Examining the Interrelatedness of NFTs, DeFi Tokens and Cryptocurrencies

Article *in* Finance Research Letters · January 2022

DOI: 10.1016/j.frl.2022.102696

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Finance Research Letters xxx (xxxx) xxx

Contents lists available at ScienceDirect

Finance Research Letters

journal homepage: www.elsevier.com/locate/frl

Examining the interrelatedness of NFTs, DeFi tokens and cryptocurrencies

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ARTICLE INFO

Keywords:
Blockchain markets
Diversification
Extreme risk spillovers, Quantile connectedness

ABSTRACT

The high volatility of the blockchain markets has driven the attention of investors and market participants to concentrate on the diversification avenues of NFTs, DeFi Tokens, and Crypto-currencies. We examined the extreme risk transmission of blockchain markets using the quantile connectedness technique at the median, extreme low, and extreme high volatility conditions. We find significant risk spillovers among blockchain markets with strong disconnection of NFTs. Meanwhile, time-varying features characterized various uneven economic circumstances. Overall, NFTs offer greater diversification avenues with substantial risk-bearing potential among other blockchain markets to shelter the investments and minimize extreme risks.

1. Introduction

From the revolutionary technology in 2008 with the release of the Bitcoin whitepaper (Nakamoto, 2008) to the second generation jump of Ethereum in 2014, the phenomenal rise of blockchain markets is riding the crest of the future digital markets. Cryptocurrencies (Cryptos), Decentralized Financial Assets (DeFis),[1] and Non-Fungible Tokens (NFTs) with the respective market capitalization of USD 2.89 trillion, USD 192 billion, and USD 13 million[2] as of November 10, 2021, are attracting increasing interest from investors, policymakers, regulatory bodies, and portfolio managers. NFTs, in particular, are undergoing a major bull session in 2021.[3] As an

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[1] The short form of Decentralized Finance (DeFi), is an umbrella term for various financial applications in cryptocurrencies (particularly Ethereum) for disrupting financial intermediaries. Inspired from blockchain, DeFi offers a decentralized system without human intervention to speed up the process behind a single financial transaction. For further details on pricing DeFis please see: https://www.coindesk.com/learn/what-is-defi/ and https://finance.yahoo.com/news/top-10-defi-projects-watch-151711072.html

[2] Please see: https://coinmarketcap.com/

[3] Please see: https://www.ndtv.com/business/nft-the-new-rage-in-the-crypto-world-key-things-to-know-2543136

https://doi.org/10.1016/j.frl.2022.102696
Received 6 December 2021; Received in revised form 10 January 2022; Accepted 18 January 2022
Available online 20 January 2022
1544-6123/

Please cite this article as: Sitara Karim, *Finance Research Letters*, https://doi.org/10.1016/j.frl.2022.102696

example, the Metaverse of Mark Zuckerberg through NFT is increasing its digital footprint across social media.[4] Literature also modeled NFT as a remarkable public success of blockchain technology (Dowling, 2021) with its unique right-transferring mechanism through digital assets. The growth in NFT has postured a dilemma for investors as to whether it is a bull market in a new asset or a bubble. In this vein, addressing the concerns of investors and portfolio managers in terms of bullish, bearish, and normal market conditions (Koutmos, 2018) notes the requirement to examine all interlinked markets.

Among the growing literature of blockchain markets and their effectiveness among the financial markets, the studies of Corbet et al. (2018, 2019), Akyildirim et al. (2019), Hasan et al. (2021), and Yarovaya and Zięba (2021) are of prime importance as cryptocurrencies carry extensive avenues for investors to diversify their risk when markets are undergoing extreme crisis episodes. Given the extremely distressing periods, Yarovaya et al. (2021) studied black swan effects on cryptocurrency herding behavior and found no influence of herding behavior during COVID-19 and ambiguous times. Meanwhile, the periods of high financial distress that bring increased connectedness of cryptocurrencies and financial markets is reported by Corbet et al. (2018), Katsiampa et al. (2019), and Yarovaya et al. (2020).

