AMRO
ASEAN +3 MACROECONOMIC RESEARCH OFFICE

Analytical Note

Much Ado About Nothing? Cryptocurrency Spillovers to ASEAN+3 Equity Markets and Financial Sectors[1]

November 22, 2023

I. Introduction

1. **ASEAN+3 jurisdictions have been leaders in cryptocurrency adoption worldwide.** With increasing exposures to cryptocurrencies among retail and institutional investors in the region, the likelihood that adverse shocks could spill over between the crypto ecosystem and the traditional financial system is rising. This note assesses the penetration of cryptocurrencies in ASEAN+3, discusses the associated financial stability risks, empirically examines the evolving connectedness of cryptocurrencies to the region's equity markets and broader financial sector, and draws policy conclusions from the analysis. The findings indicate that linkages are still weak, suggesting authorities still have time to put guardrail—in the form of robust macroprudential regulatory frameworks—in place to safeguard financial stability in the region.

II. Cryptocurrency Penetration in ASEAN+3

2. **Cryptocurrency adoption in emerging markets, especially in the ASEAN+3 region, has been strong at both the institutional and retail levels.** Three countries in the region—Vietnam, the Philippines, and Indonesia—rank among the top ten economies worldwide in the 2023 Crypto Adoption Index (Table 1). From July 2022 to June 2023, the cryptocurrency value received in Japan, Korea, Thailand, and Vietnam exceeded USD 100 billion. Cryptocurrency exposures, at USD 1.2 trillion, are up from USD 868 billion a year earlier. The market has been weighed down by the turmoil crypto markets experienced during the Crypto Winter of 2022–23 and the ongoing impact of the 2021 ban on cryptocurrencies in China.

3. **Institutional investors, which have the largest cryptocurrency exposures in the region, conduct transactions primarily in the "shadow crypto financial system."** About 60 percent of the total cryptocurrency value received in ASEAN+3 is accounted for by institutional investors; 35 percent by professional investors, and the remaining 5 percent by retail investors (Chainalysis 2023a). Banks' direct exposures are negligible at less than 5

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basis points (0.05 percent) when measured in risk weighted assets, which translate into weak cross-sectoral linkages and minimal spillover risks (for now). Most of the institutional investor exposures are through asset managers and hedge funds, who conduct their trading in unregulated crypto exchanges, most of which were based in China, North America, the United Kingdom, and Russia up to 2022 (Auer and others 2022b).

Table 1. ASEAN +3 and United States: Cryptocurrency Adoption Index
(Global ranking)

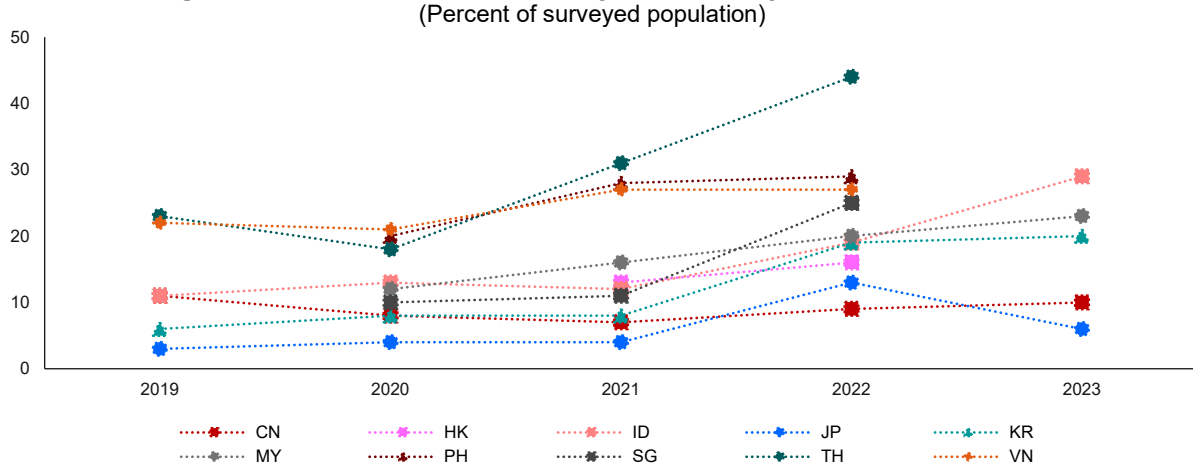
Economy	2022 Ranking	2023 Ranking
Vietnam	1	3
United States	5	4
Philippines	2	6
Indonesia	20	7
Thailand	8	10
China	10	11
Japan	26	18
Korea	23	27
Cambodia	27	30
Malaysia	29	38
Hong Kong, China	46	48
Lao PDR	86	51
Myanmar	73	53
Singapore	63	77
Brunei	145	153

Sources: Chainalysis (2022 and 2023a).

