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Opportunities and Challenges of Financial Digitalization: A New Perspective on ASEAN+3 Regional Financial Cooperation

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Opportunities and Challenges of Financial Digitalization: A New Perspective on ASEAN+3 Regional Financial Cooperation

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Executive Summary

Financial digitalization (FinDig) is changing the landscape of the international monetary and financial system. The COVID-19 pandemic helped accelerate the demand for digitalization, including in financial services. However, the crypto crisis events of 2022 were timely reminders of the significant risks FinDig can pose to financial stability if not adequately coordinated and regulated. With digital finance anticipated to increasingly dominate a growing volume of global cross-border transactions, the main challenge for policymakers is how to facilitate and support FinDig to leverage its benefits while mitigating and minimizing attendant risks.

The Japan Ministry of Finance has invited AMRO staff to study the opportunities and challenges of cross-border FinDig and what they could mean for regional financial cooperation. The objectives of this paper are to: (1) identify FinDig initiatives in the ASEAN+3 region that could have cross-border implications, and (2) assess the possible implications of FinDig for the Regional Financing Arrangement (RFA), through its impact on capital flows and potential balance of payments (BoP) needs, currency substitution, and the speed of contagion in a financial crisis, among other issues.

FinDig offers many cross-border benefits and opportunities for ASEAN+3 economies. Its advances have improved the functioning of market infrastructures and payment systems, increased transaction speeds, and lowered transaction costs through greater competition. Importantly, it has also broadened financial inclusion—and consequently economic growth—through wider access to services and enhanced transparency in information that enable lenders to provide financing while managing risks.

However, digital innovation in the financial sector also carries inescapable cross-border risks. The growing share of unrecorded cross-border digital transactions could increasingly affect the ability of authorities to monitor and manage capital flows, with consequences for a country's exchange rate and foreign exchange reserves, especially given the potential speed of spillovers and contagion in a crisis. Some transactions could also be exploited for nefarious aims such as money laundering, bypassing international sanctions, and financing of terrorism. FinDig could also lead to widespread fragmentation of processes, lack of interoperability, and/or give rise to dominant players and products that challenge monetary sovereignty.

Appropriate and proportionate regulations and their digital enforcement are needed to ensure the sustainable growth of innovative technology in the financial sector. More specifically, policies may be necessary to limit speculative activities and enforce safeguards,

while incentivizing long-term adoption initiatives. To date, speculation in virtual assets has crowded out practical adoption of other aspects of FinDig. For example, the technology underpinning distributed ledger technology and smart contracts offer potentially significant improvements to financial services and beyond. However, the lack of guidelines and regulations on blockchain-related businesses has limited participation by traditional institutions that are concerned about compliance and reputational risks, and consider regulation to be a key driver of FinDig. Moreover, the public and private sectors may have to make significant investment in the requisite RegTech (cutting-edge technological regulatory solutions).

In ASEAN+3, the "division of labor" between the public and private sectors in the development of FinDig varies across countries. Both groups generally agree that the official sector should be responsible for policy, regulation, and supervision, while the private sector is better able to lead innovation, customer engagement, and product delivery. More fundamentally, the public sector should ensure a level playing field for all private sector participants, although there is no consensus on the "same risk, same regulation" principle, given differentiation across business models.

From a regional perspective, alternatives to the existing RFA may have to be reassessed in the FinDig era. For example, besides the Chiang Mai Initiative Multilateralisation currency swap arrangement, new financial support instruments may be explored to tackle growing FinDig risks to members' BoP.

Progress in FinDig also has important implications for AMRO's work. Specifically, it means expanding or refocusing surveillance and research to incorporate regional developments in FinDig; and introducing new technical assistance options to help members close capacity gaps in FinDig implementation, through training and/or further research. Among ASEAN+3 members, suggestions for collaboration in FinDig include joint exploration, knowledge sharing, and cooperation to ensure efficiency in areas such as data collection; the promulgation of technical standards and legal and regulatory frameworks to promote interoperability and facilitate trade and finance; aligning regional discussions with international standards; and the streamlining of future regionwide FinDig initiatives.

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Abbreviations

AGMFM	AMRO Global Macro-Financial Model
AML/CFT	anti-money laundering/combating the financing of terrorism
API	application programming interfaces
ASEAN	Association of Southeast Asian Nations (Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand, Vietnam)
ASEAN-5	Indonesia, Malaysia, Philippines, Thailand
ASEAN-5	Indonesia, Malaysia, Philippines, Singapore, Thailand
ASEAN+3	ASEAN plus China (including Hong Kong), Japan, Korea
BCBS	Basel Committee on Banking Supervision
BigTech	big technology firm
BIS	Bank for International Settlements
BISIH	Bank for International Settlements Innovation Hub
BoP	balance of payments
Brunei	Brunei Darussalam
CAGR	compound annual growth rate
CBDC	central bank digital currency
CFM	capital flow management measure
CNY	Chinese yuan
COVID-19	coronavirus disease 2019
DeFi	decentralized finance
DLT	distributed ledger technology
DvP	delivery-versus-payment
e-KYC	electronic know-your-customer
ECB	European Central Bank
EU	European Union
FATF	Financial Action Task Force
FinDig	financial digitalization
FinTech	financial technology
FSB	Financial Stability Board
G2C	government-to-citizen
Gen Z	Generation Z
Hong Kong	Hong Kong, China
ICIO	Inter-Country Input-Output
IMF	International Monetary Fund
IOSCO	International Organization of Securities Commissions
ISO	International Organization for Standardization
JPY	Japanese yen
KYC	know-your-customer
KYT	know-your-transaction

MAS	Monetary Authority of Singapore
mCBDC	multiple-CBDC
MMO	mobile money operator
MNO	mobile network operator
MoM	mobile money
OECD	Organisation for Economic Co-operation and Development
P2P	peer-to-peer
PBC	People's Bank of China
PBC DCI	Digital Currency Institute of the People's Bank of China
PSP	payment service provider
QR	quick response
RegTech	regulatory technology
RFA	Regional Financial Arrangement
SGD	Singapore dollar
SME	small-and-medium enterprise
SWIFT	Society of Worldwide Interbank Financial Telecommunication
THB	Thai baht
UST	TerraUSD
VASP	virtual asset service provider

Glossary

Atomic transactions. Transactions involving two assets where the transfer of one is dependent on the transfer of the other, that is, either both transfers happen or neither happens.

Big Data. Combination of structured, semi-structured, and unstructured data that are too large, high frequency, or complex to be processed using traditional data-processing methods.

BigTech. Firms with core business models that rely on technology in nonfinancial industries, such as social media, internet search, e-commerce, and telecommunications. These firms have the advantage of big customer databases acquired from nonfinance businesses and the ability to leverage such databases to generate insights and enable rapid expansion.

Bitcoin. A real-world application of blockchain. Nakamoto (2008) defines Bitcoin as a peer-to-peer (P2P) electronic cash system that allows online payments to be sent directly without going through any financial institution. The system and its transactions are managed collectively by its validators, following a consensus mechanism (Pande and Quách 2022).

Blockchain. A type of distributed ledger technology (DLT) in which transaction records are stored as a chain of blocks in a ledger that stores digital information on the transactions. Once filled, these blocks are "sealed" and linked to the next block. This structure gives them the nomenclature, "blockchain," and enables the construction of an irreversible timeline of data in a decentralized set-up. It thus allows digital information to be recorded and distributed—but not edited.

Central bank digital currency (CBDC). The digital form of a country's fiat currency, which represents a claim on the central bank. Only a handful of countries have launched CBDCs for commercial use, while many others have studied and conducted pilot projects around them. In general terms, a CBDC's value is at par with the currencies of the respective issuing countries, and differs from that of a stablecoin (see below) in several aspects, including control by a central authority, the degree of user anonymity, and/or use of private network/infrastructure (Pande and Quách 2022).

Decentralized exchange. An autonomous platform that operates on a blockchain or similar DLT. The platform facilitates transactions of virtual assets through a set of pre-determined protocols and programs.

Decentralized finance (DeFi). DeFi removes the involvement of intermediaries and is generally enabled using P2P financial networks, which ensure secure transactions between transacting entities. DeFi is provided through applications, also known as dApps, which run on a public blockchain, such as Ethereum. Automation through smart contracts removes the need for financial intermediaries. The technology also enables frictionless and quick execution, given that it does not need to satisfy stringent know-your-customer (KYC) rules mandated by financial intermediaries, while allowing users some degree of anonymity.

