Foreign Exchange Fixings and Returns Around the Clock

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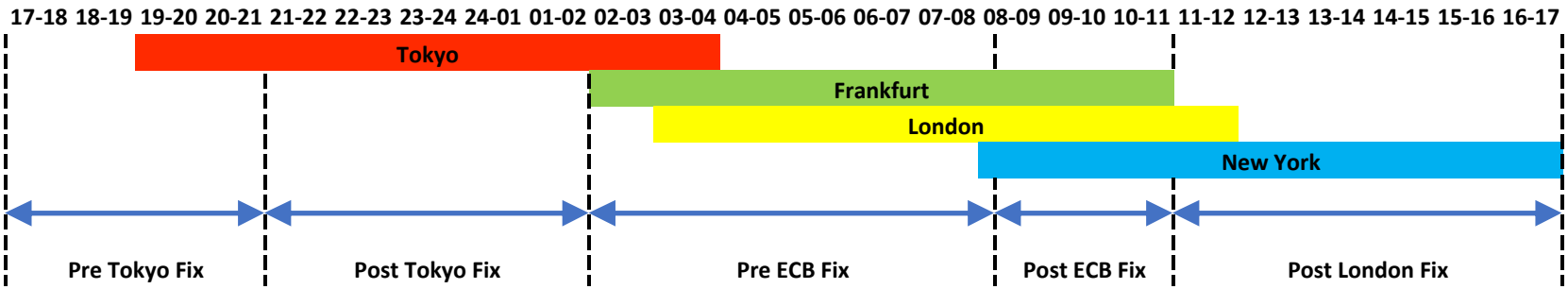
BIS-Banca d'Italia-ECB 12th Workshop on Exchange Rates
Basel, 13 December 2022

The views expressed by the speaker do not necessarily reflect those of the Bank of Canada's Governing Council.

Currency Trading in FX Markets

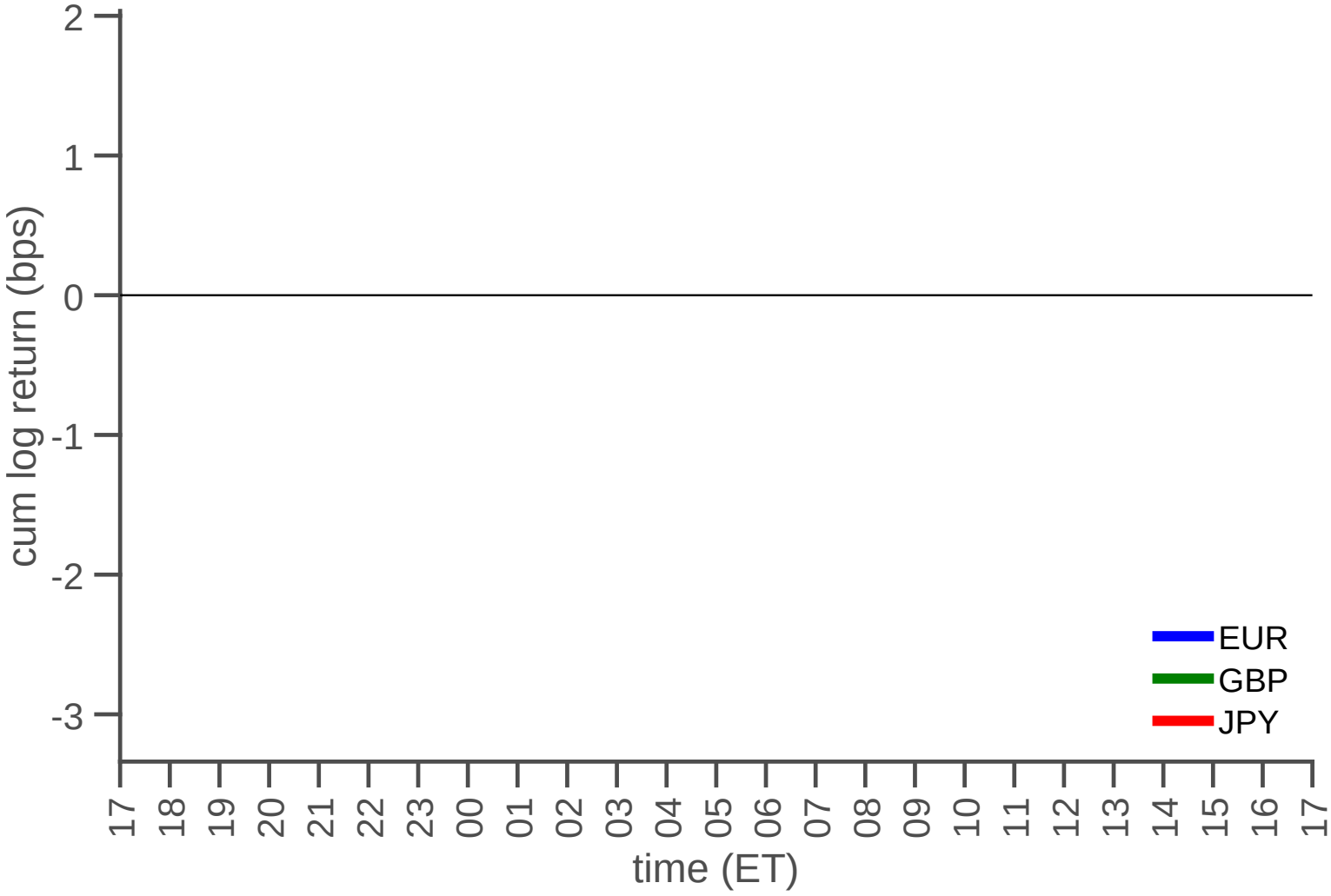
- Trading in FX markets takes place almost 24/7 and daily volume of \$8.3tr (BIS, 2019) is concentrated across three subperiods



- Three major FX fixes:
  - Tokyo Fix: 9:55 a.m. local time (or 7:55/8:55 p.m. ET)
  - European Central Bank Fix: 2:15 p.m. local time (or 8:15 a.m. ET)
  - London Fix: 4:00 p.m. local time (or 11:00 a.m. ET)

