Internet Appendix to "The U.S. Treasury Premium"

Wenxin Du, Joanne Im, Jesse Schreger [1]

The appendix contains a decomposition of the U.S. Treasury Premium (A), the Bloomberg and Thomson Reuters tickers used in the data analysis (Section B), supplementary charts and summary statistics (Section C), an extension of the bond supply regression (Section D), and regression and reduced form VAR results that comment on the explanatory power of different components in explaining variations in the U.S. Treasury Premium (Section E).

A Decomposition of the U.S. Treasury Premium

In this section, we provide a simple theoretical decomposition of the U.S. Treasury Premium into three components: convenience yield, credit risk, and swap market mispricing. The underlying assumption is that government bond markets and FX markets are integrated and priced by a global investor, which is a reasonable assumption for G10 countries. In this framework, the U.S. Treasury premium can exist for three reasons: convenience yield differentials, credit risk differentials, and swap market frictions.

A.1 Price of a U.S. Treasury Bond

Given a U.S. Treasury bond, let $\Lambda_{USD,t+1}$ denote the convenience benefit and $L_{USD,t+1}$ denote the default loss at time $t+1$. $\mathbb{E}_t^{USD}$ denotes the risk-neutral expectation at time t using the U.S. dollar numeraire. Then the price of a one-period U.S. Treasury bond is given by

$$P_{USD,t} = \exp(-y^{rf}_{USD,t})\mathbb{E}_t^{USD}[(1+\Lambda_{USD,t+1})(1-L_{USD,t+1})],$$

[1] *Citation format: Du, Wenxin, Joanne Im, and Jesse Schreger, Internet Appendix for "The U.S. Treasury Premium," Journal of International Economics (2018), doi: 10.1016/j.jinteco.2018.01.001. Please note: Elsevier is not responsible for the content or functionality of any additional information provided by the authors. Any queries (other than missing matieral) should be directed to the authors of the article.*

and the yield on the U.S. Treasury is

$$
\begin{aligned}
y^{Govt}_{USD,t} &= y^{rf}_{USD,t} - \ln \mathbb{E}^{USD}_t[(1+\Lambda_{USD,t+1})(1-L_{USD,t+1})] \\
&= y^{rf}_{USD,t} - \ln[\mathbb{E}^{USD}_t(1+\Lambda_{USD,t+1})\mathbb{E}^{USD}_t(1-L_{USD,t+1}) + Cov^{USD}_t(1+\Lambda_{USD,t+1}, 1-L_{USD,t+1})] \\
&= y^{rf}_{USD,t} - \ln \mathbb{E}^{USD}_t(1+\Lambda_{USD,t+1}) - \ln \mathbb{E}^{USD}_t(1-L_{USD,t+1}) \\
&\quad - \ln\left[1 + \frac{Cov^{USD}_t(1+\Lambda_{USD,t+1}, 1-L_{USD,t+1})}{\mathbb{E}^{USD}_t(1+\Lambda_{USD,t+1})\mathbb{E}^{USD}_t(1-L_{USD,t+1})}\right] \qquad \text{(A1)} \\
&= y^{rf}_{USD,t} - \lambda_{USD,t} + l_{USD,t} - \xi_{USD,t}, \qquad \text{(A2)}
\end{aligned}
$$

where $y^{rf}_{USD,t}$ is the hypothetical dollar risk-free rate, $\lambda_{USD,t}$ is the convenience premium, $l_{USD,t}$ is the default premium, and $\xi_{USD,t}$ is the covariance between convenience and default risk.

If the U.S. Treasury bond is default-free, we have $l_{USD,t} = 0$ and $\xi_{USD,t} = 0$, and then $y^{Govt}_{USD,t} = y^{rf}_{USD,t} - \lambda_{USD,t}$. In other words, the Treasury yield can be lower than the hypothetical dollar risk-free rate if the Treasury obligation earns a convenience yield over the private, risk-free obligation.

A.2 Price of a Foreign Government Bond

Now we price a one-period foreign government bond in an analogous way. Let $L_{i,t+1}$ denote the default loss at $t+1$ on a government bond of country i, and $\Lambda_{i,t+1}$ be the convenience benefit at $t+1$ for holding the bond. Let $y^{rf}_{i,t}$ be the hypothetical risk-free rate for currency i.

$$P_{i,t} = \exp(-y^{rf}_{i,t})\mathbb{E}_t[(1+\Lambda_{i,t+1})(1-L_{i,t+1})]$$

Based on the derivation for the U.S. Treasury yield, we have

$$y^{Govt}_{i,t} = y^{rf}_{i,t} - \lambda_{i,t} + l_{i,t} - \xi_{i,t}.$$

The hypothetical risk-free rate in currency i, $y^{rf}_{i,t}$, is connected to the hypothetical U.S. risk-free rate as follows

$$y^{rf}_{i,t} = y^{rf}_{USD,t} + \tilde{\rho}_{i,t}, \tag{A3}$$

where $\tilde{\rho}_{i,t}$ is the hypothetical forward premium in a frictionless market given by the CIP relationship for the risk-free rates $y^{rf}_{i,t}$ and $y^{rf}_{USD,t}$.