Distributed ledger technology (DLT). A decentralized database that is stored at multiple locations, managed by multiple participants, and does not have a central authority or an intermediator to process, validate, or authenticate transactions. An advantage of DLT over a centralized database is better control for users over information and transactions, thus

promoting transparency. DLT also provides stronger security in that the ledgers are immutable by design. Types of DLT include Blockchain, Hashgraph, Directed Acyclic Graph, Holochain, and Tempo (Sharma, Balamurguan, and Khan 2022).

Digital asset. An overarching term that refers to the digital-native forms of asset or currency. Digital assets may include virtual assets, CBDCs, other digital forms of fiat money, or tokenized securities.

Ethereum. A blockchain infrastructure with a built-in programming language, used as a platform on which numerous types of applications may be run. It has allowed the development of non-fungible tokens, which are digital assets designed to represent ownership of unique digital items. Its programmability also enables smart contracts, which comprise a set of instructions embedded in a digital asset that can be executed as programmed. The programmability of Ethereum has allowed the platform to be used to provide services such as lending, derivative trading, asset management, stablecoin issuance, trading, and insurance (Cointelegraph Research 2022).

Financial digitalization (FinDig). The use of new technologies and innovations to transform the delivery of traditional banking and financial services, covering a variety of applications, products, processes, and business models.

Financial technology (FinTech). Technology-enabled innovation in financial services that could result in new applications, products, processes, or business models, with associated material effects on financial markets and institutions (per FSB). The interlinkages between technology and financial services have a history of more than 150 years, but the global financial crisis of 2008 is identified as a turning point that launched FinTech into a new era (Buckley, Arner, and Barberis 2015).

InsurTech. Technology-enabled innovations used by the insurance industry to improve business processes, efficiency, and customer experience.

Integration technical partner. Provider of a real-time system that validates the existence of the recipient customer in a destination mobile money system, and that sufficient funds are available in the online account of the merchant sending the mobile money. It also determines the exchange rates used for conversion, among other functions.

Mobile money (MoM). A digital medium of exchange and store of value using MoM accounts, facilitated by a network of MoM agents (adapted from IMF 2019). It is a financial service offered to users by a mobile network operator (MNO) or another entity that partners with MNOs, independent of the traditional banking network. MoM may be used as a standalone financial service, separate from a traditional bank account.

Mobile money operator (MMO). A mobile network operator (MNO) or other entity that partners with MNOs to offer financial services through mobile phones and mobile telephone networks to its clients, independent of the traditional banking network (adapted from IMF 2019).

Mobile network operator (MNO). A telecommunications service provider that offers wireless voice and data communications to subscribers (adapted from EC 2018). The operator typically owns the telecommunications infrastructure for hosting and managing

mobile communications between subscribed mobile users on the same network, and in external wireless and wired telecommunications networks.

Payment service provider (PSP). A firm that provides payment services such as account issuance, domestic money transfer (for example, e-wallet), or point-of-sale (for example, payment pages on e-commerce).

Peer-to-peer (P2P) lending. A financial service in which lenders and borrowers transact without the involvement of a financial intermediary. DeFi has provided a new avenue through which digital assets may be lent, borrowed, or used as collateral through smart contracts.

RegTech. Technology-enabled innovations that are used by regulated financial institutions for regulatory reporting and compliance purposes (BCBS 2018).

Smart contracts. Programs or codes written on a digital infrastructure platform, such as a public or private blockchain, that will self-execute when predetermined conditions are met.

Stablecoins. A special class of virtual asset, whose values are pegged or tied to other fiat currencies, commodities, or virtual assets. There are two types of stablecoins: (1) the algorithmic stablecoin, which adopts an algorithm to maintain its value based on another virtual asset; and (2) the collateralized stablecoin, whose value is maintained by a reserve of fiats and is usually managed by private firms. Collateralized stablecoins are typically considered more stable than other virtual assets.

SupTech. Technology-enabled innovations that are used by supervisory agencies to support supervision (BCBS 2018).

Virtual asset. A digital representative of value that can be traded, transferred, and can be used for payment or investment purposes (FATF 2021a). Virtual assets refer to the assets existing on public blockchains and do not include CBDCs, other digital forms of fiats, or securities.

Virtual asset service provider (VASP). A party that provides services relating to virtual assets. These services include, but are not limited to, the following: exchange between virtual assets and fiat currencies; exchange between one or more forms of virtual assets; transfer of virtual assets; safekeeping and/or administration of virtual assets or instruments enabling control over virtual assets; and participation in and provision of financial services related to an issuer's offer and/or sale of a virtual asset (FATF 2021a).

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I. Introduction

1. **Financial digitalization (FinDig) is driving the transformation of the international monetary and financial system.** The traditional division of labor within a monetary system is built on the role of central banks, which are the bedrock of the system, and private sector intermediaries, which conduct customer-facing activities (BIS 2022). However, rapid advancements in technology and innovations in financial products—and the resultant manner in which cross-border financial transactions are being conducted—have raised concerns about the future landscape of the international monetary and financial system. In particular, the role and influence of the central bank and its interactions with the private sector may be changing, and the nature and extent of regulation may have to evolve along with it. The crisis events of 2022 in virtual asset markets proved a timely reminder that while technological progress brings significant benefits to international finance, it also poses great risks to financial stability and raises the issue of consumer protection if not adequately monitored, coordinated, and regulated.

2. **The COVID-19 pandemic has accelerated demand for digitalization, including in financial services.** Indeed, the pandemic is estimated to have sped up digital adoption across the world by as much as seven years (McKinsey & Company 2020). Amid tight physical containment measures, individuals were motivated to shop online to satisfy consumption needs while firms made the move to maintain or extend their market share. Consequently, financial facilities, such as e-commerce and digital payments, have gained traction. More generally, the e-commerce market in the Asia-Pacific region is estimated to have grown at a robust compound annual growth rate (CAGR) of 17 percent from 2017– to 2021, propelled by the strong take-up of and competition in digital wallets (FIS 2022). The value of e-commerce is expected to expand at a CAGR of 12 percent from 2022 to 2025,[1] underpinned by wider usage of digital and mobile wallets and real-time payment methods. These trends are expected to create more use cases for FinDig.

3. **On the supply side, the unbundling of financial services and entry of BigTech firms offer new solutions**. New products (such as digital wallets and mobile money (MoM)), new lending methods (such as peer-to-peer (P2P) lending), and new transaction and data storage techniques have facilitated the shift to digital finance. New financial technology (FinTech), such as decentralized finance (DeFi), exemplifies important groundbreaking innovations in how digital assets, such as virtual assets and central bank digital currencies (CBDCs), move around the world in an “always-on” global economy. Key benefits of FinDig being implemented properly should include greater transactional efficiency, deeper capital markets, lower informational asymmetry, and broader financial inclusion, leading to higher productivity and more equitable economic growth.

4. **Digital payments are anticipated to increasingly dominate as the volume of global cross-border payment transactions continues to expand.** Indeed, Seeh (2021) projects that this volume could grow by 5 percent a year, with the value of global cross-border payment flows at $156 trillion in 2021, driven by business-to-business transactions, which accounted for a 96 percent share. More than 2 billion digital payments are made

[1] In the ASEAN+3 region, e-commerce markets in Vietnam and Indonesia are projected to grow by a region-leading 22 percent annually until 2025, while the market in Korea is also expected to expand by 19 percent. More mature markets in the region, such as Hong Kong, Japan, and Singapore, are expected to post annual e-commerce growth of between 10 percent and 16 percent. Separately, China’s e-commerce market is projected to grow by 12 percent annually and exceed $3.2 trillion by 2025.

around the world each day (BIS 2022). According to a cross-country, cross-region study by Visa (2022), which covered small business owners and consumers across nine markets, more than 70 percent of small businesses acknowledged that accepting digital payments would be fundamental to growth. Among those surveyed, 59 percent indicated that they were already using or planned to use only digital payments within the next two years, compared to 41 percent of consumers who said the same.

5. **The division of roles and responsibilities between the public and private sectors is one of the most important policy considerations in the push for FinDig.** Apart from regulatory oversight and providing strategic direction (Box 1), the public sector is also responsible for creating and maintaining public goods and services, such as the international payment system (Camdessus 1999), which is being challenged by private digital asset service providers and bilateral/multilateral disjoint payment systems. Of important note, the system is confronted by the threat of fragmentation and many alternate payment options could escape oversight.

