The Stock-Bond Correlation: A Tale of Two Days in the Treasury Bond Market

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Outline

Motivation

- Correlation between **stock** and **bond** is widely examined and discussed
  - ↪ Two of the most important financial markets
  - ↪ The interplay between stock and bond is robust and dominate in the global market co-movements
  - ↪ Campbell, Pflueger, and Viceira (2020); Laarits (2022); Li, Zha, Zhang, and Zhou (2022)
- Stock-bond co-movement has become a signal of **flight-to-safety**, which is a popular phenomena mentioned with market stress and downturns
  - ↪ Flight-to-safety commonly happens in the global financial markets, across different markets and time-horizon
  - ↪ Easily observed, but difficult to measure
  - ↪ Connolly, Stivers, and Sun (2005); Baele, Bekaert, and Inghelbrecht (2010); Baele, Bekaert, Inghelbrecht, and Wei (2019)

Research Questions

- **Q1:** Does the interplay between U.S. equity and U.S. Treasury capture information about flight-to-safety?
- **Q2:** How does flight-to-safety affect asset pricing?
- **Q3:** Do other alternative safe assets contain similar information about flight-to-safety?

Main Results

- **Q1:** Measuring UST Safety via η_t^{UST}
  - ↪ **Daily** safety measure: negative correlation of 5-min SPX and 10Y-UST returns
  - ↪ **High** η_t^{UST}: flight-to-safety episodes
  - ↪ **Low** η_t^{UST}: risky U.S. Treasury market episodes
- **Q2:** Asset Pricing Under High and Low η_t^{UST}
  - ↪ **Global Assets**
    - ★ Return determined by global safeness
  - ↪ **Fixed-Income**
    - ★ High η_t^{UST}: Lower Treasury term premiums and convenience yield
    - ★ Low η_t^{UST}: Higher term premiums
  - ↪ **Currency**
    - ★ High η_t^{UST}: higher safe currency returns, lower carry trade profits
    - ★ Compare η_t^{UST} and η_t^{USD}: η_t^{UST} dominates
- **Q3:** Safeness of UST and USD
  - ↪ η_t^{USD}: alternative safety measure based on safe assets USD
  - ↪ **UST and USD**: Positive linkage between USD and UST breaks down

Related Literature

- Flights to safety
  - ↪ Theoretical: Vayanos (2004), Bekaert, Engstrom, and Xing (2009), Caballero and Krishnamurthy (2008), Brunnermeier and Pedersen (2009)
  - ↪ Empirical: Connolly, Stivers, and Sun (2005), Baur and Lucey (2009), Baele, Bekaert, and Inghelbrecht (2010), Bansal, Connolly, and Stivers (2010), Beber, Brandt, and Cen (2014), Baele, Bekaert, Inghelbrecht, and Wei (2020)
- Stock-Bond Correlation
  - ↪ David and Veronesi (2013), D.E.Shaw (2019), Campbell, Pflueger, and Viceira (2020), Ermolov (2022), Laarits (2022), Li, Zha, Zhang, and Zhou (2022)
- Global Comovements
  - ↪ Rey (2015), Miranda-Agrippino and Rey (2020), Jiang, Krishnamurthy, and Lustig (2020)
- U.S. Treasury Market
  - ↪ Adrian, Fleming, Shachar, and Vogt (2017), Du, Im, and Schreger (2018), Jiang, Krishnamurthy, and Lustig (2020), He, Nagel, and Song (2022)

Outline

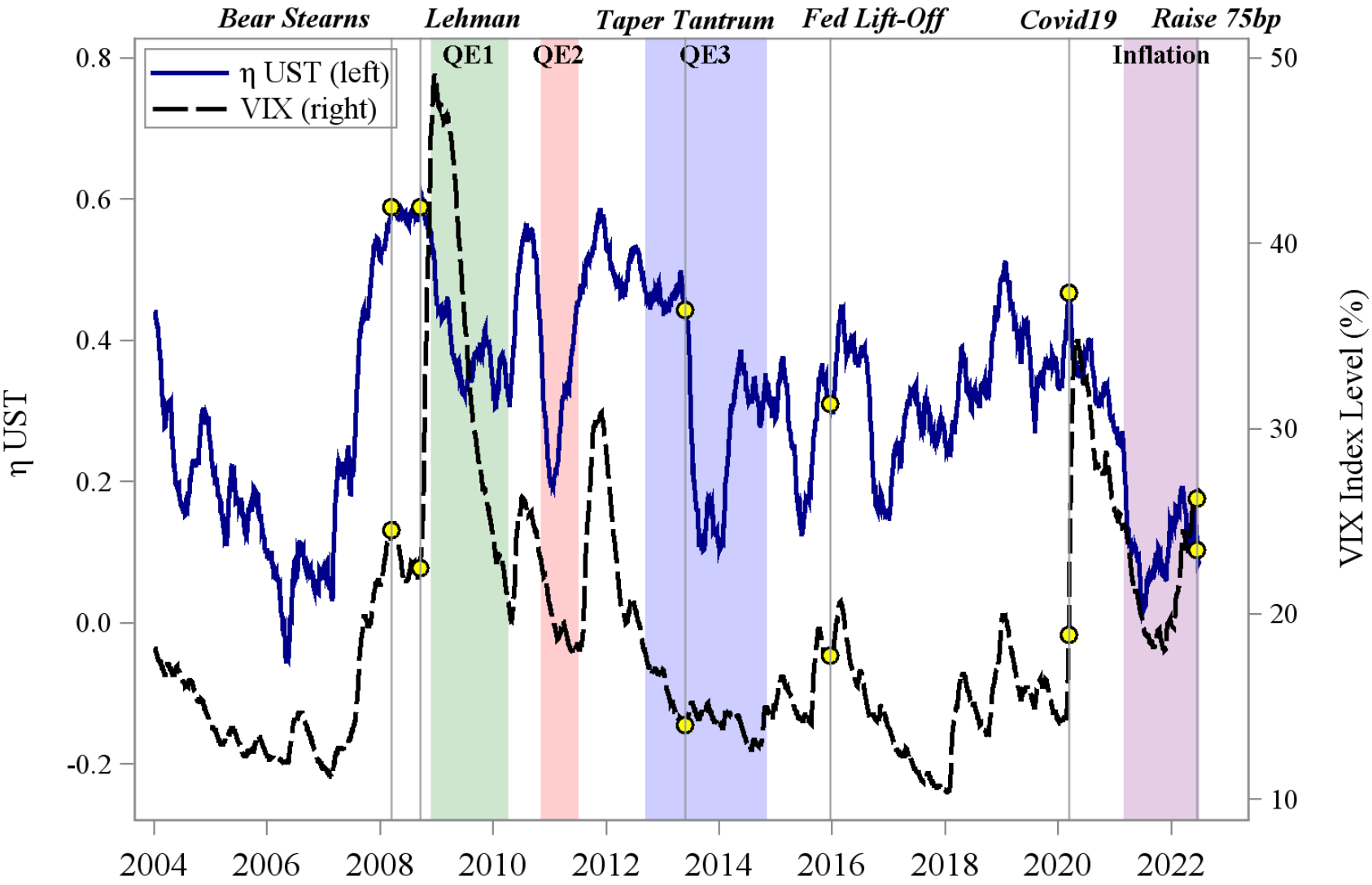
Safety Measures via Stock-Bond Correlations

