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The Crypto Multiplier

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Abstract

The exchange rates of cryptocurrencies are highly volatile. This paper provides insight into the source of this volatility by developing the concept of a "crypto multiplier," which measures the equilibrium response of a cryptocurrency's market capitalization to aggregate inflows and outflows of investors' funds. The crypto multiplier takes high values when a large share of a cryptocurrency's coins is held as an investment rather than being used as a means of payment. Empirical evidence shows that the number of coins held for the purpose of making payments is rather small for major cryptocurrencies suggesting large crypto multipliers. The analysis explains why announcements by large investors, celebrity endorsements or financial crises can result in substantial price movements.

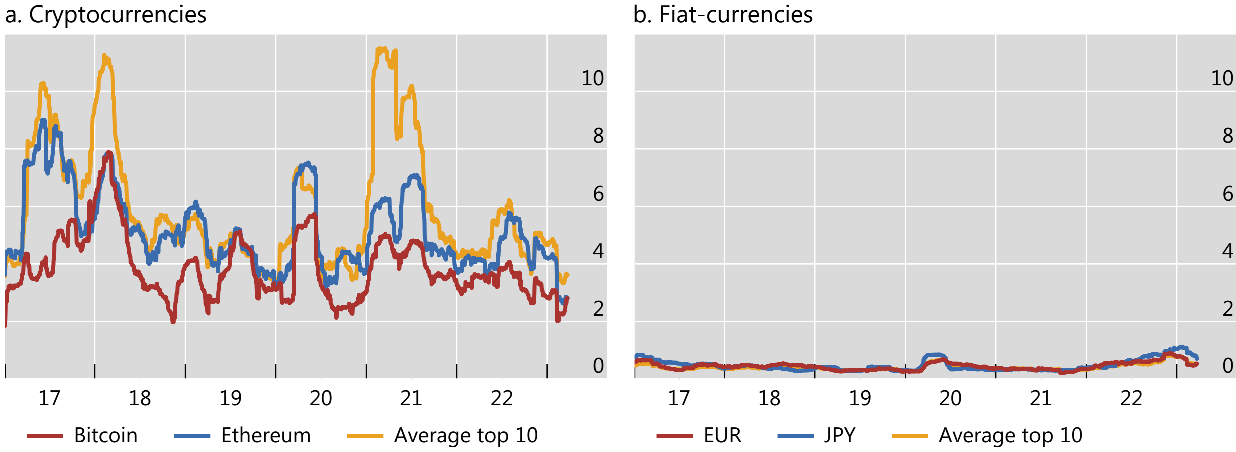
We thank Jose Maria Vidal for statistical assistance. Views expressed do not necessarily represent those of the Bank for International Settlements.

1. Introduction

The prevalence of the large fluctuations in cryptocurrency prices has been well-documented (e.g., Yermack, 2015, Dwyer, 2015, Shen et al, 2020, Catania and Grassi, 2022, Halaburda et al, 2022, Pessa et al, 2023). The situation is more accentuated for smaller cryptocurrencies but even the larger, more established ones exhibit levels of volatility that far exceed that of sovereign currencies. Figure 1 shows the standard deviation of the daily percentage changes in the exchange rates of various currencies vis-à-vis the US dollar. The daily standard deviations for the exchange rates of cryptocurrencies occasionally exceed a level of 10 per cent (Figure 1.a). Those for major fiat currencies (ie, official currencies) stay below a level of 1 per cent most of the time (Figure 1.b).

The Exchange Rate Volatility of Cryptocurrencies and Fiat Currencies

90-day rolling standard deviation of daily returns Fig. 1



[a] Top 10 cryptocurrencies by market capitalization for which the share of inactive coins was available on coinmetrics.io as of end-2016: BTC, ETH, LTC, XRP, ETC, DASH, MAID, ETC, REP and DOGE. [b] Top 10 fiat-currencies by FX turnover based on BIS Triennial Survey 2016: EUR, JPY, GBP, CNY, AUD, CAD, CHF, HKD SGD and SEK.

Sources: Coingecko; BIS.

Many factors contribute to the high levels of volatility in the exchange rates of cryptocurrencies including the inelastic supply (Claeys et al, 2018) and the relative ease with which one can switch between them (Garratt and Wallace, 2018). While these papers identify circumstances that are conducive to high volatility, they are not useful for understanding structural relationships between volatility and coin holder motives. Nor do they explain why crypto currency prices respond so dramatically to announcements by major currency holders, celebrity endorsements or events such as the collapse of Silicon Valley Bank.