- Institutional fixes provide benchmark rates for market participants

Main Result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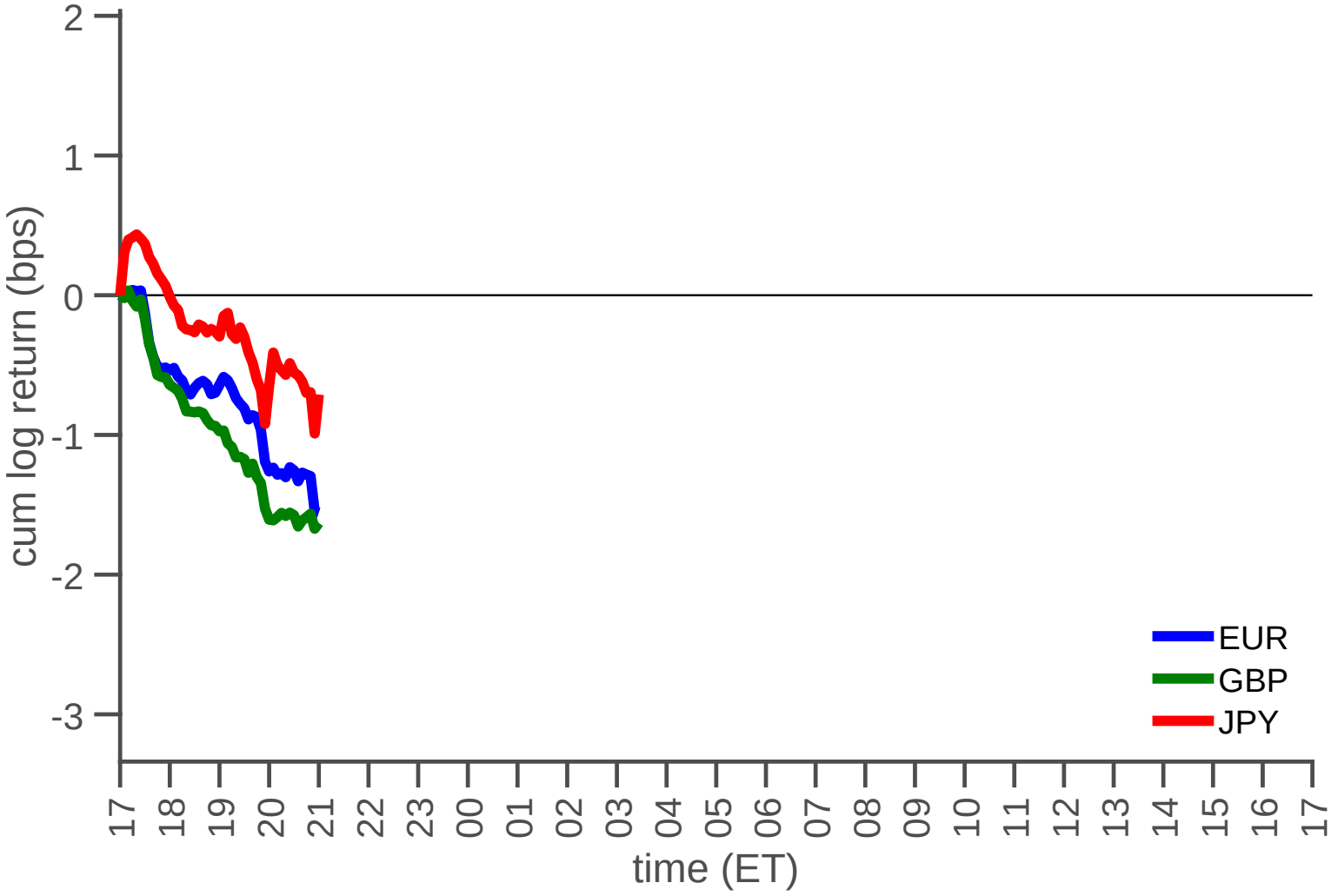
Main Result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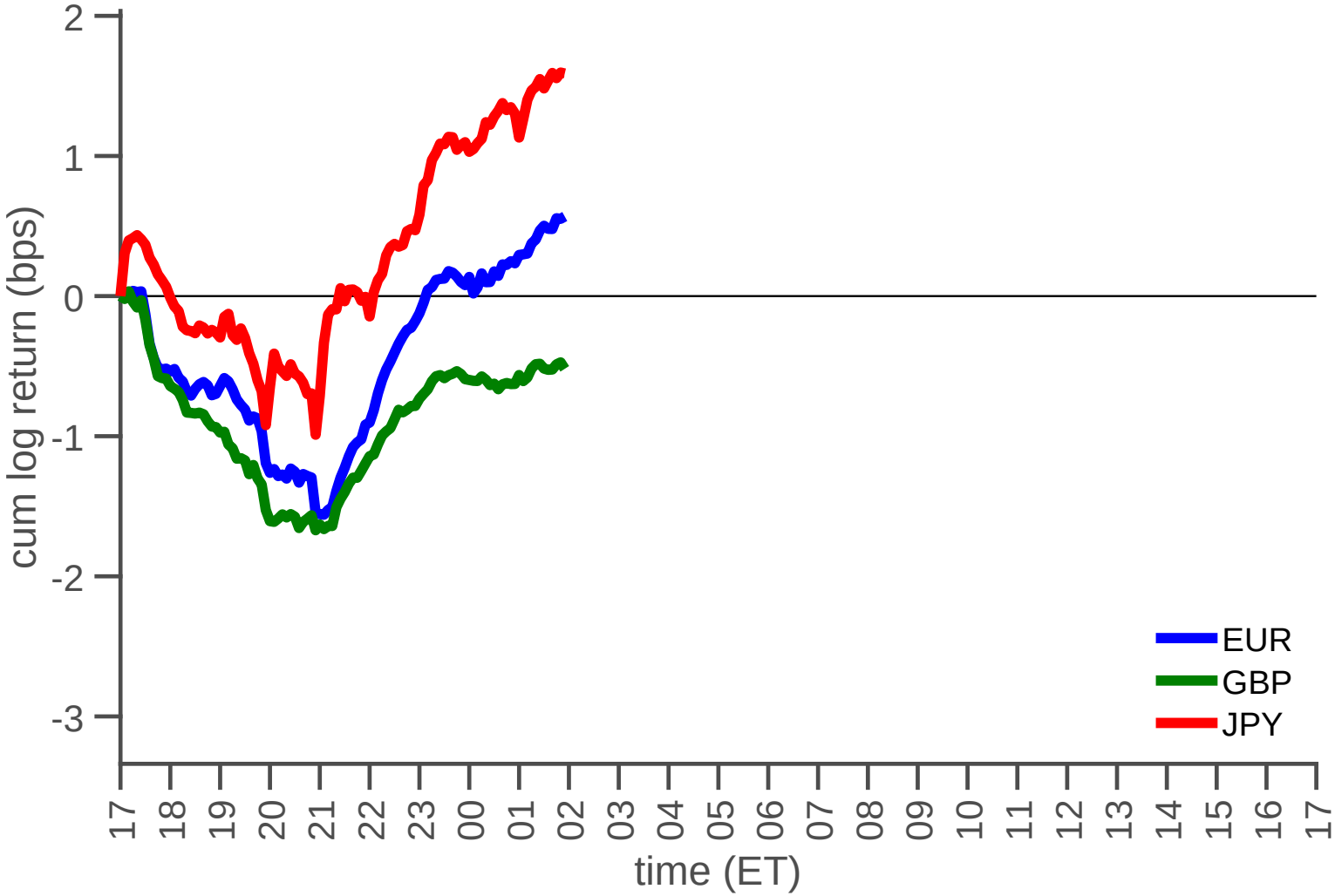
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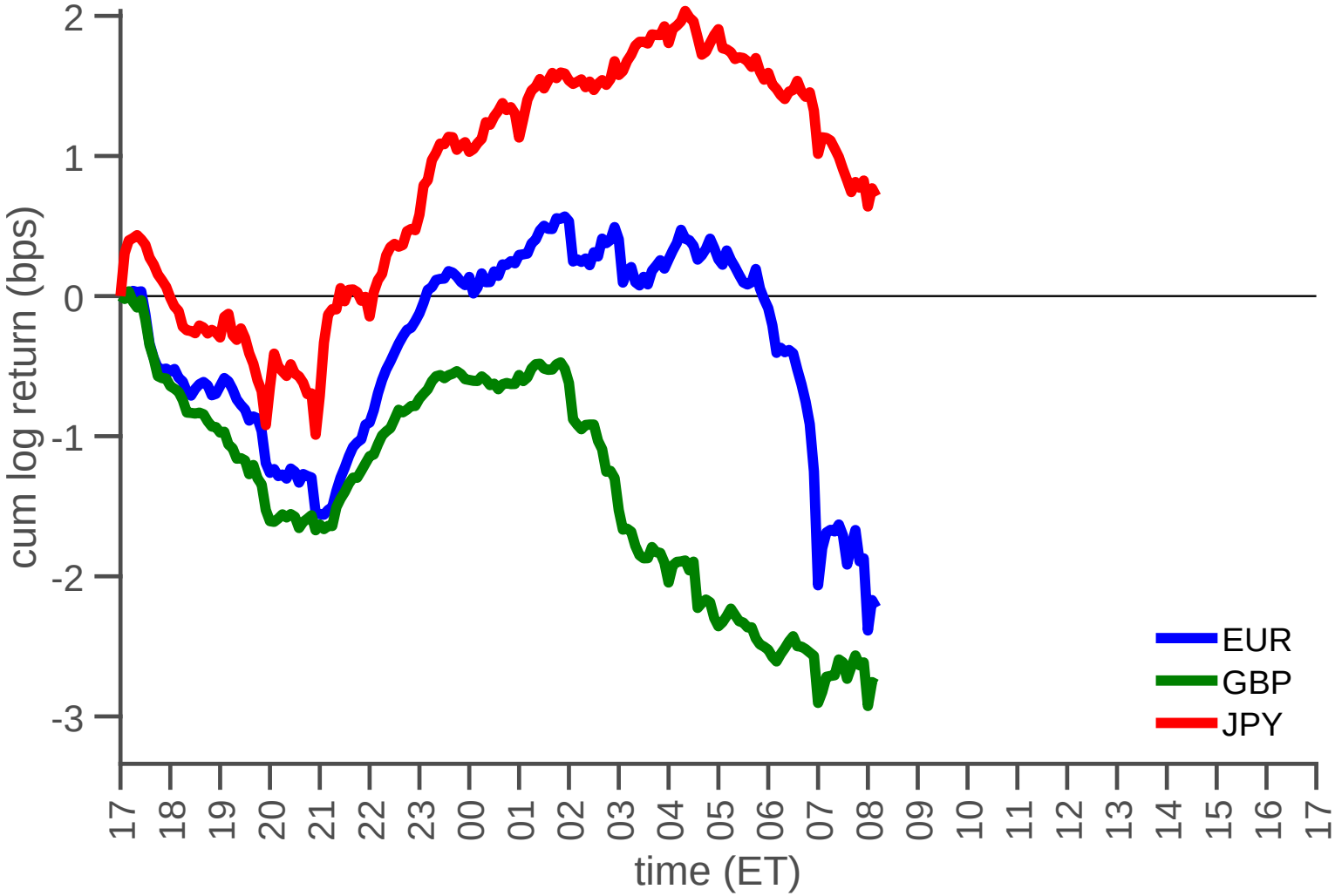
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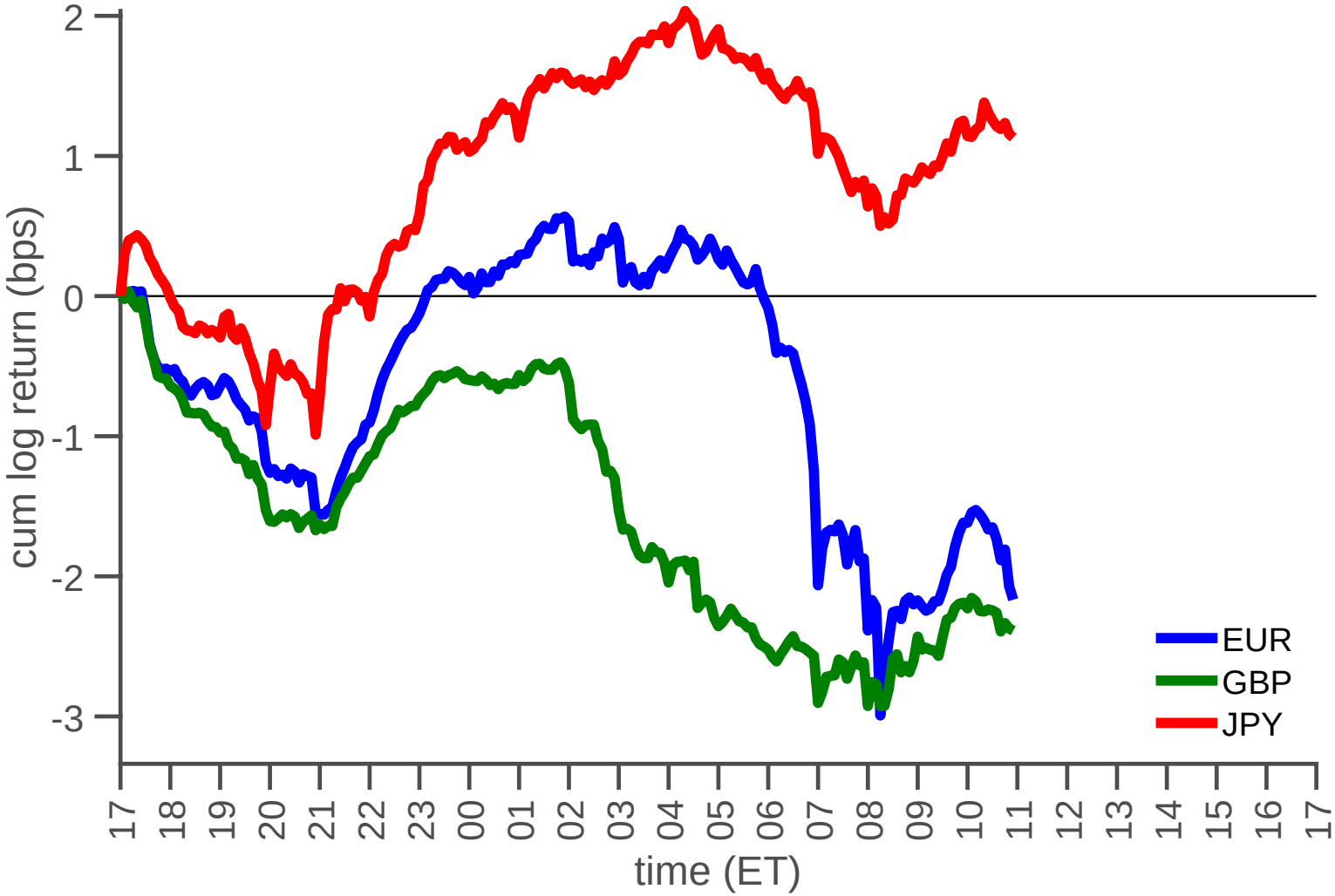