6. **The involvement of the private sector in the traditional public good domain of providing international payment system infrastructure poses potential risks to financial stability.** The risks include reduced effectiveness of policies, such as capital flow management measures (CFMs) and economic sanctions, and increased risks of currency substitution in some economies (Georgieva 2022). Hence, any regulatory framework should be sufficiently strong to maintain policy effectiveness as a minimum. Ideally, public and private initiatives should complement each other and be properly coordinated to support the innovation ecosystem and safeguard financial stability (Beau 2021).

7. **ASEAN+3 governments are providing strong support for digitalizing their financial systems.** They are attempting to bring more of the populace into digital finance, and are exploring cross-border real-time payments that connect multiple domestic systems and involve the private sector (Figure 1). For example:[2]

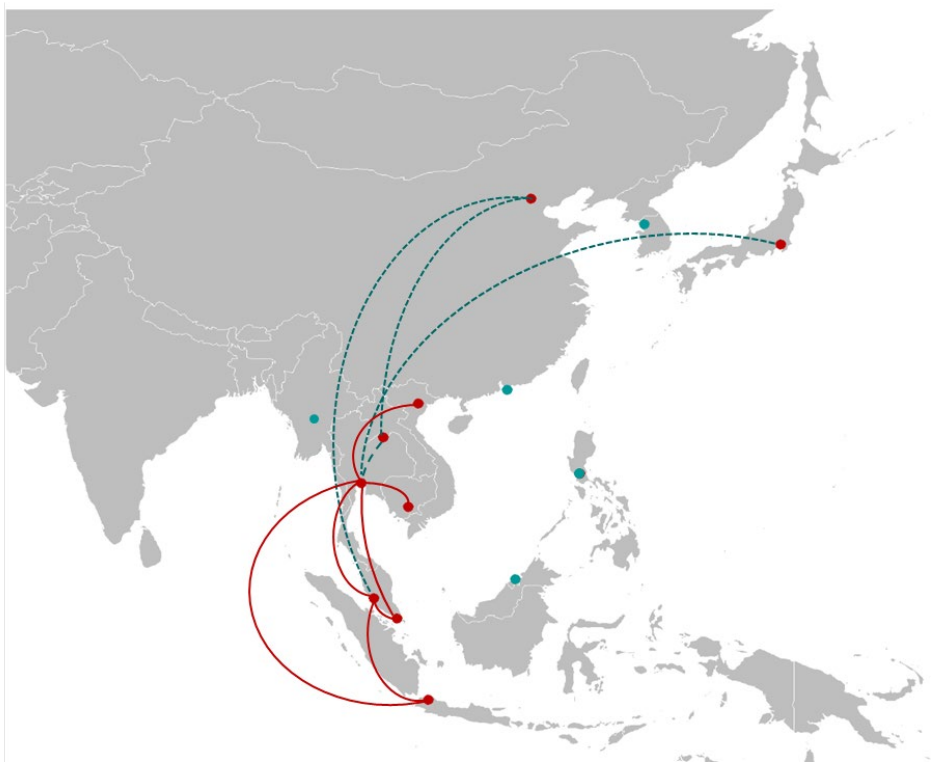
- Initiatives on instant cross-border quick response (QR) code payments have been introduced by central banks in Malaysia and Indonesia (2022) to link businesses and individuals between the two countries; in Thailand with counterparts in Cambodia (2020), Vietnam (2021), Indonesia (2021), Malaysia (2021), and Singapore (2022); and in Malaysia and Singapore (2023). Other economies in the region have also expressed interest in joining similar linkages.

- Singapore and Thailand have started the world's first linkage of real-time cross-border payment systems through connecting PayNow and PromptPay networks (April 2021). Patrons of participating banks are able to transfer funds of up to SGD 1,000 or THB 25,000 daily and around the clock (MAS 2021a). Transfers take only a few minutes, compared to one to two working days using conventional solutions.

- The private sector has also introduced cross-border payment services for customers to use abroad, although these facilities allow fund transfers in one direction only. Available linkages are for Thai visitors to Japan (2018), and Chinese visitors to Lao PDR (2019) and Malaysia (2020).

[2] See Appendix I for details on the features of cross-border FinDig initiatives in ASEAN+3.

Figure 1. ASEAN+3: Quick Response Payment Linkages

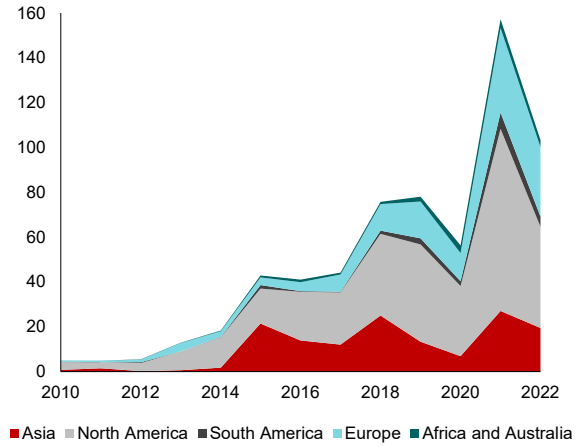


Economies	Project name	Public/ Private	Launch Date
Lao PDR – Thailand	BCEL – Thanachart Bank	Private	March 2018
Japan – Thailand	MyPromptQR cross-border QR code payment platform for Thai consumers in Japan	Private	December 2018
China – Lao PDR	UnionPay International – BCEL	Private	July 2019
Cambodia – Thailand	Cross-border QR payment linkage between Cambodia and Thailand	Public	February 2020
China – Malaysia	UnionPay QR code payment service in Malaysia	Private	July 2020
Thailand – Vietnam	Cross-border QR payment linkage between Thailand and Vietnam	Public	March 2021
Singapore – Thailand	PayNow-PromptPay cross-border payment linkage between Singapore and Thailand	Public	April 2021
Malaysia – Thailand	Cross-border QR payment linkage between Malaysia and Thailand	Public	June 2021
Indonesia – Thailand	Cross-border QR payment linkage between Indonesia and Thailand	Public	August 2021
Singapore – Thailand	NETS-PromptPay linkage	Private	September 2021 (NETS – KTB) August 2022 (NETS – ITMX)
Indonesia – Malaysia	Cross-border QR payment linkage between Indonesia and Malaysia	Public	January 2022
Malaysia – Singapore	Cross-border QR payment linkage between Malaysia and Singapore	Public	March 2023

Sources: National authorities; and AMRO staff compilations.
Note: Cross-border payment linkages led by central banks enable efficient and real-time fund transfers, usually in small amounts, among participating members. The majority of private sector linkages only allow fund transfers in one direction, from one economy to another. The green-dotted lines represent private sector linkages, from: Lao PDR to Thailand; Japan to Thailand; China to Lao PDR; and China to Malaysia. The red lines represent linkages led by central banks. The red dots represent the capital cities of ASEAN+3 economies that are linked to at least one neighbor; the green dots represent the capital cities of regional economies that are not yet linked. The boundaries and any other information shown on the map do not imply, on the part of AMRO, any judgment on the legal status of any territory or any endorsement or acceptance of such boundaries.

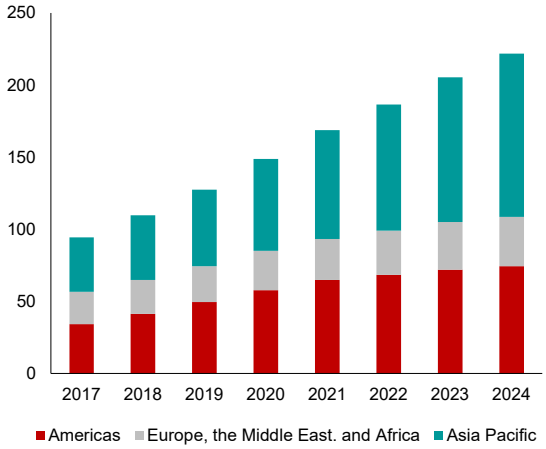
8. **FinDig as a whole is likely to continue to flourish even as the crypto crisis in 2022 has resulted in risk aversion to the more speculative elements of the digital industry.** Funding to FinTech firms, whose products are used to facilitate FinDig, have sustained a CAGR of 33 percent since 2010, taking off during the pandemic to reach $160 billion in 2021 (Figure 2). Separately, global FinTech revenues are projected to rise to $221 billion by 2024 (Figure 3), with Asia-Pacific expected to grow the fastest (Deloitte 2020), which bodes well for the development of FinDig in the region. And despite the high volatility and sharp downturn in 2022, the total market capitalization of virtual assets is up 500 percent compared to pre-pandemic levels,[3] with the impressive technology behind these assets and other FinTech innovations likely to find use in other FinDig initiatives.

