Foreign Safe Asset Demand and the Dollar Exchange Rate

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Abstract

- We develop a theory that links the U.S. dollar's valuation in FX markets to the **convenience yield** that foreign investors derive from holding U.S. safe assets
- **Convenience Yield:** measured by Treasury basis, the yield gap between U.S. government and currency-hedged foreign government bonds
- Consistent with the theory, a widening of the basis coincides with an immediate appreciation and a subsequent depreciation of the dollar
- Lend empirical support to models that impute a special role to the United States as the world's provider of safe assets and the dollar as the world's reserve currency

- In the postwar era, investors forgo a sizeable return, the convenient yield, to own safe assets in the United States
- During episodes of global financial instability, there is a flight to the safety of U.S. Treasury bonds as the convenience yield on Treasurys rises, and the dollar appreciates in foreign currency markets
- The role of the United States as the world's safe asset supplier has shaped the dynamics of the dollar exchange rate
- We derive a novel expression for the dollar exchange rate as the expected value of all future interest rate differences and convenience yields less the value of all future currency risk premia
- Our theory predicts that a country's exchange rate will appreciate whenever foreign investors increase their valuation of the current and future convenience properties of that country's safe assets

Related Literature

- Our results lend empirical support to theories of the United States as the provider of safe assets
- Our paper adds to a separate literature considers the special role of the U.S. dollar and U.S. asset markets in the world economy (Gourinchas and Rey (2007a), Gourinchas, Rey, and Govillot (2011), and Maggiori (2017); Gopinath (2015); Lustig, Roussanov, and Verdelhan (2014))
- Our empirical approach is directly related to four recent papers

The U.S. Treasury Basis: Stylized Facts

We define the U.S. Treasury basis as the difference between the yield on a cash position in U.S. Treasurys $y_t^{\$}$ and the synthetic dollar yield constructed from a cash position in a foreign government bond, which earns a yield y_t^* in foreign currency, which is hedged back into dollars:

$$x_t^{Treas} \equiv y_t^{\$} + (f_t^1 - s_t) - y_t^*$$

- s_t: the log of the nominal exchange rate in units of foreign currency per dollar
- f_t^1: the log of the forward exchange rate
- A negative U.S. Treasury basis means that U.S. Treasurys are expensive relative to their foreign counterparts

U.S. LIBOR and Treasury bases

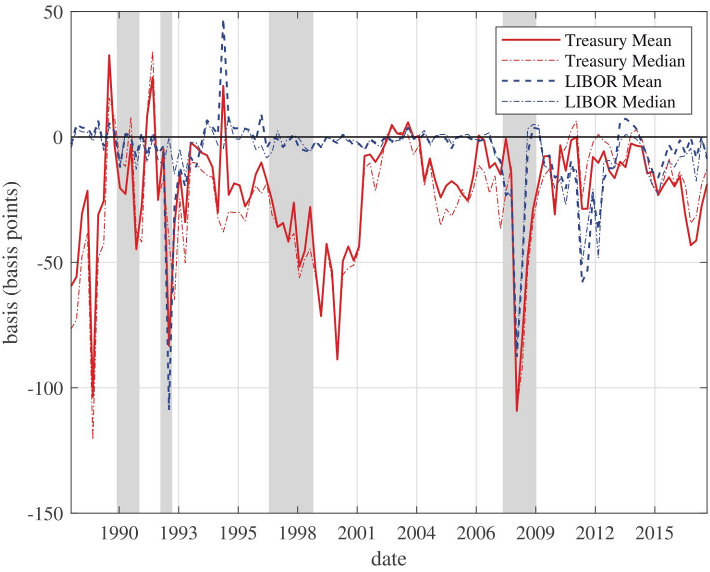


Table I

Summary Statistics for Cross-Sectional Mean Basis and Interest Rate Difference

This table reports summary statistics in percentage points for the 12M Treasury dollar basis $\bar{x}^{Treas}$, the LIBOR dollar basis $\bar{x}^{Libor}$, the 12M yield spread $y^{\$} - \bar{y}^{*}$, and the 12M forward discount $\overline{f - s}$ in logs. The reported numbers are time-series averages, time-series standard deviations, and correlations of the cross-sectional means of the unbalanced panel. The countries are Australia, Canada, Germany, Japan, New Zealand, Norway, Sweden, Switzerland, the United States, and the United Kingdom. The sample starts in 1988Q1 and ends in 2017Q2. For each of the cross-sectional averages, we employ the same set of countries that are in the sample at time t.

	$\bar{x}^{Treas}$	$\bar{x}^{Libor}$	$y^{\$} - \bar{y}^{*}$	$\overline{f - s}$
Panel A: 1988Q1–2017Q2				
Mean	−0.22	−0.06	−0.74	−0.52
Stdev	0.23	0.17	1.68	1.75
Skew	−1.22	−3.04	−1.14	−0.89
$\bar{x}^{Treas}$	1.00	0.40	−0.24	−0.36
$\bar{x}^{Libor}$	0.40	1.00	0.37	0.30
$y^{U.S.} - \bar{y}^{*}$	−0.24	0.37	1.00	0.99
Panel B: 1988Q1–2007Q4				
Mean	−0.22	−0.03	−0.76	−0.53
Stdev	0.24	0.14	1.98	2.06
Skew	−0.82	−4.51	−1.01	−0.79
$\bar{x}^{Treas}$	1.00	0.33	−0.29	−0.40
$\bar{x}^{Libor}$	0.33	1.00	0.46	0.40
$y^{U.S.} - \bar{y}^{*}$	−0.29	0.46	1.00	0.99
Panel C: 2008Q1–2017Q2				
Mean	−0.21	−0.14	−0.70	−0.49
Stdev	0.22	0.20	0.69	0.72
Skew	−2.31	−1.84	0.54	0.59
$\bar{x}^{Treas}$	1.00	0.62	0.00	−0.30
$\bar{x}^{Libor}$	0.62	1.00	0.42	0.22
$y^{U.S.} - \bar{y}^{*}$	0.00	0.42	1.00	0.95