Therefore, we can write the foreign bond yield as

$$y^{Govt}_{i,t} = y^{rf}_{USD,t} + \tilde{\rho}_{i,t} - \lambda_{i,t} + l_{i,t} - \xi_{i,t}. \tag{A4}$$

Once again, if the foreign government bond is default-free, we have $l_{i,t} = 0$ and $\xi_{i,t} = 0$, so $y^{Govt}_{i,t} = y^{rf}_{USD,t} + \tilde{\rho}_{i,t} - \lambda_{i,t}$. The foreign yield can differ from the dollar risk-free rate due to currency risk and the convenience benefit.

We let the hypothetical forward premium in a frictionless market $\tilde{\rho}_{i,t}$ be the sum of the observed $\rho_{i,t}$ and a wedge due to swap market frictions, $\tau_{i,t}$:

$$\tilde{\rho}_{i,t} = \rho_{i,t} + \tau_{i,t}. \tag{A5}$$

By substituting Equation A5 into Equation A4, we can write the foreign government bond yield as[2]

$$y^{Govt}_{i,t} = y^{rf}_{USD,t} + (\rho_{i,t} + \tau_{i,t}) - \lambda_{i,t} + l_{i,t} - \xi_{i,t}. \tag{A6}$$

[2] Our theoretical decomposition focuses on the pricing of one-period bonds. We assume the intermediate spread $\tau_{i,t}$ is known ex ante and do not consider the covariance between the $\tau_{i,t}$ and $\lambda_{i,t}$ entering the spread. However, once we extend to multi-period bond, the covariance between $\tau_{i,t}$ and $\lambda_{i,t}$ could matter for bond pricing.

A.3 Components of the U.S. Treasury Premium

Using Equations A4 and A6, the U.S. Treasury Premium, denoted by Φ, is then given by:

$$
\begin{aligned}
\Phi_{i,t} &\equiv y_{i,t}^{Govt} - \rho_{i,t} - y_{USD,t}^{Govt} \\
&= [y_{USD,t}^{rf} + \tilde{\rho}_{i,t} - \lambda_{i,t} + l_{i,t} - \xi_{i,t}] - \rho_{i,t} - (y_{USD,t}^{rf} - \lambda_{USD,t} + l_{USD,t} - \xi_{USD,t}) \\
&= \hat{\lambda}_{i,t} + \tau_{i,t} - \hat{l}_{i,t} + \hat{\xi}_{i,t} \\
&\approx \hat{\lambda}_{i,t} + \tau_{i,t} - \hat{l}_{i,t}, \qquad \text{(A7)}
\end{aligned}
$$

where $\hat{x}_{i,t} \equiv x_{USD,t} - x_{i,t}$. We assume that the difference in the covariances between currency and the convenience yield is negligible, i.e., $\hat{\xi}_{i,t} = 0$. Therefore, the U.S. Treasury Premium can be decomposed into (1) the difference in convenience premia, (2) an intermediation spread arising from frictions in the swap market, and (3) the difference in default risk..

B Bloomberg and Thomson Reuters Tickers

In this section, we list the Bloomberg and Thomson Reuters tickers used in the data analysis.

Table A2: Bloomberg and Thomson Reuters Eikon Tickers For Convenience Yield Measures

	Series		
	GC Repo Rate	BFV Agency Yield	Government Yields
USD	US3MRP=	C0915Y Index	C0795Y Index
EUR	EUR3MRP=	C9325Y Index	C9105Y Index
JPY	JPY3MRP=	C2215Y Index	C1055Y Index

Notes: This table lists the Bloomberg and Thomson Reuters Eikon tickers for the repo rate, agency yields, and government yields. Column 1 lists the Thomson Reuters Eikon Tickers for 3-month Treasury GC repo rates in their respective countries. Columns 2-3 list the Bloomberg Tickers for 5-year BFV Agency and Government par yields in their respective countries. EUR denotes Germany.

Table A1: Bloomberg Tickers: IRS, Basis Swaps, Government Yields, Policy Rates, OIS Swap Rates

	Series					
Currency	IRS	Basis Swaps	Government Yields	Policy Rates	OIS Swap Rates	VIX
USD	USSW## Curncy		C082##Y Index	FEDL01 Index	USSO## Curncy	VIX Index
EUR	EUSW##V3, EUSA## Curncy	EUBS## Curncy	C910##Y Index	EUORMARG Index	EUSWE## Curncy	
GBP	BPSW##V3, BPSW## Curncy	BPBS## Curncy	C110##Y Index	UKBRBASE Index	BPSWS## Curncy	
CHF	SFSW##V3, SFSW## Curncy	SFBS## Curncy	C256##Y Index	SZLTTR Index	SFSWT## Curncy	
JPY	JYSW## Curncy, JYBC## Curncy	JYBS## Curncy	C105##Y Index	MUTKCALM Index	JYSO## Curncy	
AUD	ADSWAP## Curncy	ADBS## Curncy	C127##Y Index	RBACOR Index	ADSO## Curncy	
CAD	CDSW## Curncy	CDBS## Curncy	C101##Y Index	CABROVER Index	CDSO## Curncy	
NZD	NDSWAP## Curncy	NDBS## Curncy	C250##Y Index	NZOCR Index	NDSO10## Curncy	
NOK	NKSW## Curncy, NKBFV## Curncy	NKBS## Curncy	C266##Y Index	NOBRDEP Index		
SEK	SKSW## Curncy	SKBS## Curncy	C259##Y Index	SWBRDEP Index		
DKK	DKSW## Curncy	DKBS## Curncy	C267##Y Index	DEBRDISC Index		

Notes: This table lists the Bloomberg tickers used to construct the U.S. Treasury Premium for each country. The ## denotes the maturity of the contract. EUR denotes Germany.