4. **Retail holdings of cryptocurrencies in the region have been growing rapidly.** Although exposures remain small in terms of volume and dollar amounts compared to institutional ownership, retail usage is spreading among consumers. Before the COVID-19 pandemic, an average of about one in ten persons owned cryptocurrencies. The ownership share is now estimated to be about one in four in most countries as of March 2023 (Figure 1). Cryptocurrency adoption at the retail level is spurred by growing demand for financial services, the high cost of traditional finance, and a supportive regulatory environment and is skewed toward the younger population (Frost 2020). Cryptocurrencies also offer reduced transaction costs for cross-border flows, especially remittances, which are very important for the Philippines and Vietnam. There is also evidence of momentum trading among retail investors, who tend to enter the market when prices are rising (Auer and others 2022a).

5. **Cryptocurrency regulation in the region varies greatly across countries.** Some jurisdictions are more proactive than others (Table 2), especially the two leading financial hubs, Hong Kong, and Singapore. Consequently, several cryptocurrency startups and established firms have chosen to incorporate in these jurisdictions (EIU 2022). In general, cryptocurrency regulation is embedded into a broader FinTech regulatory framework that emphasizes customer protection and anti-money laundering. It also encourages the exploration of innovation initiatives under carefully supervised regulatory sandboxes (CCAF 2022). The regulation is also consistent with government initiatives aimed at expanding the use of blockchain technology beyond cryptocurrencies (Ungson and Sooranpanth 2022). Some regulatory approaches consider financial stability implications. For instance, several jurisdictions place restrictions or prohibitions on bank and financial institution cryptocurrency-related activities (e.g., Cambodia, Lao PDR, Myanmar, and Thailand).

Figure 1. Selected ASEAN+3: Cryptocurrency Retail Ownership
(Percent of surveyed population)



Source: Statista (as of November 22, 2023).
Note: The ownership rates for Brunei, Cambodia, Lao PDR, and Myanmar are not available. CN = China; HK = Hong Kong; ID = Indonesia; JP = Japan; KR = Korea; MY = Malaysia; PH = Philippines; SG = Singapore; TH = Thailand; VN = Vietnam.

Table 2: ASEAN+3: Cryptocurrency Regulatory Approaches, as of end-2021

Category	Description	Members
Proactive	Seeking to regulate and allow usage/investment of cryptocurrencies, while also taking a liberal/open approach.	Japan; Hong Kong, China; Singapore; Thailand
Fairly proactive	Seeking to regulate and allow usage/investment of cryptocurrencies while allowing it to occur, but with a restrictive and cautious approach.	Indonesia, Malaysia, the Philippines, South Korea
Unclear	No clear approach but generally treats their usage and investment as illegal.	Cambodia, Vietnam.
No obvious plan	No government plans on how to deal with cryptocurrency usage beyond warnings/caution.	Myanmar, Lao PDR
Restrictive	Complete restriction of cryptocurrency investment and warnings regarding usage.	Brunei, China

Source: Sonksen (2021).

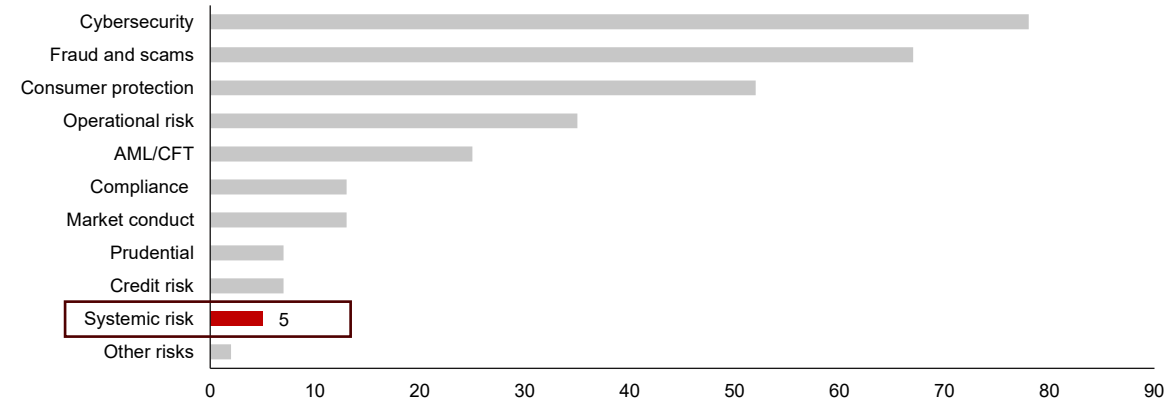
III. Financial Stability Concerns

6. **There are important structural vulnerabilities in the crypto ecosystem, which could result in large losses if risks materialize.** Market risk arises from large price swings that could lead to substantial losses from either direct or indirect exposures to crypto assets. Liquidity risk is ever present as trading relies on a few platforms, operations are opaque, and there is no lender of last resort. Credit risk originates from weak governance structures in crypto markets, crypto platforms, and crypto protocols. Operational risk is unavoidable given that the assets and platforms, which are code-based, are subject to cyberattacks and can be preyed upon by cybercriminals (CGFS 2023).