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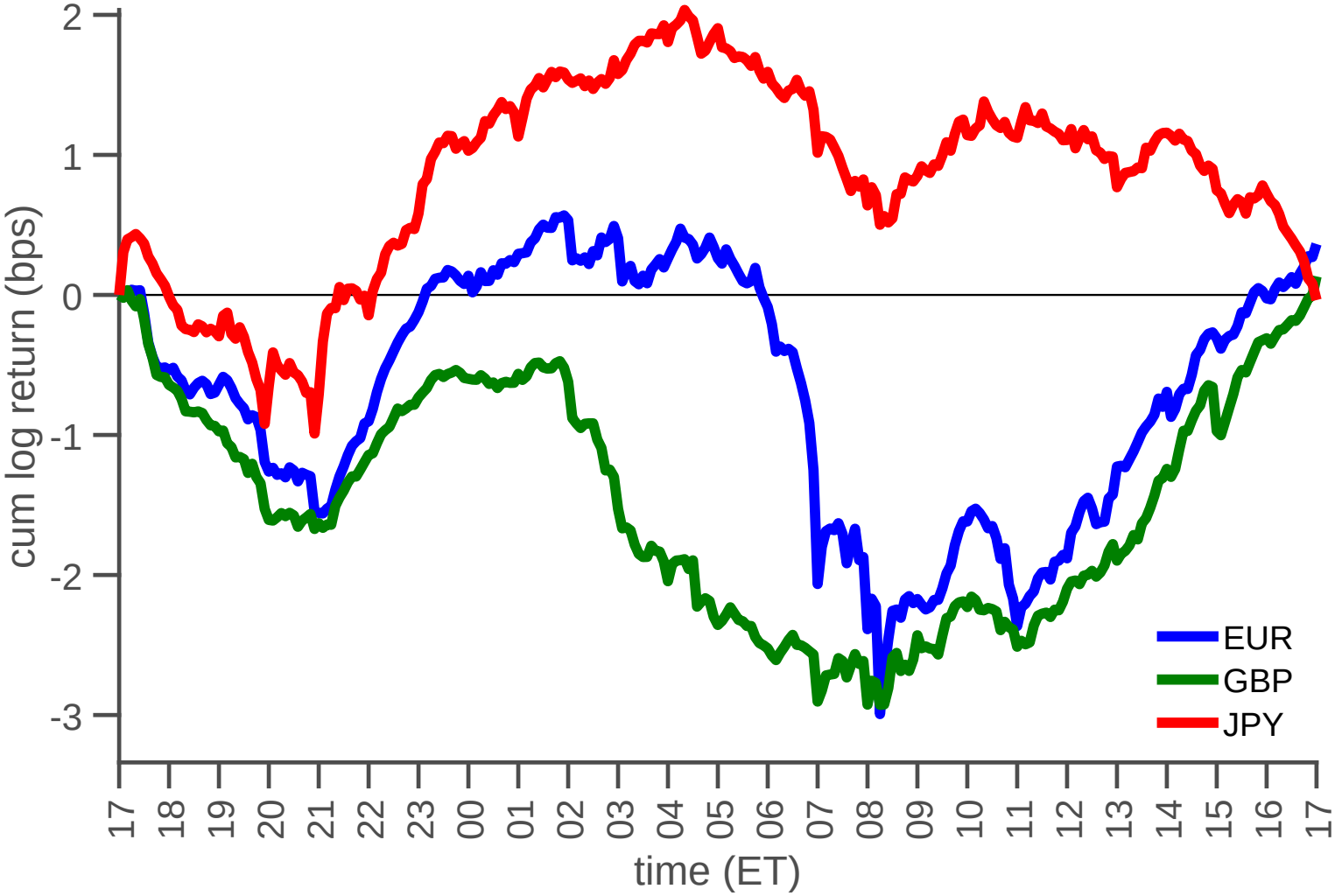
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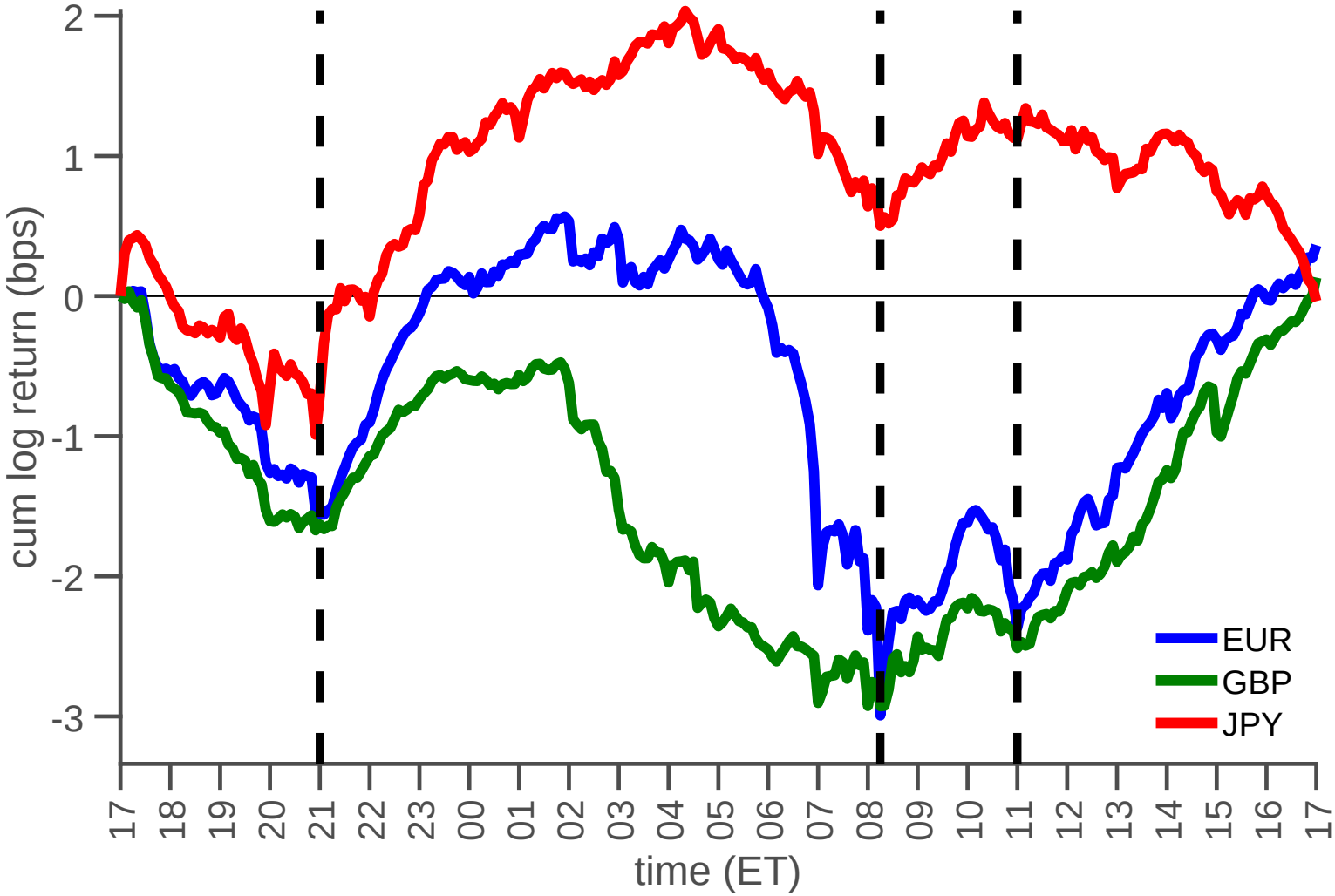
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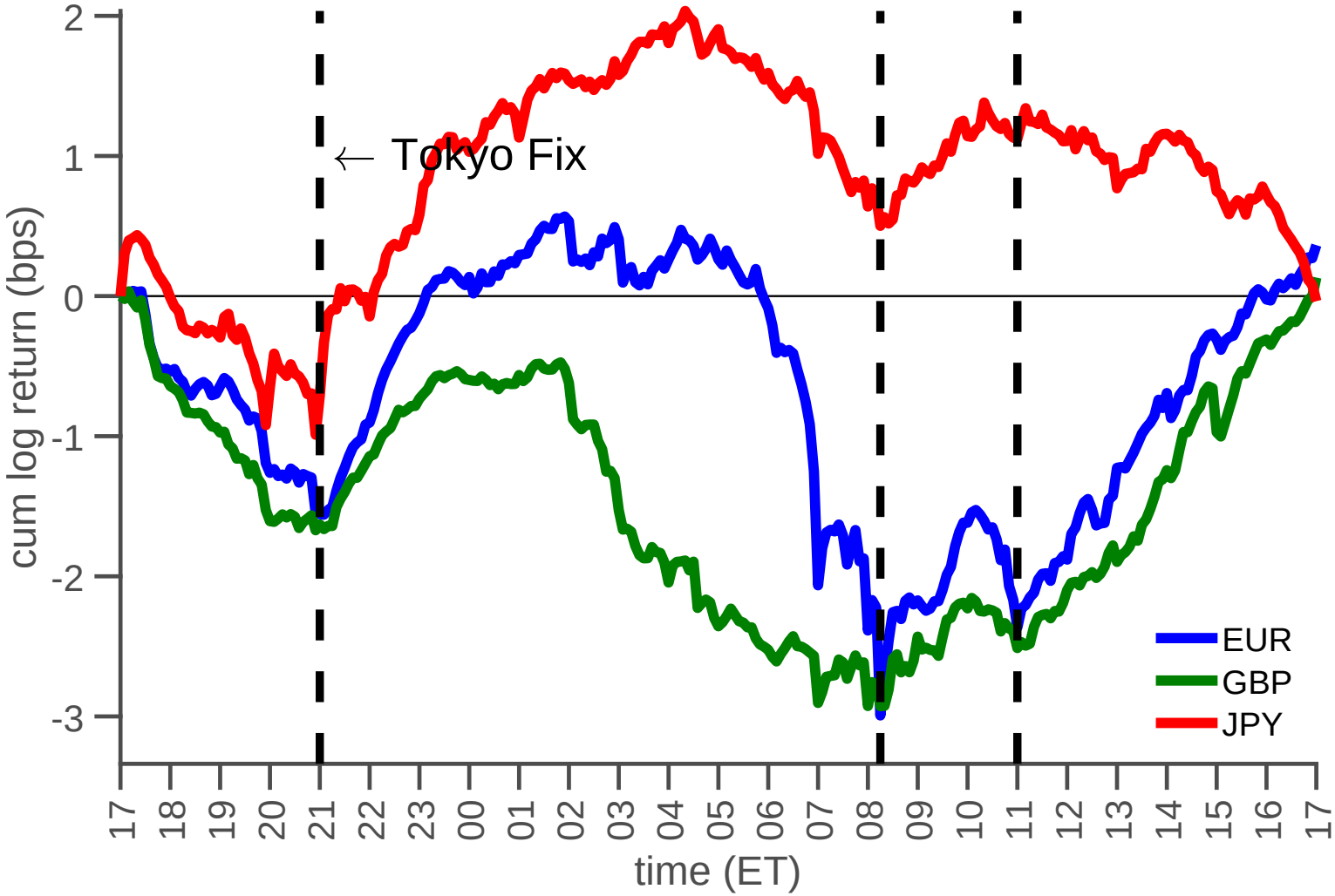
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cum log return (bps)
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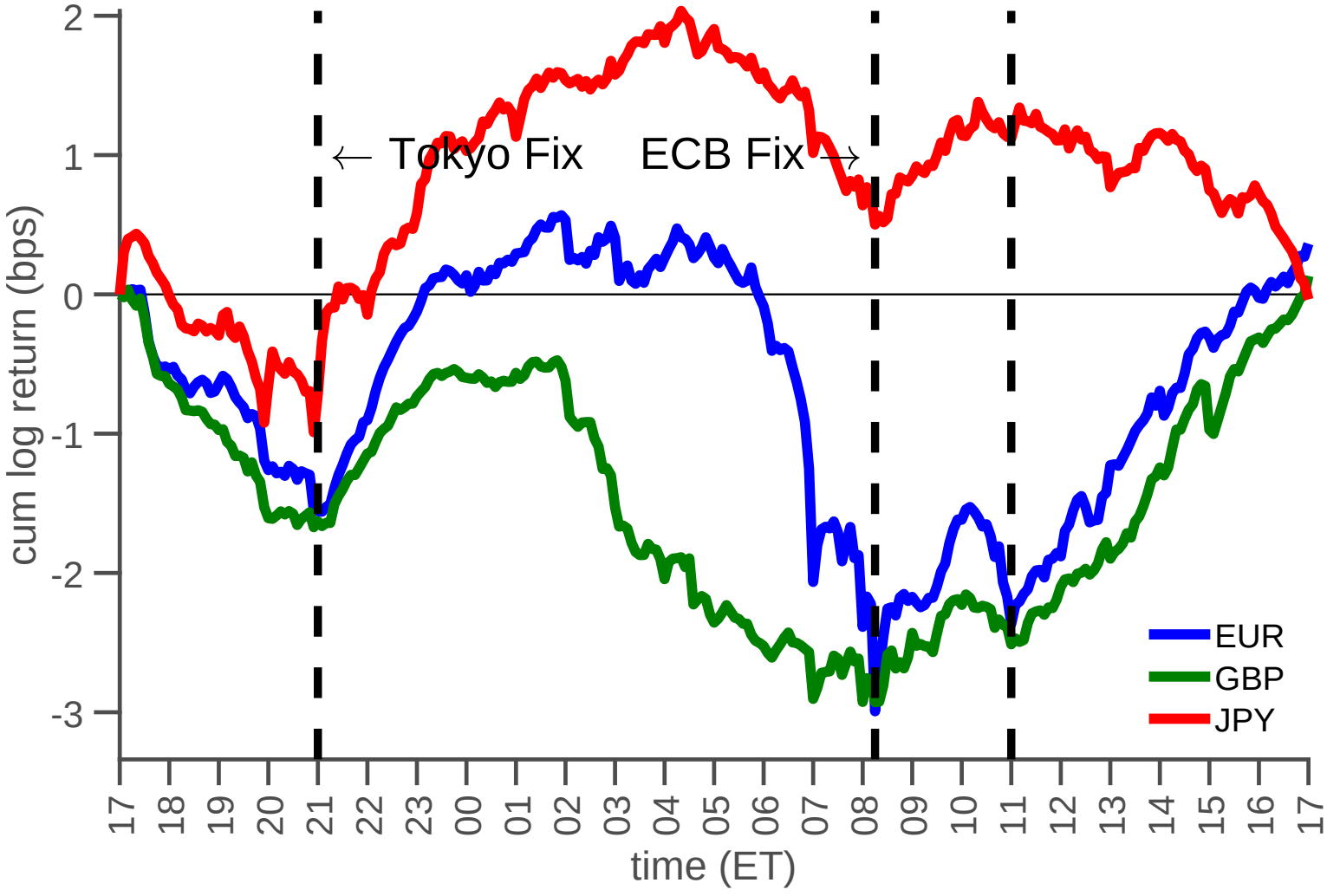
time (ET)