Based on this, the current study employs the quantile connectedness approach of Ando et al. (2018) to test diversification avenues among blockchain markets across median, extreme low, and extreme high volatility conditions. This technique has several benefits, as reported in the prior studies of Bouri et al. (2021) and Naeem et al. (2021). First, the network approach of quantile connectedness stipulates uni- or bi-directional risk spillovers identifying least connected markets. Second, time-varying attributes identify various economic events shaping dynamic spillovers at different quantiles. Third, the net directional spillovers provide useful information about net risk transmitters/receivers. Thus, this study adds to the current literature by identifying the most appropriate diversifiers among blockchain assets to mitigate the risk of extremely volatile digital assets and suggests useful strategies to investors, portfolio managers, and policymakers, including risk-absorbing diversifiers, shield their investments from extreme market events.

2. Data and methodology

2.1. Data

We examined the interrelatedness of NFTs, DeFi tokens, and cryptocurrencies at their median (50th), extreme low (5th), and extreme high (95th) volatility conditions for the period encompassing March 15, 2018 to October 24, 2021 to include the COVID-19 period and subsequent cryptocurrency market bubble period which covers the time period of January 1, 2021 to July 1, 2021.[5] For analysis purposes, the NFTs[6] included in the study are Theta (THETA), Tezos (XTZ),[7] Enjin Coin (ENJ), Decentraland (MANA), and Digibyte (DGB). DeFi tokens consist of Chainlink (LINK), Maker (MKR), Basic Attention Coin (BAT), Synthetix (SNX), and Bancor (BNT), while cryptocurrencies chosen for analysis purposes are Bitcoin (BTC), Ethereum (ETH), Binance Coin (BNB),[8] Cardano (ADA), and Tether (USDT).[9] The rationale behind selecting five respective NFTs, DeFis and Cryptocurrencies, is the maximum availability of the data. Since cryptocurrencies included in the study are mature and have strong market capitalization, NFTs and DeFis are still emerging and have varied market capitalization, they are selected based on the maximum accessibility of the data to cover multiple crisis periods of blockchain markets, including COVID-19 and cryptocurrencies market bubble in the first half of 2021.

2.2. Methodology

2.2.1. Volatility estimates

Based on the studies of Katsiampa et al. (2019), Naeem et al. (2021) & Bouri et al. (2021, 2020), we computed volatility of all types of blockchain markets, the individual time series of returns belonging to the vector of return series $R_t = [R_{1t}, \ldots\ldots, R_{nt}]'$ is supposed to be given as:

$$R_t = \mu_t + \varepsilon_t \tag{1}$$

[4] Please see: https://www.bloomberg.com/news/features/2021-10-30/what-is-the-metaverse-where-crypto-nft-capitalism-collide-in-games-like-axie

[5] The data have been sourced from https://coinmarketcap.com/

[6] Since the data of Top NFTs is available from September to November 2020, the authors find it difficult to select these markets based on larger players.

[7] Tezos is included as an NFT but not as DeFi as historically Tezos started as DeFi but due to power struggles between its founders and leaders, Tezos were partnered with NFTs group and its boom started in early 2019. Therefore, the authors have taken Tezos as NFT but not as a DeFi. In addition, DappRadar integrated Tezos and started tracking the data of that blockchain, from that day, Tezos NFT had its dominance. For further details please see: https://coincodex.com/article/12464/the-sleeping-giant-awakes-how-tezos-quietly-built-a-complete-defi-and-nft-ecosystem/ and https://cointelegraph.com/news/nft-partnerships-and-protocol-integrations-boost-tezos-wax-and-aleph-im

[8] Binance coin is a cryptocurrency which has its own Binance exchange with different Binance Future Products and Features. In fact, it is Binance Futures which is derivative of Binance Coin to shelter the investors from extreme price volatilities. For further details please see: https://www.binance.com/en/support/faq/00bd4e5720bf4ffebfadb4b15e465a73; and https://coinmarketcap.com/alexandria/article/what-are-the-essential-functions-of-derivatives-in-the-crypto-economy

[9] Tether is stablecoin by its name only. A recent study of Grobys and Huynh (2021) states that stablecoins are not stable due to too many and too large variations (Hoang and Baur, 2021) and jumps in Tether (stablecoin) derive negative returns in the Bitcoin.