7. **Systemic risk is not perceived as a major concern by authorities—for the moment**. Despite awareness of these vulnerabilities, a survey conducted by the World Bank and the Cambridge Centre for Alternative Finance in mid-2022, which collected responses

from 128 authorities in 106 jurisdictions, found that systemic risk in the FinTech market ranked second to last (Figure 2). Perceived risks were associated with the acceleration in the adoption of FinTech and its implications for operational and consumer-related risks, as well as the rapid growth in cryptocurrency related crimes (Chainalysis 2023b).

Figure 2. World: Perceived Risk in the FinTech Market due to COVID-19
(Percent of respondents)



Sources: World Bank and CCAF (2022).

8. **Systemic risk is not perceived as a major concern by authorities**. The absence of major spillovers to the traditional financial system in past crypto stress periods partly explains why. During 2022 and 2023, major players in the crypto space failed spectacularly leading to the collapse of several crypto assets and supporting platforms. Arner and others (2023) attributed these failures to the financialization of the crypto system, which has brought about several of the problems typically associated with traditional finance such as conflict of interests, information asymmetries, centralization and interconnection, and agency and operational risks. Gorton and Zhang (2023) remarked that, despite the hype, crypto lending platforms are not much different than traditional banking: borrow short to lend long. The platform runs in 2022–23 highlighted this risk. Notwithstanding these large failures, financial markets and institutions were barely affected.

9. **Empirical studies support the low ranking of systemic risk by authorities.** Until now, the crypto system and the traditional financial system are weakly connected with minimal spillovers between them. For instance, there have been only minimal volatility spillovers between Bitcoin and the Saint Louis Fed financial stress index, a widely monitored measure of aggregate financial sector risk (Nur and Korkmaz 2022). Major cryptocurrencies are only weakly coupled with emerging market assets (Omane-Adjepong and Alagidede 2020), as well as with globally systemically important banks (Chan-Lau and Quach forthcoming).[2]

10. **Regulatory complacency, however, would not be warranted in the medium-term.** Cryptocurrency adoption and the integration of the crypto space with the traditional financial system continues apace. Banks' involvement is modest at present, but it could scale up rapidly and increase the likelihood of systemic risk (Auer and others 2022b). Worldwide, crypto firms are expanding into lending and borrowing services traditionally offered by banks—a welcome development in many economies where a large share of the population does not have regular access to the banking and financial system. Banks are also

[2] See references cited in these three papers for a comprehensive list of related empirical studies.

gradually increasing their cryptocurrency holdings, driven by growing demand from their clients and the increased revenue from crypto trading and custodial fees. Indeed, several banks in the ASEAN+3 region offer or plan to offer cryptocurrency financial services (Febrian and others 2022).

11. **Effective macroprudential risk management entails close monitoring of the linkages between the crypto space and financial markets**. Increased interconnectedness could enable shocks initially affecting a single cryptocurrency to spill over to ASEAN+3 markets. Hence, macroprudential analyses that measure spillover risks could help to identify which markets may be more vulnerable to cryptocurrency shocks. Ideally, the connectedness measures should vary with time to capture the ebb and flow of systemic risks.

IV. Measuring the Systemic Risk of Cryptocurrencies: A Long-Short-Term Memory Multiplier (LSTMM) Approach

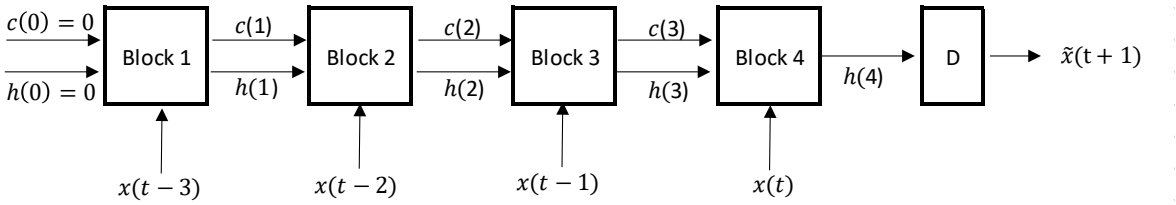
12. **One such measure is the price return connectedness between cryptocurrencies and equity markets in ASEAN+3**. Many macroprudential market-monitoring tools are based on variance decomposition (second moment) connectedness measures built upon the framework first advanced by Diebold and Yilmaz (2014). In simpler terms, a second moment connectedness measure explains how much the volatility of one asset explains the volatility of other assets. Price changes, however, might be a better gauge of systemic risk especially if shocks induce losses to consumers, firms, or the government. Loss calculations require evaluating price movements in response to shocks, so connectedness measures at the price return (first moment) level might be more informative than those at the volatility level. One such way to construct this measure, and to account for nonlinear effects and time variation, is to leverage on and adapt well-known deep-learning methods to the problem at hand.