We construct safety measure η_t^{UST} as the negative of the correlation between the intraday 5-minute returns of the U.S. equity (SPX) and the U.S. Treasury (UST) on a trading day t:

$$\eta_t^{\text{UST}} = -corr(r_{i,t}^{\text{SPX}}, r_{i,t}^{\text{UST}})|_{fixed\ t}$$

- $r_{i,t}^{\text{SPX}}$: 5-minute returns of the most liquid E-mini S&P 500 index futures
- $r_{i,t}^{\text{UST}}$: 5-minute returns of the most liquid 10-year Treasury futures contracts traded on the Chicago Mercantile Exchange (CME)
- Sample period: January 2004 to June 2022

Time Series of Safety Measure η_t^{UST}



* ηUST and VIX are all smoothed time series (exponential weighted moving average with a decaying parameter λ=0.98).

High and Low Safety Days Captured by η_t^{UST}

Summary Statistics of η_t^{UST}:

	mean	std	min	Q1	med	Q3	max	N
η_t^{UST}	0.31	0.26	-0.75	0.14	0.33	0.51	0.94	4631

We sort all days into different quintiles based on η_t^{UST}

- **High** UST Safety Days: Top 20% η_t^{UST} Days
  - ↪ $\overline{\eta^{\text{UST}}} = 0.64$
  - ↪ UST and SPX move closely in the opposite directions
  - ↪ High UST safety period for the equity market when the risk, originated in the U.S. equity market, causes a flight-to-safety from the SPX to the UST
- **Low** UST Safety Days: Bottom 20% η_t^{UST} Days
  - ↪ $\overline{\eta^{\text{UST}}} = -0.07$
  - ↪ UST and SPX move independently or in the same direction
  - ↪ Equity market is relatively safe while the Treasury market becomes risky on its own, probably as a result of inflation concerns or monetary policy uncertainties

Key Asset Performance

Major Market Performance

(a) Excess Return

	SPX	UST	DXY	EUR/USD	YEN/USD
High η_t^{UST}	-36.20***	13.60***	1.20	-1.90	16.48***
	[-8.04]	[9.57]	[0.63]	[-0.82]	[7.07]
Low η_t^{UST}	13.75***	-6.05***	2.14	-1.87	-8.43***
	[4.76]	[-3.92]	[1.22]	[-0.99]	[-4.42]