Theory

- y_t^*: the nominal yield on a one-period risk-free zero-coupon bond in foreign currency
- $y_t^\$$: the nominal yield on a one-period risk-free zero-coupon Treasury bond in dollars
- M_t^*: the stochastic discount factor (SDF) of the foreign investor
- $M_t^\$$: the stochastic discount factor (SDF) of the U.S. investor
- $\lambda_t^{i,j}$: the convenience yield of investors in country j for bonds issued by the government in country i
- Foreign investors price foreign bonds denominated in foreign currency, and the foreign investor's Euler equation is given by

$$\mathbb{E}_t(M_{t+1}^* e^{y_t^*}) = e^{-\lambda_t^{*,*}}, \lambda_t^{*,*} \geq 0.$$

Theory

- Foreign investors price foreign bonds denominated in foreign currency, and the foreign investor's Euler equation is given by

$$\mathbb{E}_t(M^*_{t+1}e^{y^*_t}) = e^{-\lambda^{*,*}_t}, \lambda^{*,*}_t \geq 0$$

- On the left side of the equation is standard.
- One the right side, we allow foreign investors to drive a convenience yield, $\lambda^{*,*}_t$, on their domestic bond holdings
- This convenience yield is asset-specific and hence cannot be folded into the SDF
- The model abstracts from the fact that the value of Treasury bonds is ultimately derived from the government's budget constraint

Theory

- Foreign investors can also invest in U.S. Treasurys

$$\mathbb{E}_t(M^*_{t+1}\frac{S_{t+1}}{S_t}e^{y^\$_t}) = e^{-\lambda^{\$,*}_t}, \lambda^{\$,*}_t \geq 0.$$

- Suppose the convenience yield $\lambda^{\$,*}_t$ rises, lowering the right side of equation. Then the required return on the investment in U.S. Treasury bonds falls
- the expected rate of dollar appreciation declines, the yield $y^\$_t$ declines, or both
- Assume that $m^*_t = \log M^*_t$ and $\Delta s_{t+1} = \log \frac{S_{t+1}}{S_t}$ are conditionally normal. Then the Euler equation for the foreign bond can be rewritten as

$$\mathbb{E}_t[m^*_{t+1}] + \frac{1}{2}var_t[m^*_{t+1}] + y^*_t + \lambda^{*,*}_t = 0$$

Theory

- The Euler equation for the foreign bond can be rewritten as

$$\mathbb{E}_t[m^*_{t+1}] + \frac{1}{2} var_t[m^*_{t+1}] + y^*_t + \lambda^{*,*}_t = 0$$

- The Euler equation for the U.S. bond can be written as

$$\mathbb{E}_t[m^*_{t+1}] + \frac{1}{2} var_t[m^*_{t+1}] + \mathbb{E}_t[\Delta s_{t+1}] + \frac{1}{2} var_t[\Delta s_{t+1}] + y^{\$}_t + \lambda^{\$,*}_t - RP^*_t = 0$$

- $RP^*_t = -cov_t(m^*_{t+1}, \Delta s_{t+1})$ is the risk premium the foreign investor requires for the exchange rate risk when investing in U.S. bonds
- The expected return in levels on a long position in dollars earned by a foreign investor is decreasing in the convenience yield gap:

$$\mathbb{E}_t[\Delta S_{t+1}] + (y^{\$}_t - y^*_t) + \frac{1}{2} var_t[\Delta s_{t+1}] = RP^*_t - (\lambda^{\$,*}_t - \lambda^{*,*}_t)$$

Theory

$$\mathbb{E}_t[\Delta S_{t+1}] + (y_t^{\$} - y_t^*) + \frac{1}{2} var_t[\Delta s_{t+1}] = RP_t^* - (\lambda_t^{\$,*} - \lambda_t^{*,*})$$

- The left-hand side is the excess return earned by a foreign investor from investing in the U.S. bond relative to the foreign bond
- This is the return on the reverse carry trade, given that U.S. yields are typically lower than foreign yields
- the convenience yield attached by foreign investors to U.S. Treasurys minus the convenience yield foreign investors derive from their holdings of their own bonds ("convenience yield gap")
- A positive convenience yield gap, $\lambda_t^{\$,*} - \lambda_t^{*,*} > 0$, lowers the required return on the reverse carry trade, that is, the return to investing in U.S. Treasury bonds
- Even in the absence of priced currency risk, $RP_t^* = 0$, the UIP fails when the convenience yield gap is greater than zero

U.S. Demand for Foreign Bonds

- The U.S. investor's Euler equation when investing in the foreign bond is
$$\mathbb{E}_t\left(M^{\$}_{t+1}\frac{S_t}{S_{t+1}}e^{y^*_t}\right) = e^{-\lambda^{*,\$}_t}, \lambda^{*,\$}_t \geq 0.$$
- We also assume that U.S. investors derive a convenience yield when investing in U.S. Treasurys:
$$\mathbb{E}_t(M^{\$}_{t+1}e^{y^{\$}_t}) = e^{-\lambda^{\$,\$}_t}, \lambda^{\$,\$}_t \geq 0.$$
- An increase in the U.S. investor's convenience yield lowers U.S. Treasury bond yields, holding the SDF fixed: $y^{\$}_t = \rho^{\$}_t - \lambda^{\$,\$}_t$, where $\rho^{\$}_t = -\log \mathbb{E}_t(M^{\$}_{t+1})$