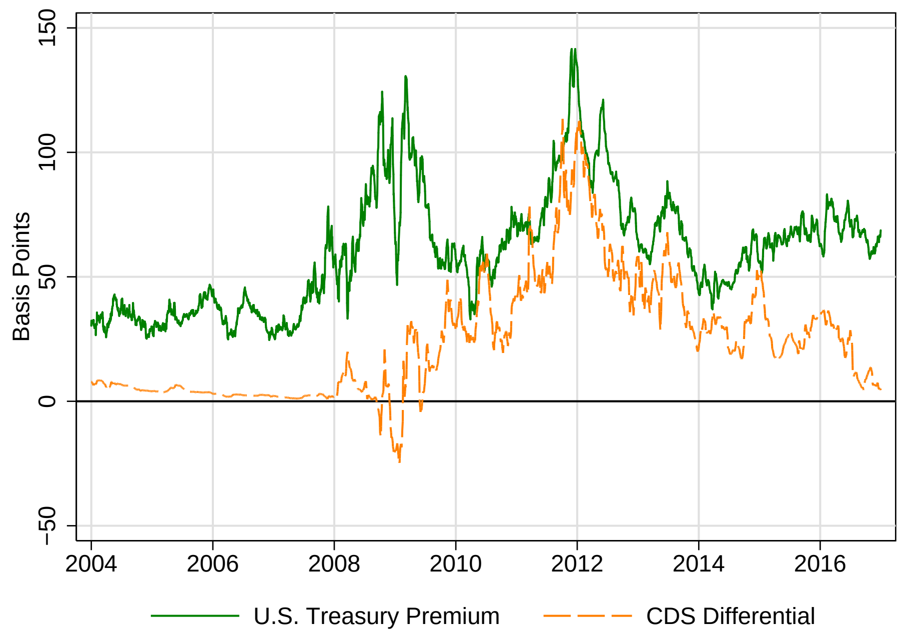
C Supplementary Charts and Regressions

In this section, we show supplementary charts and regression results: a chart of the U.S. Treasury Premium and the CDS differential vis-à-vis Japan may be found in Section C1, summary statistics of the 5-year premium adjusted for CIP deviations in LIBOR, and the 5-year premium adjusted for CIP deviations in LIBOR and credit differentials by country may be found in Section C2, and a chart showing the five-year swap spreads in the United States and foreign countries in Section C3.

C.1 Treasury Premia and CDS Differentials

A1 shows the U.S. Treasury Premium vis-à-vis Japan versus the Japan-U.S. sovereign CDS differential. Of our sample, Japan's Treasury has the lowest credit rating and the U.S. Treasury Premium defined vis-à-vis Japan displays moderate co-movement with the CDS differential, similar to the pattern we document for emerging markets in (Du and Schreger, 2016).

Figure A1: Japan: U.S. Treasury Premium vs. CDS Differential



Notes: This figure plots seven-day moving averages of the U.S. Treasury Premium against Japan (in solid green) and the Japan-U.S. sovereign CDS differential (in dashed orange). Series are seven-day moving averages.

C.2 Summary Statistics for Adjusted U.S. Treasury Premium

The secular decline in the U.S. Treasury Premium not only holds when the premium is adjusted for swap frictions and sovereign credit spread differentials, but also is more pronounced.

A3 reports the summary statistics of the 5-year premium adjusted for CIP deviations in LIBOR, and A4 reports the summary statistics of the 5-year premium adjusted for CIP deviations in LIBOR and credit differentials. Compared to the 5-year U.S. Treasury Premium, both series declined more sharply over our sample. The premia adjusted for CIP deviations in LIBOR trended down 44 basis points from 2000-2016, declining from a pre-crisis average of 22.0 basis points before the GFC to -22.4 basis points. post-GFC. The premia adjusted for CIP deviations in LIBOR and credit differentials trended down 51 basis points from 2000-2016, declining from a pre-crisis average of 13.1 basis points to -38.0 basis points.

Table A3: Summary Statistics of the 5-year Premium Adjusted for CIP Deviations in LIBOR, Φ^{CIP}

		Full Sample	2000-2006	2007-2009	2010-2016
AUD	Mean	-9.2***	14.6***	-6.6	-33.8***
	Std. Error	(3.2)	(2.9)	(5.0)	(2.5)
	N	4406	1797	783	1826
CAD	Mean	14.8***	34.9***	40.3***	-13.9***
	Std. Error	(3.9)	(2.7)	(7.9)	(3.7)
	N	4215	1609	782	1824
CHF	Mean	8.4***	26.4***	27.5***	-15.6***
	Std. Error	(3.1)	(2.8)	(5.1)	(2.1)
	N	4186	1603	770	1813
DKK	Mean	-1.8	29.1***	26.3***	-40.8***
	Std. Error	(4.3)	(1.9)	(2.8)	(2.2)
	N	4201	1599	776	1826
EUR	Mean	3.5	32.0***	23.4***	-31.4***
	Std. Error	(3.9)	(1.5)	(3.4)	(2.4)
	N	4287	1692	770	1825
GBP	Mean	0.8	12.2***	4.7	-11.7***
	Std. Error	(1.9)	(1.4)	(5.0)	(2.2)
	N	4220	1665	775	1780
JPY	Mean	30.6***	45.2***	51.3***	7.3**
	Std. Error	(3.1)	(3.5)	(5.1)	(2.9)
	N	4397	1787	784	1826
NOK	Mean	-15.7***	10.3***	-2.6	-43.8***
	Std. Error	(3.9)	(2.1)	(3.9)	(5.1)
	N	4110	1545	772	1793
NZD	Mean	-9.2***	-11.4***	-7.9	-8.1*
	Std. Error	(3.4)	(4.0)	(11.1)	(4.7)
	N	3912	1307	780	1825
SEK	Mean	-3.7	17.8***	17.6***	-31.9***
	Std.Dev.	(3.3)	(1.6)	(2.1)	(2.8)
	N	4235	1630	779	1826
Total	Mean	2.0*	22.0***	17.4***	-22.4***
	Std. Error	(1.2)	(1.2)	(2.5)	(1.4)
	N	42169	16234	7771	18164