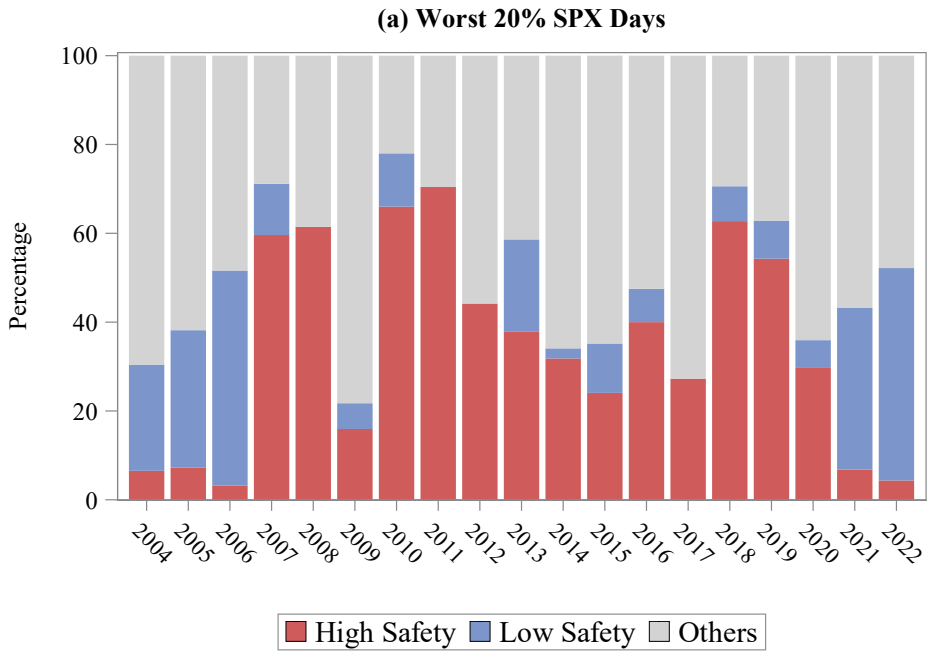
(b) CAPM α

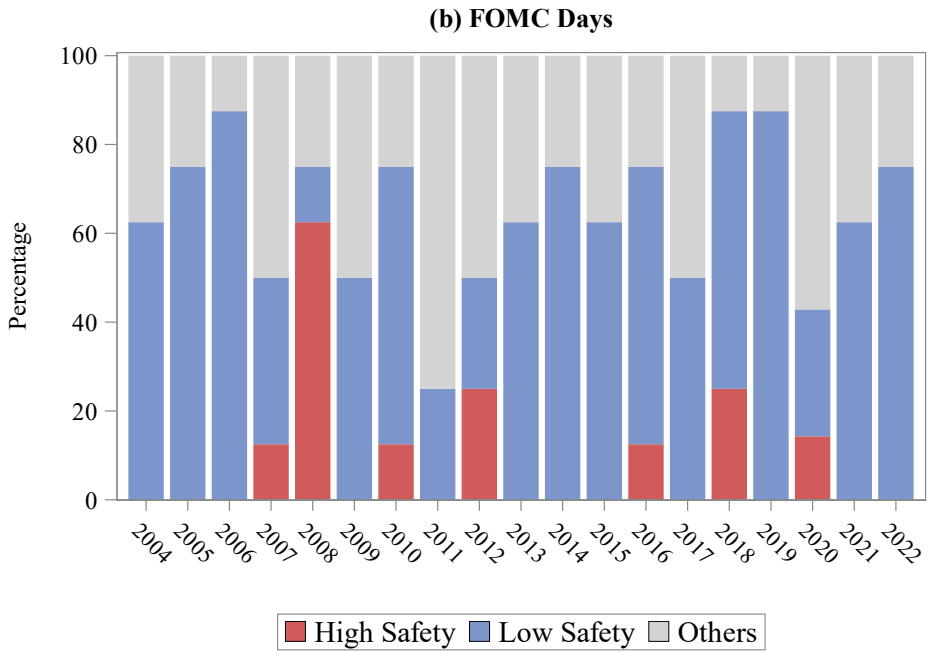
		UST	DXY	EUR/USD	YEN/USD
High η_t^{UST}		5.03***	-0.89	-0.22	10.27***
		[4.42]	[-0.49]	[-0.10]	[5.10]
Low η_t^{UST}		-7.96***	3.61**	-3.99**	-9.76***
		[-4.92]	[2.06]	[-2.06]	[-5.03]

(c) ΔImplied Vol

	VIX	MOVE	DXYV	EURV	YENV
High η_t^{UST}	0.51***	0.79***	0.07***	0.07***	0.14***
	[6.48]	[4.68]	[3.75]	[3.42]	[4.28]
Low η_t^{UST}	-0.16***	-0.11	-0.03***	-0.03**	-0.04***
	[-4.12]	[-0.96]	[-3.13]	[-2.47]	[-3.04]

Risky and Safe Days Captured by η_t^{UST}





Investor Behaviour

	Daily ETF		Weekly Primary Dealers			
	UST	SPX	Coupons	TIPS	Agency	MBS
High η_t^{UST}	13.09***	-162.85**	0.40**	0.45***	0.58***	0.74***
	[2.61]	[-2.04]	[2.07]	[2.83]	[3.44]	[4.18]
Low η_t^{UST}	-6.26	10.02	-0.60***	0.00	-0.22	-0.11
	[-1.03]	[0.11]	[-3.88]	[0.00]	[-1.34]	[-0.71]
Intercept	0.87	147.79*	-0.42*	0.26	0.32	0.10
	[0.15]	[1.85]	[-1.84]	[1.59]	[1.53]	[0.47]
NOBS	4601	3479	963	963	963	963
R2 (%)	0.25	0.51	16.56	2.30	9.93	6.10

	Weekly CFTC					
	Asset Management		Dealer		Leveraged	
	UST	SPX	UST	SPX	UST	SPX
High η_t^{UST}	0.65***	-0.38**	-0.45**	0.39*	-0.52***	-0.37**
	[3.67]	[-2.36]	[-2.31]	[1.93]	[-2.88]	[-2.29]
Low η_t^{UST}	-0.05	0.01	0.06	-0.36*	0.41**	0.58***
	[-0.22]	[0.07]	[0.36]	[-1.77]	[1.98]	[3.53]
Intercept	-0.04	1.41***	0.68***	-0.21	-0.28	-0.39**
	[-0.15]	[5.65]	[3.20]	[-0.70]	[-1.18]	[-2.05]
NOBS	835	835	835	835	835	835
R2 (%)	6.27	30.62	11.45	10.86	5.62	8.52