U.S. Demand for Foreign Bonds

- The U.S. investor's Euler equation when investing in the foreign bond is
$$\mathbb{E}_t\left(M_{t+1}^{\$}\frac{S_t}{S_{t+1}}e^{y_t^*}\right) = e^{-\lambda_t^{*,\$}}, \lambda_t^{*,\$} \geq 0.$$
- We also assume that U.S. investors derive a convenience yield when investing in U.S. Treasurys:
$$\mathbb{E}_t(M_{t+1}^{\$}e^{y_t^{\$}}) = e^{-\lambda_t^{\$,\$}}, \lambda_t^{\$,\$} \geq 0.$$
- An increase in the U.S. investor's convenience yield lowers U.S. Treasury bond yields, holding the SDF fixed: $y_t^{\$} = \rho_t^{\$} - \lambda_t^{\$,\$}$, where $\rho_t^{\$} = -\log \mathbb{E}_t(M_{t+1}^{\$})$

LEMMA 1

The expected return in levels on a long position in dollars earned by a foreign investor is decreasing in the convenience yield gap:

$$\mathbb{E}_t[\Delta s_{t+1}] + (y_t^{\$} - y_t^{*}) + \frac{1}{2} var_t[\Delta s_{t+1}] = RP_t^{*} - (\lambda_t^{\$,*} - \lambda_t^{*,*}).$$

- The left-hand side is the excess return earned by a foreign investor from investing in the U.S. bond relative to the foreign bond. This is the return on the reverse carry trade, given that U.S. yields are typically lower than foreign yields.
- On the right-hand side, the first term is the familiar currency risk premium demanded by a foreign investor going long U.S. Treasurys in dollars. The second term is the convenience yield attached by foreign investors to U.S. Treasurys minus the convenience yield foreign investors derive from their holdings of their own bonds ("convenience yield gap"). A positive convenience yield gap, $(\lambda_t^{\$,*} - \lambda_t^{*,*}) > 0$, lowers the required return on the reverse carry trade, that is, the return to investing in U.S. Treasury bonds. Even in the absence of priced currency risk, $RP^{*} = 0$, the UIP fails when the convenience yield gap is greater than zero.

LEMMA 2

$$(\lambda_t^{\$,*} - \lambda_t^{*,*}) - (\lambda_t^{\$,\$} - \lambda_t^{*,\$}) = rp_t^{\$} + rp_t^{*}$$

Under the assumption that the log currency risk premia are symmetric, $rp_t^{\$} = -rp_t^{*}$, foreign and domestic investors agree on the relative convenience of Treasurys versus foreign bonds, that is

$$(\lambda_t^{\$,*} - \lambda_t^{*,*}) = (\lambda_t^{\$,\$} - \lambda_t^{*,\$}).$$

LEMMA 3

The level of the nominal exchange can be written as

$$s_t = \mathbb{E}_t \sum_{\tau=0}^{\infty} (\lambda_{t+\tau}^{\$,*} - \lambda_{t+\tau}^{*,*}) + \mathbb{E}_t \sum_{\tau=0}^{\infty} (y_{t+\tau}^{\$} - y_{t+\tau}^{*}) - \mathbb{E}_t \sum_{\tau=0}^{\infty} rp_{t+\tau}^{*} + \mathbb{E}_t [\lim_{T \to \infty} s_{t+T}].$$

- The term $\mathbb{E}_t[\lim_{T\to\infty} s_{t+T}]$ is constant only if the nominal exchange rate is stationary
- The exchange rate level is determined by yield differences, the convenience yields, and the currency risk premia. This is an extension of Froot and Ramado- rai's (2005) expression for the level of exchange rates
- The first term involves the sum of expected convenience yields $\lambda_{t+\tau}^{\$,*}$ earned by foreign investors on their holdings of U.S. Treasurys in excess of the convenience yields $\lambda_{t+\tau}^{*,*}$ earned on their own bonds.
- The second term involves the sum of bond yield differences
- The convenience yield earned by U.S. investors on their holdings of U.S. Treasurys lowers the U.S. Treasury yield $y_{t+\tau}^{\$}$ and hence lowers the second term

LEMMA 4

The level of the real exchange rate can be witten as

$$q_t = \mathbb{E}_t \sum_{\tau=0}^{\infty} (\lambda_{t+\tau}^{\$,*} - \lambda_{t+\tau}^{*,*}) + \mathbb{E}_t \sum_{\tau=0}^{\infty} (r_{t+\tau}^{\$} - r_{t+\tau}^{*}) - \mathbb{E}_t \sum_{\tau=0}^{\infty} rp_{t+\tau}^{*} + \mathbb{E}_t [\lim_{\tau \to \infty} q_{t+\tau}],$$

where $r_t^{\$}$ and r_t^{*} are the real interest rates, that is, $y_t^{\$} - \mathbb{E}_t[\Delta p_{t+1}^{\$}]$ is the real dollar interest rate

LEMMA 5

The foreign convenience yield gap on U.S. Treasury bonds is proportional to the Treasury basis,

$$x_t^{Treas} \equiv y_t^{\$} + (f_t^1 - s_t) - y_t^* = -(1-\beta^*)(\lambda_t^{\$,*} - \lambda_t^{*,*}).$$

- This lemma is the key to our empirical work as it provides a measure of the convenience yields that drives our theory.
- We can also consider the basis from the standpoint of the U.S. investor

$$x_t^{Treas} = -(1-\beta^{\$})(\lambda_t^{\$,\$} - \lambda_t^{*,\$})$$

Five key implications relating the Treasury basis to the dollar exchange rate

- 1. The level of the nominal exchange can be written as

$$s_t = -\mathbb{E}_t \sum_{\tau=0}^{\infty} \frac{x_{t+\tau}^{Treas}}{1-\beta^*} + \mathbb{E}_t \sum_{\tau=0}^{\infty} (y_{t+\tau}^{\$} - y_{t+\tau}^{*}) - \mathbb{E}_t \sum_{\tau=0}^{\infty} rp_{t+\tau}^{*} + \mathbb{E}_t[\lim_{\tau \to \infty} s_{t+\tau}].$$