13. **Measures using the Long-Short Term Memory Multiplier (LSTMM) framework allows connectedness assessments**. The framework adapts a deep learning sequence model—the Long-Short Term Memory (LSTM) model—to analyze spillovers (or connectedness) at the price return level.[3] The architecture of the model consists of a single layer with four single LSTM blocks (four time-steps). Information is transmitted by two types of cells: the cell or memory cell state, *c*, which carries the long-term memory, and the hidden state, *h*, which carries the short-term memory (Figure 3). To predict the realization of the multivariate time series in *t*+1, the LSTM is initialized by setting the long-term and short-term memory cells to zero and feeding in information from the previous four periods. The LSTM blocks will process the information sequentially to yield a final value for the short-term cell (*h4*, in Figure 3), which is then processed in a computation layer *D* to obtain the prediction.

14. **The LSTM predictions serve to compute the LSTM multiplier.** The computation of the multiplier requires a baseline prediction and the shocked prediction. The former is obtained using as inputs the historical data from *x(t-3)* to *x(t)*. The latter is obtained using as inputs the historical data from *x(t-3)* to *x(t-1)* and adding a one percentage point shock to *x(t)*. The LSTM multiplier is set as the difference between the shocked return and the baseline return, expressed as a percent of the baseline return.

[3] See Chan-Lau and Quach (forthcoming) for technical details.

Figure 3. A Four Time-step Single Layer Long-Short-Term-Memory Model



Source: Authors' visualization.

15. **We measure the impact of Bitcoin and Ethereum on ASEAN+3 markets using LSTM multipliers**. The multipliers are computed using weekly price return data for Bitcoin, Ethereum, and selected ASEAN+3 MSCI broad domestic stock market and financial sector indices.[4] All the indices are denominated in US dollars.[5] The multipliers are also computed for the US and EU as benchmarks. The data sample covers the period from August 14, 2015, to October 18, 2023. Standard five-fold cross-validation is used to estimate to set the size of the information cells and the parameters of the models. Annual average values of the estimated LSTMM time series of the cryptocurrency multipliers in the pre-pandemic (2016–19), COVID-19 pandemic (2020–22), and post-pandemic (2023) periods are calculated using the maximum of either the Bitcoin or Ethereum weekly multipliers (Figures 4 and 5).

16. **The LSTMM analysis suggests that cryptocurrencies are only weakly connected to domestic equity markets and the broader financial sector in ASEAN+3**. Connectedness, measured as the price return movement induced on either the equity market or financial sector by a one percentage point shock to cryptocurrency returns, has been modest. The highest equity market and financial sector connectedness is recorded in Vietnam and Thailand respectively (Figures 4 and 5). But in both countries, connectedness—at less than 0.10 percent—has been one order of magnitude lower than the cryptocurrency shock. The low connectedness justifies the current low risk perception associated with cryptocurrencies and the authorities' greater emphasis on strengthening cybersecurity and customer protection.

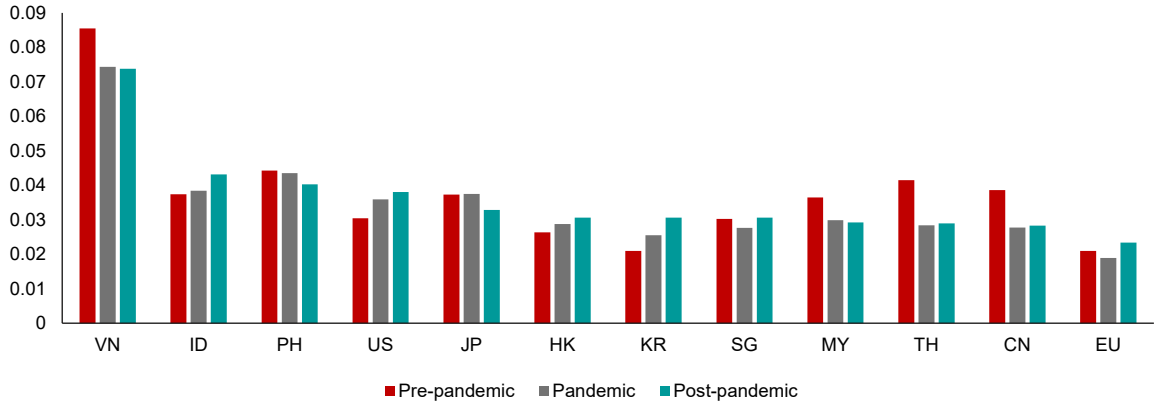
17. **Cryptocurrency connectedness to equity markets in the region exhibit similar patterns to those observed in the US.** Across most of the region, connectedness has remained relatively flat throughout the pre-pandemic, pandemic, and post-pandemic periods, mirroring trends and levels observed in the US equity market. Vietnam, however, stands out as a notable exception, with connectedness levels twice as high as those seen in other countries (Figure 4).