Main Result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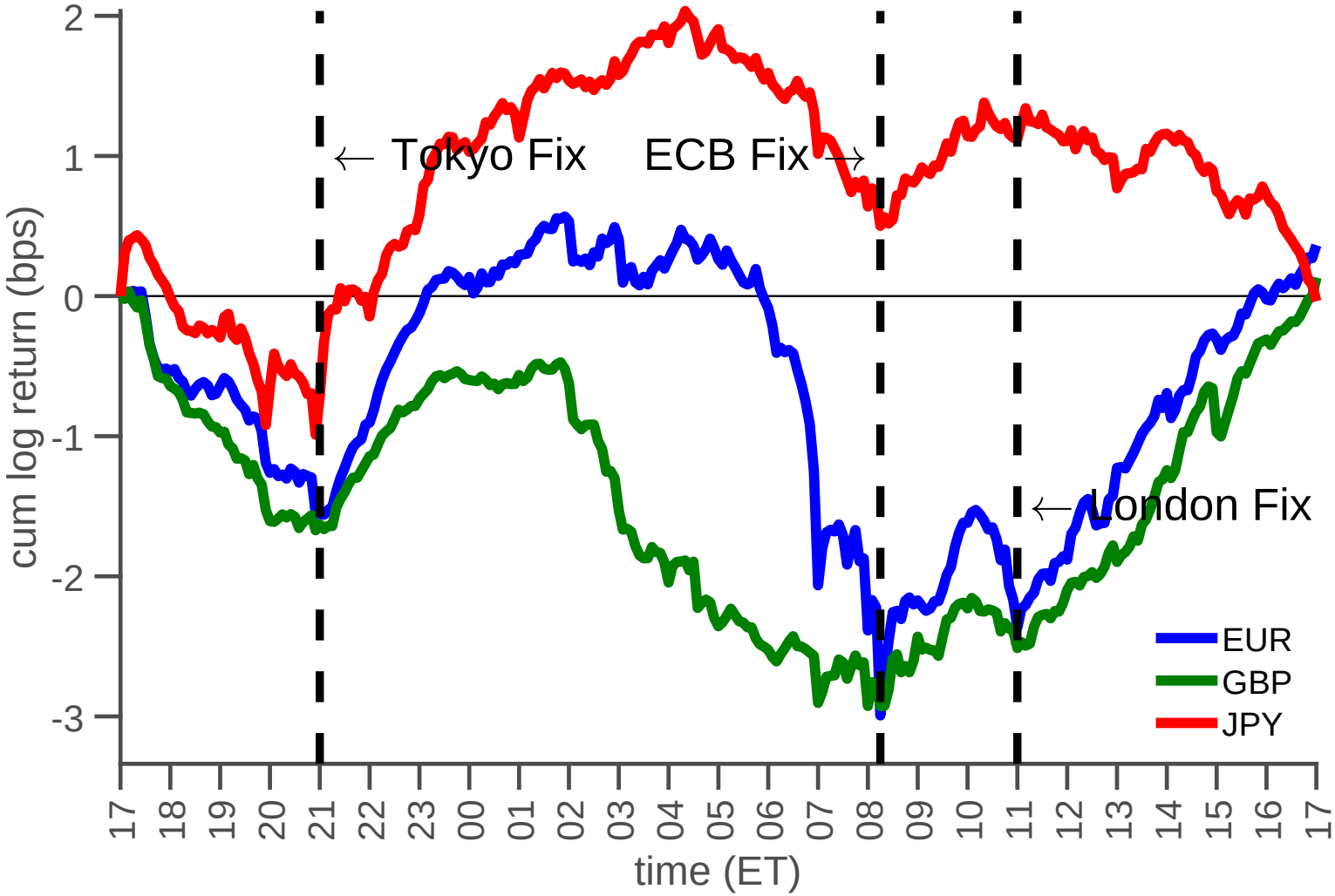
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ECB Fix →
← London Fix
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Summary