- 2. The level of the real exchange can be written as

$$q_t = -\mathbb{E}_t \sum_{\tau=0}^{\infty} \frac{x_{t+\tau}^{Treas}}{1-\beta^*} + \mathbb{E}_t \sum_{\tau=0}^{\infty} (r_{t+\tau}^{\$} - r_{t+\tau}^{*}) - \mathbb{E}_t \sum_{\tau=0}^{\infty} rp_{t+\tau}^{*} + \mathbb{E}_t[\lim_{\tau \to \infty} q_{t+\tau}].$$

- 3. The expected log excess return to a foreign investor of a long position in Treasury bonds is increasing in the risk premium and the Treasury basis,

$$\mathbb{E}_t[\Delta s_{t+1}] + (y_t^{\$} - y_t^{*}) = rp_t^{*} + \frac{1}{1-\beta^*} x_t^{Treas}$$

- 4. The expected log return to a foreign investor of going long the dollar via the forward contract is

$$\mathbb{E}_t[\Delta s_{t+1}] - (f_t^1 - s_t) = rp_t^{*} + \frac{\beta^*}{1-\beta^*} x_t^{Treas}$$

- 5. The change in the nominal exchange rate can be decomposed as $\Delta s_{t+1} = \mathbb{E}_{t+1} - \mathbb{E}_t)s_{t+1} + \mathbb{E}_t[\Delta s_{t+1}]$, where the innovation is given by

$$
\begin{aligned}
(\mathbb{E}_{t+1} - \mathbb{E}_t)s_{t+1} = -(\mathbb{E}_{t+1} - \mathbb{E}_t)\sum_{\tau=1}^{\infty} \frac{x_{t+\tau}^{Treas}}{1-\beta^*} \\
+ (\mathbb{E}_{t+1} - \mathbb{E}_t)\sum_{\tau=1}^{\infty}(y_{t+\tau}^{\$} - y_{t+\tau}^{*}) \\
- (\mathbb{E}_{t+1} - \mathbb{E}_t)\sum_{\tau=1}^{\infty} rp_{t+\tau}^{*} + (\mathbb{E}_{t+1} - \mathbb{E}_t)\lim_{\tau\rightarrow\infty} s_{t+\tau}.
\end{aligned}
$$

- We test each of these implications in the data

Takes the theory to data

- Variation in the Treasury Basis and the Dollar

$$(\mathbb{E}_t - \mathbb{E}_{t-1}) s_t = -\frac{(\mathbb{E}_t - \mathbb{E}_{t-1}) x_t}{(1-\phi_a)(1-\beta^*)} + \mathbb{E}_t \sum_{\tau=0}^{\infty} (y^{\$}_{t+\tau} - y^*_{t+\tau}) - \mathbb{E}_t \sum_{\tau=0}^{\infty} rp^*_{t+\tau} + \bar{s}.$$

- The basis is mean-reverting with a quarterly $AR(1)$ coefficient of $\phi = 0.47$
- The sum of expected future increases in the 12-month basis in response to a 10 bp rise in the 12-month basis today is $10 * \frac{1}{1-0.47^4} = 10.5$
- To rationalize the 1.02% appreciation in the exchange rate, we need a β^* of $1 - \frac{10.5}{102} = 0.90$, suggesting that much of the convenience yield attached to U.S. Treasury bonds derives from its attribute as a safe and liquid dollar payoff
- Put differently, if U.S. Treasurys were issued in foreign currency, their convenience yields would be substantially lower

Table III

Average Treasury Basis and the USD Spot Nominal Exchange Rate

This table presents the regression result in which the dependent variable is the quarterly change in the log of the spot USD exchange rate against a basket. In Panel A, the independent variables are the innovation in the average Treasury basis, $\Delta\bar{x}^{Treas}$, as a log yield (i.e., 50 bps is 0.005), the lagged value of the innovation, the innovation in the LIBOR basis, and the innovation in the U.S.-to-foreign Treasury yield differential. Panel B includes the quarterly change in the VIX (in percentage units). The data are quarterly. The constant term is omitted. OLS standard errors are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: Benchmark Results

	1988Q1–2017Q2					1988Q1–2007Q4		2008Q1–2017Q2	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\Delta\bar{x}^{Treas}$	−10.20***		−10.23***		−9.81***	−8.48***		−14.93***	
	(2.09)		(1.98)		(1.73)	(2.62)		(3.20)	
$\Delta\bar{x}^{Libor}$		−2.85					4.63		−13.51***
		(3.09)					(4.22)		(4.05)
Lag $\Delta\bar{x}^{Treas}$			−6.92***		−6.47***				
			(1.97)		(1.73)				
$\Delta(y^{\$} - \bar{y}^{*})$				3.76***	3.57***				
				(0.71)	(0.60)				
Observations	117	117	116	117	116	80	80	37	37
R^2	0.17	0.01	0.25	0.20	0.43	0.12	0.02	0.38	0.24

Panel B: Control for VIX

	1988Q1–2017Q2					1988Q1–2007Q4		2008Q1–2017Q2	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\Delta\bar{x}^{Treas}$	−9.62***		−9.22***		−9.66***	−7.10**		−10.44***	
	(2.40)		(2.31)		(1.94)	(3.14)		(3.35)	
$\Delta\bar{x}^{Libor}$		−1.89					5.19		−8.07**
		(3.09)					(4.10)		(3.94)
Lag $\Delta\bar{x}^{Treas}$			−7.06***		−4.33**				
			(2.28)		(1.95)				
$\Delta(y^{\$} - \bar{y}^{*})$				4.71***	4.48***				
				(0.73)	(0.66)				
Δvix	0.05	0.09	0.06	0.12**	0.08	−0.12	−0.13	0.21***	0.26***
	(0.07)	(0.07)	(0.06)	(0.06)	(0.05)	(0.10)	(0.10)	(0.08)	(0.08)
Observations	109	109	109	109	109	72	72	37	37
R^2	0.15	0.02	0.22	0.29	0.46	0.09	0.05	0.50	0.42

