquid Treasury bonds takes exactly the form as in models with a reduced-form Treasury convenience benefit $\zeta_t^b$, which has proven useful in understanding global currency fluctuations (Jiang et al. (2021)) and international business cycles (Jiang et al. (2020), Kekre and Lenel (2021)). Bianchi et al. (2022) introduce a similar wedge between the household and financial market Euler equations in their model of high-frequency market responses to monetary policy. We provide a new connection between this increasingly successful financial market shock and the real economy.

The analogous Euler equation for deposits is given by

$$E_t\left[M^{\$}_{t+1}\left(1+I^d_t\right)\right] \;=\; 1-\underbrace{\frac{\frac{\alpha}{Q_t}(1-\lambda_t)}{U_c\left(C_t,Q_t,H_t,N_t,\Theta_t\right)}}_{\zeta^d_t}. \tag{16}$$

Equation (15) shows that Treasury bond convenience $\zeta^b_t$ increases with the liquidity weight of Treasury bonds, $\lambda_t$, and decreases with the marginal consumption value of liquidity $\frac{\alpha/Q_t}{U_{c,t}}$. Equation (16) shows that the convenience of deposits $\zeta^d_t$ increases with the liquidity weight of deposits $1-\lambda_t$, and again decreases with the marginal consumption value of liquidity $\frac{\alpha/Q_t}{U_{c,t}}$. Combining the first-order conditions for Treasury bonds (15) and deposits (16) with assumption (9), linking the deposit and loan rates, delivers the central equation for the Treasury bond convenience spread:

$$I^l_t - I^b_t = \frac{\lambda_t}{1-\lambda_t}(1-\delta)I^l_t. \tag{17}$$

To interpret equation (17) note that in the special case where deposits are simply liquid cash ($\delta = 0$) the nominal loan rate $I^l_t$ is the cost of holding non-interest bearing cash, and $\lambda_t/(1-\lambda_t)$ is the liquidity value of Treasuries relative to cash.

## 3.6 Log-Linearized Model Dynamics

We log-linearize the model around the flexible-price steady-state $\bar{c}=\bar{y}$, $\bar{\pi}$, $\bar{i}^l$, $\bar{i}^b$, $\bar{\theta}$, and $\bar{\lambda}$. For ease of notation, we use $c_t$, $y_t$, $\pi_t$, $i^l_t$, $i^b_t$, and $i^d_t$ to denote log deviations from these steady-state values. Because potential output is constant, the log output gap $x_t$ equals log output up to a constant, i.e., $x_t = y_t = c_t$. A first-order approximation cannot speak to liquidity risk premia, which are treated in complementary papers by (Du et al., 2023) and Acharya and Laarits (2023), instead focusing on the first-order effects of liquidity.

We start with the log-linearized expressions for bond yields and convenience spreads. Log-linearizing the expression (17) gives the following log-linear expression for the illiquid loan rate

$$i^l_t \;=\; f^i i^b_t + f^\lambda \lambda_t, \tag{18}$$

where the log-linearization constant

$$f^i = \frac{1}{1-\frac{\bar{\lambda}}{1-\bar{\lambda}}(1-\delta)}\frac{1+\bar{I}^b}{1+\bar{I}^l}, \tag{19}$$

can be shown to be strictly greater than one, provided that $\bar{\lambda} > 0$ and $\delta < 1$, as in that case the illiquid loan rate increases more than one-for-one with the liquid Treasury bill rate. The intuition for $f^i > 1$ is that a higher policy rate $i_t^b$ also increases the convenience yield $i_t^l - i_t^b$ via the money channel, and therefore, $i_t^l$ increases with $i_t^b$ more than one-for-one. The constant $f^\lambda$ is a log-linearization constant linking the magnitude of the liquidity shock $\lambda_t$ to its impact on illiquid loan rates.

The log-linearized convenience yield spread then equals

$$\underbrace{i_t^l - i_t^b}_{\text{Convenience yield}} = \underbrace{\left(f^i - 1\right) i_t^b}_{\text{Money channel}} + \underbrace{f^\lambda \lambda_t}_{\text{NK demand channel}}. \tag{20}$$

Long-term Treasury convenience, to first order, is given by the expected short-term Treasury convenience over the lifetime of the bond

$$i_{n,t}^l - i_{n,t}^b = \frac{1}{n}E_t\left[\sum_{i=0}^{n-1}\left(i_{t+i}^l - i_{t+i}^b\right)\right] = \frac{1}{n}E_t\left[\sum_{i=0}^{n-1}\left(\left(f^i - 1\right) i_{t+i}^b + f^\lambda \lambda_{t+i}\right)\right]. \tag{21}$$

The two different channels of Treasury convenience are visible in equations (20) and (21). The money channel of Treasury bond convenience corresponds to the first term. The convenience spread between illiquid loans and liquid Treasury bonds rises with the Treasury bond rate provided that Treasury bonds have positive steady-state convenience ($\bar{\lambda} > 0$) and there is incomplete interest rate pass-through to deposits ($\delta < 1$). As the government bond rate rises, it becomes more expensive to hold money-like assets such as deposits. Because Treasury bonds and deposits are substitutes, the Treasury bond convenience yield increases as well.

The New Keynesian (NK) demand channel is captured by the second term in (20). A widening gap between the liquidity value of Treasury bonds relative to deposits, captured by an exogenously given $\lambda_t$, drives up the convenience spread between illiquid loans and liquid government bonds. As such, rising Treasury convenience in itself acts as a shock in the economy, and as we argue below, has the usual properties associated with a demand shock, depressing household spending and reducing inflation.

The representative household's log-linearized intertemporal first-order condition takes the standard form

$$x_t \;\;=\;\; \rho^x x_{t-1} + (1-\rho^x)E_t x_{t+1} - \psi\left(i_t^l - E_t\pi_{t+1}\right) + v_{x,t}, \tag{22}$$

where the backward-looking coefficient equals $\rho^x = \frac{h}{1+h}$, and the elasticity of intertemporal substitution is given by $\psi = \gamma^{-1}\frac{1-h}{1+h}$. The demand shock equals $v_{x,t} = \psi\left(\theta_t - E_t\theta_{t+1}\right)$ and captures the typical New-Keynesian demand shifter arising from preference or taste shocks, unrelated to Treasury liquidity (e.g., Galí, 2008).

Substituting the log-linearized convenience yield (18) into the macroeconomic Euler equation yields the Euler equation with liquidity:

$$x_t = \rho^x x_{t-1} + (1-\rho^x)E_t x_{t+1} - \psi(\underbrace{f^i i_t^b}_{\text{Money}} - E_t\pi_{t+1}) \; - \; \psi\underbrace{f^\lambda \lambda_t}_{\text{NK}} + v_{x,t}. \tag{23}$$

Demand for liquid assets enters the macroeconomic Euler equation (23) in two ways. First, the effect of the nominal rate on consumption and output is amplified by a factor $f^i$, which arises from the money channel of bond convenience. This amplification implies that a rise in inflation that is accompanied by the same rise in the nominal rate is contractionary, as $f^i > 1$.[22] Second, an increase in government bond convenience acts just like a negative demand shock via the $f^\lambda\lambda_t$ term, reflecting the New-Keynesian channel, and thereby provides an alternative microfoundation for demand shocks. When the Treasury bond convenience increases due to a shift in $\lambda_t$, households face a higher loan rate for a given Treasury bond rate, increasing their incentive to save and decreasing the incentive to consume this period.

Because utility is separable in consumption, leisure, and liquidity, the standard log-linearization of the firm's optimal price setting problem gives the log-linearized Phillips curve

$$\pi_t \;\;=\;\; \rho^\pi \pi_{t-1} + (1-\rho^\pi)E_t\pi_{t+1} + \kappa x_t + v_{\pi_t}, \tag{24}$$

where $\rho^\pi$ and $\kappa$ are log-linearization constants, and the cost-push shock $v_{\pi,t}$ arises from deviations

[22] This channel is complementary to Drechsler et al. (2023), who argue that an increase in inflation affects firms directly, thereby amplifying the increase in inflation. We abstract from that channel, which would tend to amplify but not change the sign of the inflation-convenience relationship.

in the markup from its steady-state value (see Appendix B for details). The slope parameter $\kappa$ reflects the rise in marginal costs of production when output is running above potential, leading firms to optimally raise prices.

We use Blanchard and Kahn (1980) algorithm to solve the equilibrium dynamics (23) , (24) and (10) for an equilibrium of the form

$$Z_t = BZ_{t-1} + \Sigma v_t, \tag{25}$$

where the state vector equals $Z_t = [x_t, \pi_t, i_t^b, u_t]$ and the vector of exogenous iid shocks is given by $v_t = [v_{\lambda,t}, v_{\pi,t}, v_{i,t}]$. In the baseline calibration, we focus on the Treasury liquidity $\lambda_t$ as the only source of demand shocks, $v_{\lambda,t}$. To compare the effects of the convenience-driven demand, we also consider a standard New-Keynesian benchmark without Treasury convenience where demand shocks originate solely from preference shocks, $v_{x,t}$. Our calibration features a single non-explosive equilibrium of the form (25). The short- and long-term convenience spreads can then be solved by substituting (11) into the log-linear expressions (18) and (21).

## 3.7 Quantitative Illustration

We illustrate the properties of the model using standard parameter values, with parameters listed in Appendix Table A.3.

The backward-looking component of the Euler equation ($\rho^x$) and the slope of the Euler equation ($\psi$) follow Pflueger and Rinaldi (2022), who show that these values match the empirical output response to identified monetary policy shocks. The Phillips curve has a substantial backward-looking component, which Fuhrer (1997) found necessary to explain the empirical persistence of inflation. The slope of the Phillips curve is set following Rotemberg and Woodford (1997).[23] The monetary policy rule has a long-term inflation weight greater than one, ensuring that the Taylor principle holds, and a moderate amount of inertia or gradualism. We consider versions of the model with only one shock switched on at a time, so the impulse responses and regression results are invariant to the magnitude of the shock volatilities. We hence need to specify which shock is active and the size of the impulse, but not the equilibrium volatilities of shocks.

The liquidity parameters are more interesting. We choose to set the pass-through of loan rates to

[23] The somewhat higher Phillips curve slope compared to Hazell et al. (2022) generates a slightly larger inflation response to liquidity shocks in the model but leaves the qualitative model properties unchanged.

deposit rates to $\delta = 0.34$, within the range of $1/3$ to $1/2$ suggested by Nagel (2016). The steady-state liquidity weight of government bonds and the autocorrelation coefficient of this liquidity weight are set to match summary statistics in our data, where the average Aaa-Treasury spread over the sample period 1926–2020 has a mean of 87 bps with a quarterly AR(1) coefficient of 0.91. The average long-term government bond yield over the same sample period equals $5.28\%$. Setting $\bar{\lambda} = 0.20$ and substituting into equation (17) then implies a steady-state Treasury liquidity spread of $\bar{i}^l - \bar{i}^b = \frac{0.2}{1-0.2} \times (1 - 0.34) \times 5.29\% = 87$ bps in the model. The steady-state discount rate is set to $\beta = 0.98$ and inflation to $\bar{\Pi} = 2\%$ in annual units, so the steady-state illiquid loan rate equals 4.03% annualized. These values imply an interest rate multiplier of $f^i = 1.20$. Thus, a 100 bps increase in inflation expectations that is accompanied by a one-for-one increase in the policy rate $i_t^b$ has the same macroeconomic impact as a 120 bps increase in the illiquid loan rate $i_t^l$. Our baseline scenario treats liquidity shocks $\lambda_t$ as completely exogenous and, thus, sets $b = 0$ in equation (11). Later, we consider an extension in which we allow inflation to directly negatively affect the liquidity value of Treasuries via $b > 0$.