(1) Major FX fixes mark intraday **reversal points**

  (i) U.S. dollar **appreciates** before & **depreciates** after local fixes
  (ii) Multiple **natural experiments** confirm pattern is determined by fixes

(2) On average **positive dollar demand** determines direction of swings

  (i) Purchases of dollar denominated assets in **pre-fix hours**
  (ii) Order flow pattern **changes sign** around the fix

(3) **Inventory risk management** and pre-hedging activity cause reversals

  (i) Higher **dollar demand** pre-fix leads to bigger reversal returns
  (ii) Magnitude of return swings increase with **level of volatility**

Three fixes

(1) **London fix**

- Introduced in 1994 by WMR (now owned by Thomson Reuters).
- **Actual executed trades and bid and offer order rates** from the order matching systems are captured every second over a 5-minute fix period around 16:00 GMT.
- From each data source, a single traded rate will be captured and valid trades are pooled to calculate a mid-rate.

(2) **ECB fix**

- ECB "reference rate" are intended for **information purposes only** and are not to be used in transactions.
- Methodology: "The euro foreign exchange reference rates are determined by the ECB daily at 14:15 CET in a teleconference between the administrator and the calculation agents, and are published by the ECB on its website and selected wire services at around 16:00 CET."

(3) **Tokyo fix**

- Each bank announces its own "Telegraphic Transfer Middle Rate" based on transactions that transpire "around" 9:55 JST.
- Rate is applicable **throughout the day** (with exceptions).

Data: Main Sources

- Intraday FX quotes for 252 months
  - Refinitiv Tick History (RTH)
  - Sample period: January 1999–December 2019
- G9 currencies versus U.S. dollar
  - AUD, CAD, CHF, EUR, GBP, JPY, NOK, NZD, SEK
  - Approx. 75% of daily FX turnover (BIS, 2019)
- High frequency data sampled at 5-min frequencies
- Days with low-trading activity are excluded in a standard fashion (e.g. weekends, public holidays)
- Information on quoted bid and ask prices