In this study, we show that the high exchange rate volatility can be well-understood through the lens of a "crypto multiplier" that measures the equilibrium response of a cryptocurrency's market capitalization to aggregate inflows and outflows of investors' funds. Building on the quantity equation (Fisher, 1911, Bolt and Van Oordt, 2020), we derive the value of the crypto multiplier as a simple ratio that takes high values with no upper limit when a large share of a cryptocurrency's coins is held as an investment rather than being used as a means of payment. Empirical evidence demonstrates that the number of coins held for the purpose of making payments is rather small for major cryptocurrencies suggesting large crypto multipliers. Such large crypto multipliers help to explain the high price elasticities of investors' demand for cryptocurrencies found in empirical work (Divakaruni and Zimmerman, forthcoming). Our analysis suggests that the relatively high volatility of cryptocurrencies compared to fiat currencies is likely to remain unless the primary use case of a cryptocurrency shifts from being an investment vehicle towards being a means of payment.

2. Derivation of the crypto multiplier

Cryptocurrencies do not serve as a unit of account

To understand the volatility of cryptocurrencies, it is important to recognize that they typically do not serve as a unit of account. The number of coins one must pay when making a purchase with cryptocurrency usually depends on a price that is posted in fiat money (e.g., dollars or euros) and the latest available exchange rate of the cryptocurrency.

Prices of products and services in cryptocurrency tend to be perfectly flexible with respect to changes in the cryptocurrency's exchange rate.[1] Consider a car dealership that would be willing to accept a payment of two bitcoin for a car with a price tag of $60,000 given a current exchange rate of $30,000 per bitcoin. If the exchange rate of bitcoin were to drop to $20,000 per bitcoin, then the dealership would generally increase the number of bitcoins one has to pay from two to three bitcoin while leaving the price tag of $60,000 unchanged. The number of coins one must pay when paying with cryptocurrency tends to fully adjust to changes in the cryptocurrency's exchange rate, while the prices of goods and services in terms of fiat money tend to be unaffected. Fiat money acts as the unit of account even though cryptocurrency can be the means of payment.

Telecommunication technology allows any store to update the number of coins the customer must pay in near real-time when the customer arrives at the checkout to pay. When accepting a cryptocurrency

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[1] This generally does not hold true for all the prices expressed in a fiat currency. For a fiat currency, there are generally some prices expressed in that currency that do not respond immediately to changes in the exchange rate of that currency. The price of a car at a dealership located in the euro area is unlikely to respond minute-by-minute to changes in the euro-dollar exchange rate. Even fiat currency prices for online subscription services may be inflexible with respect to exchange rate shocks (Ambros, 2022). That said, there are several historical inflationary episodes where fiat currencies completely lost their function as a unit of account even though they continued to function as a means of payment (e.g., Sgard, 2003).

payment, a store simply calculates the number of coins the customer must pay, P, by dividing the value of the purchase in fiat money, $P^{\$}$, by the latest available exchange rate of the cryptocurrency, $S^{\$/coin}$, so that

$$P = P^{\$} / S^{\$/coin}. \quad (1)$$

It is common for stores to rely on third-party payment service providers to do these calculations and accept cryptocurrency payments for them, so that store owners do not need to directly handle cryptocurrency payments and instead receive fiat currency in their bank accounts. Many economic models rely implicitly or explicitly on the observation that cryptocurrencies are not used as a unit of account (e.g., Schilling and Uhlig, 2019, Bolt and Van Oordt, 2020, Lee et al, 2021, Cong et al, 2021, Garratt and Van Oordt, 2022, Pagnotta, 2022, Prat et al, 2022, Biais et al, 2023).

The exchange rate equation

The observation that cryptocurrencies are not used as a unit of account has implications for the exchange rate of cryptocurrencies. These can be demonstrated using the classical transaction version of the so-called quantity equation (Fisher, 1911):

$$PT = MV. \quad (2)$$

The quantity equation states that the total value of all payments made with a certain currency within a period (the left-hand-side) must equal to the amount of that currency that changed hands during payments (the right-hand-side). In the context of a cryptocurrency, the symbols on the left-hand-side are interpreted as the average number of coins paid per payment, P ("Price"), multiplied with the number of payments made with that cryptocurrency, T ("Trade"). The symbols on the right-hand-side represent the total number of coins in existence, M ("Money"), multiplied with how often the coins were used on average to make a payment within the period, V ("Velocity"). The quantity equation follows immediately from the definition of velocity – divide both sides by M to see why – and holds true for any object that acts as a means of payment.