## 3.8 Baseline Model Impulse Responses

We illustrate the economic mechanism through model impulse responses. Figure 3.8 traces out the effects of positive liquidity shock $v_{\lambda,t}$ for inflation, convenience spreads, the Treasury bond yield, and the output gap. The $v_{\lambda,t}$ shock is scaled so that its on-impact effect on the convenience spread is $-100$ bps, implying a positive effect on aggregate demand in equation (23). For comparison, we report the responses to a $+100$ bps demand shock to the Euler equation (22) in a model without Treasury convenience.

Figure 3.8 shows that the New Keynesian view provides an explanation for our main empirical finding for periods 1 and 3 in the data, as inflation and convenience move against each other following a liquidity shock, $v_{\lambda,t}$. This arises because a negative convenience shock acts similarly to a positive demand shock to the Euler equation, raising the output gap, inflation and the Treasury bond rate. The intuition follows directly from equation (18): households face a lower illiquid loan rate $i_t^l$ at a given policy rate $i_t^b$, increasing their demand to borrow and consume today. Firms produce to meet this demand. The stronger demand means that firms optimally raise prices through the Phillips curve (24). The macroeconomic responses for the model with convenience are somewhat dampened compared to the responses to a demand shock in the New Keynesian model without convenience. Intuitively, in the model with convenience, the same monetary policy rule is more powerful because it gets amplified by time-varying convenience spreads, thereby mitigating inflation, output, and policy rate fluctuations in response to a disturbance to the Euler equation.

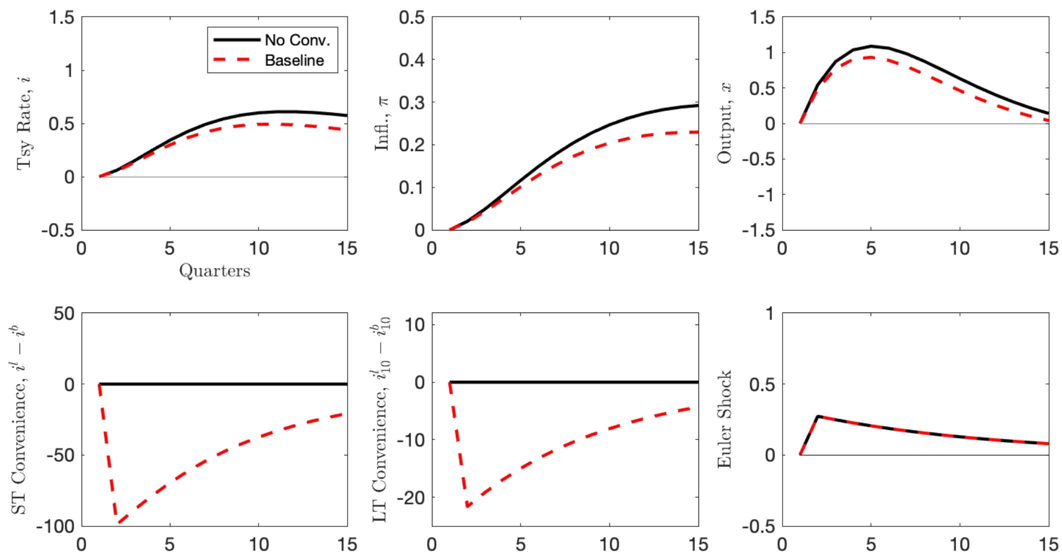



Figure 6: **Baseline model responses to liquidity shock** This figure shows impulse responses to a liquidity shock to $v_{\lambda,t}$ for our baseline model with $b = 0$. The shock is scaled so that in the model with convenience it corresponds to a 100bps decline in the convenience yield spread $i^l_t - i^b_t$. The black line reports the impulse response to a demand shock to the Euler equation, $v_{x,t}$, with identical AR(1) coefficient as the liquidity shock while setting Treasury convenience to zero ($\bar{\lambda} = 0$). Responses for inflation, $\pi$ and the Treasury rate $i^b$ are in annualized percent units. The response for the convenience spread $i^l - i^b$ is in annualized basis points units. The response for the output gap $x$ is in percent units. Quarters are shown on the x-axis.

Figure 3.8 shows that the money view explains the empirical evidence for the 1952–1999 period (period 2), as a cost-push shock moves inflation and convenience – especially long-term convenience – in the same direction. The impulse response for the long-term convenience spread follows most closely the inflation response, while the short-term convenience spread follows most closely the policy rate response to a cost-push shock. The intuition is that due to its persistence, inflation is a better indicator of high nominal interest rates in the future than the current policy rate, thereby driving long-term convenience through the expectation of the future convenience benefit of

Treasury bonds. Monetary policy is amplified in the presence of Treasury convenience, deepening the recession but mitigating inflation in response to a positive cost-push shock compared to a New Keynesian model without Treasury convenience.

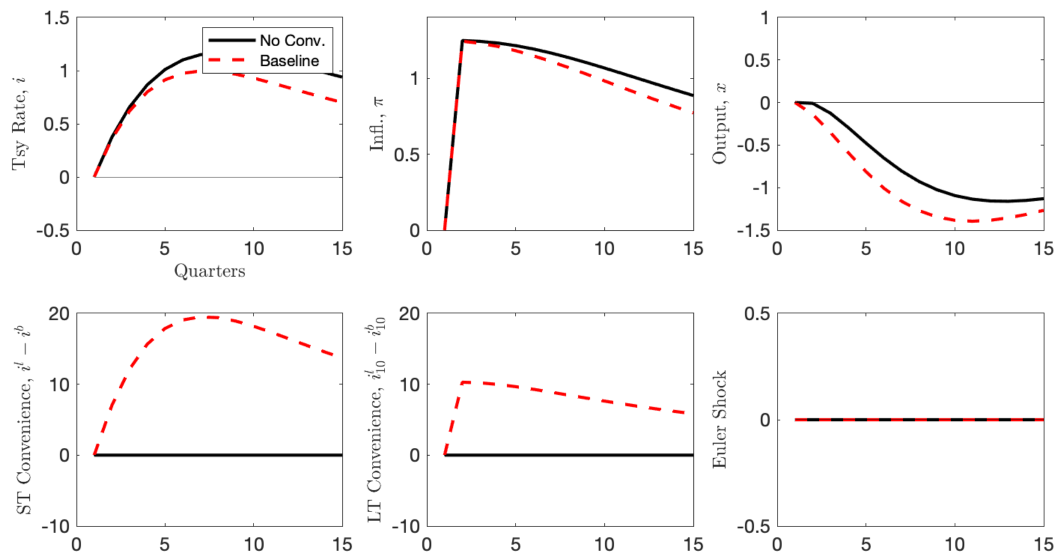



Figure 7: **Baseline model impulse responses to cost-push shock** This figure shows impulse responses to a cost-push (supply) shock for our baseline model. The supply shock is a positive 100 bps shock to the Phillips curve. Responses for inflation, $\pi$ and the Treasury rate $i^b$ are in annualized percent units. The response for the convenience spread $i^l - i^b$ is in annualized basis points units. The response for the output gap $x$ is in percent units. Quarters are shown on the x-axis.

Table 7 summarizes the switch in the convenience-inflation relationships in the model that is driven either by liquidity or supply shocks. For clarity, we switch on one shock at a time in model simulations. The first column in Panel A shows that when the economy is hit repeatedly by liquidity shocks, as in Figure 3.8, inflation-convenience correlation is negative. On the other hand, the second column in Panel A shows that the correlation is strongly positive if the economy is exposed to supply shocks, as in Figure 3.8. Panel B of the table shows correlations of inflation with leads and lags of long-term Treasury convenience 8 quarters after and 8 quarters ahead. When the liquidity shock is switched on, the negative inflation-convenience correlation is strongest between convenience 8 quarters prior, i.e. convenience leads inflation as in the right panels of Figure 5,

Table 7: **Model convenience, inflation, and policy rate relationships.** The table reports model correlations between ST and LT convenience spreads with contemporaneous inflation (Panel A) and with the contemporaneous policy rate $i_t$ (Panel B). All correlations are from a simulation of the model of length 500. Columns labeled "Liquidity Shock" use a model simulation with only the liquidity shock $v_{\lambda,t}$ switched on, and all other shocks set to zero. Columns labeled "Supply Shock" use a model simulation with only the supply shock $v_{\pi,t}$ switched on and all other shocks set to zero. Columns labeled "MP Shock" use a model simulation with only the monetary policy shock $v_{i,t}$ switched on and all other shocks set to zero. Panel C shows model correlations between inflation and the long-term convenience spread 8 quarters before and after.

**Panel A:** Inflation-Convenience Correlation

| Corr(Convenience spread, Inflation) | Liquidity Shock | Cost-Push Shock | MP Shock |
|---|---|---|---|
| ST Convenience | -0.43 | 0.98 | 0.07 |
| LT Convenience | -0.40 | 1.00 | 0.99 |

**Panel B:** Policy Rate-Convenience Correlation

| Corr(Convenience Spread, Policy Rate) | Liquidity Shock | Cost-Push Shock | MP Shock |
|---|---|---|---|
| ST Convenience | -0.59 | 1.00 | 1.00 |
| LT Convenience | -0.57 | 0.97 | 0.09 |

**Panel C:** Leads and Lags

| Corr(LT Convenience Spread$_{q\pm h}$, Inflation$_q$) | Liquidity Shock | Cost-Push Shock | MP Shock |
|---|---|---|---|
| LT Convenience $(q-8)$ | -0.67 | 0.76 | 0.88 |
| LT Convenience | -0.40 | 1.00 | 0.99 |
| LT Convenience $(q+8)$ | -0.07 | 0.74 | 0.82 |

further supporting the interpretation that the New Keynesian channel was dominant pre-WWII and during the pre-Covid 2000s. When the supply shock is switched on, the model does not generate a clear lead-lag pattern between inflation and convenience, in line with the somewhat more mixed evidence of inflation leading convenience in Figure 5. The reason for this model implication is that expectations are perfectly rational and long-term convenience is forward-looking, so convenience moves immediately when inflation increases due to a cost-push shock. A plausible model extension where inflation expectations move slowly (Malmendier and Nagel (2016)) would be sufficient to generate a pattern whereby inflation leads convenience spreads when supply shocks are present, as in the data.