Figure 2. World: Funding to FinTech Firms
($, billions)



Source: Tracxn; and AMRO staff calculations.

Figure 3. Selected Regions: FinTech Revenues
($, billions)



Source: Deloitte (2020).
Note: Actual data up until 2018.

9. **The main challenge for policymakers is how they can facilitate and support FinDig to leverage its benefits while safeguarding monetary and financial stability and, at the same time, ensure consumer protection.** Beau (2021) identifies three key risks: (1) growing exposure to increasingly sophisticated and evolving cyber threats, amplified by the hasty rollout of online tools and software during the COVID-19 pandemic, (2) potential fragmentation of processes, which will actually reduce the efficiency of the overall financial system if innovations are not adequately designed and organized to operate in conjunction with existing systems, and (3) challenges to monetary sovereignty and stability attributable to significant network effects from the emergence of BigTech and the widespread adoption of virtual assets as private settlement assets.

10. **The Japan Ministry of Finance invited AMRO staff to study the opportunities and challenges posed by cross-border FinDig, and their potential implications for regional financial cooperation.** The aim of this project is to provide recommendations on reinforcing the current Regional Financing Arrangement (RFA), as a standalone agenda of the ASEAN+3 Finance Track. In this context, the paper will: (1) identify FinDig initiatives in the ASEAN+3 region that could have cross-border implications, and (2) consider the benefits

[3] Per TradingView (https://www.tradingview.com/), accessed August 10, 2022.

and risks from FinDig and assess their possible implications for the RFA and AMRO's work program and resources.

11. **AMRO staff draw on several sources to inform their views on the topic.** These comprise: (1) findings in the rapidly growing literature, (2) AMRO staff's own modeling and analysis, and (3) discussions with or surveys of public sector officials and private sector participants (and their overseas offices, where relevant) throughout the ASEAN+3 region.[4]

12. **The findings in this paper point to the obvious importance of cross-border FinDig for the RFA.** Continuing expansion of FinDig will likely have short-term implications for the use of AMRO's resources, such as additional surveillance coverage and technical assistance for members. It has also motivated members' desire for cooperation in the medium and longer terms across areas such data collection, technical standards, and legal and regulatory frameworks. In addition, the paper reviews the opportunities offered by FinDig and discusses cross-border challenges from the adoption of FinDig. It goes on to cover regulatory and policy developments and perspectives, and concludes with recommendations for both AMRO and ASEAN+3 authorities.

Box 1. Financial Digitalization: The Role of Public versus Private Sectors

Financial services are predominantly provided by heavily regulated institutions such as banks, insurers, and payment systems, but the landscape is changing. In recent years, nonfinancial corporations, such as BigTech firms and FinTech specialists, have increased in number, bringing financial services advantages such as superior technology, better consumer experience, greater efficiency, wider financial inclusion, and increased competition. Although the benefits offered by these firms should not be underestimated, they also give rise to risks, such as conflicts of interest, anti-competitive behavior, spillovers, and contagion, as well as oversight issues attributable to organizational structures (Zamil and Lawson 2022).

The challenge for authorities is to facilitate the optimization of potential benefits from FinDig while mitigating new risks to financial stability. The three key areas for policy making are:

- **Regulation.** A key feature of BigTechs and FinTechs is that they unbundle and sometimes rebundle core services in banking and financial value chains (Walsh 2021). This capability has forced regulators to reconsider the mix of entity-based and activity-based regulations (Crisanto and Ehrentraud 2021), given the fluidity that such actions create among financial instruments, entities, and activities (Borio, Claessens, and Tarashev 2022). Activity-based regulations have been applied to areas such as anti-money laundering and combating the financing of terrorism (AML/CFT) and consumer protection. However, regulators are applying entity-based regulations in areas such as risk management, operational resilience, and competition. Different approaches, such as providing licenses for specific activities (for example, payment systems) or defining newly regulated entities (for instance, digital banks) have been used in different jurisdictions.

- **Investment.** The role of government is typically to provide the overall direction and guidance on FinDig efforts. The official sector would be involved in areas such as setting up appropriate regulatory frameworks and providing equal treatment for all private sector players. However, some initiatives may be strategically important for the economy and require the government to initiate and drive them. For example, authorities in various jurisdictions have considered CBDC as a means for countering risks arising from private digital payment platforms and currencies (Pande and Quách 2022). The government may also see its role as the financier of last resort as requiring it to take the initiative on commercially unprofitable projects that private firms are not willing to undertake.[1/]

[4] See Appendix II for the list of interlocutors/contributors for this project. AMRO staff would like to thank member authorities for their inputs and for facilitating AMRO staff access to official sector agencies and private sector participants in the region.

- **Public–private partnerships.** The arrangement allows both public and private players to bring their strengths to the table. In the case of FinDig, the government could provide public support for initiatives, beyond strategic direction and regulation, and in some cases, investment. On the other hand, the private sector could bring expertise, innovation, client focus, and the capability of making products commercially viable. Indeed, most retail CBDC projects are gravitating toward partnerships between central banks and commercial banks (Adrian 2020; Pande and Quách 2022).

Meanwhile, the private sector could either explore unchartered waters by leveraging on its strengths and improving existing service delivery, or participate in the rapid, scalable execution of government initiatives. BigTechs, for instance, use large amounts of customer data and advanced analytics to provide financial services and quickly expand as network effects drive interaction, user activity, and the generation of ever greater amounts of data (Adrian 2021a). Innovation in service execution and delivery is evident in ideas such as Banking as a Service—the provision of banking products and services through third-party distributors that are typically nonfinancial corporations. The arrangement is usually provided through the technology platforms of nonfinancial corporations and helps banks reach more customers at lower costs (Jones, Pardiwalla, and Zanichelli 2021). Lastly, the private sector could help drive the execution of government policies.[2/]

In ASEAN+3, diverse approaches have been taken in demarcating the roles and responsibilities of the public versus private sectors in the development of FinDig. AMRO staff's discussions with both groups suggest most participants agree that policy, regulation, and supervision should fall under the purview of the official sector, while the private sector is better equipped for innovation, customer engagement, and product delivery. Some interlocutors also note that the public sector should provide requisite infrastructure, encourage competition, evaluate risks in product offerings, and provide safety nets to consumers. More generally, discussants agree that the public sector should ensure a level playing field for all private sector participants, although interpretations vary as to what that would actually constitute. Although some participants agree with the "same risk, same regulation" principle, others urge that differences across business models should be considered.

[1/] For example, Singapore launched the SGQR initiative to combine multiple payment QR codes into a single SGQR label and thus simplify QR code-based mobile payments. The initiative tries to address the fragmentation of payment solutions by integrating 27 payment schemes, most of which are private sector initiatives.

[2/] For example, India's flagship government financial inclusion initiative Pradhan Mantri Jan Dhan Yojana was executed by the country's banks. It started with the provision of basic saving accounts to households that did not have them, but has expanded gradually toward providing digital financial products (Tiwari 2021).

The author of this box is Prashant Pande.

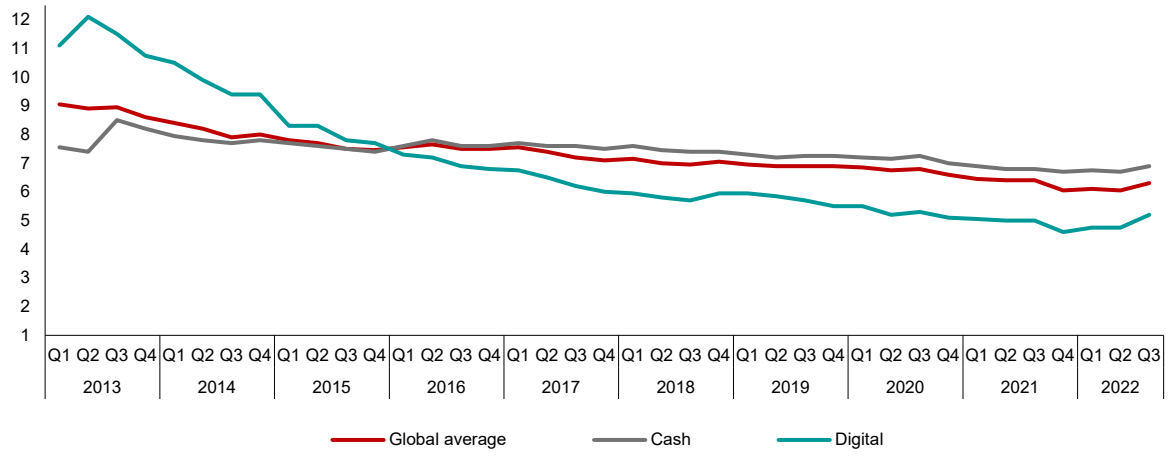
II. Opportunities of Financial Digitalization

13. **FinDig offers many benefits and opportunities for the ASEAN+3 region.** Innovations in money and payments are transforming the international monetary and financial system in positive ways. Advances in FinDig have enhanced the functioning of market infrastructures and payment systems, lowered transaction costs through greater competition, improved the speed of transactions, and broadened financial inclusion. The result is stronger economic growth through wider access to financial services, as heightened availability, transparency, and analyses of information enable the wider and more inclusive provision of financial services, while also facilitating risk management.