Data: Additional FX Market Segments

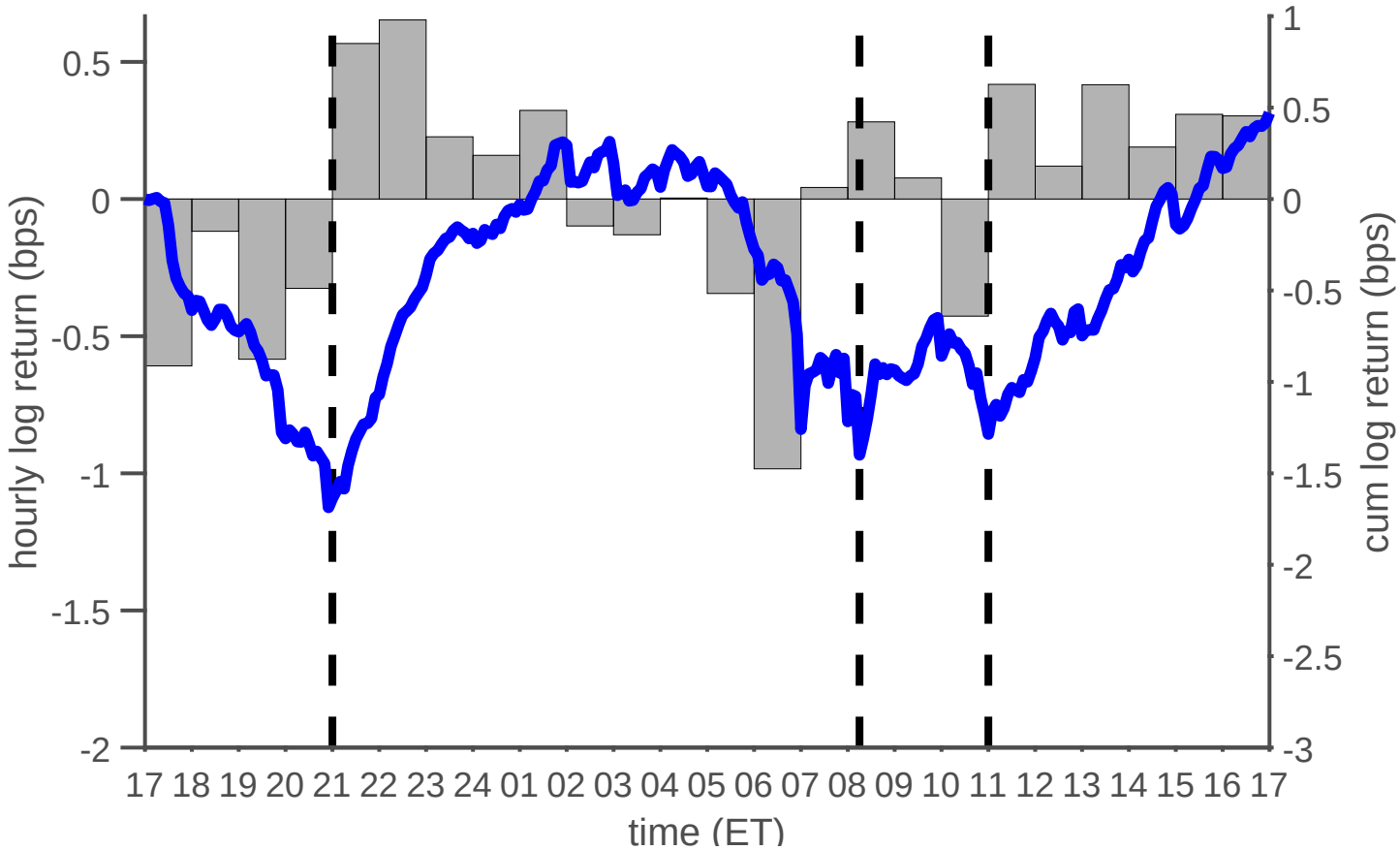
- Refinitiv Matching database (RM)
  - Traded prices, volumes, and direction of trades
  - Sample period: June 2006–December 2019
- Intraday FX Futures (GLOBEX)
  - Firm quotes, traded prices, and volume
  - Sample period: June 2004–December 2019
- Intraday Dollar Futures (ICE)
  - Firm quotes and traded prices
  - Sample period: June 2006–December 2019
- Intraday Refinitiv Tick History Forwards (RTH Forwards)
  - Indicative swap points quotes
  - Sample period: June 2006–December 2019

Average Returns (RTH Sample)

	pre-T 17:00–20:55	post-T 20:55–2:00	pre-E 2:00–8:15	E-L 8:15–11:00	post-L 11:00–17:00	CTC 17:00–17:00
AUD	-2.84***	1.85***	-0.41	-0.05	1.93***	0.48
CAD	-1.52***	1.50***	-0.76*	-0.41	1.54***	0.36
CHF	-1.24***	1.25***	-2.55***	1.26***	2.24***	0.96
EUR	-1.80***	2.34***	-3.52***	0.63	2.73***	0.37
GBP	-1.89***	1.27***	-2.29***	0.42	2.65***	0.15
JPY	-1.61***	3.15***	-1.03**	0.62	-1.16***	-0.03
NOK	-1.94***	2.95***	-1.39**	-2.02***	2.14***	-0.25
NZD	-3.39***	2.29***	-0.34	0.56	1.81***	0.93
SEK	-1.80***	2.16***	-3.07***	-0.06	2.60***	-0.16
DOL	-1.99***	2.10***	-1.67*	0.14	1.84***	0.41
Sign	(-)	(+)	(-)	(+)	(+)	(+)
Trend	FC ⇓	FC ⇑	FC ⇓	(~ 0)	FC ⇑	(~ 0)

This table reports average returns (in bps) for different intraday periods around the Tokyo, ECB and London fix using the RTH data base. Positive values imply the foreign currency appreciates versus the U.S. dollar. The dollar portfolio "DOL" is an equal weighted average of all nine currencies in our sample. The sample period is January 1999 to December 2019.

Dollar Portfolio



- Dollar portfolio exhibits strong "W"-pattern
- Signs of average hourly returns are consistent within pre-/post-fix windows

Dollar Portfolio: Across FX Market Segments

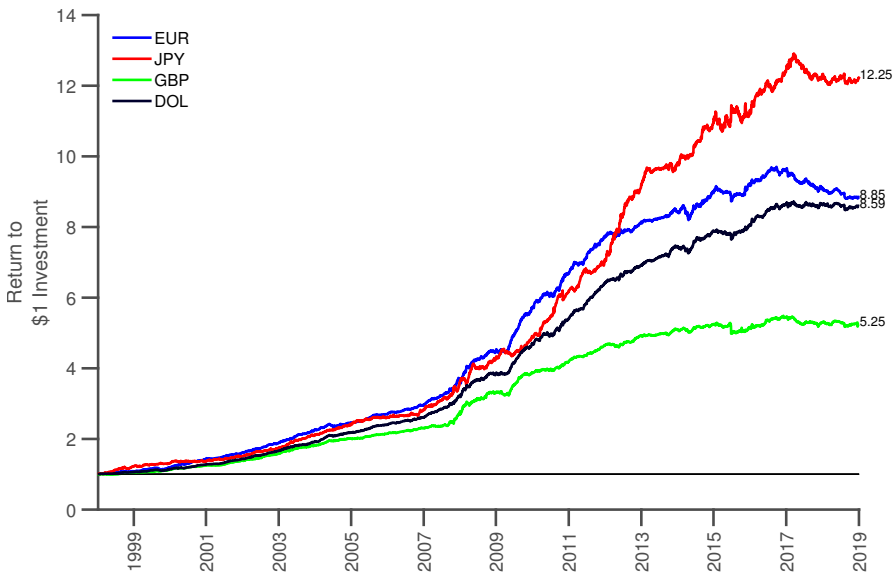
	pre-T	post-T	pre-E	E-L	post-L	CTC
RTH Spot	-1.58***	1.88***	-1.65***	-0.04	1.20***	-0.20
RTH Forwards	-1.57***	1.85***	-1.61***	-0.05	1.20***	-0.19
CME Futures	-1.46***	1.80***	-1.64***	0.11	0.64***	-0.56
ICE Futures	-1.27***	1.37***	-1.70***	0.10	1.12***	-0.38
RM VWAPS	-0.87***	1.18***	-1.10***	-0.45	1.14***	-0.09

- "W"-shape is prevalent across different FX market segments
- Intraday pattern is not
  - driven by stale / indicative quotes
  - related to intraday interest rate differentials (Forwards / Futures)
  - absorbed by effective bid-ask spread (traded prices)