Significance levels: * $p<0.10$ ** $p<0.05$ *** $p<0.01$

Notes: This figure table reports the mean, standard error of the mean based on Newey-West standard errors with a 91-day lag, and number of observations of the 5-year premium adjusted for CIP deviations by LIBOR by country, and period (pre-GFC (2000-2006), GFC (2007-2009), post-GFC (2010-2016)). EUR denotes Germany.

Table A4: Summary Statistics of the 5-Year Premium Adjusted for CIP Deviations in LIBOR and CDS Differentials, $\Phi^{CIP,CDS}$

		Full Sample	2000-2006	2007-2009	2010-2016
AUD	Mean	-34.5***	-1.2	-21.2***	-55.3***
	Std. Error	(4.1)	(1.2)	(4.9)	(4.4)
	N	3345	790	782	1773
CAD	Mean	-2.3	22.6***	32.3***	-23.8***
	Std. Error	(4.7)	(1.1)	(12.4)	(3.5)
	N	2944	711	541	1692
CHF	Mean	-25.4***		-19.9***	-26.2***
	Std. Error	(2.1)		(7.2)	(2.2)
	N	2013		253	1760
DKK	Mean	-21.5***	23.8***	17.2***	-57.4***
	Std. Error	(6.4)	(1.3)	(4.1)	(6.4)
	N	3288	740	776	1772
EUR	Mean	-10.1*	29.1***	26.6***	-43.6***
	Std. Error	(5.7)	(1.)	(3.1)	(5.2)
	N	3341	798	770	1773
GBP	Mean	-24.2***	11.5***	-13	-32.4***
	Std. Error	(-3.7)	(2.0)	(8.4)	(3.2)
	N	2657	153	775	1729
JPY	Mean	-0.5	28.5***	44***	-33.0***
	Std. Error	(5.2)	(1.4)	(6.9)	(2.4)
	N	3342	785	784	1773
NOK	Mean	-18.3***	7.7***	4.1	-39.9***
	Std. Error	(4.5)	(-1.8)	(5.9)	(-5.4)
	N	3290	778	772	1740
NZD	Mean	-33.2***	-32.6***	-33.1***	-33.5***
	Std. Error	(2.9)	(3.2)	(5.5)	(4.3)
	N	3114	569	773	1772
SEK	Mean	-15.1***	16.9***	4.6	-34.7***
	Std.Dev.	(4.)	(1.5)	(4.5)	(-4.1)
	N	3156	604	779	1773
Total	Mean	-18.2***	13.1***	5.0	-38.0***
	Std. Error	(1.6)	(1.9)	(3.1)	(1.5)
	N	30490	5928	7005	17557

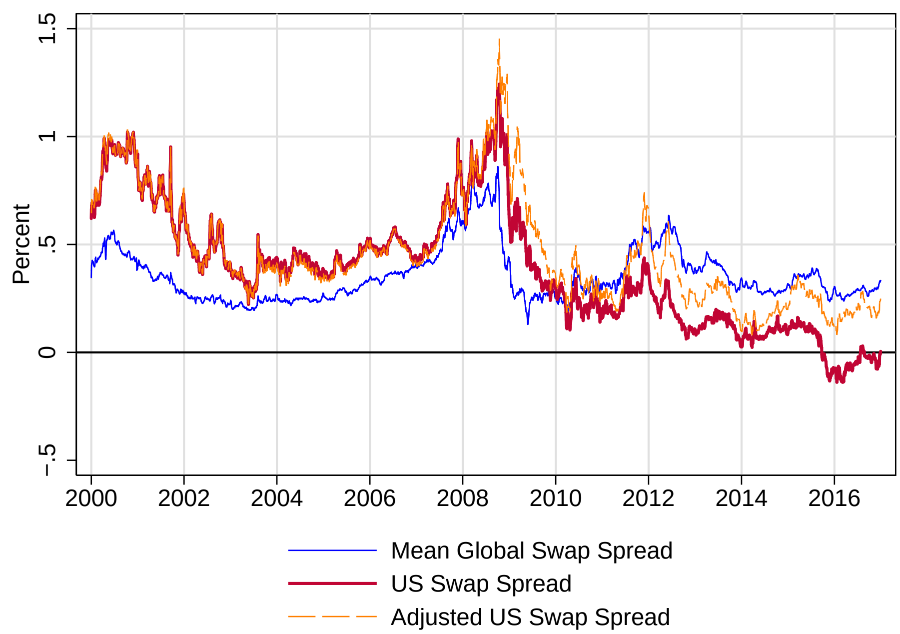
Significance levels: * $p<0.10$ ** $p<0.05$ *** $p<0.01$

Notes: This figure table reports the mean, standard error of the mean based on Newey-West standard errors with a 91-day lag, and number of observations of the 5-year premium adjusted for CIP deviations in LIBOR and CDS differentials by country, and period (pre-GFC (2000-2006), GFC (2007-2009), post-GFC (2010-2016)). Statistics are not reported for Switzerland (CHF) for 2000-2006 because of the lack of data on CDS spreads. EUR denotes Germany.