The velocity of all existing coins can be considered as a combination of the velocities of different groups of coins. The velocity of all existing coins, V, can be calculated as a weighted average of the velocity of the coins that are used to make payments within a period, say V^*, and the velocity of coins that are not used to make payments within a period (denote the number of these coins by Z). The velocity of the latter group of coins is zero by definition. So, one can write MV also as

$$MV = (M - Z)V^* + Z * 0 = (M - Z)V^*. \quad (3)$$

One can loosely think of Z as reflecting the coins that are held only as a store of value. These could reflect investment holdings (or, if you prefer, *speculative holdings*) as well as staked coins for cryptocurrencies such as Ethereum.

If cryptocurrencies are used as a means of payment but not as a unit of account, then it is possible to use the quantity equation to obtain an equation for the exchange rate of cryptocurrencies (Bolt and Van Oordt, 2020). One can do so by using (1) and (3) to replace, respectively, P and MV in the quantity equation. This yields the *exchange rate equation* for cryptocurrencies as

$$S^{\$/coin} = \frac{T^{\$} / V^{*}}{M - Z}, \tag{4}$$

where $TP^{\$}$ is conveniently rewritten as $T^{\$}$ to reflect the *dollar* value of cryptocurrency payments (the number of purchases paid for with cryptocurrency multiplied with the average value of the purchases in dollars).

The exchange rate equation has a straightforward interpretation as the ratio between the transactional demand – that is, the value of coins needed to process payments measured in terms of dollars – and the number of coins that is available to process payments. The exchange rate equation is an immediate implication of the definition of velocity and the stylized fact that cryptocurrencies do not serve as a unit of account.

By adding two further observations, the equation can be used to explain the impact of inflows and outflows of investors' funds on the exchange rate of a cryptocurrency. First, the supply of most cryptocurrencies is determined by a protocol that is non-responsive to market conditions. Second, it seems reasonable to assume as a first-order approximation that a change in the number of coins that are held only as a store of value will not permanently affect the transactional demand for a cryptocurrency in terms of fiat money.[2] These two observations imply that changes in Z affect the exchange rate, but not the equilibrium values of M, $T^{\$}$ and V^{*}. The exchange rate equation informs us that the exchange rate must increase when investors buy up coins so that fewer coins are available for payments.

The crypto multiplier

The exchange rate in Eq. (4) can be used to derive the quantitative impact of investors flooding or fleeing cryptocurrency markets, which affects the number of coins held as a store of value. In particular,

2 This will be the case if decisions to pay with cryptocurrency are ultimately determined by technology and preferences and not by the number of coins that are held as a store of value only. This assumption of exogenous transactional demand will be relaxed in what follows.

the equation reveals that the market capitalization of a cryptocurrency responds more strongly to fluctuations in investment holdings when fewer coins of that cryptocurrency are used to make payments.

Consider the crypto multiplier which is defined as the dollar change in the equilibrium market capitalization of a cryptocurrency in response to a single dollar of aggregate inflows or outflows of investors' funds.[3] This multiplier can be derived from the exchange rate equation as

$$\frac{\partial S^{\$/coin}}{\partial Z}\frac{M}{S^{\$/coin}} = \frac{M}{M-Z}. \tag{5}$$

The crypto multiplier equals the ratio between the total number of existing coins and the number of coins that are used to make payments. If all coins were used to make payments, so that $Z = 0$, then the crypto multiplier would equal $M / M = 1$. The inflow of a single dollar of aggregate investors' funds is expected to increase the market capitalization of the cryptocurrency by approximately a single dollar. By contrast, if the number of coins used for payments were only 5 per cent of the existing coins, then the crypto multiplier would equal 1 / 0.05 = 20. In this situation, the change in the market capitalization of the cryptocurrency would be approximately as much as 20 times the aggregate inflow or outflow in investors' funds. It is noteworthy that the crypto multiplier takes values of at least one so that the market capitalization must change by a larger amount than the aggregate inflow or outflow of investors' funds.