- LEMMA 5: The foreign convenience yield gap on U.S. Treasury bonds is proportional to the Treasury basis,

$$x_t^{Treas} \equiv y_t^{\$} + (f_t^1 - s_t) - y_t^* = -(1-\beta^*)(\lambda_t^{\$,*} - \lambda_t^{*,*})$$

- We estimate that foreigners earn an extra convenience yield between 1.96%$(\frac{1}{0.112} * 0.22)$ and 2.09% $(\frac{1}{0.105} * 0.22)$ per annum on dollar Treasury bonds relative to foreign-currency government bonds
- Since β^* is around 0.9, we additionally learn that much of this convenience benefit derives from the fact that the U.S. Treasury bond is a liquid and safe dollar payoff

Another Approach to Estimating the Convenience Yield

- Another approach to estimating the average convenience yield is to evaluate the spread between the real long-run returns earned by foreign investors on U.S. Treasurys and domestic bonds,

$$\lambda^{\$,*} - \lambda^{*,*} = -(R^{\$,*} - R^{*,*})$$

- Between 1980 and 2019, private foreign investors earned a dollar-weighted real return on their Treasury purchases of 2.77%, expressed in real dollars. In comparison, foreign investors earned a dollar-weighted real return of 4.66% on their holdings of foreign bonds. The return gap,

$$R^{*,*} - R^{\$,*} = 4.66\% - 2.77\% = 1.89\% = \lambda^{\$,*} - \lambda^{*,*}$$

- is a direct estimate of the long-run difference in convenience yields $\lambda^{\$,*} - \lambda^{*,*}$. Foreign investors buy U.S. Treasurys when Treasurys are expensive, consistent with our hypothesis that foreigners have a special demand for U.S. dollar safe assets. This estimate is quantitatively in line with the estimates we backed out of the Treasury basis and FX markets

Term Structure of Treasury Bases

Table IV
PCA of Treasury Bases

Panel A reports the standard deviation and the variance of the first three principal components. Panel B reports the loadings of each principal component on the Treasury bases with tenors of 1Y, 2Y, 3Y, 5Y, 7Y, and 10Y. The data are quarterly from 1991Q2 to 2017Q2.

Panel A: Summary Statistics

	PC_1	PC_2	PC_3
Std Dev	0.41	0.19	0.17
% of Variance	69.50	15.14	11.44
Cumulative %	69.50	84.64	96.08
First-order autocorrelation	0.86	0.48	0.79

Panel B: Loadings

	PC_1	PC_2	PC_3
1Y Basis	0.30	−0.93	−0.15
2Y Basis	0.43	−0.05	0.41
3Y Basis	0.46	0.09	0.33
5Y Basis	0.51	0.24	0.13
7Y Basis	0.36	0.20	−0.21
10Y Basis	0.35	0.17	−0.80

- Similar to the term structure of bond yields, the first three principal components of the Treasury bases correspond to a level, a slope, and a curvature basis factor

Table V

Principal Components in Treasury Basis and the USD Spot Nominal Exchange Rate

This table presents the regression results in which the dependent variable is the quarterly change in the log of the spot USD exchange rate against a basket. The data are quarterly. OLS standard errors are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively

	1991Q2–2017Q2					1991Q2–2007Q4		2008Q1–2017Q2	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$\Delta PC1$	−9.29***		−8.19***		−5.13***	−7.92**	−4.39*	−7.18**	−3.47
	(2.06)		(2.13)		(1.75)	(3.10)	(2.44)	(3.51)	(3.19)
$\Delta PC2$		7.69***	4.76*		7.09***	3.27	5.91**	8.61	9.09*
		(2.70)	(2.65)		(2.14)	(3.25)	(2.52)	(5.82)	(5.01)
$\Delta(y^{\$} - \bar{y}^*)$				4.86***	4.60***		4.34***		10.57***
				(0.66)	(0.60)		(0.64)		(2.94)
Observations	104	104	104	105	104	67	67	37	37
R^2	0.17	0.07	0.19	0.35	0.49	0.11	0.48	0.38	0.56

- A rise in the slope may be coincident with a flight to quality that affects short-term bonds more than long-term bonds. That is, the basis on the one-year bond may be a better measure of foreign investors' convenience valuations than the basis on long-term bonds

Monetary Policy Shocks and the Basis

- To help us identify the causal effect of shocks to the basis on the dollar exchange rate, we rely on Federal Funds Rate (FFR) surprises. There is a growing literature on high-frequency identification
- FOMC announcements are a useful source of variation because the news in these announcements corresponds primarily to short rates. We use Kuttner's (2001) FFR surprises as our measure of monetary shocks. There are 96 observations in our sample. We end the sample when the FFR hits the zero lower bound

Two Stage Regression

Table VI
Average Treasury Basis and the USD Spot Nominal Exchange Rate Around FOMC Announcements

Panel A presents the results of the first-stage regression of the change in Treasury basis on the monetary policy shock. Panel B presents the results of the second-stage regression of change in dollar exchange rate on the change in basis induced by an FOMC shock, controlling for the change in interest rate differences (column (1)) and the change in the VIX (column (2)). The change in the basis is the change in the first principal component (ΔPC_1) of the average Treasury bases across maturities. The interest rate difference is the first principal component of the average yield differences across maturities. The sample covers 96 FOMC announcements (excluding unscheduled FOMC meetings) between January 22, 1997 and December 30, 2008. We use a one-day window around FOMC announcements. OLS standard errors are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: First Stage		
	(1)	(2)
Monetary Policy Shock	-0.58^{**}	-0.58^{**}
	(0.25)	(0.25)
Observations	96	96
R^2	0.05	0.05