C.3 Swap Spread Decomposition

As discussed in Section 3.3, A2 plots five-year U.S. swap spread between the U.S. Libor interest rate swap rate and the U.S. Treasury yield in red, the average U.S. adjusted U.S. swap spread between the foreign interest rate swap rate and the swapped U.S. Treasury yield in orange, and the average foreign swap spread between the foreign interest rate swap rate and the foreign Treasury yield. We can see a notable decline in the two U.S. swap spread measures.

Figure A2: Five-Year Swap Spreads



Notes: This figure plots the mean 5-year foreign swap spread (in solid blue), the five-year U.S. swap spread over the U.S. Libor interest rate swap (in solid red), and the mean adjusted U.S. swap spread over the foreign interest rate swap (in dashed orange). Series are seven-day moving averages.

D Supplementary Analysis on Effects of Government Bond Supply on the U.S. Treasury Premium

In this section, we report results on a version of the bond supply regressions where bond supply is defined as the log of the ratio of federal debt (including central bank purchases) and nominal GDP. As noted in the main text, our general regression framework is given by:

$$\Phi_{i,n,t} = \alpha + \beta \cdot \log\left(\frac{debt}{GDP}\right)_{USD,t} + \gamma \cdot \log\left(\frac{debt}{GDP}\right)_{it} + \zeta \cdot X_{i,t} + \epsilon_{i,t}, \tag{A8}$$

where $\log\left(\frac{debt}{GDP}\right)_{USD,t}$ is the log of the U.S. debt to GDP ratio at time t, $\log\left(\frac{debt}{GDP}\right)_{i,t}$ is the log of country i's debt to GDP ratio at time t, and $X_{i,t}$ is a set of additional covariates motivated by (Nagel, 2016). In particular, $X_{i,t}$ includes the U.S. Policy Rate (the Federal Funds rate), the country i policy rate, and the VIX, which is the CBOE Volatility Index and measures the market expectation of 30-day volatility in the S&P 500. In columns 1-4, we estimate the regressions in levels, and in columns 5-8 we estimate the regressions in changes at the quarterly frequency from 2000-2016. In the even numbered columns, we include country fixed effects and in the odd number columns we omit these fixed effects. As we noted in our interpretation of the baseline model, given the short sample period, the results should be interpreted conservatively.

The results correspond in magnitude, sign, and significance with the results obtained when the measure of bond supply netted out central bank purchases.

Table A5: Effects of Government Bond Supply on the U.S. Treasury Premium (Quarterly Frequency, 2000-2016)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Φ_{5Y}	Φ_{5Y}	Φ_{5Y}	Φ_{5Y}	$\Delta\Phi_{5Y}$	$\Delta\Phi_{5Y}$	$\Delta\Phi_{5Y}$	$\Delta\Phi_{5Y}$
$\log\left(\frac{debt}{GDP}\right)_t^{USD}$	-67.94***	-60.28***	-70.52***	-48.00***				
	(7.844)	(8.365)	(11.73)	(10.98)				
$\log\left(\frac{debt}{GDP}\right)_{it}$	27.74***	4.302	16.80***	5.268				
	(2.601)	(5.705)	(2.566)	(4.123)				
Policy Rate$_t$			-0.0807***	-0.0153				
			(0.0123)	(0.0162)				
U.S. Policy Rate$_t$			0.0462***	0.0234*				
			(0.00962)	(0.0124)				
VIX$_t$			0.0136***	0.0115***				
			(0.00300)	(0.00303)				
$\Delta\log\left(\frac{debt}{GDP}\right)_t^{USD}$					-67.68	-67.81	-113.2*	-113.4*
					(72.78)	(72.81)	(64.55)	(64.66)
$\Delta\log\left(\frac{debt}{GDP}\right)_{it}$					15.45*	15.61*	9.165	9.079
					(8.576)	(8.912)	(9.003)	(9.375)
Δ Policy Rate$_t$							-0.0559***	-0.0563***
							(0.0128)	(0.0129)
Δ U.S. Policy Rate$_t$							-0.000237	-0.000141
							(0.0171)	(0.0170)
Δ VIX$_t$							0.00492***	0.00493***
							(0.00172)	(0.00172)
Constant	19.71***	-35.27***	-9.324	-51.23***	-0.125	-0.797	0.0430	-0.590
	(3.243)	(10.82)	(6.244)	(10.26)	(0.761)	(1.133)	(0.849)	(1.132)
Observations	670	670	670	670	660	660	660	660
R-squared	0.387	0.638	0.555	0.693	0.007	0.008	0.075	0.075
Country FE	No	Yes	No	Yes	No	Yes	No	Yes

Significance levels: * $p<0.10$ ** $p<0.05$ *** $p<0.01$

Notes: The table reports panel regression results of the level and differences of the 5-year U.S. Treasury Premium on country level and U.S. variables that proxy for the scarcity of government bonds. Heteroskedasticity autocorrelation spatial correlation robust standard errors were used with a 8 quarter lag. The variable $\log\left(\frac{debt}{GDP}\right)_{it}$ is the ratio of the country's federal debt to nominal GDP and the variable $\log\left(\frac{debt}{GDP}\right)_t^{USD}$ is the ratio of the United States' federal debt to nominal GDP. The debt/GDP measures include central bank purchases. The variable Policy Rate is the country-specific policy rate, the variable Policy Rate$_{USD}$ is the U.S. policy rate, and the VIX is the CBOE Volatility Index. All data are at the quarterly frequency and span 2000-2016. The U.S. Treasury Premium is from the authors' calculations using data from Bloomberg. Data on federal debt and nominal GDP are from Haver Analytics.