Blockchain data suggests that the multiplier must be large for popular cryptocurrencies. Over 75 per cent of the bitcoins are held in addresses that were not used over the past 6 months (Figure 2.a). For Ethereum, the equivalent number is around 60 per cent. One can consider these numbers as lower bounds for the fraction of coins that were held only as a store of value.[4] For the remaining coins that were active over the past 6 months, it is not clear whether they were really used to make any real payments because investment activities can also trigger activity on the blockchain.[5] In other words, most coins for cryptocurrencies such as Bitcoin and Ethereum are held as a store of value.

The relationship between the volatility of a cryptocurrency's exchange rates and the number of coins held for store-of-value motives is illustrated in Figures 2.b and 2.c.[6] In Figure 2.b, the share of coins held as a store-of-value is proxied by the share of value in held in addresses that contain more than 0.1 per

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3 The concept of a multiplier is applied in a similar sense as that by Keynes (1930, Chapter 8) in that it refers to how an incremental change in one economic quantity results in a multiplicative incremental change in another related economic quantity.

4 A qualification is that coins in some addresses may be allocated to protocols that facilitate cheaper off-chain payments such as the lightning network (Poon and Dryja, 2016, Divakaruni and Zimmerman, 2023). Coins in such addresses could appear as inactive. The quantitative impact is reasonably small. Less than 0.3 per cent of all bitcoins were allocated to the lightning network at the end-of-2022 (source: txstats.com).

5 Short-term investment was the most popular option as the primary reason for acquiring cryptocurrency in the survey by Akani and Li (2022). Moreover, the number of inactive coins in Figure 2.a decreases during periods of strong appreciations such as the end-of-2017 and early-2021 when the exchange rate of bitcoin hit 20,000 USD and 60,000 USD, respectively.

6 The appendix reports a formal statistical analysis of the relationship between speculative holdings and exchange rate volatility.

cent of the market capitalisation of the coin. In Figure 2.c, the share of coins held as a store-of-value is proxied by the fraction of coins held in the top 1 per cent of the cryptocurrency addresses. Although these measures are imperfect, the argument for using these measures as proxies for the store-of-value motive is that such large accounts are unlikely to be maintained for the purpose of making payments. In both cases there are cautious signs of an upward relationship between the proxy and volatility, which is consistent with the observation that the crypto multiplier increases as the share of coins held as store of value grows.

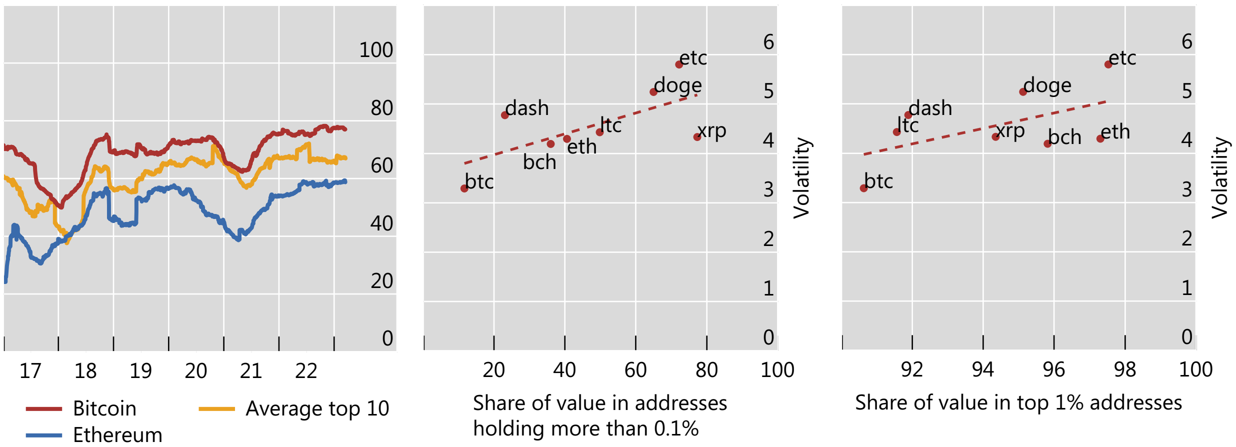
Cryptocurrency investment and volatility

In per cent Fig. 2

a. Share of inactive coins

b. Volatility and value in addresses holding more than 0.1 per cent

c. Volatility and value in top 1 per cent addresses



[a] 100 - 100 * (180 Day Active Supply/Current Supply (native units)). Top 10 cryptocurrencies by market capitalization for which the share of inactive coins was available on coinmetrics.io as of end-2016: BTC, ETH, LTC, XRP, ETC, DASH, MAID, ETC, REP and DOGE. [b,c] Cryptocurrencies that are native tokens on a blockchain.