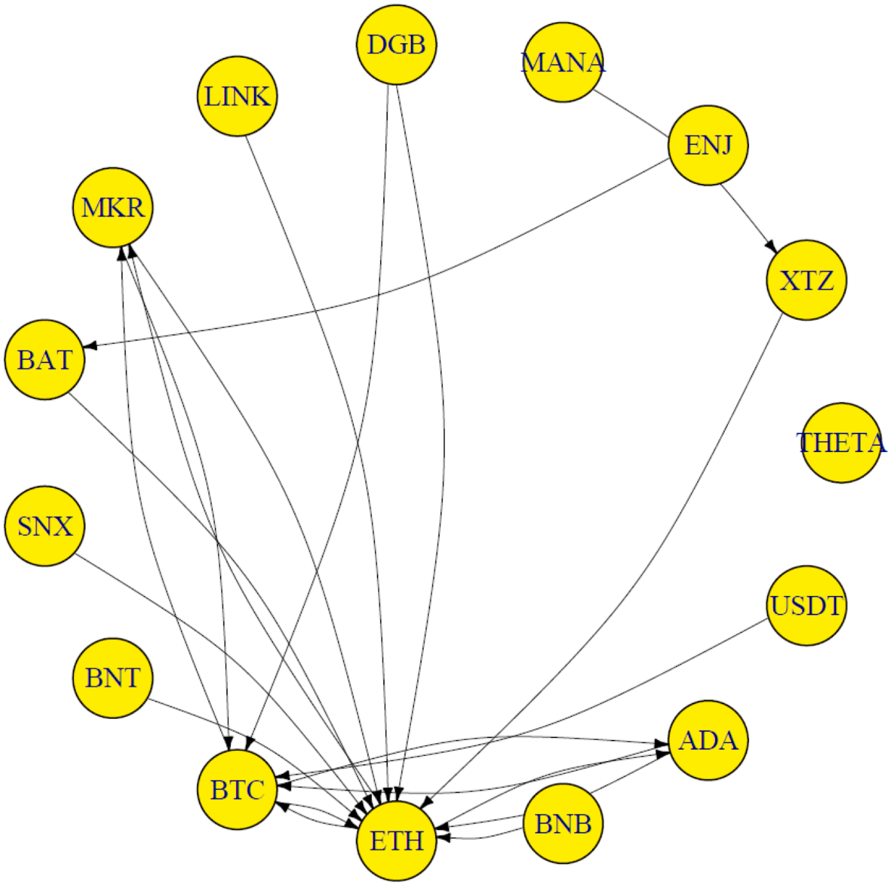


Fig. 1. Risk spillovers at median quantile
Note: This network graph illustrates the degree of network connectedness among THETA (THETA), XTZ (TEZOS), ENJ (ENJIN COIN), MANA (DECENTRALAND), DGB (DIGIBYTE), LINK (CHAINLINK), MKR (MAKER), BAT (BASIC ATTENTION COIN), SNX (SYNTHETIX), BNT (BANCOR), BTC (BITCOIN), ETH (ETHEREUM), BNB (BINANCE COIN), ADA (CARDANO), and USDT (TETHER).

The vector of constant terms is denoted by $\boldsymbol{\mu}$, whereas $\boldsymbol{\varepsilon}_t = [e_{1t}, \ldots\ldots, \varepsilon_{nt}]$ illustrates the vector of error terms. In addition, the conditional volatilities h_{it}^2 (for each market i) are based on estimating the univariate GARCH (1,1) models for each of them given as:

$$h_{it}^2 = \omega + a\varepsilon_{it-1}^2 + \beta h_{it-1}^2 \tag{2}$$

where $\omega > 0,\ \alpha \geq 0,\ and \beta \geq 0,\ and \alpha + \beta < 1.$

2.2.2. Quantile var estimates

Next, we examined volatility connectedness using the methodology of Ando et al. (2018). Following Basset and Koenker (1978), we estimate the dependence structures of y_t on x_t at varying quantile levels $\tau[\tau \in (0, 1)]$ through the conditional distribution of y_t/x_t of pth order for n-variable of quantile VAR process.