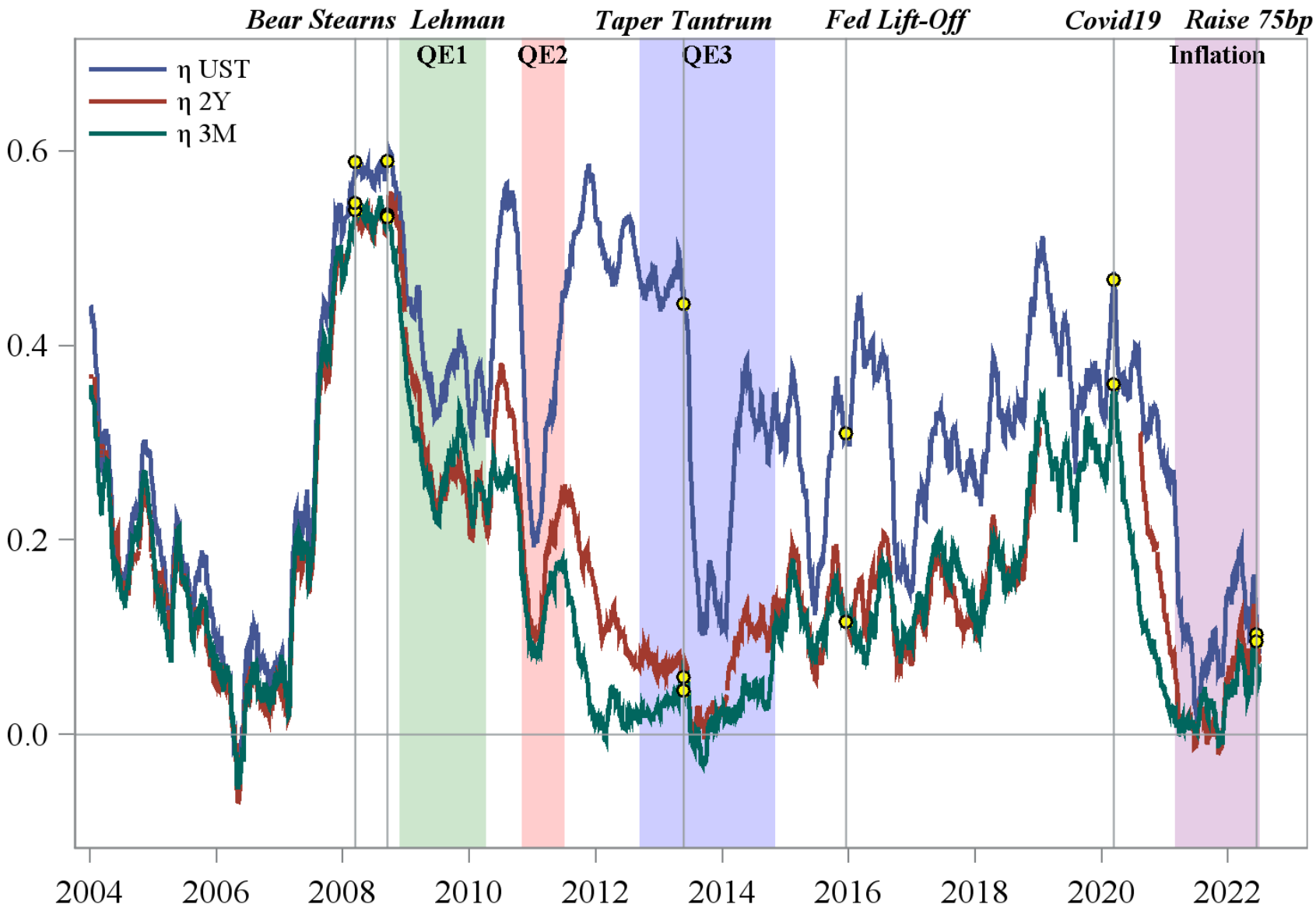
High and Low UST Safety Days

- **High** UST safety days:
  - ↪ Negative SPX-UST correlation
  - ↪ Strong **flight-to-safety** characteristics such as:
    - ★ Sharp decline in SPX
    - ★ Significant rallies in UST
    - ★ Strong appreciation of Yen to USD
    - ★ Large spikes in options implied-volatility
    - ★ Capital flows from SPX to UST
- **Low** UST safety days:
  - ↪ Zero or positive SPX-UST correlation
  - ↪ **The U.S. Treasury market becomes risky itself**
    - ★ Higher volatility and worsened liquidity in the Treasury market
    - ★ Most of the FOMC (56%) announcement days belong to this group
    - ★ Many days fall between 2004 and 2006, and after 2021, when Fed hiked interest rates to curb inflation and cool the economy.