Panel A: Second Stage		
	(1)	(2)
$\Delta\bar{x}^{Treas}$	-13.93^{***}	-11.98^{***}
	(2.71)	(2.89)
$\Delta(y^{\$} - \bar{y}^{*})$	0.71	1.00^{*}
	(0.55)	(0.57)
ΔVIX		0.08^{*}
		(0.05)
Observations	96	96
R^2	0.25	0.27

- In the first stage, we regress the change in the first principal component of the basis on the monetary policy shock
- We argue that a contractionary monetary policy shrinks the supply of liquid and safe assets and widens the basis. A 10 bp surprise rate increase widens the average Treasury basis by more than 5.8 bps

- In the second stage, we regress the dollar appreciation on the exogenous variation in the basis induced by the FFR surprise
- The exclusion restriction is that shocks to monetary policy do not covary with the exchange rates once we control for changes in interest rates
- we assume that only the future convenience yields and future interest rates respond to FFR surprises, but not the future currency risk premia. Given that most of the news on these days corresponds to short rates, this seems like a plausible restriction
- There is one caveat: we include unscheduled announcements, which are more likely to include the release of news about fundamentals
- The second-stage slope coefficients are comparable in magnitude to the OLS estimates. Controlling for changes in the VIX only moderately decreases the size of these coefficients in absolute value

The Treasury Basis and Dollar Safe Asset Demand

Table VII

Explain Exchange Rate Movement Using Treasury Basis Innovation in Different Countries

This table presents the results of regressions of exchange rate movements on concurrent Treasury basis innovations and changes in the Treasury yield. A higher exchange rate means a stronger base currency. For each non-U.S. country, we exclude the United States when we calculate its average Treasury basis and average exchange rate movement against other non-U.S. countries. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively. We use DEM as a stand-in for EUR prior to the creation of the Euro.

Panel A: Univariate Regressions

	(1) USD	(2) AUD	(3) CAD	(4) EUR	(5) JPY	(6) NZD	(7) NOK	(8) SEK	(9) CHF	(10) GBP
Innov $\bar{x}^{Treas}$	−10.20***	0.19	2.06	−6.21	4.31	−3.97**	0.24	−0.80	1.94	2.45
	(2.09)	(3.48)	(1.67)	(3.81)	(4.86)	(1.90)	(0.96)	(0.85)	(1.50)	(2.38)
Observations	117	70	94	79	88	52	109	105	109	79
R^2	0.17	0.000	0.02	0.03	0.01	0.08	0.001	0.01	0.02	0.01

Panel B: Bivariate Regressions

	(1) USD	(2) AUD	(3) CAD	(4) EUR	(5) JPY	(6) NZD	(7) NOK	(8) SEK	(9) CHF	(10) GBP
Innov $\bar{x}^{Treas}$	−9.79***	−2.76	2.13	−8.71**	3.70	−4.75**	0.38	−1.85*	3.21**	−0.61
	(1.81)	(3.22)	(1.70)	(3.68)	(4.49)	(1.97)	(0.95)	(1.09)	(1.55)	(2.32)
Change in IR Diff	3.80***	6.23***	0.26	4.41***	6.87***	1.62	1.11*	0.88	−1.65**	4.62***
	(0.61)	(1.51)	(0.82)	(1.38)	(1.72)	(1.16)	(0.62)	(0.58)	(0.66)	(1.19)
Observations	117	70	94	79	88	52	109	105	109	79
R^2	0.38	0.20	0.02	0.15	0.17	0.12	0.03	0.03	0.07	0.18

Panel C: IR Differential Only

	(1) USD	(2) AUD	(3) CAD	(4) EUR	(5) JPY	(6) NZD	(7) NOK	(8) SEK	(9) CHF	(10) GBP
Change in IR Diff	3.92***	5.94***	0.12	3.72***	6.92***	1.17	1.09*	0.25	−1.21*	4.51***
	(0.68)	(1.47)	(0.81)	(1.39)	(1.71)	(1.04)	(0.62)	(0.46)	(0.63)	(1.11)
Observations	117	70	94	79	88	70	109	105	109	79
R^2	0.22	0.19	0.000	0.09	0.16	0.02	0.03	0.003	0.03	0.18

- We perform a placebo test of dollar safe asset demand. We repeat the univariate regression using other non-U.S. countries

Predictability of Exchange Rates and Excess Returns

- We next turn to result 3 of Proposition 1, which can be read as a forecasting regression
- A more negative x_t (i.e., a higher convenience yield) today is associated with a higher dollar exchange rate today, which induces expected depreciation in the future
- Overall, the results are in line with our theory: a more negative basis (i.e., higher convenience yields) predicts lower returns on the carry trade
- However, we should note that the statistical significance of the results is weak, and the results of this section should be seen as a consistency check of our theory

Table VIII

Forecasting Currency Excess Returns in Panel Data

This table presents the results of regressions whose dependent variable is the annualized nominal excess return (in logs) $rx^{fx}_{t\to t+k}$ on a long position in U.S. Treasuries and a short position (equal-weighted) in all foreign bonds with maturities of k quarters. The independent variables are the average Treasury basis $\bar{x}^{Treas}$ lagged by one quarter, and the nominal Treasury yield difference $(y^{\$}_{t\to t+k} - \bar{y}^{*}_{t\to t+k})$ with maturities of k quarters. The data are quarterly from 1988Q1 to 2017Q2. We omit the constant, and report Newey-West standard errors with lags equal to the length of the forecast horizon k. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: 1988Q1–2017Q2