Another important takeaway from Table 7 is that the fed funds rate should drive out inflation in explaining the short-term convenience spread but not the long-term convenience spread, provided that monetary policy shocks are present. Column labeled ”MP shock” shows convenience-inflation correlations (Panel A) and convenience-policy rate correlations (Panel B) when the model is simulated with only monetary policy shocks. In this scenario, long-term convenience remains highly correlated with inflation, whereas short-term convenience is closely correlated with the policy rate but almost uncorrelated with inflation. Intuitively, a contractionary monetary policy shock drives up the policy rate and increases short-term convenience via the money channel. However, a contractionary monetary policy shock also lowers inflation in the long run, moving short-term and long-term convenience in opposite directions.[24] Thus, the model helps explain the contrasting finding in Table 2 and Table 3 that the fed funds rate drives out inflation in the short-term convenience regressions, where convenience is measured with the Repo-Tbill spread, but not in long-term convenience regressions, where convenience is measured with the AAA-Treasury spread.

## 3.9 Alternative Model Impulse Responses with Direct Inflation-Convenience Link

Finally, we investigate the implications of an alternative model allowing for a direct inflation-Treasury liquidity link, and show that it cannot explain our empirical findings. Specifically, by setting $b > 0$ in equation (11), we assume that inflation can directly undermine the liquidity benefits of the Treasuries. We keep all other parameters in Table A.3 unchanged, and calibrate $b = 0.02$. This value means that at an annualized steady-state inflation rate of 10% the liquidity value of

[24] The corresponding impulse responses are shown in the Appendix in Table A.4.

Treasury bonds would be eliminated because $\bar{\lambda} - 10 \times b = 0.2 - 10 \times 0.02 = 0$. To illustrate the implications of the inflation-liquidity link in a low- vs. high-inflation environment we consider two levels for steady-state inflation, with $\bar{\Pi}^{high} = 4.01\%$ corresponding to the empirical average in our period 2 and $\bar{\Pi}^{low} = 0.65\%$ corresponding to empirical inflation averaged across our periods 1 and 3. For simplicity we assume a constant discount rate $\beta = 0.98$ across the two calibrations, so the real risk-free rate is held constant.

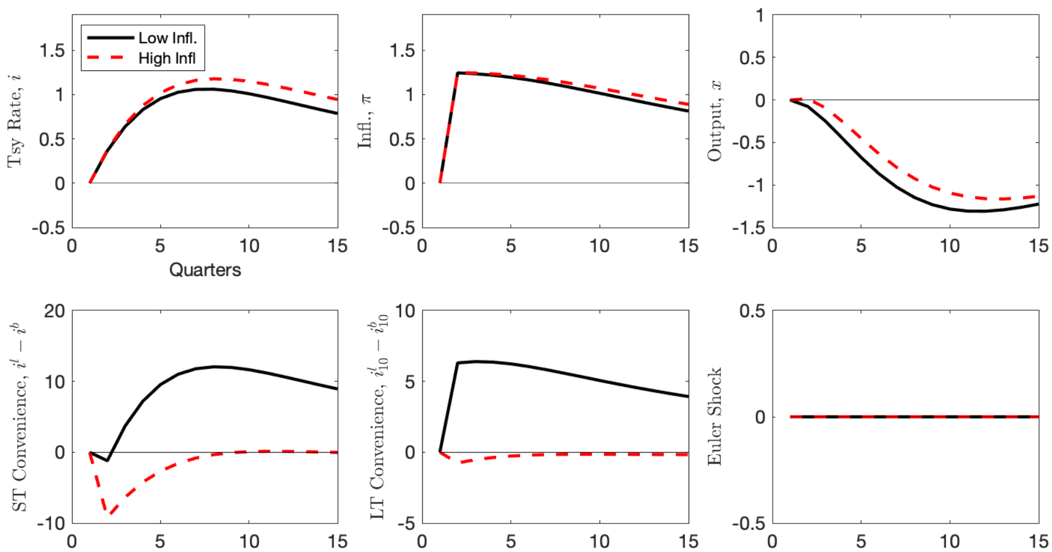



Figure 8: **Alternative model impulse responses to cost-push shock.** This figure shows impulse responses to a cost-push (supply) shock for the model with a direct inflation-convenience link ($b = 0.02$ in equation (11)). The high-inflation equilibrium assumes $\bar{\Pi}^{high} = 4.01\%$ and the low-inflation equilibrium assumes $\bar{\Pi}^{low} = 0.65\%$. The supply shock is a positive 100 bps shock to the Phillips curve. Responses for inflation, $\pi$ and the Treasury rate $i^b$ are in annualized percent units. The response for the convenience spread $i^l - i^b$ is in annualized basis points units. The response for the output gap $x$ is in percent units. Quarters are shown on the x-axis.

Figure 3.9 shows that this alternative model implies a *more negative* convenience-inflation relationship when steady-state inflation is high than when it is low. This is in stark contrast to the data where we found a *more positive* inflation-convenience relationship during the high-inflation 1970s and 1980s than during the low-inflation pre-WWII and 2000s periods. Figure 3.9 focuses on the cost-push impulse responses for the alternative model, as impulse responses to the other two shocks are very similar to our baseline model.[25] To the extent that higher cost-push inflation reduces the attractiveness of Treasury bonds as a convenient asset, one might expect a decrease in convenience spreads following an inflationary cost-push shock. The bottom panels of Figure 3.9 show that this pattern emerges only for the high-inflation equilibrium. In the data, the inflation-convenience relationship is instead more positive during the high-inflation 1970s and 1980s.

Why does the alternative model imply a more negative relationship between Treasury convenience and inflation when inflation is high? The intuition is simply that with higher steady-state inflation, Treasuries have less steady-state convenience $\bar{\lambda}$, which implies that the convenience response to monetary policy rate is lower according to equation (20). The money channel is hence weaker. In this case, the response of Treasury convenience is dominated by the direct effect on $\lambda_t$ as in the NK demand channel. By contrast, when steady-state inflation is low, the money channel is more important and a cost-push shock that leads to higher nominal rates has a pronounced positive effect on Treasury convenience.

Overall, the simple New Keynesian model with Treasury convenience shows that low-frequency shifts between the New Keynesian channel and the money channel of Treasury convenience can explain patterns documented in our empirical analysis, while a direct link between inflation and Treasury convenience cannot.

# 4 Conclusion

This paper argues that two different mechanisms driving Treasury bond convenience – the "money channel" and the "New Keynesian demand channel" – have dominated over distinct historical periods, leading to sign changes in the comovement between Treasury convenience and inflation. We show that Treasury convenience tended to fall with higher inflation in the first half of the 20th century and again during the post-2000 period. However, during the 1970s and 1980s, Treasury convenience was robustly positively correlated with inflation. An empirical decomposition of inflation into components reveals that the positive correlation during the 1970s and 1980s was due to the persistent component of inflation, largely driven by supply shocks.

We explain these findings in a New Keynesian model that embeds the money view of Treasury convenience along with liquidity-driven demand shocks. We study the implications for convenience of liquidity shocks through the first half of the 20th century and in the 2000s, and of

[25] We show that these implications are robust to alternative parameter values in the Appendix.

inflationary cost-push shocks during the 1970s and 1980s. In the model, a higher liquidity value of Treasuries increases the incentive to save and reduces consumption, lowering demand and hence inflation via the standard New-Keynesian demand channel. A negative inflation-convenience relationship ensues, similar to the experience of the early 20th century and the 2000s. In contrast, an inflationary cost-push shock raises the nominal interest rate, thus the opportunity cost of holding money, and by extension, the cost of holding convenient money-like assets. Because cost-push shocks lead to persistent inflation in standard New Keynesian models, the positive inflation-convenience relationship is most pronounced for long-term convenience and not absorbed by the current policy rate, consistent with our empirical evidence from the 1970s and 1980s.

While intuition might suggest that episodes of high inflation deplete the convenience benefits of Treasuries, this intuition does not accurately describe the historical experience to date. Our results highlight a more complex link between Treasury convenience and the macroeconomy through the interplay of money and demand channels. To the extent that shocks to convenience are in and of themselves sources of fluctuations in the economy, establishing causality between inflation and convenience requires taking a stance on the sources of shocks driving the economy.

# References


Joseph Abadi, Markus Brunnermeier, and Yann Koby. The reversal interest rate. *American Economic Review*, 113(8):2084–2120, 2023.

Viral V. Acharya and Toomas Laarits. When do Treasuries earn the convenience yield? - A hedging perspective. NBER Working Paper wp31863, 2023.

Diego Anzoategui, Diego Comin, Mark Gertler, and Joseba Martinez. Endogenous technology adoption and R&D as sources of business cycle persistence. *American Economic Journal: Macroeconomics*, 11(3):67–110, 2019.

Andrew Atkeson and Lee E Ohanian. Are Phillips curves useful for forecasting inflation? *Federal Reserve Bank of Minneapolis Quarterly Review*, 25(1):2–11, 2001.

William A Barnett, Edward K Offenbacher, and Paul A Spindt. The new Divisia monetary aggregates. *Journal of Political Economy*, 92(6):1049–1085, 1984.

Robert J Barro and Anthony M Santomero. Household money holdings and the demand deposit rate. *Journal of Money, Credit and Banking*, 4(2):397–413, 1972.

Christiane Baumeister, Dimitris Korobilis, and Thomas K Lee. Energy markets and global economic conditions. *Review of Economics and Statistics*, 104(4):828–844, 2022.

Ben Bernanke. Gradualism, 2004. URL `https://www.federalreserve.gov/boarddocs/speeches/2004/200405202/default.htm`. Remarks at an economics luncheon co-sponsored by the Federal Reserve Bank of San Francisco and the University of Washington, Seattle, Washington, on May 20.

Harjoat S Bhamra, Christian Dorion, Alexandre Jeanneret, and Michael Weber. High inflation: Low default risk and low equity valuations. *Review of Financial Studies*, 36(3):1192–1252, 2023.

Francesco Bianchi, Sydney C Ludvigson, and Sai Ma. Monetary-based asset pricing: A mixed-frequency structural approach. NBER Working Paper wp30072, 2022.

Olivier Jean Blanchard and Charles M Kahn. The solution of linear difference models under rational expectations. *Econometrica*, 48(5):1305–1311, 1980.

Markus K Brunnermeier, Sebastian A Merkel, and Yuliy Sannikov. The fiscal theory of price level with a bubble. NBER Working Paper wp27116, 2022a.

Markus K Brunnermeier, Sebastian A Merkel, and Yuliy Sannikov. Debt as safe asset. NBER Working Paper wp29626, 2022b.

Markus K Brunnermeier, Sergio Correia, Stephan Luck, Emil Verner, and Tom Zimmermann. The debt-inflation channel of the German hyperinflation. NBER Working Paper wp31298, 2023.

Ricardo J Caballero and Arvind Krishnamurthy. Collective risk management in a flight to quality episode. *Journal of Finance*, 63(5):2195–2230, 2008.

Ricardo J Caballero and Alp Simsek. A risk-centric model of demand recessions and speculation. *Quarterly Journal of Economics*, 135(3):1493–1566, 2020.

Ricardo J Caballero and Alp Simsek. A monetary policy asset pricing model. 2022b.