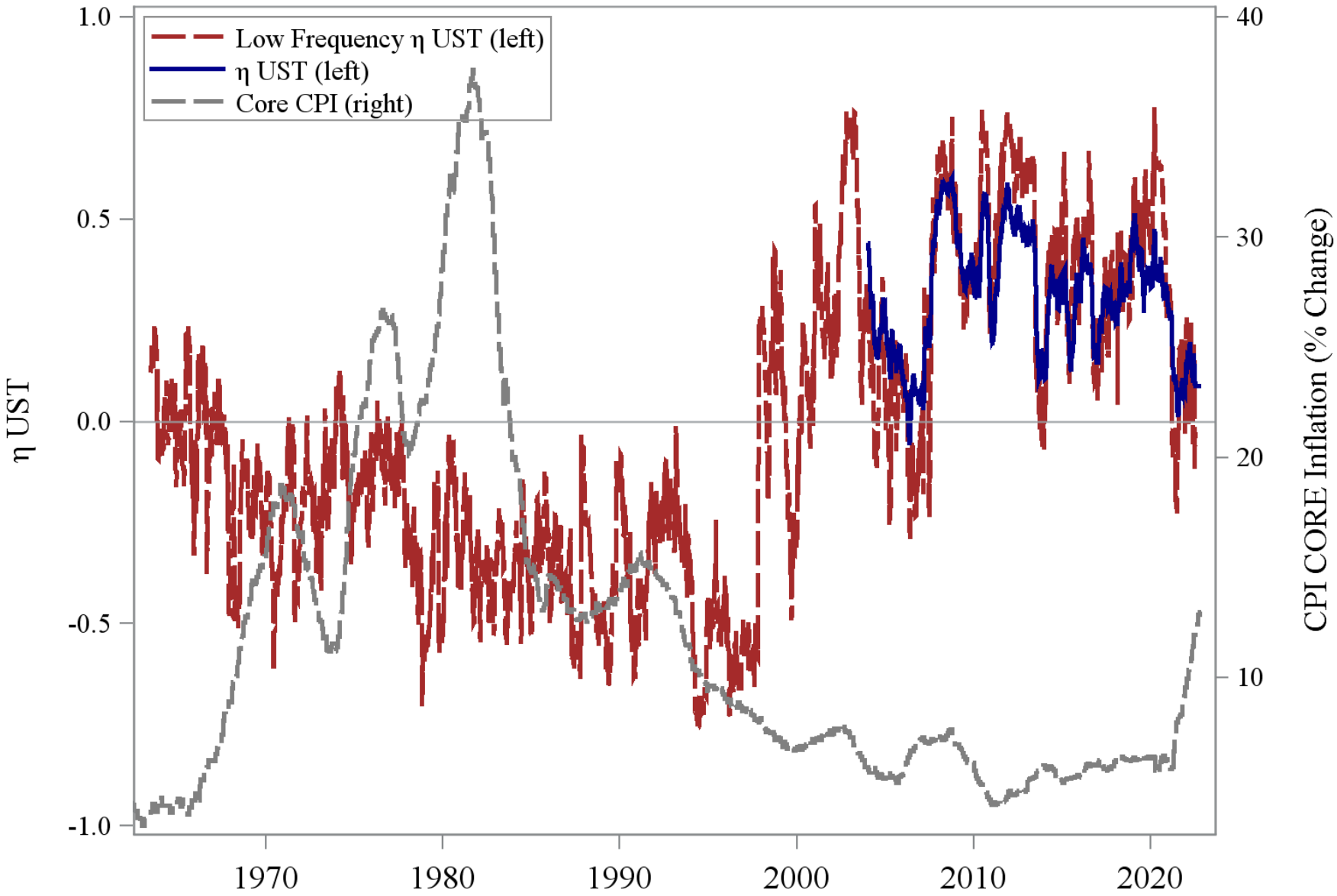
Alternative Safety Measures

- **Risk aversion or growth shocks? (Cieslak and Schrimpf, 2019)**
  - ↪ **2-Year**: $\eta_t^{2Y} = -corr(r_{i,t}^{SPX}, r_{i,t}^{UST\ 2Y})$
    - ★ $r_{i,t}^{UST\ 2Y}$ is the 5-minute return of the most liquid 2-year Treasury futures contracts
  - ↪ **3-Month**: $\eta_t^{3M} = -corr(r_{i,t}^{SPX}, r_{i,t}^{EuroDollar\ 3M})$
    - ★ $r_{i,t}^{EuroDollar\ 3M}$ is the 5-minute return of 3-month EuroDollar futures contract expiring one year later
  - ↪ Growth shocks have a more pronounced effect on short-term yields, risk aversion shocks have a greater impact on long-term yields
- **Low-Frequency Measures**
  - ↪ Exponential-weighted moving average (EWMA) correlation of daily returns of SPX and T10Y
  - ↪ Slow-moving, but consistent with our high-frequency measure

Comparing with η_t^{2Y} and η_t^{3M}

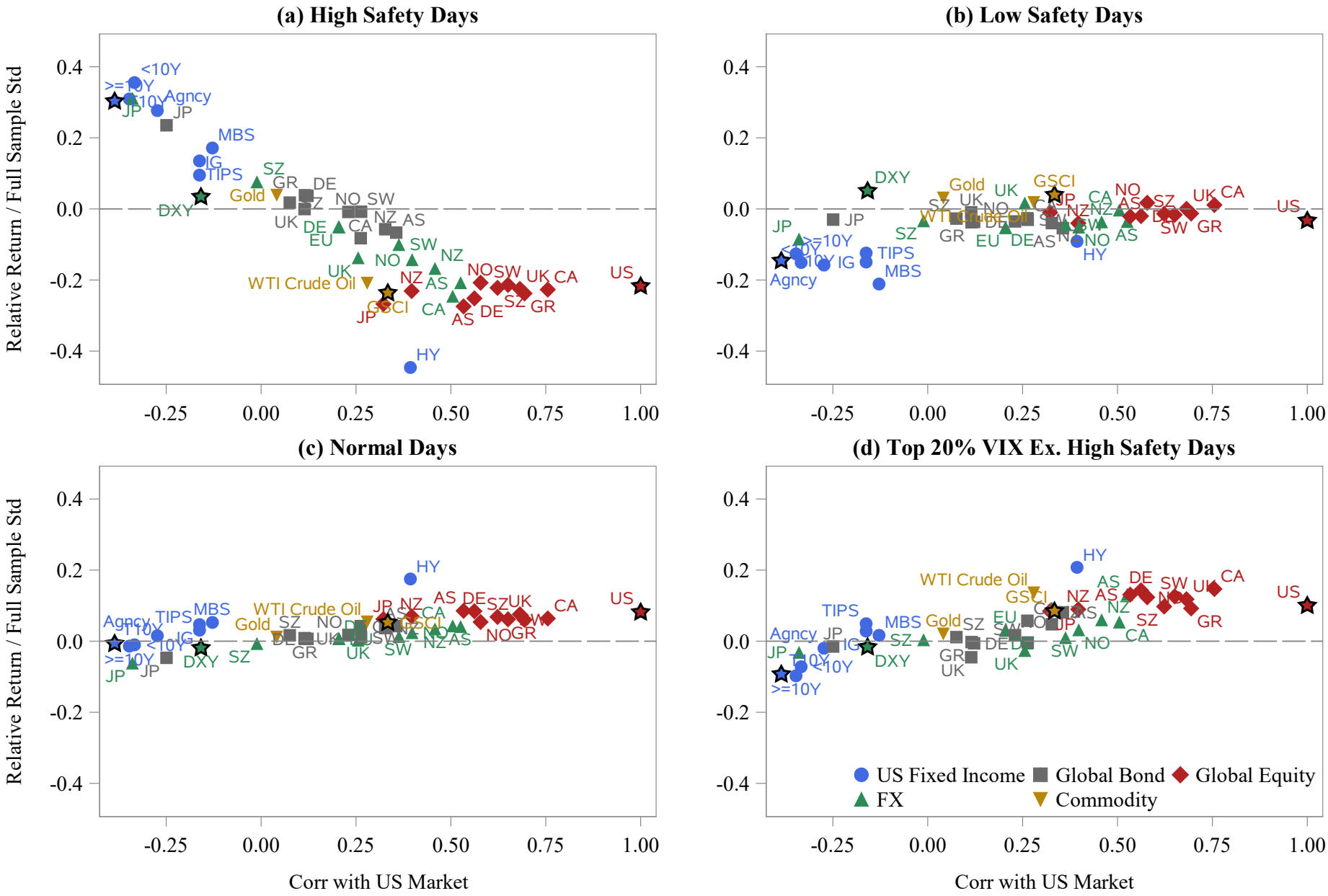


Comparing with Low Frequency η_t^{UST}



Outline

(1) Global Comovements



(2) Fixed-Income Market: UST Term Premium

Term Premium: long-term yield minus expectations of the future path of short-term rate, which is risk premium for bearing the risk of long-term bonds