A. Efficiency and Costs

14. **The traditional cross-border payment system is expensive and inefficient.** Unlike domestic payments, where transactions are made directly between banks in a single national system, cross-border transactions have to navigate multiple entities under different regulations. Those that rely on the conventional Society of Worldwide Interbank Financial Telecommunication (SWIFT) network for cross-border payments continue to suffer pain points, traversing different time zones, currencies, tax regimes, regulations, fees, and charges. The result is that both consumers and businesses experience a lack of transparency and traceability, long settlement periods, high transaction costs, and limited accessibility (IMF 2022; Seeh 2021). Indeed, World Bank (2022) finds that banks remain the most expensive service providers and that overall international transfer costs are still high, estimated at more than 6 percent as of the third quarter of 2022 (Figure 4).

Figure 4. World: Costs of Sending $200 in Remittances
(Percent)



Source: World Bank (2022).

15. **The introduction and progressive acceptance of digital transfers have put downward pressure on remittance costs.** According to World Bank (2022), MoM is the least costly for sending and receiving remittances. FinDig has made cross-border business payments cheaper and faster by eschewing payment platforms on traditional bank networks (Bhattacharyya 2021) and using application programming interfaces (APIs) and internet connections instead. Specifically, advancements in distributed ledger technology (DLT) and DeFi have facilitated the movement of virtual assets through P2P transactions (BIS 2021). The lack of financial intermediaries reduces costs and increases the efficiency of cross-border transactions by reducing the length of payment chains. Consequently, individuals and

small businesses—entities that typically move smaller sums of money—are seeing the traditionally high costs of cross-border transactions come down.

16. **The unbundling and rebundling of traditional financial intermediation processes can significantly improve efficiency.** FinDig has the capacity to disaggregate financial intermediation (Figure 5), with new technology providers along the chain providing specialized yet cost-friendly services (Feyen and others 2021; IMF 2022). Conversely, some technology providers have forged innovative partnerships with different segments of the financial value chain to improve service delivery to end-users. These firms can position their services strategically toward segments that are unserved or underserved by large financial institutions, with automation or innovative solutions that offer efficiency gains and better customer experience, generally without compromising on risk management. The financial services sector and its customers stand to benefit from economies of scale by cooperating with these so-called disruptors, through use of the latter's services or through mergers and acquisitions, which can broaden customer bases and reduce intermediation costs (IMF 2022).

17. **Efficiency gains can also be achieved through other forms of technology that support the digital finance ecosystem.** Digitalized systems reduce dependence on legacy systems and yield significant cost savings for users, whereas transitioning by financial incumbents is usually slowed by high switching costs, security concerns, and regulatory compliance issues (OECD 2020). With FinDig:

- Machine learning algorithms and other sophisticated forms of data analysis are used by FinTechs (such as digital banks and BigTechs) and P2P lending firms to improve their product offerings to a wider range of customers in ASEAN+3. As an example, some lenders are able to use Big Data to process mortgage applications about 20 percent faster than other lenders without significantly higher defaults and are more flexible in adjusting supply in response to exogenous mortgage demand shocks (Fuster and others 2019).[5]

- Data analytics, automation, and regulatory technology may be able to save firms time and expense, especially in complex and costly know-your-customer (KYC) and anti-money laundering and combating the financing of terrorism (AML/CFT) compliance checks (FATF 2021b; Feyen and others 2021; WEF 2022), compared to how regulated financial firms traditionally handle such tasks. These solutions also find use in real-time transaction monitoring and faster reporting of suspicious submissions on specific transactions, which may help regulators take prompt action.

- Artificial intelligence—even though it cannot replace human interaction with clients—performs at higher accuracy, speed, and significantly lower costs (Ringe and Ruof 2018). The rise of robo-advisors in Asia-Pacific has been among the key applications of artificial intelligence (Gilmour and others 2019).

- Digital banks are able to provide better services at cheaper rates by eliminating the need for staff in certain operational areas (loan officers and tellers) and physical

[5] Some of these lenders may be unregulated and considered illegal in jurisdictions where they operate.

branches. Well-designed systems with proper APIs enable seamless information flow and verification, reducing costs and increasing the efficiency of administrative tasks.

18. **Central banks around the world have been exploring CBDCs to address challenges in cross-border transactions.** While many CBDC projects focus on domestic use cases, a survey of 50 central banks shows that more than a quarter are considering integrating interoperable features by forming multiple-CBDC (mCBDC) arrangements (Box 2). Their motivation is to minimize frictions in cross-border and cross-currency settlements (Auer and others 2021). Such arrangements would essentially allow CBDCs issued by multiple central banks to be used for cross-border payments.

19. **The development of CBDCs offer the potential for using smart contracts to enhance efficiency and reduce costs through automation.** Among ASEAN+3 initiatives, for example:

- Project Ubin (MAS and SGX 2018) and Project Stella (ECB and Bank of Japan 2018) have examined the use of DLTs and smart contracts in establishing delivery-versus-payment (DvP) systems for the settlement of tokenized assets. Project reports suggest that their application could reduce the settlement cycle to T+0, as transactions are completed within seconds.

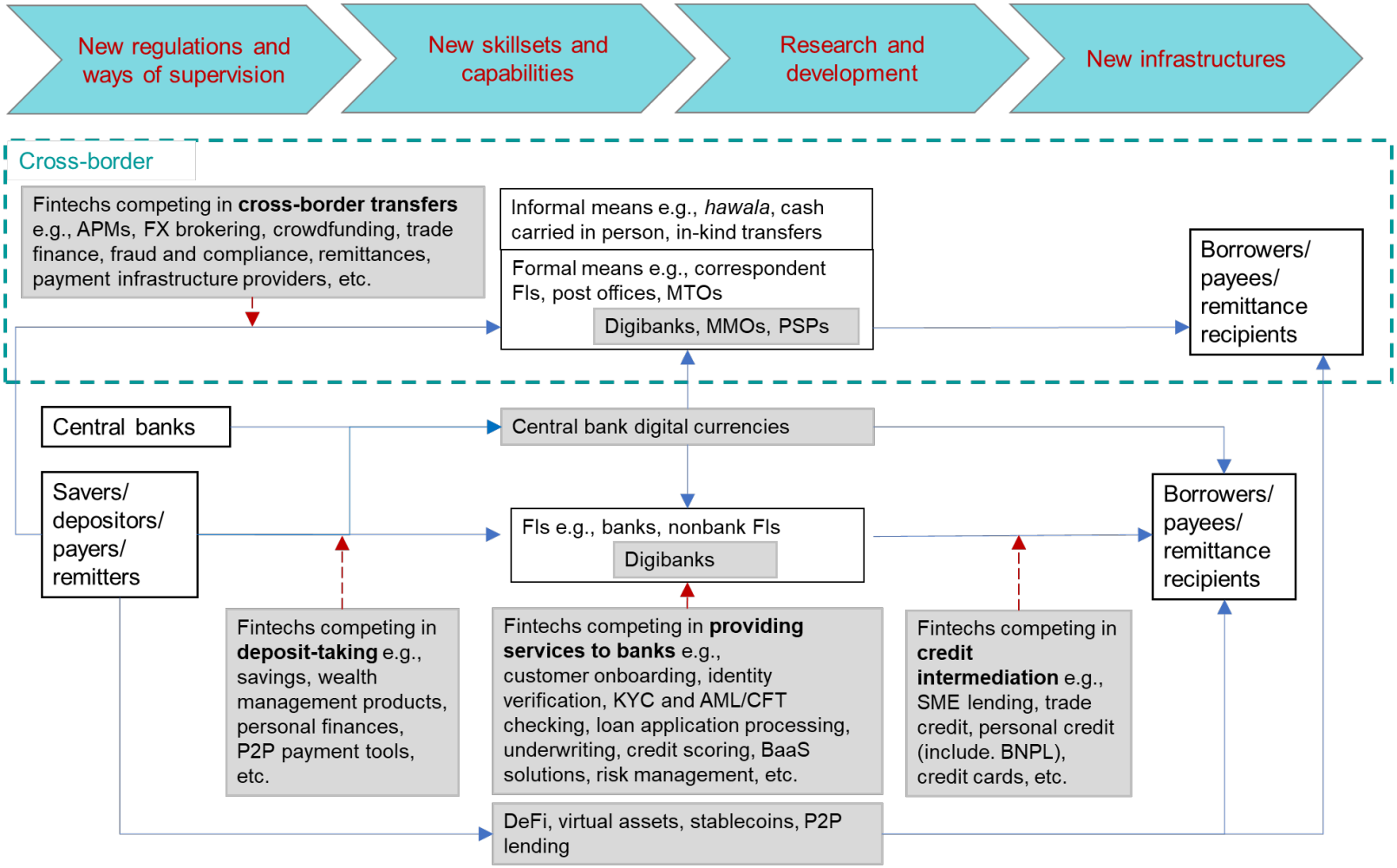
- Project Inthanon-LionRock between the Bank of Thailand and the Hong Kong Monetary Authority has examined the use of smart contracts in cross-border payments since 2019. With the BIS Innovation Hub Hong Kong Centre, the Digital Currency Institute of the People's Bank of China (PBC DCI), and the Central Bank of the United Arab Emirates joining in, the project has evolved and it has been renamed Project mCBDC Bridge, or "mBridge." Its phase 3 has used smart contracts to automate the settlement cycle and treasury operations, lowering operational costs and cutting transaction times from an average of three to five days to near real-time.