Phillip Cagan. The demand for currency relative to the total money supply. *Journal of Political Economy*, 66(4):303–328, 1958.

Guillermo A Calvo. Staggered prices in a utility-maximizing framework. *Journal of Monetary Economics*, 12(3):383–398, 1983.

John Y Campbell, Adi Sunderam, and Luis M Viceira. Inflation bets or deflation hedges? The changing risks of nominal bonds. *Critical Finance Review*, 6(2):263–301, 2017.

John Y Campbell, Carolin Pflueger, and Luis M Viceira. Macroeconomic drivers of bond and equity risks. *Journal of Political Economy*, 128(8):3148–3185, 2020.

Lawrence H Christiano, Martin Eichenbaum, and Charles L Evans. Nominal rigidities and the dynamic effects of a shock to monetary policy. *Journal of Political Economy*, 113(1):1–45, 2005.

Richard Clarida, Jordi Galí, and Mark Gertler. The science of monetary policy: A New Keynesian perspective. *Journal of Economic Literature*, 37(4):1661–1707, 1999.

Richard Clarida, Jordi Galí, and Mark Gertler. Monetary policy rules and macroeconomic stability: Evidence and some theory. *Quarterly Journal of Economics*, 115(1):147–180, 2000.

John H Cochrane. *The fiscal theory of the price level*. Princeton University Press, 2023.

Vasco Curdia and Michael Woodford. Credit spreads and monetary policy. *Journal of Money, Credit and Banking*, 42:3–35, 2010.

Marco Del Negro, Gauti Eggertsson, Andrea Ferrero, and Nobuhiro Kiyotaki. The great escape? A quantitative evaluation of the Fed's liquidity facilities. *American Economic Review*, 107(3): 824–857, 2017.

Sebastian Di Tella. Risk premia and the real effects of money. *American Economic Review*, 110 (7):1995–2040, 2020.

William Diamond and Peter Van Tassel. Risk-free rates and convenience yields around the world. Working Paper, University of Pennsylvania, 2023.

Itamar Drechsler, Alexi Savov, and Philipp Schnabl. The deposits channel of monetary policy. *Quarterly Journal of Economics*, 132(4):1819–1876, 2017.

Itamar Drechsler, Alexi Savov, and Philipp Schnabl. A model of monetary policy and risk premia. *Journal of Finance*, 73(1):317–373, 2018.

Itamar Drechsler, Alexi Savov, and Philipp Schnabl. Banking on deposits: Maturity transformation without interest rate risk. *The Journal of Finance*, 76(3):1091–1143, 2021.

Itamar Drechsler, Alexi Savov, and Philipp Schnabl. Credit crunches and the great stagflation. Working Paper, New York University and University of Pennsylvania, 2023.

Wenxin Du, Joanne Im, and Jesse Schreger. The US Treasury premium. *Journal of International Economics*, 112:167–181, 2018a.

Wenxin Du, Alexander Tepper, and Adrien Verdelhan. Deviations from covered interest rate parity. *Journal of Finance*, 73(3):915–957, 2018b.

Wenxin Du, Benjamin M Hébert, and Wenhao Li. Intermediary balance sheets and the Treasury yield curve. *Journal of Financial Economics*, 150(3), 2023.

Darrell Duffie, Nicolae Gârleanu, and Lasse Heje Pedersen. Valuation in over-the-counter markets. *Review of Financial Studies*, 20(6):1865–1900, 2007.

Mark Egan, Stefan Lewellen, and Adi Sunderam. The cross-section of bank value. *The Review of Financial Studies*, 35(5):2101–2143, 2022.

Charles Engel and Steve Pak Yeung Wu. Liquidity and exchange rates: An empirical investigation. *Review of Economic Studies*, 90(5):2395–2438, 2023.

Milton Friedman. *The optimum quantity of money*. Aldine, Chicago, 1969.

Milton Friedman and Anna J Schwartz. The effect of term structure of interest rates on the demand for money in the united states. *Journal of Political economy*, 90(1):201–212, 1982.

Milton Friedman and Anna Jacobson Schwartz. *A monetary history of the United States, 1867-1960*. Princeton University Press, 1963.

Zhiyu Fu, Jian Li, and Yinxi Xie. Convenience yield, inflation expectations, and public debt growth. Working Paper, Columbia University and University of Chicago, 2023.

Jeffrey C Fuhrer. The (un)importance of forward-looking behavior in price specifications. *Journal of Money, Credit and Banking*, 29(3):338–350, 1997.

Jeffrey C Fuhrer. Habit formation in consumption and its implications for monetary-policy models. *American Economic Review*, 90(3):367–390, 2000.

Masao Fukui, Emi Nakamura, and Jón Steinsson. The macroeconomic consequences of exchange rate depreciations. NBER Working Paper wp31279, 2023.

Jordi Galí. *Monetary policy, inflation, and the business cycle*. Princeton University Press, 2008.

Mark Gertler and Peter Karadi. A model of unconventional monetary policy. *Journal of Monetary Economics*, 58(1):17–34, 2011a.

Jonathon Hazell, Juan Herreno, Emi Nakamura, and Jón Steinsson. The slope of the Phillips curve: Evidence from U.S. states. *Quarterly Journal of Economics*, 137(3):1299–1344, 2022.

Sebastian Di Tella Benjamin Hébert, Pablo Kurlat, and Qitong Wang. The zero-beta rate. Working Paper, Stanford University and USC, 2023.

Bengt Holmström and Jean Tirole. Private and public supply of liquidity. *Journal of Political Economy*, 106(1):1–40, 1998.

Peter N Ireland. On the welfare cost of inflation and the recent behavior of money demand. *American Economic Review*, 99(3):1040–1052, 2009.

Oleg Itskhoki and Dmitry Mukhin. Exchange rate disconnect in general equilibrium. *Journal of Political Economy*, 129(8):2183–2232, 2021.

Zhengyang Jiang, Arvind Krishnamurthy, and Hanno Lustig. Dollar safety and the global financial cycle. NBER Working Paper wp27682, 2020.

Zhengyang Jiang, Arvind Krishnamurthy, and Hanno Lustig. Foreign safe asset demand and the dollar exchange rate. *Journal of Finance*, 76(3):1049–1089, 2021.

Alejandro Justiniano and Giorgio E Primiceri. The time-varying volatility of macroeconomic fluctuations. *American Economic Review*, 98(3):604–641, 2008.

Johnny Kang and Carolin Pflueger. Inflation risk in corporate bonds. *Journal of Finance*, 70(1): 115–162, 2015.

Rohan Kekre and Moritz Lenel. The flight to safety and international risk sharing. NBER Working Paper wp29238, 2021.

John Maynard Keynes. The general theory of employment. *Quarterly Journal of Economics*, 51 (2):209–223, 1937.

Lutz Kilian. Not all oil price shocks are alike: Disentangling demand and supply shocks in the crude oil market. *American Economic Review*, 99(3):1053–1069, 2009.

Arvind Krishnamurthy and Wenhao Li. The demand for money, near-money, and Treasury bonds. *Review of Financial Studies*, 36(5):2091–2130, 2023.

Arvind Krishnamurthy and Annette Vissing-Jorgensen. The aggregate demand for Treasury debt. *Journal of Political Economy*, 120(2):233–267, 2012.

Wenhao Li. Public liquidity and financial crises. *American Economic Journal: Macroeconomics*, 2023.

Yang Liu, Lukas Schmid, and Amir Yaron. The risks of safe assets. Working Paper, University of Hong Kong and USC, 2021.

Francis Longstaff. The flight-to-liquidity premium in U.S. Treasury bond prices. *Journal of Business*, 77(3):511–526, 2004.

Robert E Jr Lucas and Juan Pablo Nicolini. On the stability of money demand. *Journal of Monetary Economics*, 73:48–65, 2015.

Ulrike Malmendier and Stefan Nagel. Learning from inflation experiences. *Quarterly Journal of Economics*, 131(1):53–87, 2016.

Stefan Nagel. The liquidity premium of near-money assets. *Quarterly Journal of Economics*, 131 (4):1927–1971, 2016.

Carolin Pflueger. Back to the 1980s or not? The drivers of inflation and real risks in Treasury bonds. NBER Working Paper wp30921, 2023.

Carolin Pflueger and Gianluca Rinaldi. Why does the Fed move markets so much? A model of monetary policy and time-varying risk aversion. *Journal of Financial Economics*, 146(1):71–89, 2022.

Monika Piazzesi, Ciaran Rogers, and Martin Schneider. Money and banking in a New Keynesian model. *Working Paper, Stanford University*, 2019.

Julio J Rotemberg and Michael Woodford. An optimization-based econometric framework for the evaluation of monetary policy. *NBER Macroeconomics Annual*, 12:297–346, 1997.

Adam Hale Shapiro. Decomposing supply and demand driven inflation. Federal Reserve Bank of San Francisco San Francisco Working Paper, 2022.

Robert J Shiller. Irrational exuberance. Princeton University Press, 2016.

Miguel Sidrauski. Rational choice and patterns of growth in a monetary economy. *American Economic Review*, 57(2):534–544, 1967.

Christopher A Sims. Macroeconomics and reality. *Econometrica*, pages 1–48, 1980.

Richard Startz. Implicit interest on demand deposits. *Journal of Monetary Economics*, 5(4):515–534, 1979.

Jeremy C Stein and Adi Sunderam. The Fed, the bond market, and gradualism in monetary policy. *Journal of Finance*, 73(3):1015–1060, 2018.

James H Stock and Mark W Watson. Why has U.S. inflation become harder to forecast? *Journal of Money, Credit and Banking*, 39:3–33, 2007.

John B Taylor. Discretion versus policy rules in practice. *Carnegie-Rochester Conference Series on Public Policy*, 39:195–214, 1993.

John B. Taylor and John C. Williams. Chapter 15 - Simple and robust rules for monetary policy. In *Handbook of Monetary Economics*, volume 3, pages 829–859. Elsevier, 2010.

James Tobin. A general equilibrium approach to monetary theory. *Journal of Money, Credit and Banking*, 1(1):15–29, 1969.

Harald Uhlig. A toolkit for analysing nonlinear dynamic stochastic models easily. In Ramon Marimon and Andrew Scott, editors, *Computational Methods for the Study of Dynamic Economics*, pages 30–61. Oxford University Press, 1999.

Carl E Walsh. *Monetary theory and policy*. MIT press, 2017.

Olivier Wang. Banks, low interest rates, and monetary policy transmission. Working Paper, NYU Stern School of Business, 2022.

Yifei Wang, Toni M Whited, Yufeng Wu, and Kairong Xiao. Bank market power and monetary policy transmission: Evidence from a structural estimation. *Journal of Finance*, 77(4):2093–2141, 2022.

Michael Woodford. *Interest and prices*. Princeton University Press, 2003a.

Michael Woodford. Optimal interest-rate smoothing. *Review of Economic Studies*, 70(4):861–886, 2003b.

# Online Appendix to
# "Inflation and Treasury Convenience"

Anna Cieslak, Wenhao Li, and Carolin Pflueger

## A Robustness of Empirical Results

In this section, we provide robustness checks of our main results.