Source: Coingecko; Coinmetrics.io; BIS.

The crypto multiplier can substantially amplify the exchange rate impact of significant movements by market participants on the market capitalization of cryptocurrencies. For example, the exchange rate of Ripple's cryptocurrency plummeted more than 40 per cent after one of the founders announced his intention to liquidate his entire holdings in May 2014 (Cawrey, 2014). Another example is the exchange rate of Dogecoin increasing by 50 per cent around Elon Musk’s tweet that Dogecoin “might be my fav cryptocurrency” in April 2019 (Dale, 2019). Celebrity endorsements of small cryptocurrencies, such as the promotion of EthereumMax by Kim Kardashian in June 2021, were also followed by significant price moves (U.S. Securities and Exchange Commission, 2022). Such events are likely to have attracted individuals who were looking for investment opportunities rather than a new way of making payments.

3. The crypto multiplier with endogenous transactional demand

The crypto multiplier in Eq. (5) was derived under the assumption that, in equilibrium, the transactional demand for a cryptocurrency does not depend on the number of coins that are held only as a store of value. This assumption is difficult to test empirically because the transactional demand and speculative holdings are not directly observed. It seems plausible that big shifts by speculators in or out of a cryptocurrency could cause sufficient attention that affects the enthusiasm for a cryptocurrency and therefore the adoption of that cryptocurrency for payments. Alternatively, speculators flocking into a cryptocurrency could be associated with an increase in transaction fees and, hence, the cost of paying with that cryptocurrency (Zimmerman, 2020). As mentioned above, these impacts will be inconsequential for the transactional demand in equilibrium if they are temporary. To the extent that they have permanent effects, we can quantify their impact on the crypto multiplier. The following equation computes the crypto multiplier while allowing for an endogenous response of the transactional demand:

$$\frac{\partial S^{\$/coin}}{\partial Z}\frac{M}{S^{\$/coin}} = \frac{M}{M-Z} + \frac{\partial\left(T^{\$}/V^{*}\right)}{\partial Z}\frac{M}{T^{\$}/V^{*}}. \tag{6}$$

Eq. (6) relies on two assumptions only: (i) the number of coins one must pay when making a purchase with cryptocurrency depends only on the price in fiat money and the latest available exchange rate, and (ii) the total number of coins that exists is not affected by speculative demand.

The crypto multiplier with endogenous transactional demand has an additional term. The sign of this term will depend on whether the relationship between speculative holdings and transactional demand is positive or negative. If it is positive, then the crypto multiplier will be larger than before, meaning that the impact of changes in speculative holdings on the exchange rate would be even bigger. If speculative holdings result in a permanent negative shift in transactional demand, then the crypto multiplier would be smaller than before.

An interesting aspect is to identify the conditions under which the crypto multiplier is larger than one: in this case an inflow or outflow of one dollar of investors' funds would change the market capitalization by more than one dollar. From Eq. (6), we can derive that the crypto multiplier is larger than one whenever

$$\frac{\partial\left(T^{\$}/V^{*}\right)}{\partial Z}\frac{1}{S^{\$/coin}} \geq -\frac{Z}{M}. \tag{7}$$

This seems like a very weak condition. The condition holds always if the permanent impact of speculative holdings on transactional demand is positive. Even if the permanent impact were negative, it must be sufficiently strong for the crypto multiplier to be smaller than one. More precisely, for the crypto multiplier to be smaller than one, it would require a dollar inflow of investors' funds to permanently reduce the transactional demand by more than the fraction of coins held as a store of value which is substantial for the major cryptocurrencies (Figure 2).

4. Additional Implications

Our findings warrant caution when evaluating the value of block holdings in cryptocurrency, particularly when accepting those as collateral. The crypto multiplier predicts that winding down a large speculative position is likely to have a significant price impact unless the position is absorbed by other speculators. In other words, the liquidation value of block holdings may be substantially below the value of the coins at the prevailing market price.