$$y_t = c(\tau) + \sum_{i=1}^{p} Bi(\tau) y_{t-i} + et(\tau),\ t = 1, \ldots,\ T \tag{3}$$

2.2.3. DY spillover indices

For spillover indices at various quantiles, we used the approach of Diebold and Yilmaz (2012) and re-stated Eq. (3) as:

$$y_t = \mu(\tau) + \sum_{s=0}^{\infty} A_s(\tau) e_{t-s}(\tau),\ t = 1, \ldots,\ T \tag{4}$$

Assuming that shocks are non-orthogonalized, it is not necessary that the sum of forecast error variance contributions must be equal to one. We used the generalized forecast error variance decomposition (GFEVD) of a variable exposed to various shocks:

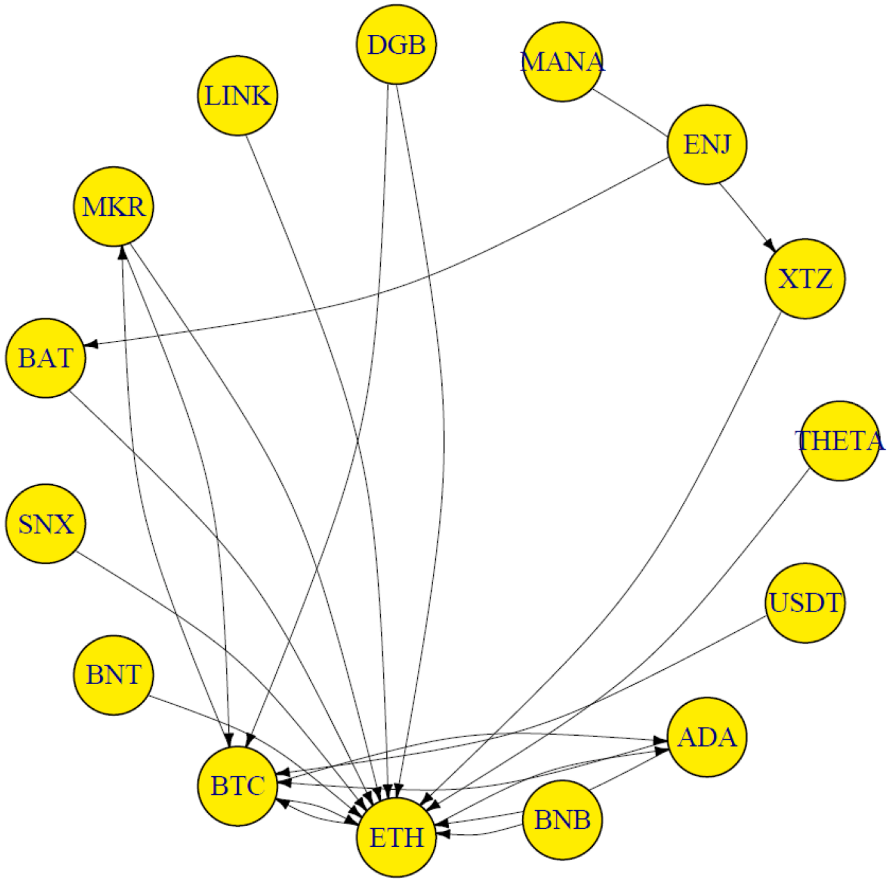


Fig. 2. Risk spillovers at extreme low quantile
Note: Refer to note in Fig. 1.

$$\theta_{ij}^{g}(\mathrm{H}) = \frac{\sigma_{jj}^{-1}\sum_{h=0}^{H-1}\left(e_i^{'}A_h\Sigma e_j\right)^2}{\sum_{h=0}^{H-1}\left(e_i^{'}A_h\sum A_h^{'}e_i\right)}, \tag{5}$$