### A.1 Robustness on the Regimes of Inflation and Treasury Convenience

In the main results of Table 2, we used the AAA-Treasury spread as the main measure of Treasury convenience yield. In this subsection, we present separate results using T-bill convenience yield and show that results are broadly consistent. Furthermore, we also present results that separately deal with three periods to account for potential structural changes in the economy.

In Table A.1, we replicate Table 2 but using T-bill convenience yield. All the signs of interaction terms between inflation and periods are the same as Table 2. The remarkable consistency between T-bill convenience and long-term Treasury convenience, despite the differences in their measures, is a sign that the three regimes are prevalent in the term structure of Treasury convenience and not limited to certain maturity. Furthermore, we note that monetary policy rate (FFR) is highly positive and significant, while in the regression on Treasury convenience yield of Table 2, it is insignificant across all specifications. The contrast between these results is consistent with the model implications in Table 7.

Next, in Table A.2, we show the subsample regression results for both Treasury convenience and T-bill convenience. We find that results are broadly consistent with the main settings shown in Table 2 and Table 3. The only exception is column (6), where the coefficient on inflation is insignificant and positive. In Panel B, we control for lagged inflation and we find that the sign is negative on lagged inflation. A plausible explanation is that aggregate demand response to liquidity shocks is sluggish. This explanation predicts that short-term convenience does not immediately correlates to current inflation, but responds to lagged inflation. On the other hand, since long-term convenience reflects the expectation of future short-term convenience (see equation (20)), it has a

Table A.1: Inflation and T-bill Convenience

| | *Dependent variable:* | | |
|---|---|---|---|
| | T-bill Convenience $\text{Yield}_t$ | | |
| | (1) | (2) | (3) |
| $\text{Inflation}_{t-1,t}$ | $-2.946^{***}$ | $-0.832$ | $-0.748$ |
| | (0.688) | (0.925) | (0.791) |
| $\text{Inflation}_{t-1,t}\times$period2 | $15.441^{***}$ | $11.829^{***}$ | $7.295^{***}$ |
| | (1.902) | (1.909) | (2.469) |
| $\text{Inflation}_{t-1,t}\times$period3 | $-1.366$ | $-5.827$ | $-9.325$ |
| | (5.523) | (5.376) | (5.734) |
| period2 | $-0.207^{**}$ | 0.046 | $-0.013$ |
| | (0.085) | (0.116) | (0.113) |
| period3 | 0.188 | $0.480^{**}$ | $0.503^{**}$ |
| | (0.174) | (0.234) | (0.233) |
| VIX | | $0.015^{***}$ | $0.015^{***}$ |
| | | (0.004) | (0.004) |
| FFR | | | $0.058^{***}$ |
| | | | (0.017) |
| Debt/GDP | | $-0.526$ | $-0.226$ |
| | | (0.348) | (0.373) |
| Constant | $0.235^{***}$ | $-0.095$ | $-0.264^{**}$ |
| | (0.054) | (0.126) | (0.130) |
| Observations | 987 | 987 | 987 |
| $R^2$ | 0.433 | 0.483 | 0.532 |
| Adjusted $R^2$ | 0.430 | 0.479 | 0.528 |
| *Note:* | | | $^{*}p<0.1$; $^{**}p<0.05$; $^{***}p<0.01$ |

Table A.2: **Robustness: Estimates by subsample.**

Panel A. Estimates by subsample

| | Aaa-Tsy spread | | | Repo-T-bill spread | | |
|---|---|---|---|---|---|---|
| | (1) per=1 | (2) per=2 | (3) per=3 | (4) per=1 | (5) per=2 | (6) per=3 |
| Inflation | -0.032*** | 0.041 | -0.053** | -0.011** | 0.027 | 0.015 |
| | (-4.55) | (1.51) | (-2.24) | (-2.39) | (1.36) | (0.90) |
| FFR | 0.14*** | -0.000053 | 0.031 | 0.064** | 0.080*** | 0.056*** |
| | (4.63) | (-0.00) | (0.70) | (2.15) | (5.07) | (6.09) |
| Debt/GDP | 0.46 | -2.54*** | 0.87** | -2.48* | -0.81** | 0.22* |
| | (0.31) | (-3.60) | (2.11) | (-1.89) | (-2.27) | (1.67) |
| VIX | 0.0017 | 0.019*** | 0.022*** | 0.0085*** | 0.026*** | 0.0065** |
| | (0.79) | (2.76) | (5.31) | (4.25) | (4.63) | (2.40) |
| Constant | 0.47** | 0.90*** | 0.28 | 0.13 | -0.27* | -0.20** |
| | (2.09) | (3.43) | (1.05) | (0.63) | (-1.69) | (-2.04) |
| $\bar{R}^2$ | 0.66 | 0.55 | 0.37 | 0.45 | 0.62 | 0.46 |
| N | 164 | 576 | 247 | 164 | 576 | 247 |

Panel B. Estimates by subsample with lagged inflation

| | Aaa-Tsy spread | | | Repo-T-bill spread | | |
|---|---|---|---|---|---|---|
| | (1) per=1 | (2) per=2 | (3) per=3 | (4) per=1 | (5) per=2 | (6) per=3 |
| Inflation | -0.027*** | 0.014 | -0.080** | -0.011** | 0.038* | 0.0093 |
| | (-6.23) | (0.59) | (-2.41) | (-2.00) | (1.74) | (0.40) |
| L12.Inflation | -0.012** | 0.037** | -0.046 | 0.0010 | -0.013 | -0.015 |
| | (-2.31) | (2.21) | (-1.24) | (0.15) | (-0.84) | (-1.03) |
| L24.Inflation | -0.021*** | 0.038*** | -0.049 | 0.0073 | -0.038*** | -0.0015 |
| | (-3.55) | (2.76) | (-1.51) | (1.23) | (-2.81) | (-0.10) |
| FFR | 0.11*** | -0.020 | 0.040 | 0.072** | 0.097*** | 0.059*** |
| | (3.92) | (-1.36) | (0.99) | (2.44) | (6.92) | (5.33) |
| Debt/GDP | -2.47* | -2.26*** | 0.56 | -1.68 | -1.07*** | 0.17 |
| | (-1.88) | (-3.73) | (1.13) | (-0.97) | (-3.57) | (1.20) |
| VIX | -0.0022 | 0.022*** | 0.022*** | 0.0094*** | 0.024*** | 0.0067** |
| | (-1.40) | (3.32) | (5.34) | (5.12) | (4.62) | (2.41) |
| Constant | 0.94*** | 0.70*** | 0.65* | 0.010 | -0.11 | -0.14 |
| | (4.86) | (3.28) | (1.67) | (0.04) | (-0.87) | (-0.86) |
| $\bar{R}^2$ | 0.76 | 0.65 | 0.40 | 0.45 | 0.66 | 0.46 |
| N | 164 | 576 | 247 | 164 | 576 | 247 |

stronger response.

Finally, in Figure A.1, we plot the moving averages of Treasury convenience and inflation to better understand the frequency of the relationship. We use both the headline inflation (two upper panels) and the core inflation (two lower panels). The dramatic regime shifts across three periods are more prominent at the 60-month moving average than 12-month moving average. As a result, the relation between inflation and Treasury convenience is stronger at lower frequency, indicating that they are likely related to macroeconomic changes, rather than having a direct linage through the financial market.

## A.2 Impulse Responses

To gain better identification, we apply the standard VAR local projection method and show the impulse responses in Figure A.2 (headline inflation) and A.3 (core inflation). We find that results are generally similar to the results in Figure 5.

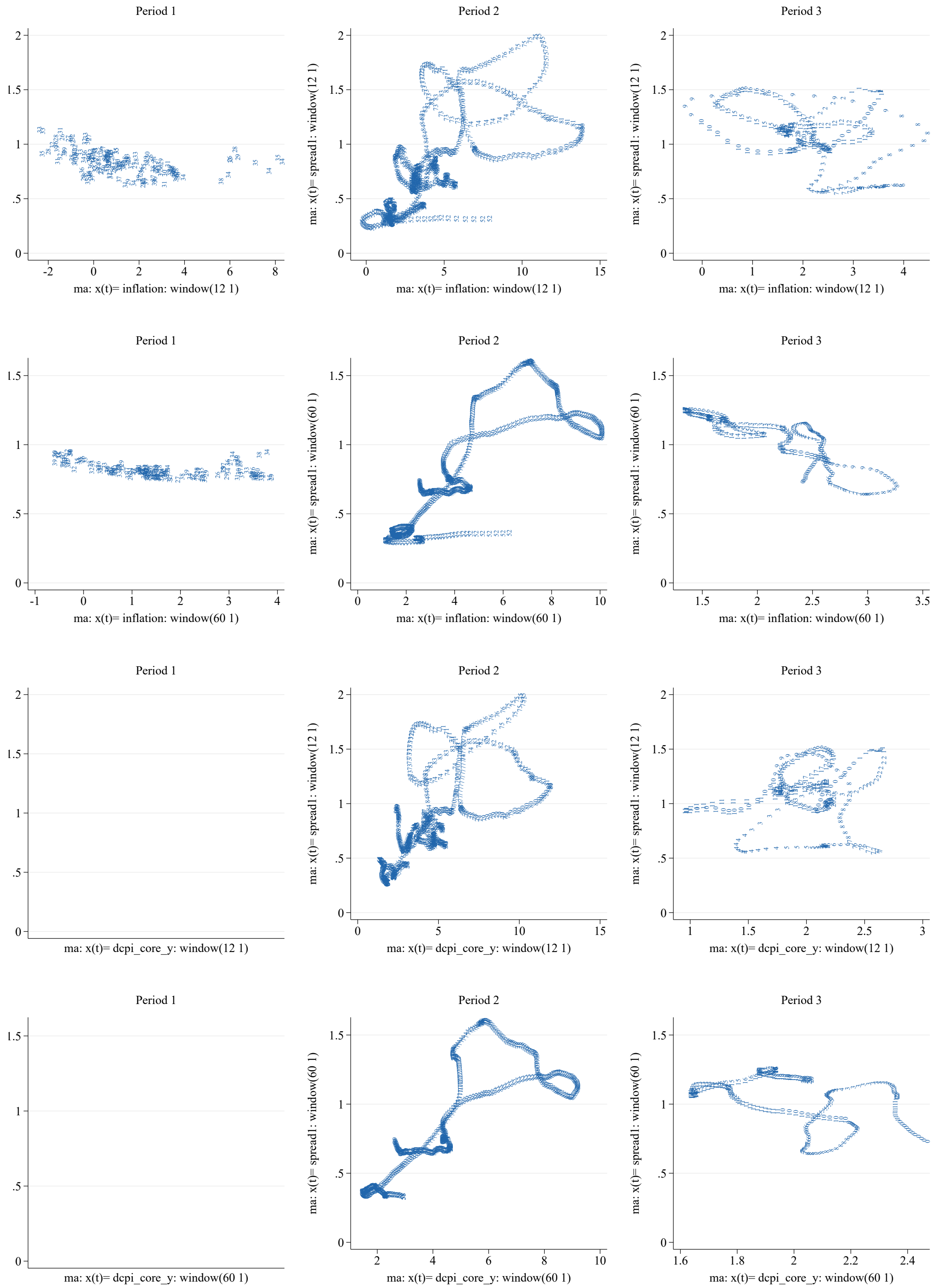





Figure A.1: **Low frequency relationship between inflation and convenience yield.**