An illustration is the scenario that ensued after one of Ripple's founders publicly preannounced to sell-off all his holdings of the Ripple-issued cryptocurrency XRP in May 2014. The co-founder, who no longer worked for the company, indicated he made this public preannouncement because of transparency reasons and an "immense respect for the community members" (McCaleb, 2014). The exchange rate of Ripple's cryptocurrency plummeted more than 40 per cent following the announcement (Cawrey, 2014) even though the co-founder held at most 9 per cent of the coins. Ripple, which relied on the sale of coins as a source of revenue, seemed to have been well-aware of the price impact of winding down such a large position. The company entered into an agreement with the co-founder that required him to spread-out the sales of the coins over a period that exceeded seven years (Long, 2014). The co-founder finished selling his last coins in 2022 (Ripple, 2022).

Another example of an historical episode that involved large block holdings was the prelude to the collapse of the crypto exchange FTX in November 2022. Revelations in a news report early November suggested the largest holding of the crypto hedge fund Alameda Research was a position of 3.5 billion USD in the FTX-issued cryptocurrency FTT that had an estimated market capitalization of about 5.1 billion USD (Allison, 2022). A peculiar aspect was that Alameda Research and FTX where both majority-owned by the CEO of FTX. The following weekend, the CEO of the crypto exchange Binance announced his firm intended to liquidate their block holdings of FTT tokens "due to recent revelations" (Zhao, 2022a). These holdings by Binance were substantial as revealed by a blockchain transaction that involved almost 10 per cent of the existing FTT tokens (Zhao, 2022b). The price impact could have been considerable, and the CEO of Alameda Research responded almost immediately with an offer to buy the coins over-the-counter at 22 USD – close to the prevailing market price – if Binance was "looking to minimize the market impact" (Ellison, 2023). That offer was not accepted (Zhao, 2022c). The price of FTT tokens started sliding with the price hitting less than 5 USD on Tuesday after the CEOs of both exchanges announced they were working on a deal where Binance would take over the FTX exchange as investors withdrew funds from FTX *en* *masse*. Upon inspection of the books, Binance withdrew from the deal on Wednesday after which FTX filed for bankruptcy protection on Friday.

5. Concluding Remark

We provide a tractable indicator of volatility that relates to a cryptocurrency's use as a store of value by crypto investors (ie, speculators). The indicator, which we call the crypto multiplier, provides the theoretical relationship between the share of a cryptocurrency that is used for payments and the response of the equilibrium exchange rate to changes in aggregate investor flows. Changes in investor flows happen for a multitude of reasons, some of which may be grounded in fundamentals and others which arise from the whims of influencers. The point is that if these flows are constantly changing, and the multiplier is large, then we will see high volatility. This volatility is likely to remain unless the primary use case of a cryptocurrency shifts from being an investment vehicle to a means of payment.

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Appendix: Statistical Analysis of Speculation and Future Volatility

We collect data for a statistical analysis of the relationship between the size of the speculative position and exchange rate volatility of cryptocurrencies that function as native tokens on a blockchain. For this purpose, we select all cryptocurrencies that are classified by coinmetrics.io as being based on any consensus mechanism ("POS," "POW," "dPOS" or "other"). We select data measured on the last day of each quarter over a period from 2016Q1 until 2023Q1. We include observations only if there are no missing values for all variables. For each cryptocurrency, we exclude the first quarter in our dataset. This yields a total dataset of 423 quarterly observations for 23 cryptocurrencies. Descriptive statistics are reported in Table 1.

Table 1

Descriptive Statistics

	Mean	Standard deviation	10th-percentile	90th-percentile	Observations (cryptocurrencies)
Daily exchange rate volatility (180-days), %	6.208	1.947	4.178	8.670	423 (23)
Share of coins in addresses with at least 0.1%	0.534	0.236	0.221	0.874	423 (23)
Share of coins in top 1% of the addresses	0.867	0.136	0.702	0.977	423 (23)
Principal component for speculative share	0.093	1.479	-1.840	1.918	423 (23)
Transactions per second	2.553	8.517	0.005	7.326	423 (23)
Estimated market capitalization in billion USD	6.579	14.717	0.052	19.240	423 (23)
Mean amount per transaction in USD	12,923.40	112,601.90	66.73	17,699.65	423 (23)

[1] All variables are measured on the last day of each quarter.