E Variance Analysis of the U.S. Treasury Premium

In this section, we examine the explanatory power of credit differentials, swap market frictions, and the residual convenience yield factor in explaining the total variation in the U.S. Treasury Premium. Table A6 shows panel regression results of changes in the U.S. Treasury Premium on changes in swap market frictions and changes in the CDS differential at the daily, weekly, and monthly frequency. The coefficient on the swap market friction, as measured by CIP deviations for the interbank rates, is very close to 1. However, the coefficient on the CDS differential is small and slightly negative, which suggests CDS differentials have a limited role in driving the U.S. Treasury Premium. The R^2 of the regressions with both CIP deviations and the CDS spread is 5% at the daily frequency and 25% at the monthly frequency. This implies a large fraction of total variations in the U.S. Treasury Premium can be attributed to the residual convenience yield factor.

Table A6: Panel Regression of Changes in the 5-Year Unadjusted U.S. Treasury Premium (Varying Frequencies, 2000-2016)

	(1)	(2)	(3)
	$\Delta\Phi_{5Y}$	$\Delta\Phi_{5Y}$	$\Delta\Phi_{5Y}$
$\Delta\tau$	0.983***	1.185***	1.170***
	(0.0581)	(0.0708)	(0.109)
$\Delta\hat{l}_i$	-0.0501***	0.00319	-0.105*
	(0.0191)	(0.0288)	(0.0601)
Constant	-0.00729	-0.0964	-0.502*
	(0.0113)	(0.0636)	(0.282)
Observations	29,004	4,459	1,037
R-squared	0.039	0.188	0.247
Frequency	Daily	Weekly	Monthly

Significance levels: * p<0.10 ** p<0.05 *** p<0.01

Notes: The table reports results from panel regressions of changes in the 5-year U.S. Treasury Premium on changes in the LIBOR CIP deviation, defined as the difference between the swapped foreign interbank rate and the U.S. Libor rate and the CDS differential at the daily, weekly, and monthly frequency. Heteroskedasticity autocorrelation spatial correlation robust standard errors were used with 65 lags at the daily frequency, 13 lags at the weekly frequency, and 3 lags at the monthly frequency. The variable $\Delta\tau$ is changes in LIBOR CIP deviations; and the variable $\Delta\hat{l}_i$ is changes in the CDS differential, defined as the foreign sovereign's CDS spread on a 5-year senior, unsecured contract. Data range from 2005-2016. The U.S. Treasury Premium is from the authors' calculations using data from Bloomberg. Data on CIP deviations are from Bloomberg; data on CDS differentials are from Mark.it.

To take into account dynamic interactions among these factors, we present results from individual country vector autoregressions (VAR). For each country in our sample, we estimate a dynamic system based on quarterly time series for three variables: the CDS differential, CIP deviations, and the U.S. Treasury Premium, in that order.

$$\begin{bmatrix} \hat{l}_{i,t-l} \\ \tau_{i,t-l} \\ \Phi_{5Y,i,t-l} \end{bmatrix} = A_1(L) \begin{bmatrix} \hat{l}_{i,t-1} \\ \tau_{i,t-1} \\ \Phi_{5Y,i,t-1} \end{bmatrix} + A_2(L) \begin{bmatrix} \hat{l}_{i,t-2} \\ \tau_{i,t-2} \\ \Phi_{5Y,i,t-2} \end{bmatrix} + A_3(L) \begin{bmatrix} \hat{l}_{i,t-3} \\ \tau_{i,t-3} \\ \Phi_{5Y,i,t-3} \end{bmatrix} +$$

$$A_4(L) \begin{bmatrix} \hat{l}_{i,t-4} \\ \tau_{i,t-4} \\ \Phi_{5Y,i,t-4} \end{bmatrix} + B \begin{bmatrix} u_{i,t} \\ \epsilon_{i,t} \\ \xi_{i,t} \end{bmatrix}$$

Formal lag selection procedures (the Akaike information criterion (AIC), the Hannan and Quinn criterion, (HQ) and the Schwarz Criterion (SC)) suggest one to four lags. Given our relatively small sample of quarterly observations (34 to 53 quarters), we used the Edgerton and Shukur test to test the null hypothesis of residual autocorrelation. Across currencies, only a model with four lags rejects the null hypothesis for all currencies. We therefore choose four lags. For model stability, we want eigenvalues to be less than one; a formal test confirms all eigenvalues lie inside a unit circle. We triangularize the shocks using an upper triangular Cholesky decomposition, calling the first shock a CDS shock; the second, a CIP shock; and the third, a residual convenience yield shock. We then use the estimated VAR system to analyze the dynamic effect of the shocks via a historical decomposition and variance decomposition.