B. Competition and Complementarity

20. **FinDig involves opening up segments of the intermediation process, thereby injecting competitiveness into existing financial systems**. Increased competition between traditional banks and digital service providers is beneficial to the financial services sector, especially when disruptions emanate from direct competition for the same services. As noted, agile firms can provide innovative solutions and specialized services that spur efficiency and create a better customer experience, by inserting themselves into the financial intermediation chain at different stages (IMF 2022). In recent years, technology-based firms have moved into the cross-border transaction space.[6]

[6] For example, Singapore-based FinTech, Nium, has been able to overcome the challenges of traditional money transfer by offering instantaneous settlement and low costs for transactions and foreign exchange to compete with bank transfers. The opportunity has attracted other nonfinancial corporations, such as Grab, to the remittance market (Koh, Fernandez, and Cheah 2020).

Figure 5. Stylized Banking Intermediation Chain: Use of FinTech in FinDig



Sources: Casu and Wandhöfer (2018); IMF (2022); and AMRO staff visualization.
Note: Gray text boxes refer to the stages of intermediation process where FinTechs have participated/disrupted; red dotted arrows represent the stages of intermediation process; blue solid arrows represent the direction of money flow. AML/CFT = anti-money laundering/ combating the financing of terrorism, APM = alternative payment method, BaaS = Banking as a Service, BNPL = buy-now-pay-later, DeFi = decentralized finance, FI = financial intermediary, KYC = know-your-customer, MMO = mobile money operator, MTO = money transfer operator, P2P = peer-to-peer, PSP = payment service provider, SME = small-and-medium enterprise.

Box 2. Multiple Central Bank Digital Currency Arrangements in ASEAN+3

ASEAN+3 economies have been exploring arrangements for multiple central bank digital currency (mCBDC) and other CBDC solutions as a means of enabling efficient cross-border payments. Auer and others (2021) define three conceptual models: (1) enhancing compatibility between CBDC systems (model 1), (2) linking multiple CBDC systems (model 2), and (3) integrating multiple CBDCs into a single mCBDC system (model 3). Although many of the initiatives are in the exploration phase of understanding the use of new technologies, findings across different initiatives suggest the possibility of using distributed ledger technology (DLT) in cross-border transactions to reduce transaction fees and increase efficiency. However, given that most studies were done on a controlled scale with selective participants, any future large-scale implementation would require additional considerations, taking into account technology, execution, and regulation. There are several notable examples of such initiatives in the region:

- In 2018, the Monetary Authority of Singapore (MAS) published a joint report with the Bank of Canada and the Bank of England assessing alternative models in cross-border payments and settlements. The study uses the scenario of an existing payment and settlement with hypothetical improvements as the baseline (Bank of Canada, Bank of England, and MAS 2018). This baseline model is compared to a model with an expanded role for in-country real time gross settlement operators and three models using wholesale CBDC. In a subsequent project, the MAS worked with the Bank of Canada to develop a proof-of-concept that would allow atomic transactions of the Canadian dollar and Singapore dollar across two DLTs using smart contracts (Bank of Canada and Monetary Authority of Singapore 2019). The exercise demonstrates the possibility of a cross-border, cross-currency, cross-platform atomic transaction without the need for a trusted intermediary.

- In 2019, the Bank of Thailand and Hong Kong Monetary Authority studied, on a proof-of-concept basis, a corridor network between the two-CBDC system (model 3) on wholesale cross-border payments, through Project Inthanon-LionRock. A report published by both central banks finds that CBDCs could indeed enable real-time cross-border transactions, lower transaction costs, improve settlement and liquidity efficiencies, and ensure regulatory compliance without the need to go through layers of correspondent banks (Bank of Thailand and Hong Kong Monetary Authority 2020). The project entered the next phase, known as “mBridge,” in February 2021. Since then, mBridge has broadened its geography and currency coverage as well as use cases, with participation from the Digital Currency Institute of the People’s Bank of China and the Central Bank of the United Arab Emirates (BIS Innovation Hub Hong Kong Centre and others 2021). A trial implementation of the project was completed in September 2022. In the trial, 20 banks from the participating economies conducted over 160 payments and foreign exchange transactions, valued at more than $22 million—among the first mCBDC projects to settle real-value cross-border transactions (BIS Innovation Hub Hong Kong Centre and others 2022).

- In March 2022, the MAS and Bank Negara Malaysia with the BIS Innovation Hub, Reserve Bank of Australia, and South African Reserve Bank published the Project Dunbar report. The project aims to develop an experimental mCBDC platform to enable international settlements using CBDCs issued by the participating central banks. In this model, commercial banks can hold these CBDCs directly without the need for accounts with correspondent banks, and also transact directly with each other. The proposed platforms also facilitate direct cross-border transactions in different currencies between financial institutions and offer the potential to cut costs and increase speed. The project has also explored models for nonresident banks—participating commercial banks that do not have a presence in the local economy—to access the local CBDC (BIS Innovation Hub Singapore Centre and others 2022).

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21. **The entry of challengers could improve the quality of services, lower prices, and broaden access, while driving incumbents to compete more effectively.** Healthy doses of rivalry could push traditional banks to rejuvenate their information technology and digital systems, and innovate, either in-house or by acquiring inventive firms (Cecchetti and Schoenholtz 2021). A digital finance ecosystem that includes antitrust regulation, regulatory sandboxes, and platforms that allow comparisons of products and prices across providers

could facilitate equal treatment for new entrants and promote competition (Beck and Frame 2018; Appaya, Gradstein, and Haji Kanz 2020).

22. Several inherent attributes of a robust digital finance ecosystem could spur innovation throughout a community:

- First, the nimbleness and absence of legacy technologies enable digitally focused firms to operate efficiently and allow them to innovate faster than conventional entities (OECD 2020).

- Second, increased competition from the entry of technology firms tends to put pressure on incumbents to innovate and modernize their services, especially to tech-savvy consumers (Caragea and others 2022).

- Finally, complementarity between the two groups of entities could induce innovation among firms by reducing their financing constraints and providing opportunities to boost profitability. The effects appear to be pronounced in new firms, state-owned enterprises, non-leveraged, and listed firms (Li, Li, and Cheng 2021).

23. **ASEAN+3 could reap many benefits from incentivizing the financial sector to adopt new digital solutions.** In banking services, for example, some of the regional digital/virtual banks have grown quickly and are offering a broad range of services, including credit to small-and-medium enterprises (SMEs).[7] These new types of banks are able to scale up quickly by positioning themselves among a largely untapped—and previously ignored and underserved—customer base, and leveraging data while providing their services to evaluate risks.