	Panel A: Adrian, Crump, and Moench (2013)					Panel B: Kim and Wright (2005)				
	(1)	(2)	(3)	(4)	(5)	(1)	(2)	(3)	(4)	(5)
High η_t^{UST}	-0.99***		-0.82***		-0.70***	-0.84***		-0.63***		-0.61***
	[-4.71]		[-3.78]		[-3.25]	[-8.06]		[-5.52]		[-5.69]
Low η_t^{UST}	0.45**		0.44**		0.38**	0.37***		0.35***		0.35***
	[2.31]		[2.22]		[2.05]	[3.40]		[3.20]		[3.14]
FTS by Baele et al. (2019)		-2.70**	-1.97*				-2.87***	-2.38***		
		[-2.47]	[-1.82]				[-9.12]	[-7.52]		
FOMC					-0.85					-0.43
					[-1.54]					[-1.47]
SPX worst 20%				-1.78***	-1.82***				-1.30***	-1.25***
				[-6.32]	[-6.66]				[-10.40]	[-10.01]
SPX best 20%				1.93***	1.96***				0.84***	0.86***
				[8.56]	[8.26]				[8.03]	[8.33]
VIX top 20%					0.33					0.12
					[1.07]					[0.77]
VIX bottom 20%					-0.28*					-0.19**
					[-1.87]					[-2.17]
ΔNoise					1.67***					0.08
					[2.89]					[0.31]
ΔTYF Vol					0.01					-0.01
					[0.17]					[-0.54]
Intercept	0.06	0.02	0.08	-0.08	0.00	0.07	0.04	0.09	0.06	0.12*
	[0.60]	[0.20]	[0.77]	[-1.03]	[0.01]	[1.22]	[0.90]	[1.59]	[1.38]	[1.85]
NOBS	4570	4588	4570	4588	4433	4570	4588	4570	4588	4433
R2 (%)	0.81	0.63	1.13	4.94	6.22	2.42	3.00	4.36	7.05	8.95

(3) FX Market: Asset v.s. Funding Currencies

	Panel A: Carry trade portfolio returns				*Panel B: DXY and major funding-currencies (YEN and CHF)*		
	Carry 1	Carry 2	Carry 3	Carry 1−3	DXY	YEN	CHF
High η_t^{UST}	-10.83***	-4.61*	4.17*	-15.01***	0.87	17.28***	6.25
	[-3.27]	[-1.70]	[1.75]	[-5.47]	[0.37]	[6.50]	[1.64]
Low η_t^{UST}	-4.38*	-2.48	-2.00	-2.38	2.69	-2.52	-1.82
	[-1.73]	[-1.19]	[-0.88]	[-1.38]	[1.30]	[-1.07]	[-0.74]
Intercept	14.80***	5.97*	-1.05	15.84***	-3.25	-11.51***	1.03
	[3.17]	[1.81]	[-0.42]	[4.30]	[-1.17]	[-3.70]	[0.34]
NOBS	4577	4576	4577	4577	4577	4577	4577
R2 (%)	1.27	0.52	0.39	2.53	0.38	2.32	0.28

	Panel C: Other G10 currencies (ex. YEN, CHF)							
	NZD	AUD	NOK	GBP	CAD	SEK	EUR	DKK
High η_t^{UST}	-10.50***	-13.43***	-7.74**	-6.00**	-11.61***	-4.95	-1.98	-2.09
	[-2.67]	[-3.22]	[-2.09]	[-1.98]	[-3.91]	[-1.42]	[-0.70]	[-0.74]
Low η_t^{UST}	-4.09	-3.94	-5.97*	0.25	-1.38	-4.08	-2.41	-2.37
	[-1.36]	[-1.41]	[-1.82]	[0.11]	[-0.69]	[-1.42]	[-1.00]	[-0.98]
Intercept	15.28***	14.88***	14.34**	9.29**	12.11***	9.83***	3.20	3.23
	[3.23]	[2.78]	[2.41]	[2.42]	[3.39]	[2.59]	[1.01]	[1.01]
NOBS	4577	4577	4575	4577	4577	4575	4575	4577
R2 (%)	0.95	1.13	0.75	0.86	1.44	0.49	0.34	0.35