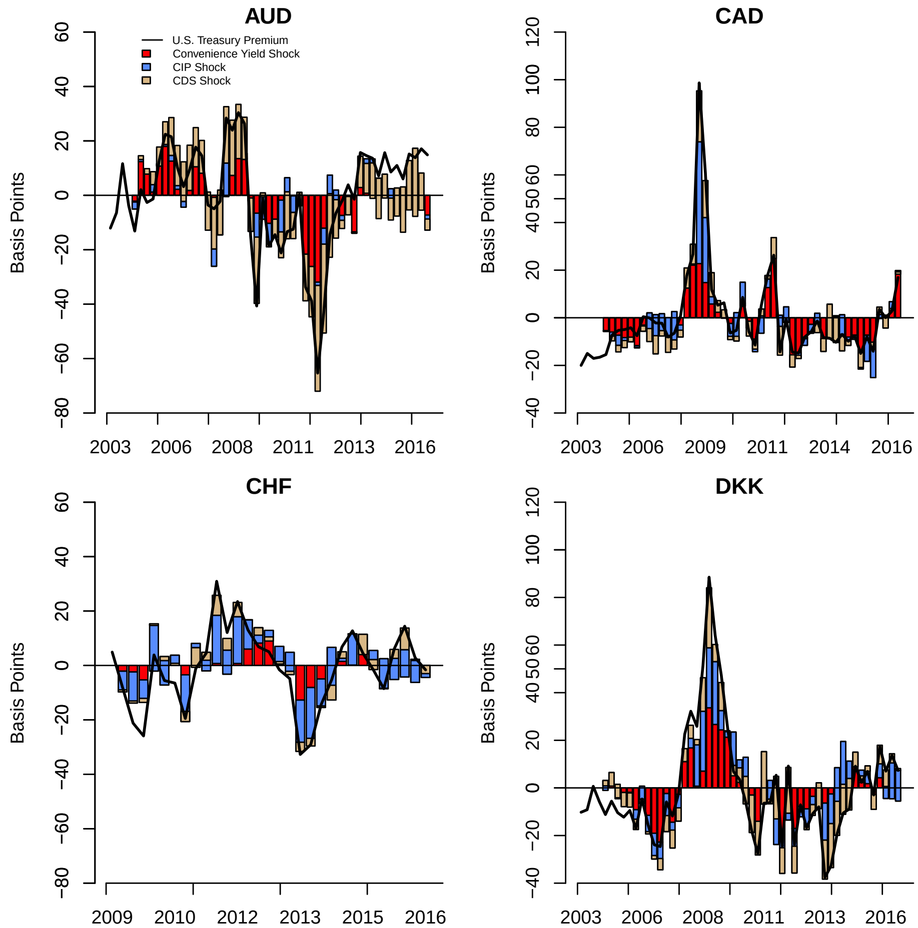
We find the contribution of the convenience yield shock to the forecast error to be sizable across countries despite some variation in the exact percentage. Table A7 shows variance decomposition results based on the 8-quarter forecasting horizon. The average contribution across countries is 20% for the CDS shock, 33% for the CIP shock, and 47% for the residual convenience yield shock. The historical decompositions of the five-year U.S. Treasury Premium by country are shown in Figure A3. We can see that the residual convenience yield shocks (in red) play an important role in all countries, especially in Denmark, Europe, Norway, and Germany.

Table A7: Proportion of Forecast Error 8 Quarters Ahead Produced By Each Innovation: 5-Year U.S. Treasury Premium (Quarterly Frequency, 2000-2016)

	Triangularized innovation		
	CDS Shock	CIP Shock	Convenience Yield Shock
AUD	0.58	0.05	0.37
CAD	0.13	0.41	0.47
CHF	0.12	0.66	0.22
DKK	0.21	0.25	0.54
EUR	0.06	0.26	0.68
GBP	0.19	0.37	0.44
JPY	0.39	0.35	0.26
NOK	0.19	0.21	0.59
NZD	0.06	0.02	0.92
SEK	0.07	0.67	0.26
Avg.	0.20	0.33	0.47
Std. Dev.	0.16	0.21	0.21