24. **For some ASEAN economies, the opportunities from introducing digital banking are even greater.** Choi and others (2020) notes that the main reasons bank customers in ASEAN give for defecting from traditional operators toward digital challengers are the lack of personalized services (58 percent), expensive fees (45 percent), and unfavorable brand images (40 percent). According to Bain & Company, Google, and Temasek (2019), more than 70 percent of adults in the ASEAN-5 economies are either unbanked or underbanked, and SMEs in these economies—which contribute between 30–60 percent of GDP—must still deal with large funding gaps. In this context, a CBDC may be a low-cost public good that bridges access to finance for economic segments where competition has been lacking (Auer and others 2022).

C. Accountability and Transparency

25. **Digital assets, such as CBDCs, could increase accountability and transparency, both domestically and across borders.** In recent years, the private and public sectors have rolled out versions of digital assets. Digital assets enable the use of smart contracts in optimizing transaction processes, which could increase confidence in contractual obligations given that execution is built into the contract code—once the agreed conditions are met, transactions will be made automatically without any need for third-party involvement. Smart contracts could also be used to automate administrative and compliance processes, improving both transparency and efficiency. One potentially important use case

[7] Examples include WeBank (China), OneConnect Bank (Hong Kong), au Jibun Bank (Japan), KakaoBank (Korea), Tonik (the Philippines).

is government provision of services to citizens—known as government-to-citizen (G2C) services—where programmable digital currencies could be made available with conditions on the amount, purpose, or duration of use.

26. **The use of technology could also lead to greater traceability, building trust in certain products.** Adoption of a CBDC, besides boosting remittances, cross-border trade, and financial inclusion, could provide greater transparency around informal payments, wherein transactions recorded in immutable digital ledgers would be easier to track than cash (Appendix III). Embedding digitalization into government finance processes, such as electronic filing and payments, could also help to reduce incidences of fraud and improve tax collection (Kitsios, Jalles, and Verdier 2020). Separately, the use of stablecoin, if well governed, could improve accountability in aid and donations during humanitarian crises, given that it would be traceable (Grameen Foundation 2021).[8]

27. **Besides supporting better quality services, the large amounts of data generated by FinDig processes could improve transparency in financial transactions.** One area where use of personal data and information, with the consent of individuals, could contribute to financial stability and market integrity is the reduction in illicit financial activities. For example, DLT could be used to monitor AML/CFT activity through the ledger without needing intermediaries. The technology enhances transparency of transactions and ownership, among other benefits (Feyen and others 2021). DLT or blockchain could also be used for data storage to safeguard information from manipulation and, in jurisdictions where registries are still paper-based or on rudimentary computer systems, to deter corruption and protect property rights.[9]

28. **Big Data, a key feature of digital finance, could reduce information asymmetries by facilitating more effective and efficient assessments of customer creditworthiness.** Studies have evidenced the advantage of leveraging Big Data in predicting borrower default, such as using mobile phone call records (Björkegren and Grissen 2019) and data from e-commerce platforms (Frost and others 2019), as well as digital footprints (such as website visits), which may be as good as or better than credit bureau scores in screening borrowers (Berg and others 2020). Big Data could also be useful for InsurTech to more accurately assess underlying insurance risks—insurers could offer more customized products and services and, at the same time, strengthen risk management by excluding candidates with risky profiles (Beck 2021). The emergence of new technologies—which include Big Data—is among major trends disrupting cross-border payments, through improving efficiencies, supporting the development of new products and services, and mitigating fraud (JPMorgan 2021).

29. **In some cases, data and information amassed by lenders could even substitute for collateral in securing loans, leading to stronger trust between parties.** Loans could be approved almost immediately and provided to some firms and households without their

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[8] In June 2020, the Grameen Foundation, a global nonprofit organization based in Washington, DC, sent emergency cash support to microentrepreneurs in the Philippines. Amid difficulty in withdrawing cash during lockdowns, Grameen instead used Celo stablecoins to send almost $160,000 worth of financial aid to at least 730 microentrepreneurs (CBInsights 2022).

[9] As an example, Georgia's government decided to shift the land registry system to blockchain in 2016 in a bid to stem bribery (Shang and Price 2019).

posting collateral, if lenders were able to screen candidate borrowers using statistical models based on Big Data (OECD 2020). Higher quality information and greater transparency would lead to improvements in risk assessments and greater assurance, and so reduce the need for collateral.[10] With sufficient transparency between lenders and borrowers, insurers and insured, conventional intermediation might arguably not even be required (Gambacorta and others 2020). In other words, the adoption of digitalization in financial processes could reduce the burden of KYC compliance and asymmetric information for financial institutions, while also increasing transparency and accountability between counterparties.

D. Financial Inclusion and Growth

30. **FinDig aims to democratize access to financial services by unbanked populations.** Globally, about 1.7 billion adults (or a quarter of the world's population) remained unbanked as of end-2021;[11] that is, they do not use financial institutions and MoM providers in any capacity. Yet, an estimated two-thirds of them own mobile phones that could facilitate access to financial services (Demirgüç-Kunt and others 2018). In the ASEAN+3 region, more than half of the population is unbanked in six countries—Cambodia, Indonesia, Lao PDR, Myanmar, Philippines, and Vietnam (Table 1). However, with high internet penetration rates, the region would be able to leverage the huge potential of FinDig to extend financial services to populations spread over large areas. For example, the Philippines has targeted half of all transactions to be digital and 70 percent of the adult population to have bank accounts by 2023 (Bangko Sentral ng Pilipinas 2021).

31. **FinDig expands financial inclusion by empowering developing economies to modernize their financial services**. Its potential includes opening up access to finance at lower costs, deepening funding markets, using Big Data to assess risks, and encouraging new types and forms of businesses (IMF 2018b). As discussed, participation of BigTech firms has generated greater customer information and insights about the market for financial services. The use of massive troves of data has enabled lenders to extend financing and other services to individuals and SMEs with no or limited credit record, and so promoted financial inclusion (Feyen and others 2021).

32. **Digital innovations could directly impact efficiency and capital allocation within the financial sector, where savings and investment are intermediated, and in turn benefit growth.** Financial inclusion could be widened by extending financial services to low-income and unbanked segments of the population, and SMEs that at present are unserved or underserved by financial incumbents (OECD 2020). Indeed, as many as 68 percent of SMEs in ASEAN have not been able to secure sufficient, if any, financing on at least one occasion or more in the past five years, and many have instead turned to challenger banks (Thompson 2022). The expansion of access to financial services through digitalization could

[10] For example, MYbank—China's first digital bank, and part of the Ant Financial Services Group—enables borrowers to apply for loans online within three minutes and receive approval almost instantly without any human involvement, through its MYbank 310 lending app. With consent from its SME borrowers, MYbank leverages massive, real-time transactions data and artificial intelligence technology to gain insights into creditworthiness and manage risks. The lender has helped ease the credit bottleneck to small businesses in China—over four years of operation since 2018, it has lent about $290 billion (CNY 2 trillion) to nearly 16 million small firms that lenders previously shunned, with a default rate of 1 percent (Bloomberg News 2019).

[11] The World Bank's Global Findex data.

also boost and smooth consumption over the long term and alleviate poverty in the process.[12]

Table 1. ASEAN+3: Unbanked Population by Economy
(Ranking)

Regional Ranking	Economy	Total Population (Millions)	Unbanked Population (Percent)	Cash Transactions (Percent)	Card Transactions (Percent)	Number of ATMs per 100,000 Adults	Internet Penetration (Percent)
1	Vietnam	97.5	69.2	26	35	27.1	86.0
2	Cambodia	16.4	66.6	–	–	31.6	81.1
3	Lao PDR	7.3	62.7	–	–	28.1	57.5
4	Myanmar	53.8	52.2	–	–	6.9	51.9
5	Philippines	110.2	48.6	37	22	29.4	91.0
6	Indonesia	272.3	48.2	13	34	48.1	76.3
7	Malaysia	32.6	11.6	11	32	54.3	93.8
8	China	1,412.6	11.3	6	22	81.4	69.8
9	Thailand	71.6	4.4	16	26	108.1	88.3
10	Singapore	5.5	2.5	4	75	54.3	92.0
11	Hong Kong	7.4	2.2	2	73	51.2	92.0
12	Japan	125.5	1.5	6	68	116.9	93.3
13	Korea	51.7	1.3	2	73	259.5	97.0
–	Brunei	0.4	–	–	–	73.1	119.7

Sources: National authorities; Internet World Statistics; Merchant Machine; and World Bank.
Note: Cells with "–" denote no data. All data are as of 2021 except the following due to data unavailability at sources: statistics on unbanked population for Vietnam are as of 2017; statistics on number of ATMs per 100,000 adults for Korea are as of 2020, and for Myanmar are as of 2019; statistics on internet penetration are estimated by Internet World Statistics and are as of July 2022.