18. **Equity market connectedness might be associated with the degree of cryptocurrency penetration and the regulatory framework**. The four most connected countries in our sample—Vietnam, Indonesia, Philippines, and the US—are the top 4 country adopters (Table 1 and Figure 4). In addition, tighter cryptocurrency regulations might have caused relatively large declines in connectedness in China and Thailand from pre-pandemic levels. Indeed, connectedness in the EU, which has arguably the most comprehensive cryptocurrency regulatory framework, is the lowest in the sample.

[4] Brunei, Cambodia, Lao PDR, and Myanmar are excluded due to lack of market data.

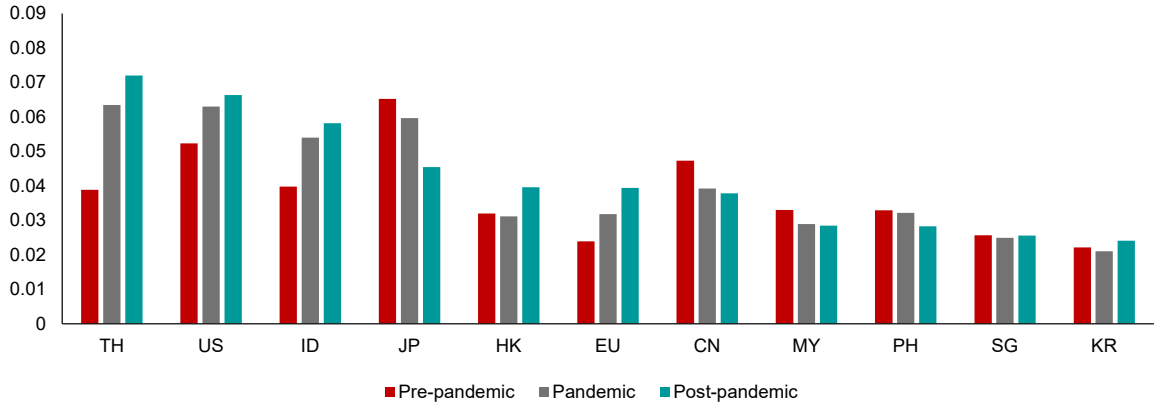
[5] See Appendix I for indices and corresponding Bloomberg codes.

Figure 4. LSTMM Cryptocurrency Connectedness to Domestic Equity Markets
(Percent)



Sources: Bloomberg Finance L.P.; CoinGecko; and AMRO staff calculations.
Note: The figure shows the annual average of weekly maximum LSTM multipliers from one-percent shock return of Bitcoin and Ethereum to MSCI broad domestic equity market indices. Pre-pandemic = 2016 – 2019 period; pandemic = 2020 – 2022 period; post-pandemic = 2023, up to October 18. Selected equity indices are in US dollars. CN = MSCI China Index; HK = MSCI Hong Kong Index; JP = MSCI Japan Index; KR = MSCI Korea Index; ID = MSCI Indonesia Index; MY = MSCI Malaysia Index; PH = MSCI Philippines Index; SG = MSCI Singapore Index; TH = MSCI Thailand Index; VN = MSCI Vietnam Index; US = MSCI United States Index; EU = MSCI Europe Index.

Figure 5. LSTMM Cryptocurrency Connectedness to Domestic Financial Sector
(Percent)