We compute the total connectedness index (TCI) for each quantile τ measuring the contribution of risk spillovers across various blockchain markets to the total forecast error variance as:

$$TCI(\tau) = \frac{\sum_{i=1}^{N}\sum_{j=1,i\neq j}^{N}\widetilde{\theta}_{ij}^{g}(\tau)}{\sum_{i=1}^{N}\sum_{j=1}^{N}\widetilde{\theta}_{ij}^{g}(\tau)} \times 100 \tag{6}$$

Further, net connectedness is computed as:

$$NC(\tau) = C_{\rightarrow i}(\tau)\left[\frac{\sum_{j=1,i\neq j}^{N}\widetilde{\theta}_{ji}^{g}(\tau)}{\sum_{j=1}^{N}\widetilde{\theta}_{ji}^{g}(\tau)} \times 100\right] - C_{i\leftarrow}(\tau)\left[\frac{\sum_{j=1,i\neq j}^{N}\widetilde{\theta}_{ij}^{g}(\tau)}{\sum_{j=1}^{N}\widetilde{\theta}_{ij}^{g}(\tau)} \times 100\right] \tag{7}$$

Based on the Bayesian information criterion (BIC), a VAR lag of order 1 is selected, and for connectedness estimations, a 10-step ahead forecast variance decomposition is employed.

3. Empirical results

3.1. Network of quantile volatility spillovers

Figs. 1-3 reveal the network of blockchain assets at the median, extreme low, and extreme high volatility conditions, where network sphere of comparable results at the median and extreme low volatility conditions indicate ETH as receiving majority risk spillovers succeeded by BTC from other blockchain markets corroborating Katsiampa et al. (2019) and Lucey et al. (2021), where the inherent bubble effect of cryptocurrencies shape the volatility spillovers. Urquhart (2018) also reported increased investor attention following the enhanced volatility of Bitcoin. Meanwhile, a complex connectedness sphere is displayed at extreme high volatility conditions,

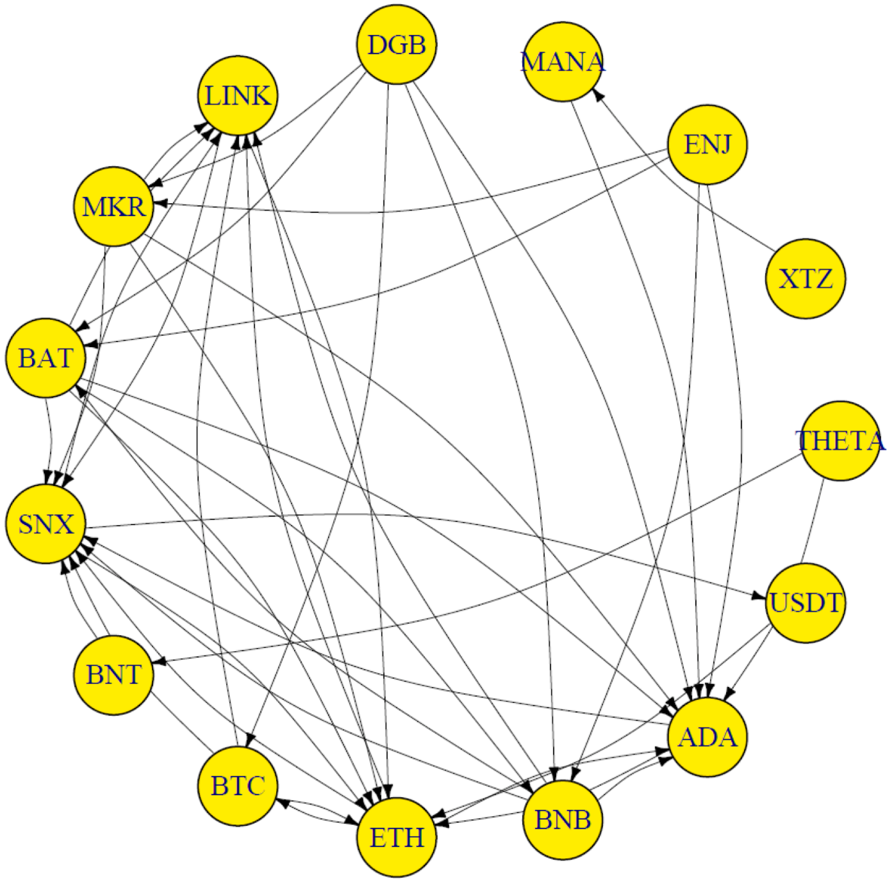


Fig. 3. Risk spillovers extreme high quantile
Note: Refer to note in Fig. 1.