Sources: coinmetrics.io and authors' calculations.

The dependent variable in our regressions is the 180-days daily volatility of the exchange rate. The independent variables of interest are various proxies that are assumed to be positively correlated to the speculative position. Note that the statistical significance of the analysis hinges crucially on the assumption that the proxy must be strongly correlated with the speculative position since any noise in our proxy of the speculative position will bias the estimated coefficient in our regression towards zero (Hausman, 2001). We use three different proxies for the speculative position. The first proxy is the share of coins held in addresses with at least 0.1 per cent of the total supply. The second proxy is the total share of coins held in the top 1 per cent of the addresses. Our third proxy is the first principal component extracted from the previous two proxies as well as the share of coins held in the top-100 addresses and the logarithm of the number of addresses with positive balances that hold less than 100 USD (the latter is expected to be negatively correlated to the speculative position). The principal component is expected to have the least noisy relationship with the actual speculative position since combining various proxies may cancel out the noise of individual proxies. As control variables, we include the number of transactions per second, the market capitalization in billion USD and the mean amount per transaction in USD. These control variables, which tend to be positively skewed, are included in the regression analysis in logs. All independent variables are measured on the last day of the quarter preceding the 180-days estimation window of the daily volatility.

Table 2

Speculation and Future Exchange Rate Volatility

	Exchange rate volatility (I)	Exchange rate volatility (II)	Exchange rate volatility (III)	Exchange rate volatility (IV)	Exchange rate volatility (V)	Exchange rate volatility (VI)
Share of coins in addresses with at least 0.1%	1.088*** (0.324)			3.653* (1.826)		
Share of coins in top 1% of the addresses		0.411 (0.362)			0.189 (1.232)	
Principal component for speculative share			0.198*** (0.062)			0.675*** (0.218)
Transactions per second (log)	0.099 (0.080)	0.139* (0.074)	0.099 (0.083)	0.108 (0.134)	0.132 (0.143)	0.147 (0.124)
Market capitalization in billions of USD (log)	-0.342** (0.123)	-0.417*** (0.120)	-0.321** (0.127)	-0.294** (0.120)	-0.417*** (0.120)	-0.271** (0.118)
Mean amount per transaction in USD (log)	0.040 (0.081)	0.083 (0.077)	0.028 (0.085)	0.173 (0.111)	0.193* (0.107)	0.173 (0.110)
Constant	5.504*** (0.502)	5.495*** (0.539)	6.154*** (0.510)	3.215** (1.199)	4.892*** (1.200)	5.173*** (0.695)
Obs (cryptocurrencies)	423 (23)	423 (23)	423 (23)	423 (23)	423 (23)	423 (23)
R-squared	0.112	0.097	0.116	0.056	0.040	0.070
Fixed effects	No	No	No	Yes	Yes	Yes

[1] The dependent variable is the future exchange rate volatility measured over a period of 180-days. All variables are measured on the last day of each quarter. All models are estimated with least squares. Standard errors clustered at the cryptocurrency level are reported in parentheses. Statistical significance at the 1%, 5% and 10% significance levels are indicated by ***, ** and *, respectively.

Sources: coinmetrics.io and authors' estimations.

The results of the regression analysis (Table 2) confirm a positive relationship between the speculative position and future exchange rate volatility with the strongest results observed for the proxy based on the principal component analysis. We report results both for a simple pooled regression (columns I-III) as well as a regression that includes fixed effects (columns IV-VI). All standard errors are clustered at the cryptocurrency level. In general, we observe a positive relationship between the size of the speculative position and exchange rate volatility, with statistically significant relationships when measuring the speculative position by the share of coins in addresses with at least 0.1 percent of the tokens (column I) and the first principal component obtained from various speculation-related variables (columns III and VI). The results are insignificant when using the share of coins held in the top 1 percent of the addresses as a proxy for the speculative position. The statistically most meaningful control variable is the size of cryptocurrencies as measured by their market capitalization with larger cryptocurrencies being associated with less volatility (consistent with the findings of Pessa et al., 2023). Excluding the control variables does not qualitatively impact the estimated relationship between future exchange rate volatility and the speculative position (unreported).

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