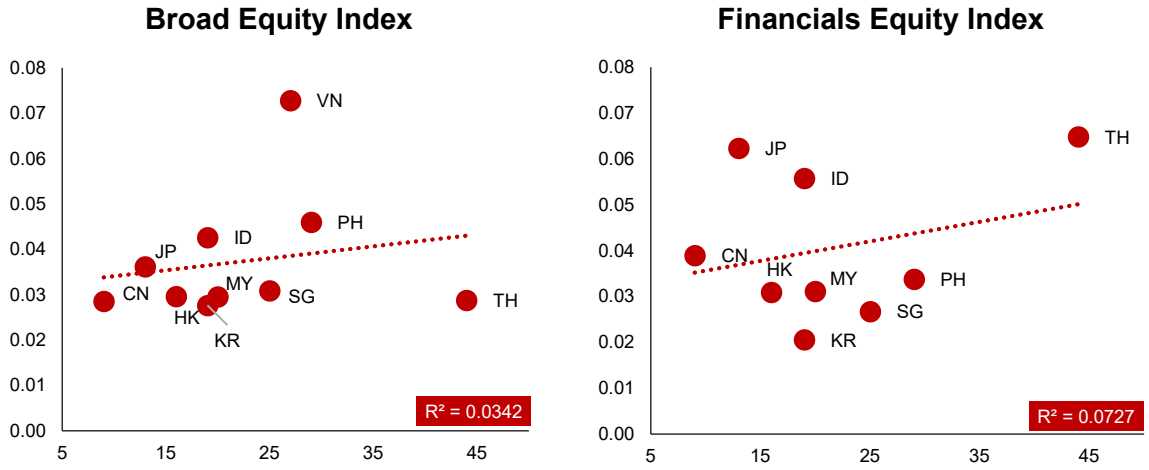
Sources: Bloomberg Finance L.P.; CoinGecko; and AMRO staff calculations.
Note: The figure shows the annual average of weekly maximum LSTM multipliers from one-percent shock return of Bitcoin and Ethereum to MSCI domestic financials equity indices. Pre-pandemic = 2016 – 2019 period; pandemic = 2020 – 2022 period; post-pandemic = 2023, up to October 18. Selected equity indices are in US dollars. CN = MSCI China Financials Index; HK = MSCI Hong Kong Financials Index; JP = MSCI Japan Financials Index; KR = MSCI Korea Financials Index; ID = MSCI Indonesia Financials Index; MY = MSCI Malaysia Financials Index; PH = MSCI Philippines Financials Index; SG = MSCI Singapore Financials Index; TH = MSCI Thailand Financials Index; US = MSCI United States Financials Index; EU = MSCI Europe Financials Index.

19. **Against regional trends, cryptocurrency connectedness with the broader financial sector has increased in Thailand, Indonesia and Korea, mirroring trends in the US and the EU** (Figure 5). Connectedness almost doubled from the pre-pandemic to the post-pandemic period in Thailand, increased by about 50 percent in Indonesia, and ticked up slightly in Korea. In contrast, most other countries in the region saw connectedness decline. Connectedness also increased in the US and EU, arguably due to the growing integration of the crypto space and the traditional financial sector. The drivers in the region might be different though.

20. **Retail ownership could be driving financial sector connectedness higher, as evidenced by the surge in retail ownership in Thailand, Indonesia, and the US.** In Thailand, retail ownership jumped by a record 44 percent in 2022 from 23 percent in 2019,

ranking second globally behind Nigeria (45 percent). Similarly, retail ownership in Indonesia soared to 29 percent in 2023 from just 11 percent in 2019; and in the US, to 16 percent from 5 percent. In Japan, where financial sector connectedness in 2023 declined to two thirds of pre-pandemic levels, ownership halved to 6 percent in 2023 from 13 percent in 2022. Indeed, simple scatterplot charts show a positive relationship between retail ownership and connectedness (Figure 6).

Figure 6. LSTMM Cryptocurrency Connectedness and Ownership Rate, 2022
(Percent)



Sources: Bloomberg Finance L.P.; CoinGecko; Statista (as of November 22, 2023); and AMRO staff calculations.
Note: The horizontal axis is the crypto ownership rate of said economies. The vertical axis is the annual average of weekly maximum LSTM multipliers from one-percent shock return of Bitcoin and Ethereum to MSCI national equity indices (left) and MSCI financials indices of said economies. Selected indices are in US dollars. CN = China; HK = Hong Kong; JP = Japan; KR = Korea; ID = Indonesia; MY = Malaysia; PH = Philippines; SG = Singapore; TH = Thailand; VN = Vietnam.

V. Conclusion

21. **Weak connections between crypto and other assets more generally, support the view that the crypto space has yet to become a major source of systemic risk**. Several empirical studies, including ours, have found that price and volatility contagion between crypto assets and the traditional financial system have been limited.[6] The weak connections held even during the Crypto Winter of 2021–2022, which witnessed large failures of cryptocurrencies and platforms. Given the limited resources of regulatory authorities, they have appropriately focused on strengthening cybersecurity and customer protection frameworks to cope with near-term risks. But the medium-term systemic risk potential of the crypto space should not be neglected. From a supervisory perspective, it is worth looking at two factors that influence connectedness: retail ownership and the regulatory framework.