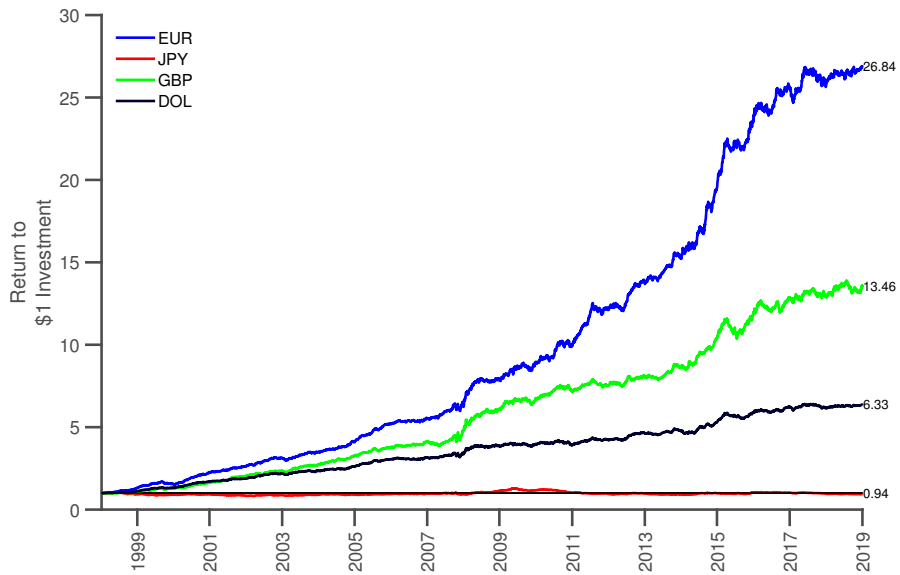
Return Reversals: Economic Significance of Drifts

$$\Delta s^{Tokyo} = -\Delta_d^{Pre-T} + \Delta_d^{Post-T}$$

$$\Delta s^{Europe} = -\Delta_d^{Pre-E} + \Delta_d^{Post-L}$$



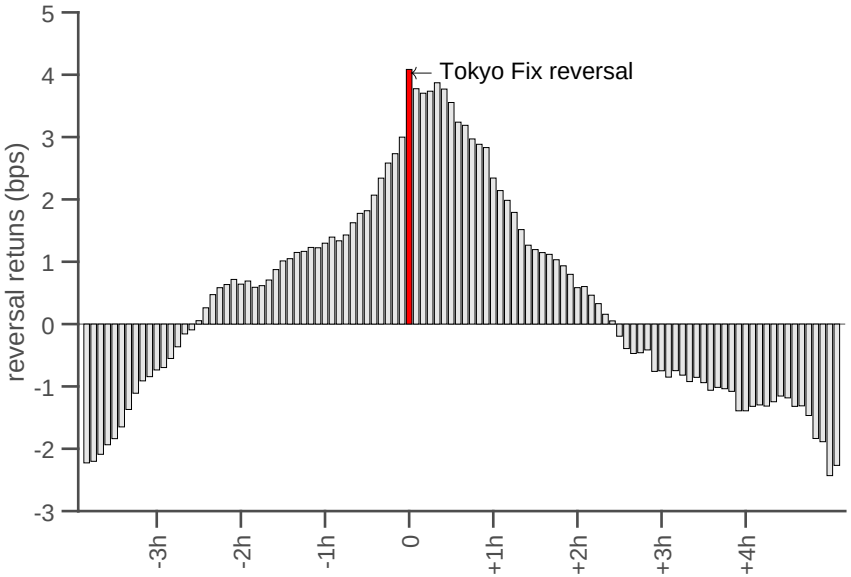
Tokyo



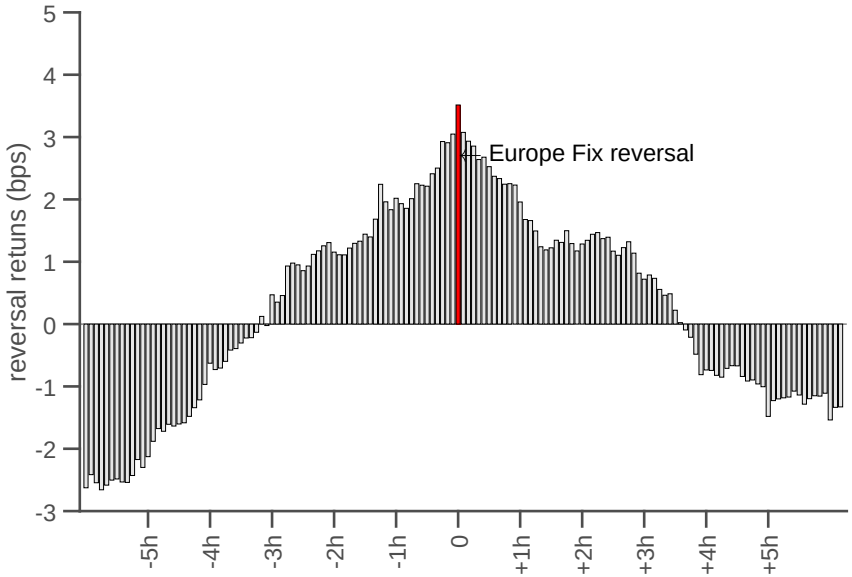
Europe

- Return reversal: Long (Short) USD position in pre-fix (post-fix) hours
- European fixes: $1 investment in 1999 grows up to approx. $27 in 2019

Event Study: Alternative Reversal Times



Tokyo Fix



Europe Fix

- Consider alternative strategies based on earlier/later reversal point
- Reversal returns are largest when turning point coincides with fixes
- Alternative reversal strategies consistently generate lower returns

Natural Experiments

- Daylight savings time changes
- Asynchronous holidays
- Institutional changes
  - Introduction of the London fix in 1994
  - Introduction of the ECB fix in 1999
  - Changes in publication time of ECB fix rate in 2016

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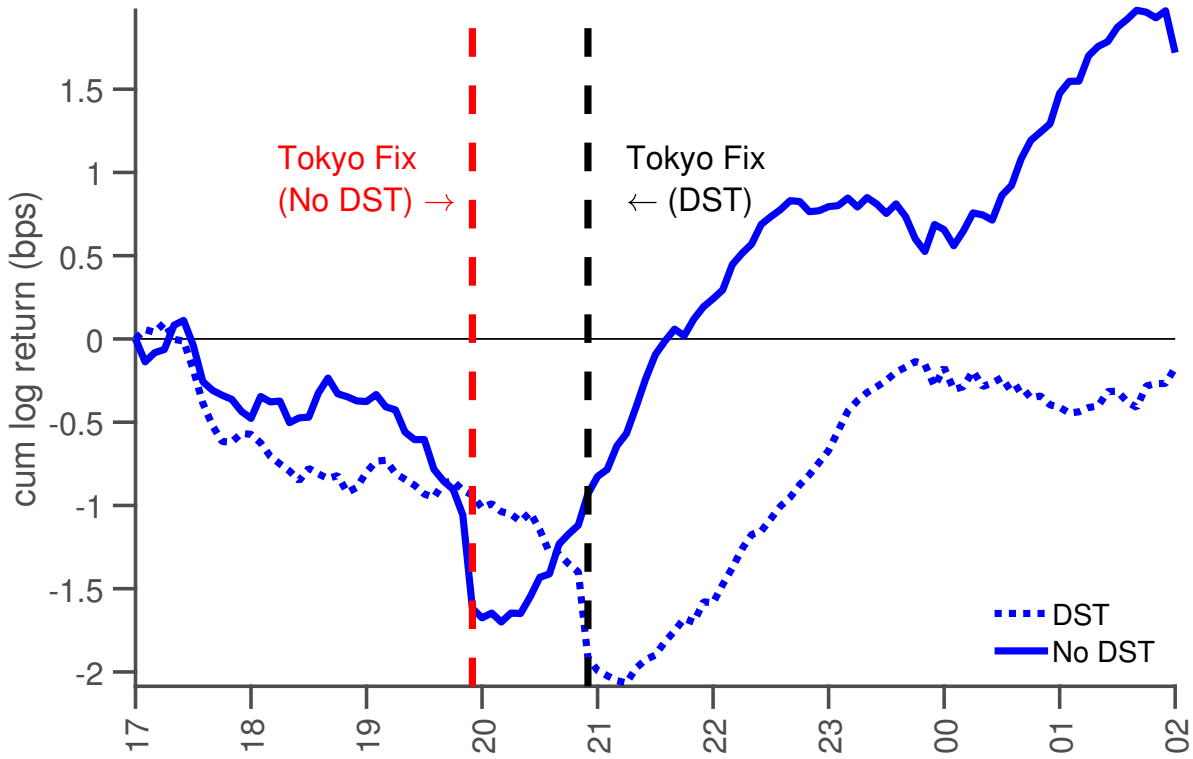
When fixes are not published or don't exist, reversals do not occur.