	(1) Three Months	(2) One Year	(3) Two Years	(4) Three Years
Lag $\bar{x}^{Treas}$	−1.46	4.15	4.41	4.44*
	(5.89)	(6.42)	(3.19)	(2.30)
$y^{\$}_{t\to t+k} - \bar{y}^{*}_{t\to t+k}$	0.47	0.83	1.72	1.59
	(0.92)	(1.04)	(1.13)	(1.02)
Observations	117	117	117	115
R^2	0.004	0.03	0.13	0.14

Panel B: 1988Q1–2007Q4

	(1) Three Months	(2) One Year	(3) Two Years	(4) Three Years
Lag $\bar{x}^{Treas}$	−10.00	−2.38	−0.42	3.59
	(6.25)	(7.64)	(2.96)	(2.58)
$y^{\$}_{t\to t+k} - \bar{y}^{*}_{t\to t+k}$	0.64	0.69	1.64	2.42**
	(0.91)	(1.06)	(1.24)	(0.96)
Observations	80	80	80	80
R^2	0.04	0.03	0.15	0.30

Panel C: 2008Q1–2017Q2

	(1) Three Months	(2) One Year	(3) Two Years	(4) Three Years
Lag $\bar{x}^{Treas}$	16.47	19.81***	16.00***	10.04***
	(10.27)	(6.32)	(3.33)	(1.83)
$y^{\$}_{t\to t+k} - \bar{y}^{*}_{t\to t+k}$	−5.52*	0.52	1.41	1.28
	(3.10)	(0.91)	(0.96)	(1.01)
Observations	37	37	37	35
R^2	0.13	0.29	0.40	0.34

Term Structure and Excess Returns

- We next investigate whether other **maturities** of the basis have forecasting power for excess returns on the reverse carry trade
- We summarize the other maturities using the principal component of the term structure and use these to forecast excess returns
- We report the results for the pre- and postcrisis subsamples. The results are stronger in the postcrisis sample, consistent with earlier results

Table IX

Forecasting Currency Excess Returns using Principal Components

This table reports the results of regressions whose dependent variable is the annualized nominal excess return (in logs) $rx^{fx}_{t\to t+k}$ on a long position in U.S. Treasuries and a short position (equal-weighted) in all foreign bonds with maturities of k quarters. The nominal Treasury yield difference $(y^{\$}_{t\to t+k} - \overline{y}^{*}_{t\to t+k})$ also has a maturity of k quarters, averaged across the same set of foreign countries. The data are quarterly from 1991Q2 to 2017Q2. We omit the constant. Heteroskedasticity- and autocorrelation-adjusted standard errors are in parentheses; we use the Newey-West estimator with the number of lags equal to the overlap in returns. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A: 1988Q1–2017Q2

	(1) Three Months	(2) One Year	(3) Two Years	(4) Three Years
Lag *PC*1	3.41	5.41	7.11**	4.90*
	(5.08)	(4.79)	(3.21)	(2.67)
Lag *PC*2	10.91*	4.18	1.67	0.34
	(6.50)	(7.82)	(5.36)	(3.82)
$y^{\$}_{t\to t+k} - \overline{y}^{*}_{t\to t+k}$	0.38	0.83	2.57**	2.48***
	(1.43)	(1.46)	(1.15)	(0.94)
Observations	104	104	104	102
R^2	0.02	0.05	0.29	0.30

Panel B: 1988Q1–2007Q4

	(1) Three Months	(2) One Year	(3) Two Years	(4) Three Years
Lag *PC*1	−2.38	−0.13	5.40	4.78
	(4.35)	(6.81)	(4.50)	(3.90)
Lag *PC*2	20.80***	11.91	4.18	−2.69
	(6.73)	(8.90)	(5.28)	(2.14)
$y^{\$}_{t\to t+k} - \overline{y}^{*}_{t\to t+k}$	0.44	0.32	2.81**	4.04***
	(1.53)	(1.74)	(1.35)	(1.55)
Observations	67	67	67	67
R^2	0.09	0.06	0.29	0.50

Panel C: 2008Q1–2017Q2

	(1) Three Months	(2) One Year	(3) Two Years	(4) Three Years
Lag *PC*1	16.16**	11.28**	11.60***	9.90***
	(7.87)	(4.81)	(1.75)	(1.94)
Lag *PC*2	17.56	−2.48	4.42**	7.86*
	(15.03)	(8.19)	(2.15)	(4.02)
$y^{\$}_{t\to t+k} - \overline{y}^{*}_{t\to t+k}$	−8.34***	−1.23	−0.68	−1.29
	(3.07)	(1.44)	(1.16)	(1.15)
Observations	37	37	37	35
R^2	0.17	0.34	0.57	0.63

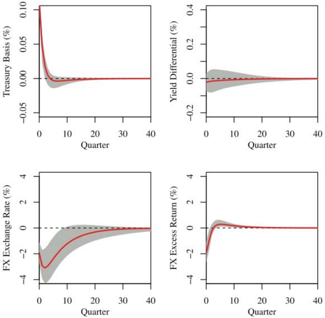
VAR model

- We run a VAR with three variables: the basis x_t, the real interest rate i_t, and the log of the real exchange rate q_t,
- We estimate the first-order VAR for $\mathbf{z}_t$, $\mathbf{z}_t' = [x_t \quad i_t \quad q_t]$

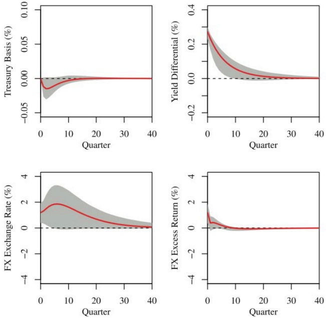
$$\mathbf{z}_t = \mathbf{\Gamma}_0 + \mathbf{\Gamma}_1 \mathbf{z}_{t-1} + \mathbf{a}_t,$$

where $\mathbf{\Gamma}_0$ is a three-dimensional vector, $\mathbf{\Gamma}_1$ is a $3 * 3$ matrix, and $\mathbf{a}_t$ is white noise random vector with mean zero and variance-covariance matrix Σ.