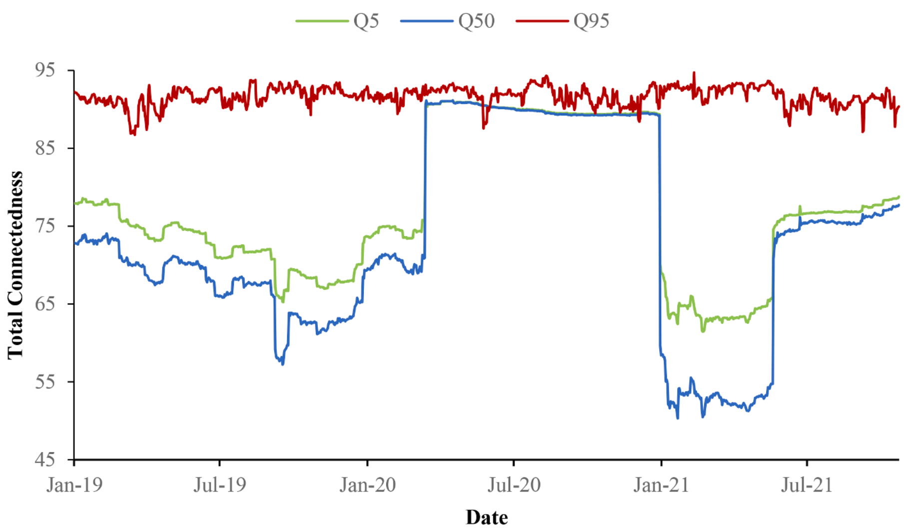


Fig. 4. Dynamic risk connectedness median, extreme low and extreme high quantiles
Note: This figure shows the rolling-window estimates of total risk spillovers at the 5th, 50th, and 95th quantile, respectively, among THETA (THETA), XTZ (TEZOS), ENJ (ENJIN COIN), MANA (DECENTRALAND), DGB (DIGIBYTE), LINK (CHAINLINK), MKR (MAKER), BAT (BASIC ATTENTION COIN), SNX (SYNTHETIX), BNT (BANCOR), BTC (BITCOIN), ETH (ETHEREUM), BNB (BINANCE COIN), ADA (CARDANO), and USDT (TETHER). The rolling window size is 292 days.

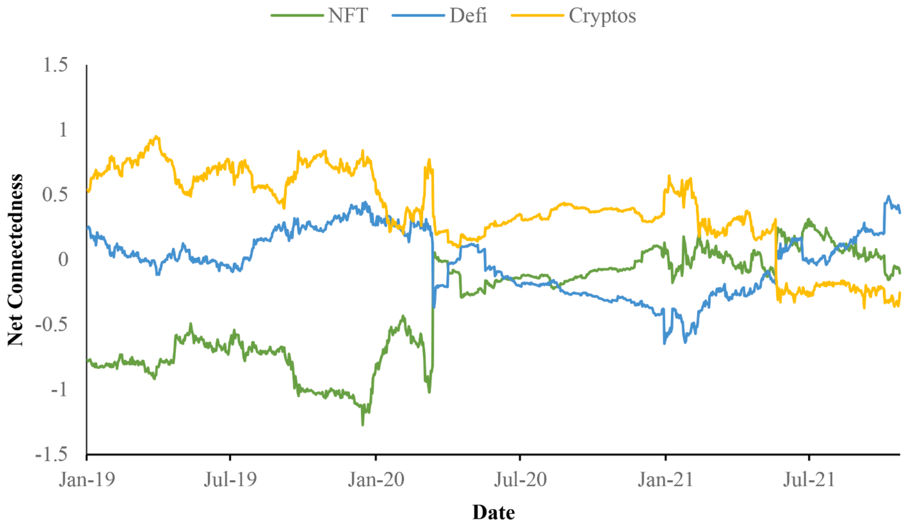


Fig. 5. Net directional risk connectedness at median quantile
Note: Refer to note in Fig. 4.