Natural Experiment: DST Change (EUR)



- Japan does not observe daylight sayings time
- Time difference between Tokyo and NY is either 13 or 14 hours
- In line with NY DST change, reversal point moves by 1 hour

Fix Reversals: Economic Explanation

1. Asymmetric information alone does not explain fix reversals, i.e.,
   - Not driven by standard news releases
   - Unrelated to calendar effects (e.g., day-of-the-week, etc.)
   - Impact is temporary instead of permanent

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2. **Inventory management and liquidity provision**
   - Demand for immediacy to trade foreign currencies vs. U.S. dollar
   - Unknown ex-ante U.S. dollar demand on each day
   - Dealers' pre-hedging practices generate interdealer demand in the direction of expected imbalances

Anectodal Evidence: Pre-Fix Hedging

Banco Santander FX Disclosure Notice:

'the bank will engage in pre-hedging to manage inventory risks ... and these transactions may have an unintended effect by impacting the benchmark fixing or related markets'

- Banks are explicit that they engage in pre-fix hedging, ...
- and that there could be **unintended negative consequences** for clients that choose to trade at the fix
- A number of the largest FX dealers (according to the Euromoney Survey) provide similar FX disclosure documents

Unconditional Order Flow Imbalances

	AUD			GBP		
	pre-E	pre-L	post-L	pre-E	pre-L	post-L
Fraction positive	0.48	0.47	0.52	0.48	0.48	0.54
Probability	0.01	0.00	0.01	0.02	0.04	0.00
Mean	-7.97	-26.47	2.52	2.35	-3.39	22.55
t-stat	(-1.87)	(-4.26)	(0.71)	(0.30)	(-0.33)	(5.04)
Median	-10.26	-19.49	6.37	-13.12	-20.57	18.64
z-stat	(-2.77)	(-3.42)	(2.50)	(-2.26)	(-2.02)	(4.82)
Std. Dev.	248.65	363.55	208.63	450.71	592.74	261.51
Skewness	-0.21	-0.23	-0.46	0.61	0.36	0.18
Kurtosis	6.34	5.34	9.40	10.52	7.54	8.02

- Order flow (OF) imbalances: Buyer- minus seller-initiated traded volume

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- Order flow (OF) imbalances: Buyer- minus seller-initiated traded volume
- Time-zone segmented FX transaction demand
  - Pre-fix hours: Large U.S. dollar demand (OF< 0)

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- Order flow (OF) imbalances: Buyer- minus seller-initiated traded volume
- Time-zone segmented FX transaction demand
  - Pre-fix hours: Large U.S. dollar demand (OF< 0)
  - Post-fix hours: U.S. dollar sell-off (OF> 0)

Conditional Order Flow Imbalances and FX Volatility

	GBP							
	Avg. DD		Avg. FXV		Avg. Returns			
	FXV^L	FXV^H	FXV^L	FXV^H	FXV^L	FXV^H	H-L	p-val
DD^L	440.79	417.79	3.32	13.30	-11.89	-23.94	-12.05	0.00
DD^M	-15.62	-13.05	3.42	10.84	2.58	6.80	4.22	0.07
DD^H	-423.64	-418.03	3.54	10.82	22.12	29.40	7.29	0.01
H-L					34.01	53.35		
p-val					0.00	0.00		

- Double-sorts on pre-fix U.S. dollar demand and FX volatility

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H-L					34.01	53.35		
p-val					0.00	0.00		

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H-L					34.01	53.35		
p-val					0.00	0.00		

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	FXV^L	FXV^H	FXV^L	FXV^H	FXV^L	FXV^H	H-L	p-val
DD^L	440.79	417.79	3.32	13.30	-11.89	-23.94	-12.05	0.00
DD^M	-15.62	-13.05	3.42	10.84	2.58	6.80	4.22	0.07
DD^H	-423.64	-418.03	3.54	10.82	22.12	29.40	7.29	0.01
H-L					34.01	53.35		
p-val					0.00	0.00		

- Double-sorts on pre-fix U.S. dollar demand and FX volatility
  - Higher volatility is associated with larger reversal returns

Conditional Order Flow Imbalances and FX Volatility

	GBP							
	Avg. DD		Avg. FXV		Avg. Returns			
	FXV^L	FXV^H	FXV^L	FXV^H	FXV^L	FXV^H	H-L	p-val
DD^L	440.79	417.79	3.32	13.30	-11.89	-23.94	-12.05	0.00
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- Double-sorts on pre-fix U.S. dollar demand and FX volatility
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  - Return reversals increase monotonically in conditional order imbalance

Conditional Order Flow Imbalances and FX Volatility

	GBP							
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	FXV^L	FXV^H	FXV^L	FXV^H	FXV^L	FXV^H	H-L	p-val
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- Double-sorts on pre-fix U.S. dollar demand and FX volatility
  - Higher volatility is associated with larger reversal returns
  - Return reversals increase monotonically in conditional order imbalance
  - Returns grow from -12bps (DD^L, FXV^L) to 29bps (DD^H, FXV^H)

Liquidity Provision

	GBP				
	Δs^{pre-E}	Δs^{pre-L}	Δs^{post-L}	$\Delta s^{pre-E} + \Delta s^{post-L}$	$\Delta s^{pre-L} + \Delta s^{post-L}$
LP	1.89	2.15	2.06	3.95	4.21
	(2.86)	(2.55)	(4.61)	(4.83)	(4.32)
LD	-0.54	-0.28	-0.44	-0.98	-0.73
	(-0.81)	(-0.34)	(-0.98)	(-1.19)	(-0.74)
p-val	0.01	0.00	0.00	0.00	0.00

- Liquidity provider (LP) sources U.S. dollars in D2D market
- Liquidity demander (LD) trades in D2C segment only
- Returns to LP are positive and statistically different from LD returns (LP can sell U.S. dollars at the ask)
- Returns to speculation become positive with better signals

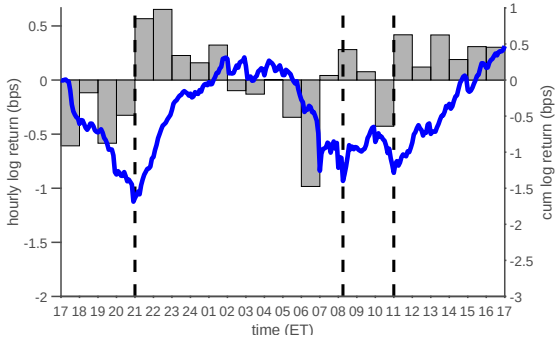
Liquidity Provision and U.S. Dollar Demand

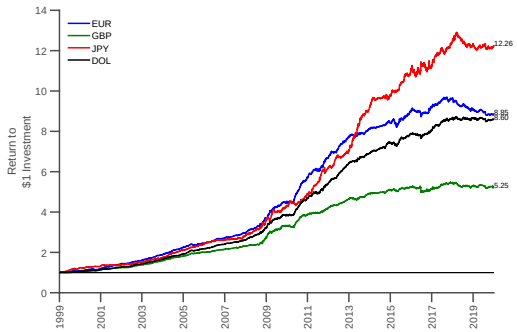
- Unconditional demand for U.S. dollars manifests itself at the fixes
- Estimated transaction cost-adjusted returns to liquidity provision are positive and significant
- Evidence for predictable demand for immediacy at specific points in time of the day also exists in other asset classes (e.g., Lou, Polk, and Skouras, 2019)
- Demand for U.S. dollars arises most likely due to the currency's safe haven and reserve currency status (e.g., Jiang, Krishnamurthy, and Lustig, 2021)

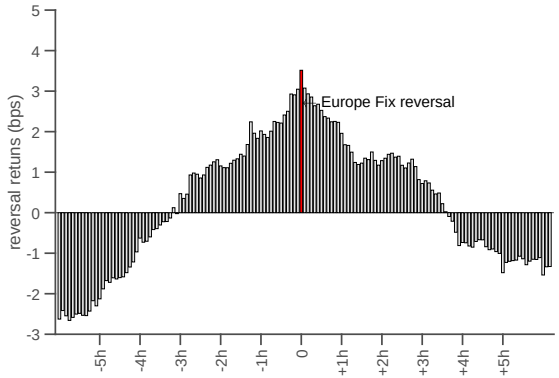
Literature

- 'Low frequency' reversals, liquidity and limits to arbitrage
  - Lou, Yan, and Zhang (2013) (Treasury bonds), Nagel (2012), Mueller, Tahbaz-Salehi, and Vedolin (2017) (FOMC)
- Local currency depreciations in local time
  - Cornett, Schwarz, and Szakmary (1995), Ranaldo (2009), Breedon and Ranaldo (2013)
- The role of fixings
  - Melvin and Prins (2015), Marsh, Panagiotou, and Payne (2017), Ito and Yamada (2017), Evans (2018), Evans, O'Neill, Rime, and Saakvitne (2018)
- Equity returns around the clock
  - Lou, Polk, and Skouras (2019), Boyarchenko, Larsen, and Whelan (2022)

Conclusion







- Major FX fixes mark intraday reversal points
- Swings during pre- and post-fix periods are economically significant
- Structural demand for U.S. dollars at the fixes that is increasing in volatility
- Pre-hedging activities and inventory risk management by spot dealers cause reversal pattern around benchmark reference rates

Thank you

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