

*DeFi*ying Gravity?

An empirical analysis of cross-border Bitcoin, Ether and stablecoin flows

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Why study crypto cross-border flows?

- **Rapid growth:** Cryptoasset markets and decentralised finance (DeFi) expanding quickly
- **Knowledge gap:** Macro-financial implications and spillover risks are poorly understood
- **Transparency paradox:** Public blockchains vs. (pseudo-)anonymous wallet ownership
- **Evidence base:** Empirical analysis of cross-border crypto activity remains patchy

Research Questions

- ① How do crypto flows compare to traditional financial flows?
- ② What drives cross-border flows of cryptoassets and stablecoins?
- ③ How do capital flow management measures affect crypto flows?

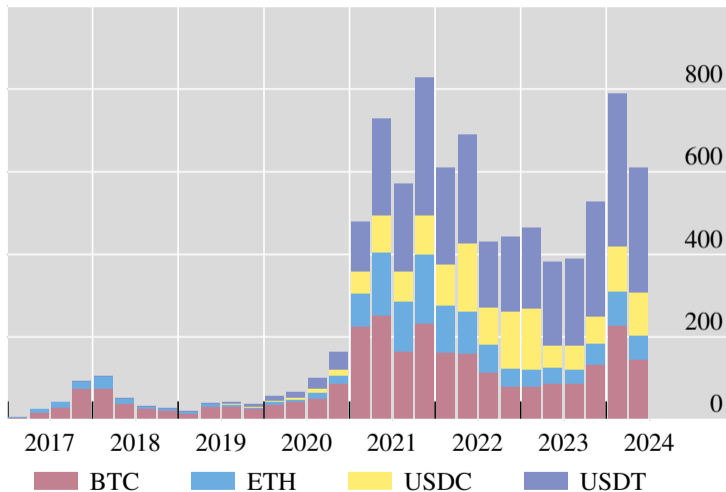
Related literature

- Drivers of international capital flows
 - Beck et al. (2024), Coppola et al. (2021), Miranda-Agrippino and Rey (2020), Hoffmann et al. (2019) and Forbes and Warnock (2012), on global factors e.g. Obstfeld and Zhou (2023) and Bruno and Shin (2015)
- Bilateral gravity frameworks
 - Anderson and van Wincoop (2003), Anderson and Yotov (2016), Weidner and Zylkin (2021), application to financial flows e.g. Badarinza et al. (2022), Brei and von Peter (2018) and Portes et al. (2001)
- Emerging literature on crypto markets and particularly cross-border flows
 - Makarov and Schoar (2020,2021), on cross-border flows von Luckner et al. (2023), Cerutti et al. (2024) and Reuter (2025)