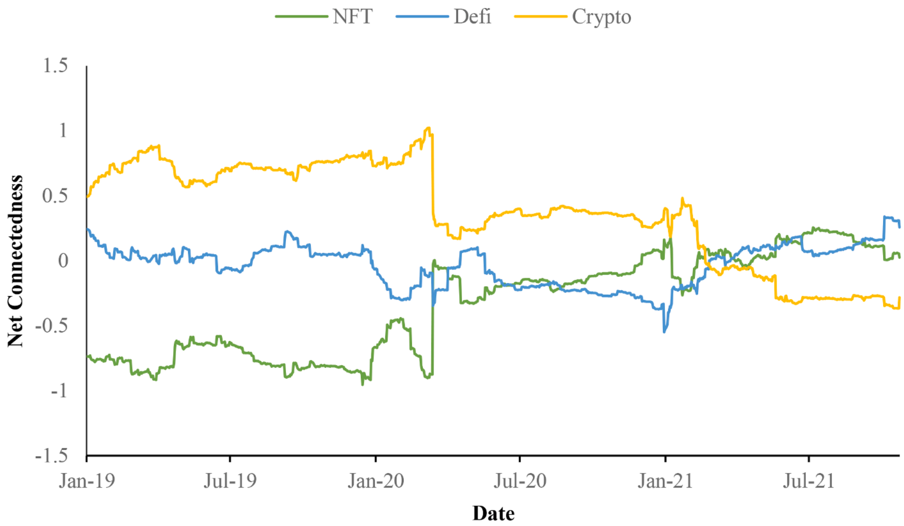
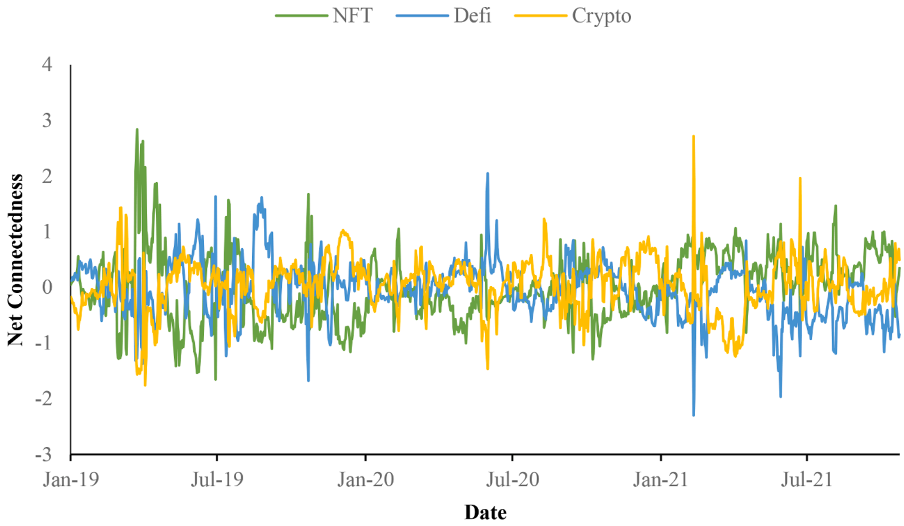


Fig. 6. Net directional risk connectedness at extreme low quantile
Note: Refer to note in Fig. 4.

echoing the higher sensitivity of blockchain markets in the upper-tails. Thus, the extreme risk spillovers at upper tails are mainly distinct from the average and low volatility connectedness. Correspondingly, strong diversification opportunities are identified in THETA (NFT) for DeFi and cryptocurrencies at median quantiles as THETA remained disconnected from other blockchain markets. Overall, strong diversification avenues are described by NFT for DeFis and Cryptos attracting investors' attention when markets are experiencing high volatility. In these circumstances, NFTs can offer greater risk-absorbance and investment shield in a portfolio of DeFis and Cryptos.