22. **Cryptocurrency ownership and regulation influence the degree to which crypto is connected to the traditional financial system**. The data suggest that connectedness between crypto and traditional financial systems is high in economies where retail ownership of cryptocurrencies is substantial. Identifying the main drivers of crypto adoption and the role of cryptocurrencies in household portfolios could help assess future connectedness trends. Tighter and more comprehensive regulation also appears to affect connectedness, as evidenced by China's ban on crypto activities and the EU's comprehensive regulatory

[6] See references to empirical studies in Chan-Lau and Quach (forthcoming).

framework. To advance the regulatory agenda, it is necessary to monitor crypto connectedness and design adequate regulatory frameworks that balance the pros and cons of crypto assets. Cryptocurrencies, and crypto assets more generally, enable financial inclusion and deepening, facilitate remittances, and help reduce transaction costs—these benefits should be preserved under the regulatory regime.

23. **Building systemic risk monitoring tools now will help authorities stay ahead of trends and developments in the crypto space and its interaction with the traditional financial system.** Among them, market-based monitoring tools constructed upon price and volatility co-movements models, such as those in Vector Auto-Regression-based variance decompositions or LSTMMs, serve to track how systemic risks evolve over time and identify what firms or markets might be more exposed to crypto asset connections.

24. **The ideal risk monitoring tool should capture information from different sources**. Market-based tools are only one element in a comprehensive systemic risk monitoring framework. These tools can only capture the information that prices and trading volume convey and offer a particular perspective on systemic risks. Sound macroprudential risk management also requires timely assessments of business practices, regular discussions with market participants, and a thorough understanding of the technology underlying crypto innovations

25. **Strengthening regulatory requirements and information disclosures should be complemented with strict compliance.** For instance, in hindsight the recent failure of a large US commercial bank in 2023 could be blamed on the bank's excessive client exposure and deposit concentration to the FinTech industry. The exposures, which were not priced by the market, made the bank very vulnerable to adverse cryptocurrency price shocks affecting its clients. Despite several warnings by the US FDIC, the bank took no action (BCBS 2023). Absent compliance, regulation might not be effective.

26. **Potential regulatory gaps should be identified and closed to minimize undisclosed or unmonitored exposures**. Banking strategies that circumvent some of the cryptocurrency regulations expose the banks involved to adverse cryptocurrency movements. For instance, some banks have offset regulatory restrictions by moving cryptocurrency activities to non-bank subsidiaries. Others have established or plan to establish their own crypto exchange platforms (Febrian and others 2022). The introduction of new crypto assets needs in-depth scrutiny to ensure no regulatory arbitrage opportunities exist, which may require assessing the adequacy of the legal framework (Minto and others 2021). Finally, harmonization of regulatory standards, practices, and mandates, both domestically and internationally is necessary to close the gaps (FSB 2023).

Appendix I. Equity Indices Used in the Analysis

Appendix Table 1. MSCI Indices and Corresponding Bloomberg Codes

MSCI Name	Group	Bloomberg Code
MSCI CHINA	Broad stock market index	MXCN
MSCI JAPAN	Broad stock market index	MXJP
MSCI KOREA	Broad stock market index	MXKR
MSCI HONG KONG	Broad stock market index	MXHK
MSCI THAILAND	Broad stock market index	MXTH
MSCI MALAYSIA	Broad stock market index	MXMY
MSCI PHILIPPINES	Broad stock market index	MXPH
MSCI INDONESIA	Broad stock market index	MXID
MSCI SINGAPORE	Broad stock market index	MXSG
MSCI VIETNAM	Broad stock market index	MXVI
MSCI USA	Broad stock market index	MXUS
MSCI EUROPE	Broad stock market index	MXEU
MSCI SG/FINANCIALS	Financials stock index	MXSG0FN
MSCI ID/FINANCIALS	Financials stock index	MXID0FN
MSCI PH/FINANCIALS	Financials stock index	MXPH0FN
MSCI MY/FINANCIALS	Financials stock index	MXMY0FN
MSCI TH/FINANCIALS	Financials stock index	MXTH0FN
MSCI HK/FINANCIALS	Financials stock index	MXHK0FN
MSCI KR/FINANCIALS	Financials stock index	MXKR0FN
MSCI JP/FINANCIALS	Financials stock index	MXJP0FN
MSCI CN/FINANCIALS	Financials stock index	MXCN0FN
MSCI USA/FINANCIALS	Financials stock index	MXUS0FN
MSCI EUROPE/FINANCIALS	Financials stock index	MXEU0FN

Source: Bloomberg Finance L.P..

References

Arner, Douglas, Dirk Zetzsche, Ross Buckley, and Jamieson Kirkwood. 2023. "The Financialization of Crypto: Lessons from FTX and the Crypto Winter of 2022-2023." University of Hong Kong Faculty of Law Research Paper No. 2023/19, Hong Kong. https://ssrn.com/abstract=4372516.

Auer, Raphael, Giulio Cornelli, Sebastian Doerr, Jon Frost, and Leonardo Gambacorta. 2022a. "Crypto Trading and Bitcoin Prices: Evidence from a New Database of Retail Adoption." BIS Working Papers No. 1049, Bank for International Settlements, Basel. https://www.bis.org/publ/work1049.htm.