(4) Equity Market: High v.s. Low β Stocks

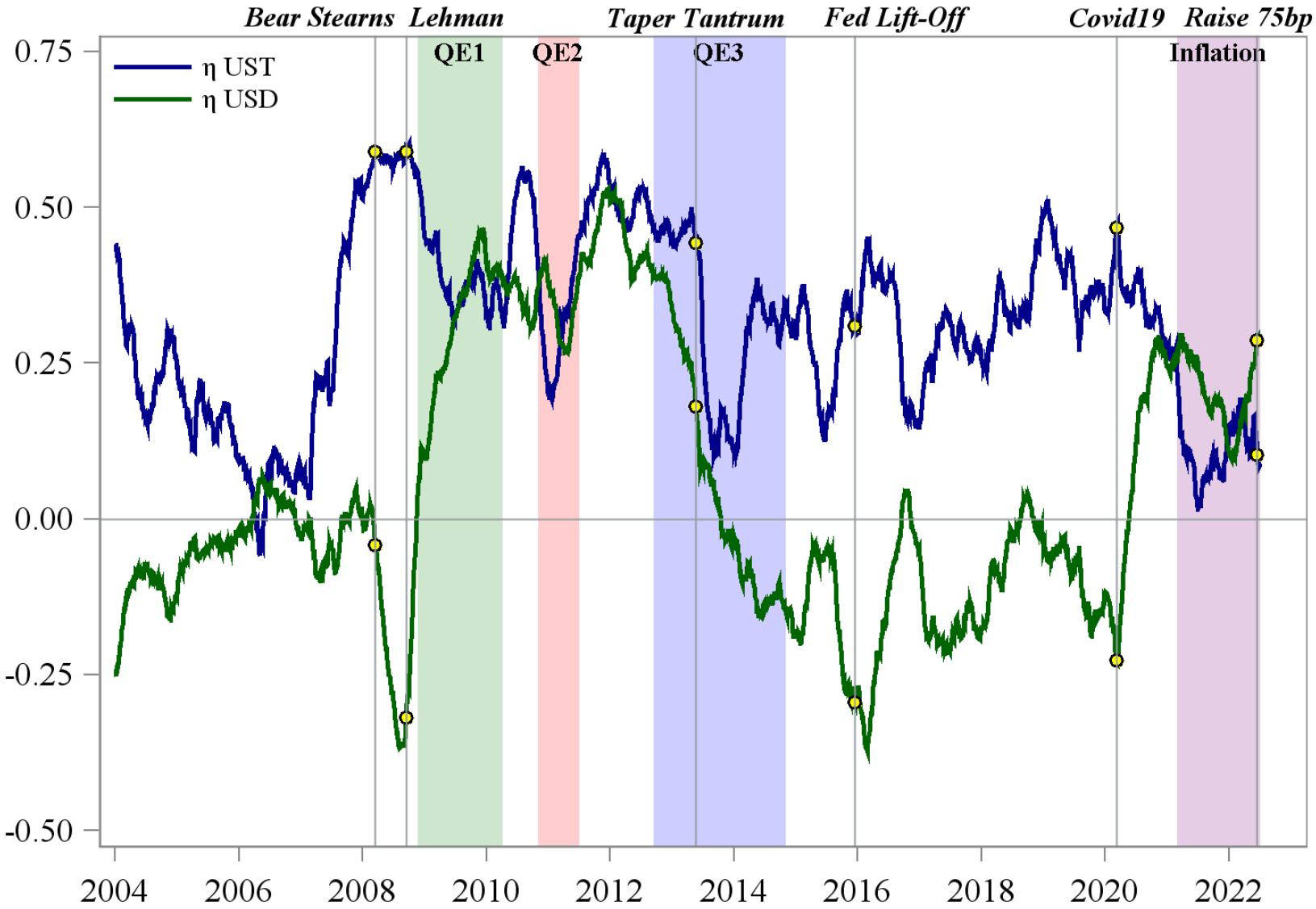
Portfolio	Excess Return	CAPM α	CAPM β	R2	CAPM α High η_t^{UST}	CAPM α Low η_t^{UST}	CAPM α Normal
1 (low beta)	3.22***	0.94	0.60***	69.99	7.73***	-3.73**	0.54
	[2.99]	[1.40]			[4.79]	[-2.13]	[0.57]
2	3.62***	0.82	0.74***	85.55	5.85***	-0.22	-0.46
	[2.92]	[1.48]			[4.07]	[-0.17]	[-0.64]
3	4.55***	1.07**	0.92***	90.7	1.52	0.43	0.79
	[3.08]	[2.30]			[1.12]	[0.39]	[1.23]
4	4.66***	0.93*	0.99***	91.31	-1.52	0.56	1.58**
	[2.84]	[1.71]			[-1.20]	[0.41]	[2.25]
5	5.11***	1.08*	1.07***	91.28	0.04	0.46	1.23
	[2.86]	[1.94]			[0.02]	[0.39]	[1.62]
6	4.82**	0.54	1.13***	91.05	-1.70	-0.66	0.72
	[2.54]	[0.90]			[-1.02]	[-0.53]	[0.89]
7	5.01**	0.6	1.17***	88.56	-2.63	-0.06	1.68
	[2.48]	[0.79]			[-1.53]	[-0.04]	[1.51]
8	4.94**	0.13	1.27***	86.71	-5.10**	2.41	0.73
	[2.15]	[0.15]			[-2.52]	[1.13]	[0.59]
9	4.75*	-0.46	1.38***	82.75	-7.87***	4.04	0.18
	[1.84]	[-0.43]			[-3.22]	[1.56]	[0.12]
10 (high beta)	5.23*	-0.53	1.52***	79.27	-10.59***	2.10	0.69
	[1.75]	[-0.38]			[-3.61]	[0.65]	[0.37]
BAB	2.79	2.79	0.00		20.65***	-6.27	1.19
	[1.61]	[1.61]			[5.08]	[-1.40]	[0.49]

Outline

Alternative Safety Measure Based on USD

- **U.S. Dollar**: $\eta_t^{\text{USD}} = -(w \times corr(r_t^{\text{SPX}}, r_t^{\text{USD/EUR}}) + (1-w) \times corr(r_t^{\text{SPX}}, r_t^{\text{USD/YEN}}))$
  - ↪ $w = \frac{0.576}{0.576+0.136} = 0.81$ is the relative ratio between the index weights of EUR (0.576) and JPY (0.136) in U.S. dollar index (DXY)