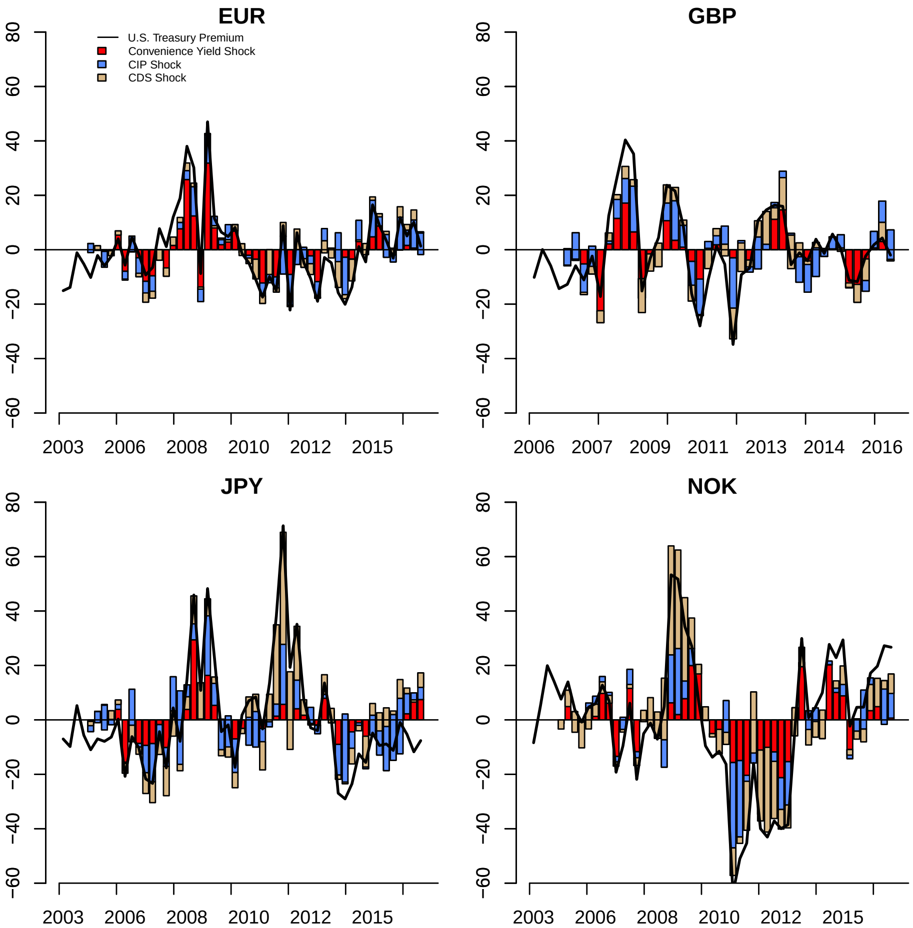
Notes: This table reports the variance decomposition of the 5-year U.S. Treasury Premium from a four-lag reduced form VAR of three variables: the CDS differential, CIP deviations, and the 5-year U.S. Treasury Premium, in that order. Orthogonalized shocks were obtained by taking the upper triangular Cholesky decomposition of residuals. EUR denotes Germany.

Figure A3: Historical Decomposition of the 5-Year Unadjusted U.S. Treasury Premium (Quarterly Frequency, 2000-2016)



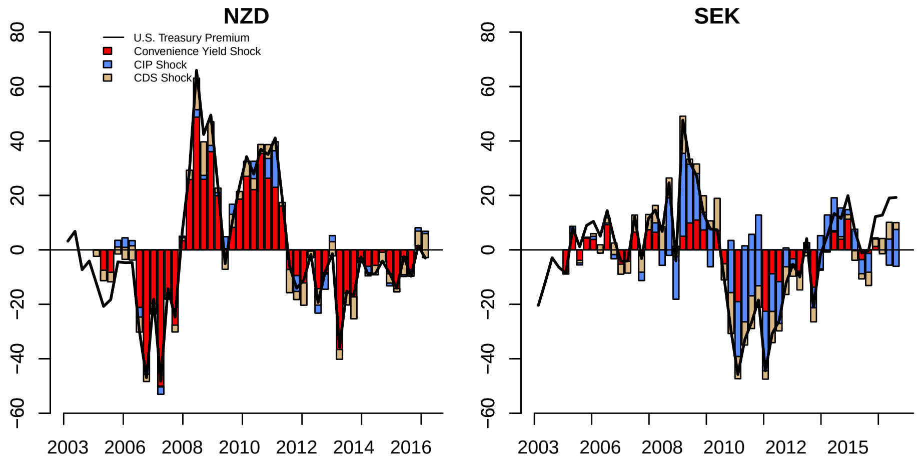
Notes: This figure plots the cumulative contribution of each structural shock to the evolution of the 5-year U.S. Treasury Premium over time. Structural shocks were obtained by taking the upper triangular Cholesky decomposition of residuals from a four-lag, reduced form VAR of three variables: the CDS differential, CIP deviations, and the 5-year U.S. Treasury Premium, in that order. Bars in red represent the contribution of a convenience yield shock; bars in blue, a CIP shock; bars in gold, a CDS shock. The black line is the demeaned, and detrended U.S. Treasury Premium.

Figure A3: (Continued) Historical Decomposition of the 5-Year U.S. Treasury Premium (Quarterly Frequency, 2000-2016)



Notes: This figure plots the cumulative contribution of each structural shock to the evolution of the 5-year U.S. Treasury Premium (demeaned and detrended) over time. Structural shocks were obtained by taking the upper triangular Cholesky decomposition of residuals from a four-lag, reduced form VAR of three variables: the CDS differential, CIP deviations, and the 5-year U.S. Treasury Premium, in that order. Bars in red represent the contribution of a convenience yield shock; bars in blue, a CIP shock; bars in gold, a CDS shock. The black line is the demeaned, and detrended U.S. Treasury Premium. EUR denotes Germany.

Figure A3: (Continued) Historical Decomposition of the 5-Year U.S. Treasury Premium (Quarterly Frequency, 2000-2016)



Notes: This figure plots the cumulative contribution of each structural shock to the evolution of the 5-year U.S. Treasury Premium (demeaned and detrended) over time. Structural shocks were obtained by taking the upper triangular Cholesky decomposition of residuals from a four-lag reduced form VAR of three variables: the CDS differential, CIP deviations, and the 5-year U.S. Treasury Premium, in that order. Bars in red represent the contribution of a convenience yield shock; bars in blue, a CIP shock; bars in gold, a CDS shock. The black line is the demeaned, and detrended U.S. Treasury Premium.

References

Du, W. AND J. SCHREGER (2016a): “Local Currency Sovereign Risk,” *Journal of Finance*, 71, 1027-1070.

NAGEL, S. (2016): “The Liquidity Premium of Near-Money Assets,” *Quarterly Journal of Economics*, 131, 1927-1971.