3.2. *Dynamic risk spillovers*

Fig. 4 plots dynamic risk spillovers of blockchain markets at various quantiles where explicit time-varying features are indicated. At median and extreme low volatility conditions, parallel risk spillovers are formed where total connectedness index (TCI) retains between 73 and 78% initially with significant ups and downs shadowing China's switching to blockchain technology, Libra



v7. Net directional risk spillovers at extreme high quantile
Note: Refer to note in Fig. 4.

announcement by Facebook, Trump's "twitter rant", the theft of 0.2 million bitcoins in Ponzi Scheme,[10] which dramatically enhanced the TCI during 2019. After that, we see a sharp increase in the TCI, reaching 93% during the onset of COVID-19 marked extreme volatility in each quantile, giving unprecedented shocks to blockchain markets (Le et al., 2021; Yarovaya et al., 2020). Soon after markets normalized during January 2021, TCI dropped to 65% and 50% at the median and extreme low volatility conditions, respectively. Concurrently, another rise in the TCI at 75% during May 2021 points toward Tesla's decision to stop taking Bitcoins following environmental concerns[11] (Naeem and Karim, 2021), highlighting the volatility of blockchain markets. However, TCI sustained at 93% at extreme high volatility conditions.

3.3. Net directional risk spillovers

Net directional volatility spillovers in Figs. 5-7 indicate that positive spillovers of DeFi and Cryptos dominated the negative spillovers of NFT at median and extreme low volatility conditions indicating diversification potential of NFT conquering our results in network risk connectedness. Correspondingly, significant overlaps in the volatilities are reflected at extreme high volatility and the period signifying the onset of COVID-19 manifesting high-risk transmission in the blockchain markets during high uncertainty periods consistent with Goodell and Goutte (2021).

4. Conclusion

Given the underlying higher uncertainty and volatility in blockchain markets, we examined extreme risk transmission among NFTs, DeFis, and Cryptos. We reported strong volatility connectedness among blockchain markets at the median, extreme low, and extreme high volatility conditions. Time-varying attributes revealed explicable patterns of TCI at each quantile, while net directional risk spillovers exhibited substantial overlaps in the blockchain markets. Pointing towards diversification avenues, NFTs revealed a higher diversification potential against DeFis and Cryptos. Our findings stipulate beneficial investing features in blockchain markets for policymakers, regulators, and risk-seeking investors as high volatility underscoring cryptocurrencies and DeFis can get higher returns, for the investors, in a shorter period. Conversely, investing in NFTs can overcome the risk of DeFis and Cryptos for risk-averse investors, portfolio managers, and institutional investors.

Policymakers and regulators can benefit by re-structuring their existing policies of investing in financial markets and these blockchain markets as blockchain markets, particularly NFTs, carry considerable risk-mitigation avenues for the investors and financial markets. In addition, with their further exclusive features of cryptocurrencies futures and options, a substantial investment potential exists in NFTs and DeFi Tokens, which are evolving rapidly. Following this, our study presents useful insights and policy ramifications to reap the benefits of investing in blockchain markets and rescue investments from extreme market conditions.

[10] Please see: https://medium.com/interdax/2019-in-review-top-10-cryptocurrency-events-themes-cae71a4aa38c
[11] Please see: https://www.bbc.com/news/business-57096305

Author statement

Sitara Karim; Conceptualization; Writing - Original Draft; Writing - Review & Editing; Methodology

Brian M. Lucey; Writing - Review & Editing; Supervision

Muhammad Abubakr Naeem; Conceptualization; Data Collection; Data Curation; Methodology; Software; Formal analysis; Visualization

Gazi Salah Uddin; Writing - Original Draft; Writing - Review & Editing; Methodology; Supervision; Funding Acquisition

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