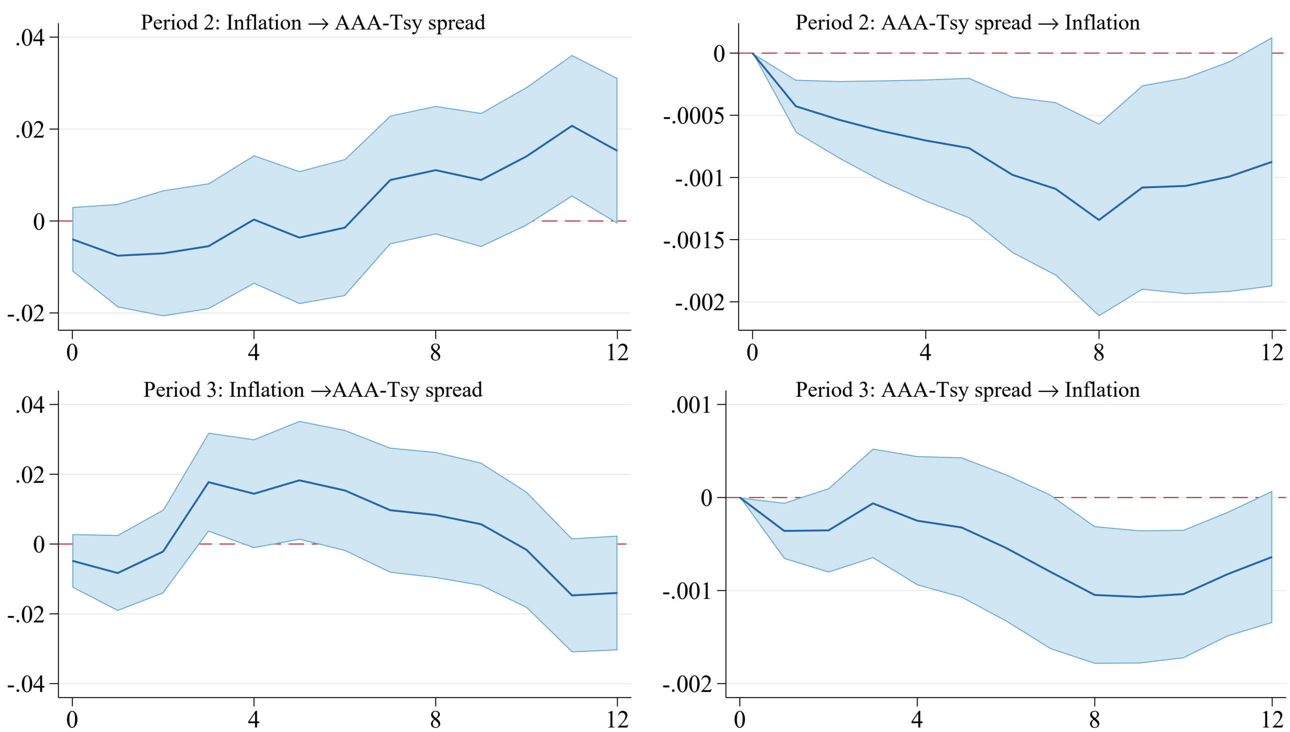



Figure A.2: **VAR local projection impulse responses: headline inflation.** The graphs present orthogonalized impulse-responses obtained from a local projections VAR. The VAR is estimated separately for each subperiod, using monthly data with 12 lags. The following variables are included and ordered as Debt/GDP, headline CPI inflation, unemployment, FFR, and AAA-Treasury spread. We report 90% confidence intervals using robust standard errors.

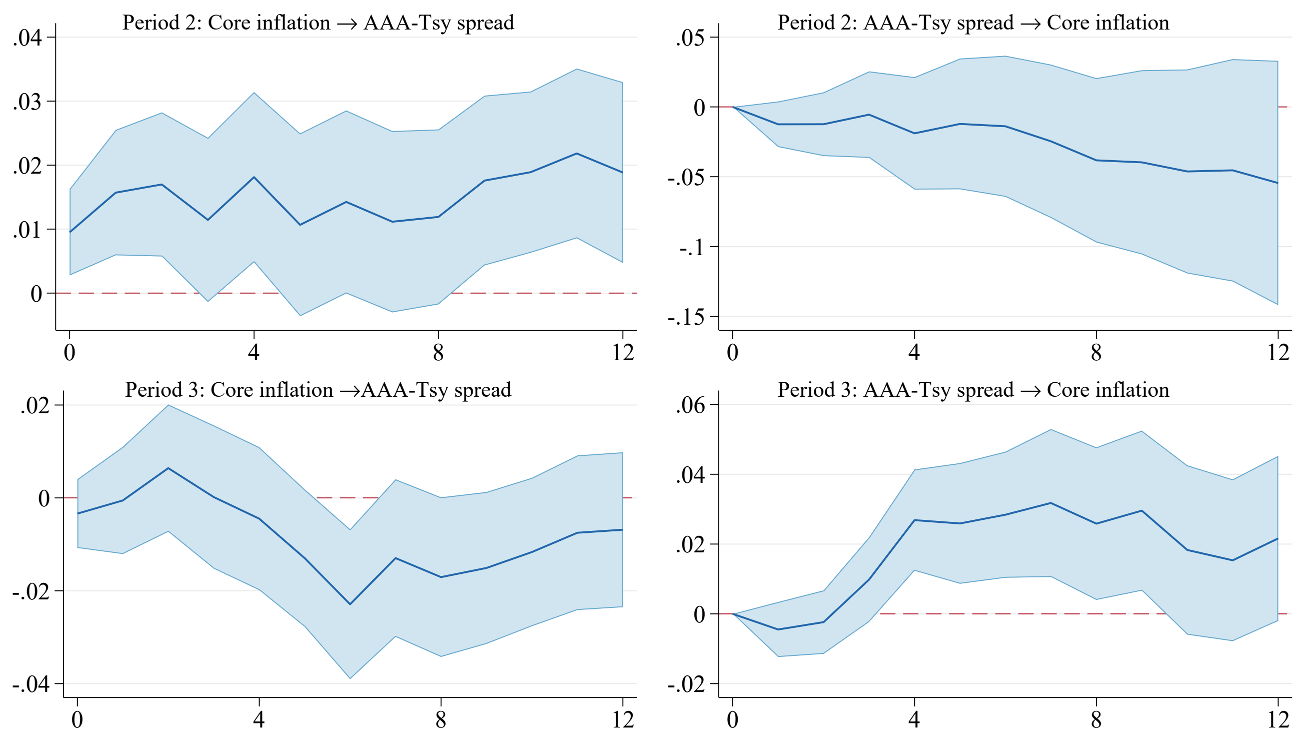



Figure A.3: **VAR local projection impulse responses: core inflation.** The graphs present orthogonalized impulse-responses obtained from a local projections VAR. The VAR is estimated separately for each subperiod, using monthly data with 12 lags. The following variables are included and ordered as Debt/GDP, energy CPI inflation, core CPI inflation, unemployment, FFR, and AAA-Treasury spread. We report 90% confidence intervals using robust standard errors.

# B Model Appendix

In this appendix, we provide detailed model solutions. We start the baseline model, and then provide details on the extension model that directly introduces the inflation-convenience linkage.

## B.1 Supply Side and Price-Setting Frictions

The consumption aggregate is given by

$$C_t = \left( \int_0^1 C_{jt}^{(\sigma_t - 1)/\sigma_t} \right)^{\frac{\sigma_t}{\sigma_t - 1}}, \tag{26}$$

where $C_{jt}$ denotes the quantity consumed of consumption good of variety $j$, and $\sigma_t$ is the potentially time-varying elasticity of substitution across varieties, which will give rise to supply-type shocks in the log-linearized Phillips curve (Woodford (2003a), p. 451). Household optimization then implies that demand for variety $j$ is downward-sloping in its price $P_{jt}$

$$C_{jt} = \left( \frac{P_{jt}}{P_t} \right)^{-\sigma} C_t, P_t = \left( \int_0^1 P_{jt}^{1-\sigma_t} \right)^{1/(1-\sigma_t)}. \tag{27}$$

We set up the firm's problem as simple and standard as possible. Firms face price-setting frictions in the manner of Calvo (1983). We assume that there is a unit mass of firms producing consumption good $j$. Firms of type $j$ have a constant returns to scale production technology and use labor as their only input

$$Y_{jt} = N_{jt}. \tag{28}$$

Each period a random fraction $1 - \omega$ of firms is allowed to adjust prices, while the remaining fraction $\omega$ of firms have a price that is automatically indexed to lagged inflation. That is, the time $t + \tau$ price of a firm that last re-set its product price to $P_t^*$ at time $t$ equals $P_t^* \left( \frac{P_{t-1+\tau}}{P_{t-1}} \right)^\zeta$, where $\zeta$ is an indexation parameter as in Christiano et al. (2005) and leads to a backward-looking term in the Phillips curve. There is no real investment in the model, so consumption must equal output for each variety

$$C_{jt} = Y_{jt}. \tag{29}$$

## B.2 Model Derivations

### B.2.1 Liquidity Spread

Taking the difference between (15) vs. (14) and (16) vs. (14) gives the following expressions

$$\frac{I_t^l - I_t^b}{1 + I_t^l} = \frac{\frac{\alpha}{Q_t}\lambda_t}{U_c\left(C_t, H_t\right)} \tag{30}$$

$$\frac{I_t^l - I_t^d}{1 + I_t^l} = \frac{\frac{\alpha}{Q_t}(1-\lambda_t)}{U_c\left(C_t, H_t\right)}. \tag{31}$$

Substituting in (9) into (31) then gives (17) in the main text. A simple rearrangement gives that

$$I_t^l = \frac{1}{1 - \frac{\lambda_t}{1-\lambda_t}(1-\delta)} I_t^b \tag{32}$$

### B.2.2 Flexible Price Steady-State

We log-linearize the model around the flexible-price steady-state values $\bar{c}$, $\bar{\pi}$, $\bar{\imath}^l$, $\bar{\imath}^b$, $\bar{\theta}$, and $\bar{\lambda}$ with deviations $c_t$, $\pi_t$, $i_t^l$, $i_t^b$, $\theta_t$, and $\lambda_t$. Before we can log-linearize we need to solve for the flexible-price steady-state. With flexible prices, profit-maximization implies all firms optimally choose to charge a constant markup

$$\frac{P_t^*}{P_t} = \frac{\sigma}{\sigma - 1}\frac{W_t}{P_t}. \tag{33}$$

The representative household's optimal labor-leisure choice implies that the real wage must satisfy

$$\frac{\chi N_t^\eta}{(C_t - hC_{t-1})^{-\gamma}} = \frac{W_t}{P_t}. \tag{34}$$

In the flexible-price equilibrium, we must have $P_t^* = P_t$. Substituting in good markets clearing ($Y_t = C_t$) implies that the steady-state flexible price output is constant and equals

$$\bar{Y}_t = \left(\frac{(1-h)^\gamma(\sigma-1)}{\chi\sigma}\right)^{1/(\gamma+\eta)}. \tag{35}$$