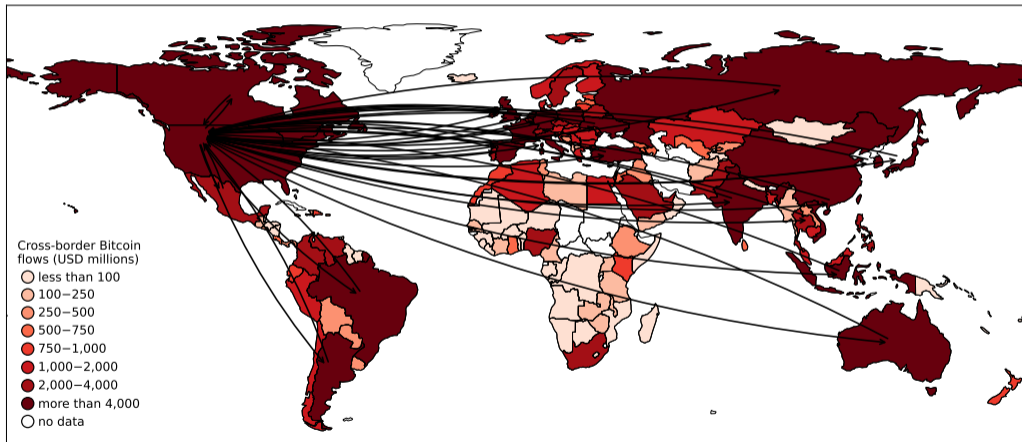
Crypto flows data

- **Scope:** Cross-border flows of Bitcoin, Ether, Tether USDT and USD Coin, spanning 184 countries from 2017 to 2024
- Measurement challenge – wallet ownership and geographic attribution
- Approach: Exchange-level flows assigned to countries based on web traffic and app usage (Chainalysis and Iknai)
- Example: If X% of Coinbase's app usage originates from German users, X% of Coinbase's in- and outflows are allocated to Germany
- Additionally, we apply GDP weights to Iknai data

Cross-border crypto flows over time (billion USD)



Global BTC flows map

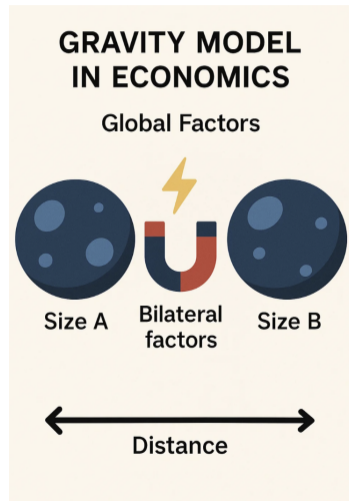


Global USDT flows map



Empirical approach

- Crypto flows modeled using a bilateral gravity framework
- Controls for global factors, country-specific factors and bilateral frictions
- Estimated using PPML (Poisson pseudo-maximum likelihood)



Methodology

- Gravity model:

$$f_{ijt} = \exp \left[\underbrace{\alpha_i}_{\text{Sender fixed effect}} + \underbrace{\gamma_j}_{\text{Receiver fixed effect}} + \underbrace{(x_{ij} + x_{t-1} + x_{it-1} + x_{jt-1})\beta}_{\text{Covariates: bilateral, global, sender- and receiver-specific (lagged)}} \right] \omega_{ijt}$$

- Impact of bilateral remittance costs:

$$f_{ijt} = \exp \left[\underbrace{\alpha_{it}}_{\text{Sender-time fixed effect}} + \underbrace{\gamma_{jt}}_{\text{Receiver-time fixed effect}} + \underbrace{(x_{ij} + x_{ijt-1})\beta}_{\text{Bilateral controls + lagged remittance costs}} \right] \omega_{ijt}$$

- Impact of capital flow management measures:

$$f_{ijt} = \exp \left[\underbrace{\alpha_{it}}_{\text{Sender-time fixed effect}} + \underbrace{\gamma_{jt}}_{\text{Receiver-time fixed effect}} + \underbrace{\eta_{ij}}_{\text{Pair fixed effect}} + \underbrace{cfm_{ijt-1}\beta}_{\text{CFM effect (lagged)}} \right] \omega_{ijt}$$

Variables

Dependent variables: Cross-border flows f_{ijt}

- Crypto flows (Chainalysis and Iknai), Interbank claims (BIS locational banking statistics), Trade flows (IMF), Remittances (World Bank)

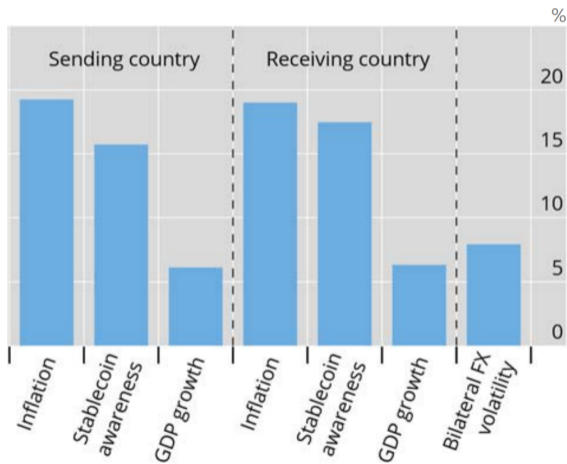
Controls

- **Gravity-type:** Distance, common language, common border
- **Global factors:** Volatility (VIX), High-Yield spread, Federal Funds rate, U.S. Growth, US Dollar index
- **Crypto-specific factors:** BTC-USD volatility, Crypto market, Crypto size, Crypto momentum
- **Country-specific factors:** Inflation, GDP growth, FX volatility, Capital flow management measures
- **Crypto awareness:** Google searches for “Bitcoin”, “Ethereum” and “Stablecoins”