Auer, Raphael, Marc Farag, Ulf Lewrick, Lovrenc Orazem, and Markus Zoss. 2022b. "Banking in the Shadow of Bitcoin? The Institutional Adoption of Cryptocurrencies." BIS Working Paper No. 1013, Bank for International Settlements, Basel. https://www.bis.org/publ/work1013.htm.

Basel Committee on Banking Supervision (BCBS). 2023. "Report on the 2023 Banking Turmoil." Bank for International Settlements, Basel, October.

Chainalysis. 2022. "The 2022 Global Crypto Adoption Index: Emerging Markets Lead in Grassroots Adoption, China Remains Active Despite Ban, and Crypto Fundamentals Appear Healthy." Singapore, September 14. https://www.chainalysis.com/blog/2022-global-crypto-adoption-index.

———. 2023a. "The 2023 Global Crypto Adoption Index: Central & Southern Asia are Leading the Way in Grassroots Crypto Adoption." Singapore, September 12. https://www.chainalysis.com/blog/2023-global-crypto-adoption-index.

———. 2023b. "The 2023 Crypto Crime Report." Singapore, February. https://go.chainalysis.com/2023-crypto-crime-report.html.

Chan-Lau, Jorge A., and Toan Long Quach. Forthcoming. "Cryptocurrencies and Banking Sector Connectedness: Don't Worry, Be Happy … for Now." AMRO Working Paper, ASEAN+3 Macroeconomic Research Office, Singapore.

Consultative Group of Directors of Financial Stability (CGFS). 2023. "Financial Stability Risks from Cryptoassets in Emerging Market Economies." BIS Papers No. 138, Bank for International Settlements, Basel, August. https://www.bis.org/publ/bppdf/bispap138.htm.

Diebold, Francis, and Kamil Yilmaz. 2014. "On the Network Topology of Variance Decompositions: Measuring the Connectedness of Financial Firms." *Journal of Econometrics* 182 (1): 119–34.

Economist Intelligence Unit (EIU). 2022. "Cryptocurrency Regulations Diverge Across Asia." February 8, accessed on October 30, 2023. https://www.eiu.com/n/cryptocurrency-regulation-diverges-across-asia.

Febrian, Tamma, Willie Tanoto, and Ducan Innes-Ker. 2022. “Growing Crypto Engagement Carries Risks for SE Asian Banks.” *Fitch Wire*, Hong Kong, Singapore, January 27. https://www.fitchratings.com/research/banks/growing-crypto-engagement-carries-risks-for-se-asian-banks-27-01-2022.

Financial Stability Board (FSB). 2023. “Global Regulatory Framework for Crypto-Asset Activities.” Consultative Document, Basel, July. https://www.fsb.org/2023/07/fsb-global-regulatory-framework-for-crypto-asset-activities.

Frost, Jon. 2020. “The Economic Forces Driving Fintech Adoption across Countries.” BIS Working Paper No. 838, Bank for International Settlements, Basel. https://www.bis.org/publ/work838.htm.

Gorton, Gary, and Jeffery Zhang. 2023. “Bank Runs During Crypto Winter.” Working Paper, Yale University and University of Michigan. https://ssrn.com/abstract=4447703.

Harvey, Campbell, Ashwin Ramachandran, and Joey Santoro. 2021. *DeFi and the Future of Finance*. New York: Wiley.

Minto, Andrea, Stephanie Prinz, and Melanie Wulff. 2021. “A Risk Characterization of Regulatory Arbitrage in Financial Markets.” *European Business Organization Law Review* 22: 719–52.

Nur, Tugba and Turhan Korkmaz. 2022. “Volatility Spillover Between Bitcoin and Financial Stress Index.” *Journal of Corporate Governance, Insurance, and Risk Management* 9: 49–70.

Omane-Adjepong, Maurice and Imhotep Paul Alagidede. 2020. “Dynamic Linkages and Economic Role of Leading Cryptocurrencies in Emerging Markets.” *Asia-Pacific Financial Markets* 27: 537–85.

Sonksen, Clark. 2021. “Cryptocurrency Regulations in ASEAN, East Asia, and America: to Regulate or not to Regulate.” *Washington University Global Studies Law Review* 20: 171–99.

Ungson, Gerardo R., and Sada Soorapanth. 2022. “The ASEAN Blockchain Roadmap.” *Asia and the Global Economy* 2: 100047.

World Bank and Cambridge Centre for Alternative Finance (CCAF). 2022. “The 3rd Global Fintech Regulatory Survey.” World Bank Group and the University of Cambridge. https://www.jbs.cam.ac.uk/faculty-research/centres/alternative-finance/publications/3rd-global-fintech-regulator-survey.