In the steady-state interest rates must satisfy:

$$\left(1+\bar{I}^l\right)\beta E\left[\frac{U_c(C_{t+1})}{U_c(C_t)}\frac{P_t}{P_{t+1}}\right] \;=\; 1, \tag{36}$$

where we suppress the non-consumption arguments in the utility function to sav on notation. In the nonstochastic steady-state consumption and habit are constant, so:

$$1+\bar{I}^l \;=\; \frac{1+\bar{\Pi}}{\beta}. \tag{37}$$

The steady-state government bond yield (in levels) then satisfies

$$\bar{I}^b \;=\; \bar{I}^l\left(1-\frac{\bar{\lambda}}{1-\bar{\lambda}}(1-\delta)\right). \tag{38}$$

#### B.2.3 Log-Linearization

We define the log steady-state interest rates by $\bar{i}^l = \log(1+\bar{I}^l)$, and $\bar{i}^b = \log(1+\bar{I}^b)$. For conciseness we define the function

$$\phi\left(\lambda_t\right) \;=\; \frac{1}{1-\frac{\lambda_t}{1-\lambda_t}(1-\delta)}. \tag{39}$$

The function $\phi$ has the first-order Taylor approximation around $\bar{\lambda}$ in terms of $\hat{\lambda}_t \equiv \lambda_t - \bar{\lambda}$:

$$\phi(\lambda_t) \;\approx\; \phi\left(\bar{\lambda}\right)+\phi'\left(\bar{\lambda}\right)\hat{\lambda}_t, \tag{40}$$

$$\phi\left(\bar{\lambda}\right) \;=\; \frac{1}{1-\frac{\bar{\lambda}}{1-\bar{\lambda}}(1-\delta)}, \tag{41}$$

$$\phi'\left(\bar{\lambda}\right) \;=\; \left(\frac{1}{1-\frac{\bar{\lambda}}{1-\bar{\lambda}}(1-\delta)}\right)^2(1-\delta)\frac{1}{\left(1-\bar{\lambda}\right)^2} \tag{42}$$

We can then re-write expression (32)

$$\exp(\hat{i}_t^l+\bar{i}^l)-1 \;=\; \phi\left(\lambda_t\right)\left(\exp(\hat{i}_t^b+\bar{i}^b)-1\right) \tag{43}$$

Substituting in the log-linear approximation for $\phi$,

$$(1+\bar{I}^l)\hat{i}^l_t + \bar{I}^l \quad \approx \quad \left(\phi(\bar{\lambda}) + \phi'(\bar{\lambda})\hat{\lambda}_t\right)\left((1+\bar{I}^b)\hat{i}^b_t + \bar{I}^b\right) \tag{44}$$

Solving out for $\hat{i}^l_t$ and dropping second-order terms gives the first-order Taylor expansion

$$\begin{aligned}\hat{i}^l_t \quad &\approx \quad \phi(\bar{\lambda})\frac{1+\bar{I}^b}{1+\bar{I}^l}\hat{i}^b_t + \phi'(\bar{\lambda})\frac{\bar{I}^b}{1+\bar{I}^l}\hat{\lambda}_t, &(45)\\ &= \quad f^i\hat{i}^b_t + f^\lambda\hat{\lambda}_t, &(46)\end{aligned}$$

where the coefficients are given by

$$\begin{aligned}f^i \quad &= \quad \phi(\bar{\lambda})\frac{1+\bar{I}^b}{1+\bar{I}^l}, &(47)\\ &= \quad \frac{1}{1-\left(\frac{\bar{\lambda}}{1-\lambda}(1-\delta)\right)}\frac{1+\bar{I}^l\left(1-\left(\frac{\bar{\lambda}}{1-\lambda}(1-\delta)\right)\right)}{1+\bar{I}^l} &(48)\\ &= \quad \frac{1}{1-\left(\frac{\bar{\lambda}}{1-\lambda}(1-\delta)\right)}\left(1-\frac{\bar{I}^l}{1+\bar{I}^l}\left(\frac{\bar{\lambda}}{1-\lambda}(1-\delta)\right)\right), &(49)\\ f^\lambda \quad &= \quad \phi'(\bar{\lambda})\frac{\bar{I}^b}{1+\bar{I}^l}. &(50)\end{aligned}$$

As long as $\frac{\bar{I}^l}{1+\bar{I}^l} < 1$, $\bar{\lambda} > 0$ and $\delta < 1$ the second expression for $f^i$ makes clear that $f^i > 1$. Alternatively, $f^i$ can be written as $f^i = \phi(\bar{\lambda})\frac{1+\bar{I}^b}{1+\bar{I}^l} = \frac{\phi(\bar{\lambda})+\bar{I}^l}{1+\bar{I}^l}$, which can be easily used to see that $f^i > 1$.

We then derive the relationship between convenience spreads across the term structure. Investing one dollar into an $n$-period zero coupon government bonds at time $t$ and selling it at time $t+1$ generates a return $R_{n,t+1} = \frac{\exp\left(-(n-1)i^b_{n-1,t+1}\right)}{\exp\left(-ni^b_{n,t}\right)}$. Since government bonds are assumed to provide the same liquidity services at time $t$ irrespective of bond maturity, the first-order condition between investing in an $n$-period vs. 1-period bond becomes

$$0 \quad = \quad \beta E_t\left[U_c\left(C_{t+1}\right)\left(\exp(i^b_t) - \frac{\exp\left(-(n-1)i^b_{n-1,t+1}\right)}{\exp\left(-ni^b_{n,t}\right)}\right)\right]. \tag{51}$$

Log-linearizing gives the long-term liquid government bond yield in terms of the expected short-term government bond yields according to the expectations hypothesis:

$$i_{n,t}^{b} = \frac{1}{n} E_t \left[ \sum_{i=0}^{n-1} i_{t+i}^{b} \right]. \tag{52}$$

Since short- and long-term illiquid loans also generate the same liquidity value at time $t$, their yields up to first-order also satisfy an expectations hypothesis:

$$i_{n,t}^{l} = \frac{1}{n} E_t \left[ \sum_{i=0}^{n-1} i_{t+i}^{l} \right]. \tag{53}$$

We derive log-linearized Euler equation (22) following standard steps. The representative household's intertemporal first-order condition is

$$\Theta_t \left(C_t - hC_{t-1}\right)^{-\gamma} = \beta \left(1 + I_t^l\right) E_t \left[ \Theta_{t+1} \frac{P_t}{P_{t+1}} \left(C_{t+1} - hC_t\right)^{-\gamma} \right] \tag{54}$$

Log-linearizing around the flexible-price steady-state $\bar{C}$ gives up to a constant

$$\log\left(C_t - hC_{t-1}\right) \approx \frac{1}{1-h}(c_t - hc_{t-1}) \tag{55}$$

The log-linearized consumption Euler equation then equals (up to constant)

$$(\theta_t - E_t\theta_{t+1}) - \frac{\gamma}{1-h}\left(c_t - hc_{t-1}\right) = i_t^l - E_t\pi_{t+1} - \frac{\gamma}{1-h}\left(E_t c_{t+1} - hc_t\right). \tag{56}$$

A simple re-arrangement then gives

$$c_t = \frac{1}{1+h} E_t c_{t+1} + \frac{h}{1+h} c_{t-1} - \gamma^{-1} \frac{1-h}{1+h} \left(i_t^l - E_t \pi_{t+1}\right) + \gamma^{-1} \frac{1-h}{1+h} \left(\theta_t - E_t\theta_{t+1}\right). \tag{57}$$

Equation (22) then follows from $x_t = c_t$ with the demand shock taking the form $v_{x,t} = \gamma^{-1} \frac{1-h}{1+h} \left(\theta_t - E_t\theta_{t+1}\right)$.

Because the labor-leisure trade-off is standard, the firm's problem is also entirely standard. Walsh (2017) provides a detailed derivation of the log-linearized New Keynesian Phillips curve (24).

The standard textbook treatment of firm decision problem will give rise to the log-linearized

Phillips curve,

$$\pi_t = \rho^\pi \pi_{t-1} + (1-\rho^\pi) E_t \pi_{t+1} + \kappa x_t + v_{\pi_t}.$$

#### B.2.4 Solution Details

Denote scaled liquidity shock by $\xi_t \equiv -\psi f^\lambda u_t$, so that

$$\xi_t = \rho^\xi \xi_{t-1} + v_{\xi,t}, \tag{58}$$

with $v_{\xi,t} = -\psi f^\lambda v_{\lambda,t}$ iid and serially uncorrelated and $\rho^\xi = \rho^\lambda$.

The log-linearized dynamics for the state vector $Y_t = [x_t, \pi_t, i_t, \xi_t]$ can then be summarized

$$\begin{aligned} x_t &= (1-\rho^x) E_t x_{t+1} + \rho^x x_{t-1} - \psi f^i i_t + \psi E_t \pi_{t+1} + \psi b f^\lambda \pi_t + \xi_t + v_{x,t}, & (59) \\ \pi_t &= (1-\rho^\pi) E_t \pi_{t+1} + \rho^\pi \pi_{t-1} + \kappa x_t + v_{\pi,t}, & (60) \\ i_t &= (1-\rho^i)\left(\gamma^x x_t + \gamma^\pi \pi_t\right) + \rho^i i_{t-1} + v_{i,t}, & (61) \\ \xi_t &= \rho^\xi \xi_{t-1} + v_{\xi,t}. & (62) \end{aligned}$$

We only need to solve the model with either the liquidity shock $\xi_t$ or the demand shock $v_{x,t}$. We start with the solution for the model liquidity shock $\xi_t$, setting the demand shock to zero. In matrix form, the model can be written as

$$0 = F E_t Y_{t+1} + G Y_t + H Y_{t-1} + M v_t, \tag{63}$$

where the matrices are given by

$$F = \begin{bmatrix} 1-\rho^x & \psi & 0 & 0 \\ 0 & 1-\rho^\pi & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \end{bmatrix} \tag{64}$$

$$G = \begin{bmatrix} -1 & \psi b f^{\lambda} & -\psi f^{i} & 1 \\ \kappa & -1 & 0 & 0 \\ (1-\rho^{i})\gamma^{x} & (1-\rho^{i})\gamma^{\pi} & -1 & 0 \\ 0 & 0 & 0 & -1 \end{bmatrix} \tag{65}$$

$$H = \begin{bmatrix} \rho^{x} & 0 & 0 & 0 \\ 0 & \rho^{\pi} & 0 & 0 \\ 0 & 0 & \rho^{i} & 0 \\ 0 & 0 & 0 & \rho^{\xi} \end{bmatrix} \tag{66}$$

$$M = \begin{bmatrix} 0 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \\ 1 & 0 & 0 \end{bmatrix} \tag{67}$$

and the vector of exogenous shocks is given by

$$v_t = [v_{\xi,t}, v_{\pi,t}, v_{i,t}]. \tag{68}$$

We use Uhlig Uhlig (1999)'s formulation of Blanchard and Kahn (1980) to solve for an equilibrium of the form (25).