Gravity factors as drivers of international flows

	IB claims	Exports		Bitcoin flows		
	(1)	(2)	(3)	(4)	(5)	(6)
Gravity						
Distance	-0.582*** (0.041)	-0.750*** (0.027)	-0.080*** (0.013)	-0.084*** (0.014)	-0.084*** (0.014)	-0.084*** (0.014)
Common border	0.608*** (0.161)	0.757*** (0.083)	0.002 (0.033)	-0.001 (0.035)	-0.001 (0.035)	-0.001 (0.035)
Common language	0.364*** (0.110)	-0.029 (0.072)	0.124*** (0.027)	0.126*** (0.028)	0.126*** (0.028)	0.126*** (0.028)
Global factors (t-1)						
VIX				2.244*** (0.028)	1.699*** (0.019)	2.086*** (0.028)
High-yield spread				-3.390*** (0.035)		-3.781*** (0.032)
Dollar index					-10.525*** (0.136)	
Federal funds rate						-0.037*** (0.003)
US growth						-0.045*** (0.002)
Crypto risk factors (t-1)						
BTC-USD volatility				1.472*** (0.037)	0.870*** (0.035)	1.139*** (0.033)
N	146,014	582,171	671,794	668,467	668,467	668,467
Pseudo R2	0.882	0.928	0.992	0.936	0.889	0.938
FE: sender \times t & receiver \times t	Yes	Yes	Yes			
FE: sender & receiver				Yes	Yes	Yes

Country specific drivers: USDT example



Transactional motives: Remittance costs as driver

	Remittances	BTC	ETH	USDC	USDT	BTC<\$500	BTC<\$200
Annual data	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Remittance cost _{t-1}	-0.453*	0.066	0.043	0.084**	0.243***	0.253**	0.257**
	(0.243)	(0.041)	(0.031)	(0.039)	(0.068)	(0.123)	(0.112)
N	1,038	1,043	1,043	751	895	701	701
Pseudo R2	0.928	0.998	0.999	1.000	0.998	0.995	0.995
FE: sender×year, receiver×year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gravity factors	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Effect of capital flow management measures

	IB claims (1)	IB claims (2)	BTC (3)	ETH (4)	USDC (5)	USDT (6)	BTC (7)	ETH (8)	USDC (9)	USDT (10)
CFM _{s_{t-1}}	-0.071 (0.048)	-0.102** (0.050)	0.249* (0.138)	0.049 (0.061)	0.048** (0.024)	-0.042 (0.029)	0.235** (0.118)	0.055 (0.059)	0.027 (0.023)	-0.031 (0.028)
N	132,647	31,127	573,331	564,168	375,061	439,883	315,204	309,746	208,561	243,780
Pseudo R2	0.992	0.992	0.996	0.998	0.998	0.999	0.995	0.997	0.996	0.999
Fixed effects: pair, sender× <i>t</i> , receiver× <i>t</i>	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sample	All	EMEs	All	All	All	All	EMEs	EMEs	EMEs	EMEs

Conclusion

- **New landscape of cross-border flows:** fast-paced and difficult to measure
- **Geographical factors are less relevant:** Smaller friction on crypto flows
- **Country-specific effects:** High inflation and FX volatility imply increased crypto use
- **Speculative and transactional motives coexist:** Evidence points to both
- **Policy implications:**
 - Greater risks to monetary sovereignty in economies with more volatile currencies
 - Potential to undermine domestic policy tools such as capital flow management measures
 - Regulatory challenges given decentralised nature and global reach