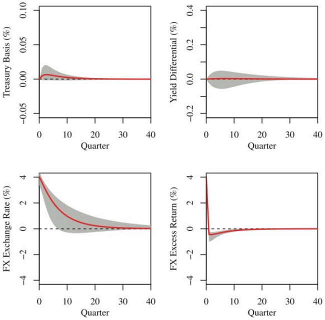
Basis Shocks



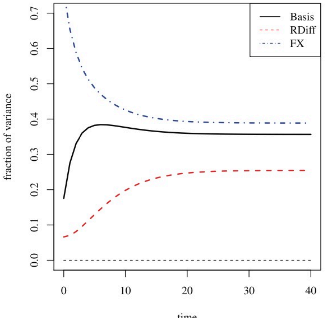
Rate Shocks



FX Shocks



Variance Decomposition



- An increase in the annualized Treasury basis of 0.2% (quarterly basis of 0.1% in the figure) depreciates the real exchange rate contemporaneously by about 3% over two quarters
- The finding that the depreciation persists over two quarters is consistent with the time-series momentum effect discussed earlier
- A gradual reversal then occurs over the next five years—the effect on the level of the dollar gradually dissipates
- There is no statistically discernible effect of the basis on the interest rate differential
- The bottom right panel plots the quarterly log excess return on a long position in dollars. The quarterly excess return drops over the first two quarters. It is then higher than average over the next 15 to 18 quarters, consistent with higher expected returns on long positions in Treasurys

Campbell-Shiller Decomposition

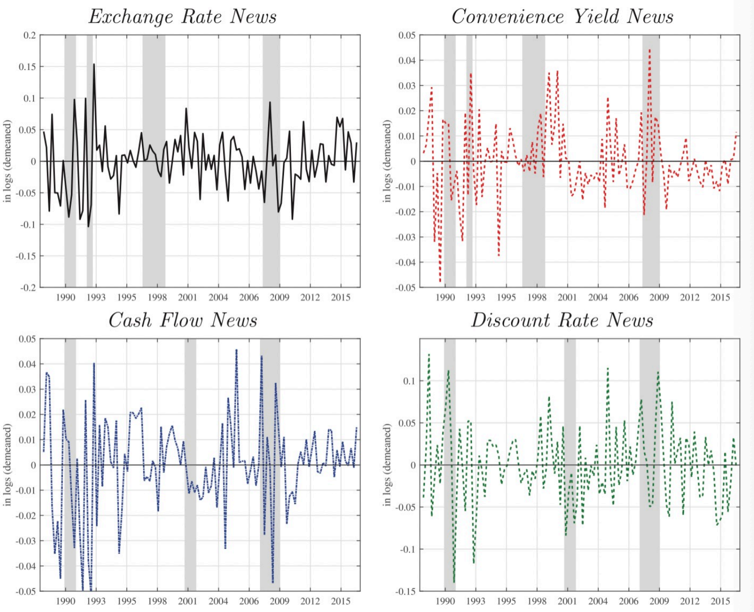


Table X

News Decomposition of Real Exchange Rates Innovations

This table reports the decomposition of quarterly innovations in log of the average dollar real exchange rate in the panel for different values of β^*. The VAR is estimated over the period 1988Q1 to 2017Q2. The VAR(1) includes $[\bar{x}_t, r_t^{\$} - \bar{r}_t^*, q_t]$.

β^*	var(CY)	var(CF)	var(DR)	2cov(CY, CF)	$-$2cov(CY, DR)	$-$2cov(CF, DR)
0.95	0.63	0.17	1.62	0.36	−1.35	−0.43
0.925	0.28	0.17	1.24	0.24	−0.62	−0.31
0.9	0.16	0.17	1.10	0.18	−0.36	−0.25
0.875	0.10	0.17	1.04	0.14	−0.24	−0.22

- When $\beta^* = 0.90$, convenience yield news (CY) accounts for 16% of the variance in quarterly exchange rates. Interest rate news (CF) accounts for a similar share of the variance, while discount rate news (DR) accounts for a sizable share of 110%
- These results are sensitive to the exact value of β^*
- The ratio of the convenience yield to the observed basis, $\frac{1}{1-\beta^*}$, is highly sensitive to β^*

Conclusion

- We present a theory of exchange rates that departs from existing theories by imputing a central role to international flows in Treasury debt and related dollar safe asset markets in exchange rate determination
- According to our theory, the spot exchange rate of a safe asset currency will reflect the cumulative value of all future convenience yields that are earned by foreign investors on safe assets denominated in that currency.
- Our results shed light on two important issues in inter- national finance. First, we help resolve the exchange rate disconnect puzzle by demonstrating that shocks to the demand for dollar-denominated safe assets drive a sizeable portion of the variation in the dollar exchange rate.
- Second, we provide strong empirical support for recent theories regarding safe assets and the central role of the United States in the international monetary system.

Comments

- I learn new facts and theories about the U.S. dollar supremacy, and useful empirical approaches including high-frequency identification, 2SLS, PCA, and so on
- I want to know deep reasons for the U.S. dollar supremacy to decide whether investors should follow the trend or predict the turning point
- The 2SLS regression relies on the assumption that convenience yield is the only channel for FOMC announcements to impact exchange rate after controlling other variables in the equation. This might not be plausible. FX traders follow the news and make immediate actions in the FX markets and change the exchange rate. Convenient yield may not be one of the variables that decide their trading direction when news releases