The convenience spread of maturity then has the following log-linearized expression:

$$spread_{n,t} \equiv i^{l}_{n,t} - i^{b}_{n,t} = \frac{1}{n}\left(\left(f^{i}-1\right)e_3 - \psi^{-1}e_4 - bf^{\lambda}e_2\right)(I-B)^{-1}(I-B^{n})\,Y_t \tag{69}$$

We then show impulse responses to shocks of the size $v_{\xi,t} = \frac{\psi}{400}$, $v_{\pi,t} = \frac{1}{400}$, and $v_{i,t} = \frac{1}{400}$ in natural units.

To solve the model with a generic demand shock but no liquidity shocks, note that if $\theta_t$ follows an AR(1) with autoregression coefficient $\rho^{\xi}$ then $\theta_t - E_t\theta_{t+1} = (1-\rho^{\xi})\theta_t$ also follows an AR(1) process with the same AR(1) coefficient. The same solution then goes through, except we need to set $f^i = 1$ and $b = 0$ to obtain the impulse responses to a generic demand shock when Treasury bonds yield no liquidity.

## B.3 Details on Model Calibration

Details about model calibration are shown in Table A.3.

Table A.3: Model Calibration

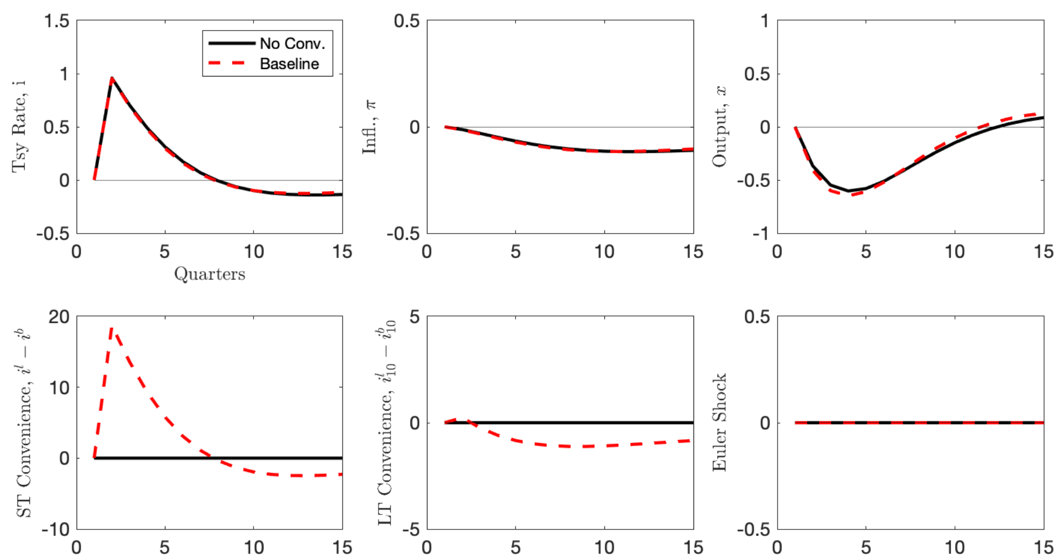
| **Panel A:** Inflation and Monetary Policy | | | |
|---|---|---|---|
| Euler equation | | | Target |
| Interest rate slope | $\psi$ | 0.07 | Pflueger and Rinaldi (2022) |
| Backward-looking component | $\rho^x$ | 0.45 | Pflueger and Rinaldi (2022) |
| PC Parameters | | | |
| Slope | $\kappa$ | 0.019 | Rotemberg and Woodford (1997) |
| Backward-looking PC | $\rho^\pi$ | 0.80 | Fuhrer (1997) |
| Monetary Policy | | | |
| MP inertia | $\rho^i$ | 0.8 | Clarida et al. (2000) |
| Output gap weight | $\gamma^x$ | 0.5 | Taylor (1993) |
| Inflation weight | $\gamma^\pi$ | 1.5 | Taylor (1993) |
| **Panel B:** Interest Rates and Liquidity | | | |
| Discount rate | $\beta$ | 0.98 | |
| Steady-state inflation | $\bar{\Pi}$ | 2% | |
| Deposit rate pass-through | $\delta$ | 0.34 | Nagel (2016) |
| Bond liquidity weight | $\bar{\lambda}$ | 0.20 | Level Aaa-Tsy Spread |
| Persistence liquidity | $\rho^\lambda$ | 0.91 | AR(1) Aaa-Tsy Spread |

Note: This table contains the calibration parameters for the New Keynesian model with convenience yields. Parameters are reported in units corresponding to inflation and interest rates in annualized percent, and output gap in percent, that is we report $\frac{\psi}{4}$, $4\kappa$ and $4\gamma^x$ compared to natural quarterly units. The values for $\delta$ and $\rho^\lambda$ in the extension with direct liquidity-inflation link are identical to the baseline model and therefore not repeated.

## B.4 Additional Model Results

Figure A.4 shows the impulse responses to a monetary policy shock in our baseline model. We see that long-term convenience and inflation both decline in response to a monetary policy shock, whereas short-term convenience and the nominal policy rate increase. This happens because the monetary policy shock first drives up the policy rate, but then eventually causes overshooting in the policy rate, as inflation declines following the contractionary shock. The short-term spread increases, similarly to the increase in the policy rate. The long-term spread, which is forward-looking declines similarly to inflation.

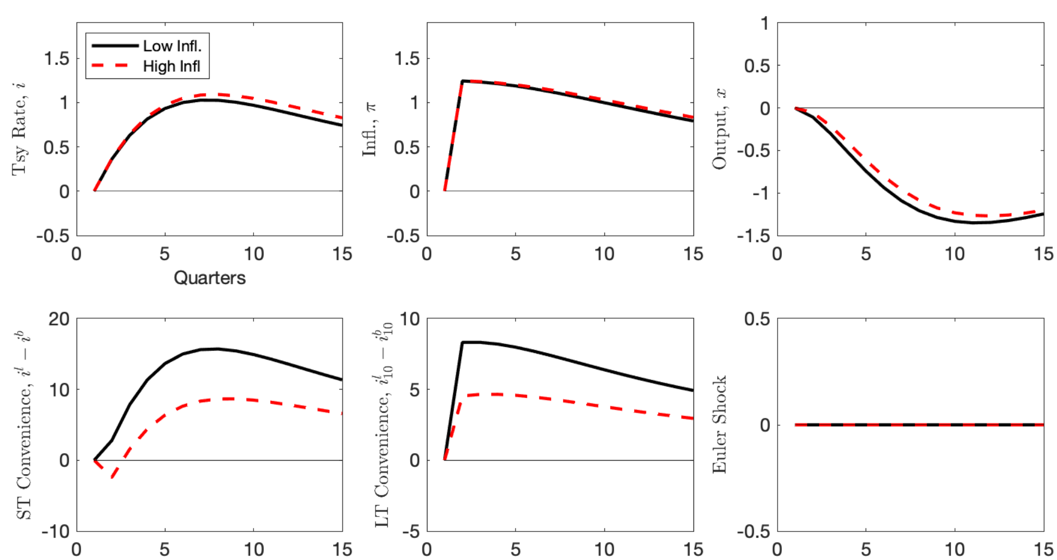
Figure A.4: Baseline Model Responses to a Monetary Shock




Note: This figure shows impulse responses to a monetary policy shock for our baseline model. The monetary policy shock is a positive 100 bps shock to the 3-month T-bill. Responses for inflation, $\pi$ and the Treasury rate $i^b$ are in annualized percent units. The response for the convenience spread $i^l - i^b$ is in annualized basis points units.The response for the output gap $x$ is in percent units. Quarters are shown on the x-axis.

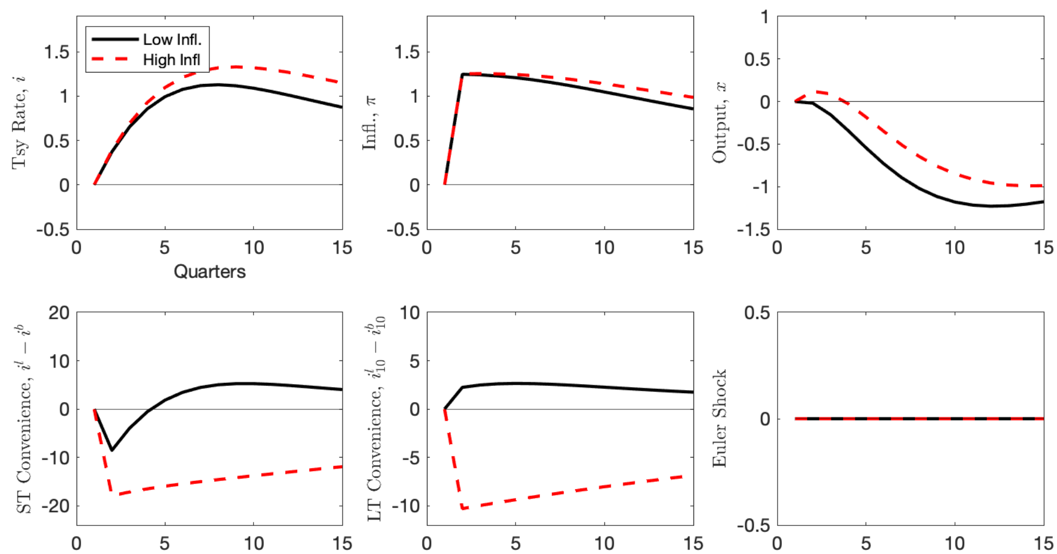
We also provide robustness for the alternative model, varying the magnitude of the direct inflation-liquidity link. Figures A.5 and A.6 report alternative versions of Figure 3.9 in the main paper. We see that the black convenience spread responses are robustly above the red dashed convenience spread responses, implying that the alternative model with a direct inflation-convenience link implies a *more negative* inflation-convenience relationship when inflation is high in steady-state, regardless of the strength of the direct inflation-convenience link parameter $b$. Of course, a stronger direct inflation-convenience link as in Figure A.6 leads to a more negative inflation-convenience spread regardless of steady-state inflation, but the gap between the red dashed and black convenience impulse responses are consistent across different values of $b$. Our key empirical result is about the change in the the inflation-convenience relationship during the high-inflation 1970s and 1980s vs. the low-inflation pref-WWII and 2000s periods, and of the opposite sign as implied by the alternative model across these different values for $b$.

Figure A.5: Alternative Model Responses to Cost-Push Shock with $b = 0.01$




Note: This figure is identical to Figure 3.9 in the main paper but sets $b = 0.01$ instead of $b = 0.02$.

Figure A.6: Alternative Model Responses to Cost-Push Shock with $b = 0.04$




Note: This figure is identical to Figure 3.9 in the main paper but sets $b = 0.04$ instead of $b = 0.02$.