Comparing η_t^{UST} and η_t^{USD}



UST Convenience Yield

	Treasuries Basis		**Treasury Basis (CIP Adjusted)**		**Libor/Swap Spreads**		**CIP Basis**	
	$y_t^{UST} - y_t^{Synt\ Govt}$		$UST\ Basis_t - CIP\ Basis_t$		$y_t^{UST} - y_t^{Libor/Swap}$		$y_t^{Libor} - y_t^{Synt\ Libor}$	
	3M	5Y	3M	5Y	3M	5Y	3M	5Y
Changes $(y = \Delta spreads_t)$								
High η_t^{UST}	-1.07**	-0.50***	-1.02***	-0.34***	-1.42***	-0.25***	-0.05	-0.16***
	[-2.35]	[-3.94]	[-3.24]	[-3.18]	[-3.81]	[-2.65]	[-0.17]	[-2.69]
Low η_t^{UST}	0.04	-0.08	-0.11	-0.05	-0.26*	0.05	0.14	-0.03
	[0.13]	[-0.82]	[-0.85]	[-0.61]	[-1.94]	[0.71]	[0.57]	[-0.65]
High η_t^{USD}	-0.05	0.09	0.19	0.14	0.26	0.20**	-0.26	-0.06
	[-0.17]	[0.74]	[1.07]	[1.40]	[1.22]	[2.19]	[-1.36]	[-0.99]
Low η_t^{USD}	0.08	-0.01	0.19	0.07	0.27	0.11	-0.15	-0.08
	[0.27]	[-0.07]	[0.97]	[0.74]	[1.24]	[1.27]	[-0.70]	[-1.36]
Intercept	0.2	0.08	0.14	0.03	0.21	-0.01	0.04	0.05*
	[1.04]	[1.43]	[1.12]	[0.64]	[1.57]	[-0.29]	[0.33]	[1.87]
NOBS	4476	4427	4291	4427	4420	4420	4296	4428
R2 (%)	0.23	0.43	0.64	0.26	1.23	0.28	0.04	0.37

Co-movement between the UST and USD

- U.S. Treasury yields and U.S. Dollar typically move in the same directions given their common exposure to the U.S. interest rates
  - ↪ Increasing interest rates in the U.S. leads to a rally in Treasury yields(↑), and an appreciation of USD (↑) against other currencies.
  - ↪ Decreasing interest rates in the U.S. leads to a drop in Treasury yields(↓), and a depreciation of USD (↓) against other currencies.
- However, on high-η_t^{UST} days, this **positive** UST-USD link breaks down because the rally of UST is the result of a global risk-off on flight-to-safety days

UST-USD: The Positive Link Breaks Down

yvar=	The Dollar Index		USD/Foreign	
	(1)	(2)	(3)	(4)
$\Delta y^{UST} \times$ High		-1.33***		-1.45***
		[-2.67]		[-2.84]
$\Delta y^{UST} \times$ Low		1.95***		1.98***
		[4.47]		[4.44]
Δy^{UST}	1.49***	1.10***	1.58***	1.25***
	[6.73]	[4.14]	[3.93]	[2.97]
$r^{SPX} \times$ High		-0.04*		-0.04*
		[1.69]		[1.77]
$r^{SPX} \times$ Low		-0.04		-0.02
		[-1.56]		[-0.85]
r^{SPX}	-0.09***	-0.08***	-0.18***	-0.17***
	[-7.66]	[-5.28]	[-3.98]	[-3.70]
High	-0.25	-0.91	-1.10	-1.99
	[-0.12]	[-0.45]	[-0.58]	[-1.09]
Low	1.59	0.67	1.25	0.05
	[0.83]	[0.34]	[0.74]	[0.03]
Intercept	0.44	0.35		
	[0.51]	[0.40]		
Currency FE	No	No	Yes	Yes
NOBS	4622	4622	46220	46220
R2 (%)	4.90	6.41	8.51	9.27

UST-USD: The Positive Link Breaks Down

yvar=	The Dollar Index		USD/Foreign			Foreign/USD	
	(1)	(2)	(3)	(4)		(5)	(6)
$\Delta y^{UST} \times$ High		-1.33***		-1.45***	$\Delta y^{\text{Local Bond}} \times$ High		1.79***
		[-2.67]		[-2.84]			[2.75]
$\Delta y^{UST} \times$ Low		1.95***		1.98***	$\Delta y^{\text{Local Bond}} \times$ Low		-2.05***
		[4.47]		[4.44]			[-4.70]
Δy^{UST}	1.49***	1.10***	1.58***	1.25***	$\Delta y^{\text{Local Bond}}$	1.57***	1.66***
	[6.73]	[4.14]	[3.93]	[2.97]		[7.93]	[6.80]
$r^{SPX} \times$ High		-0.04*		-0.04*	$r^{\text{Local Equity}} \times$ High		-0.05***
		[1.69]		[1.77]			[-2.59]
$r^{SPX} \times$ Low		-0.04		-0.02	$r^{\text{Local Equity}} \times$ Low		-0.01
		[-1.56]		[-0.85]			[-0.34]
r^{SPX}	-0.09***	-0.08***	-0.18***	-0.17***	$r^{\text{Local Equity}}$	0.05	0.06*
	[-7.66]	[-5.28]	[-3.98]	[-3.70]		[1.55]	[1.79]
High	-0.25	-0.91	-1.10	-1.99	High	-0.44	0.10
	[-0.12]	[-0.45]	[-0.58]	[-1.09]		[-0.15]	[0.04]
Low	1.59	0.67	1.25	0.05	Low	-2.81	-1.76
	[0.83]	[0.34]	[0.74]	[0.03]		[-1.48]	[-0.92]
Intercept	0.44	0.35			Intercept		
	[0.51]	[0.40]					
Currency FE	No	No	Yes	Yes	Currency FE	Yes	Yes
NOBS	4622	4622	46220	46220	NOBS	46220	46220
R2 (%)	4.90	6.41	8.51	9.27	R2 (%)	2.43	3.02

Conclusion

- We propose a daily safety measure η_t^{UST} so that we can empirically identify global risk-off episodes, during which the market performances echo classic flight-to-safety characteristics
- During global risk-off episodes, there are strong safety-chasing induced comovements both within and across global asset classes
- We highlight the uniqueness of U.S. Treasury as the global safety destination, compared to alternative safe assets like U.S. Dollar and VIX