33. **Progress in financial provision could generate more dividends for growth than digital advancements in other economic sectors.** Tok and Heng (2022) finds that emerging market economies that have been advancing digitalization in financial services (for example, China, India, and Kenya) have seen significant improvement in financial inclusion.[13] Their results also suggest that a greater degree of digitalization in financial services is significantly associated with a narrowing of the income gap and urban-rural divide. For economies coping with population aging, the productivity gains could offset the drag from a declining labor force over time.

[12] In China, payment solutions, such as Alibaba's Alipay and Tencent's WeChat Pay have accumulated about 1 billion customers each in under 10 years. BigTech payment services account for 16 percent of China's GDP, while third-party mobile payment transactions are estimated to have grown by 15 times from 2015–18. In Kenya, M-Pesa, which was launched in 2007 by Vodafone and Safaricom, enables mobile telephone users to settle low-value transactions without a bank account. The volume of mobile money transactions through M-Pesa tripled in less than seven years, and accounts for more than half of the country's GDP (Coeuré 2019). Kenya's total factor productivity is estimated to have grown by 3.4 percent from 2006–13, while real capita income grew by 14.0 percent over the same period (Beck and others 2015). More than 51 million customers across seven countries in Africa now use M-Pesa to remit and receive money, pay bills, receive wages, apply for short-term loans, and much more.

[13] In Tok and Heng (2022), the authors use the World Bank's Global Findex data and novel digital financial access indicators that include various financial access proxies such as the Digital Financial Inclusion Index (Sahay and others 2020), the Fletcher School's Digital Intelligence Index, and the World Bank's Digital Adoption Index.

34. **The extent to which each ASEAN+3 economy and its industries could benefit from worldwide FinDig appears to vary greatly.** Applying the AMRO Global Macro-Financial Model (AGMFM) (Appendix IV), AMRO staff's estimates suggest that:

- Prior to the COVID-19 pandemic in 2020, global FinDig could have contributed as much as 2.1 percent to annual real GDP for Korea, down to a more marginal 0.2 percent for Myanmar (Figure 6). The outlook is even more encouraging post pandemic, all else equal, with economies benefiting from the "shift to digital" that occurred during the pandemic. Thailand, Hong Kong, Korea, Singapore, and Malaysia appear to have led the region in terms of possible contributions from FinDig to annual real GDP, by between 2.1 percent and 3.3 percent post-pandemic, while those whose FinDig ecosystems are at nascent stages—Brunei Darussalam, Cambodia, Lao PDR, Myanmar, Vietnam—are also projected to benefit, with annual real GDP contributions of between 0.5 percent and 1.0 percent.

- The positive impact on the real GDP of most economies would mainly come from domestic FinDig, followed by positive spillover effects from FinDig in most economies of the region. In contrast, Cambodia, Lao PDR, Myanmar, the Philippines, and Vietnam would gain most from regional FinDig. FinDig in the rest of the world would also contribute to the region's growth, although only by a small amount.

- Across the region, labor influx would be the biggest factor driving the impact of FinDig on real GDP; private capital investment would be the next most important factor; while public investment would contribute the least.

- Within each of the region's economies, FinDig-related factors would have had the biggest impact on their respective electronics industries pre-pandemic, contributing an estimated 0.7 percent to 5.1 percent to their annual real output; Brunei and Japan are the exceptions, with their telecommunications industries benefitting most from worldwide FinDig relative to other industries (Figure 7). With the pandemic receding, Thailand's electronics sector, along with China, Hong Kong, Malaysia, Singapore, and Vietnam are projected to benefit most, by between 4.0 percent and 9.1 percent. In most cases, FinDig in the domestic economy or the positive spillover effects from FinDig in the rest of the ASEAN+3 region would be the main driver of growth.

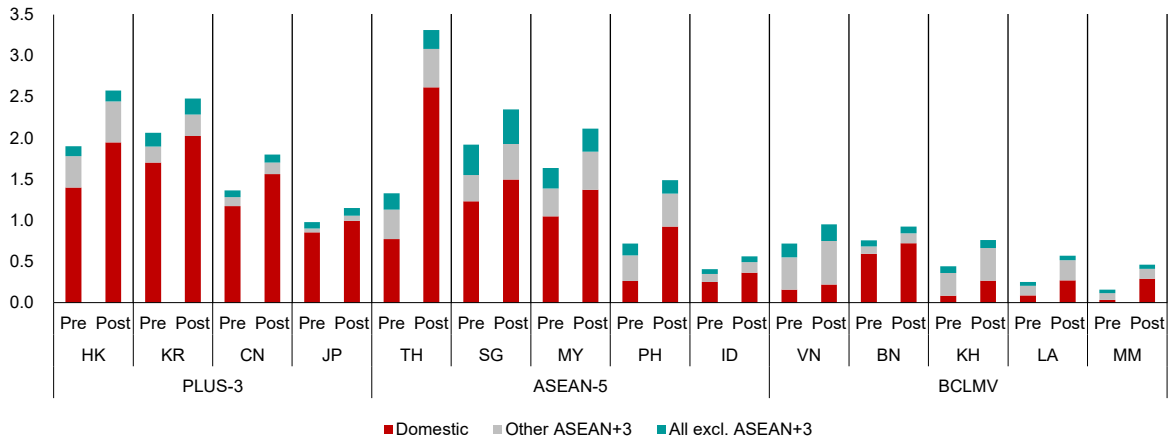
35. **FinDig and changes in consumer demographics and behavior have also driven service providers to become more customer centric**. The digitalization of finance and commerce, combined with the real-time capability of internet-based devices, has made financial services faster to provide, more convenient, and easier to access, resulting in heightened customer expectations. Perceptions by the younger generations—such as Millennials and Generation Z (Gen Z),[14] who are more receptive toward digital products and services, also play an important role (OECD 2020).[15] Also, some consumers consider digital credit platforms to be more socially responsible than conventional banking, given that the former tend to serve low-income populations and SMEs (He and others 2017; FSB 2019).

[14] The Pew Research Center defines Millennials as those born between 1981–96 and Generation Z (Gen Z) as those born between 1997–2012.

[15] According to Chase (2021), 98 percent of Millennials and 99 percent of Gen Z use mobile banking apps for a wide range of tasks, including viewing account balances, checking their credit scores, and depositing checks; less so Gen X and Boomers, at 86.5 percent and 69.5 percent, respectively.

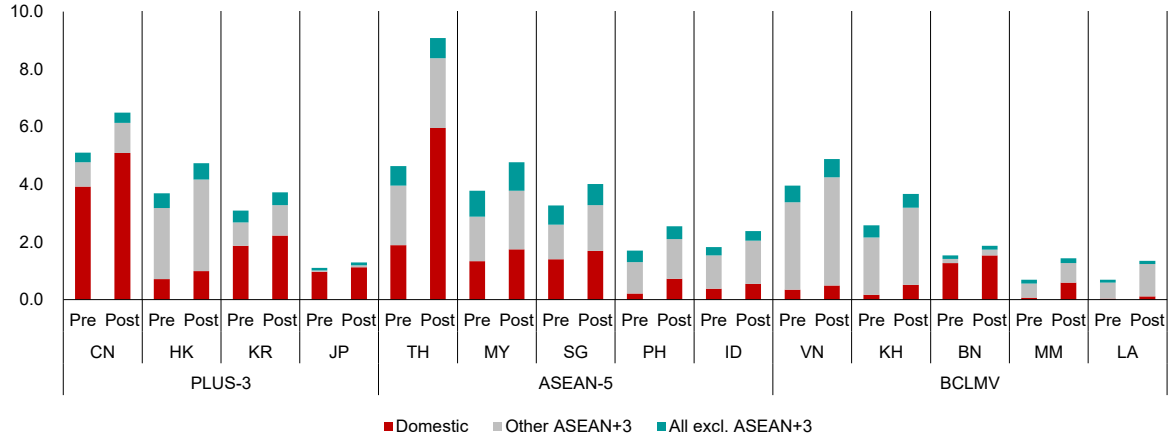
36. **Encouragingly, positive spillover effects from FinDig could be more pronounced in Asia than in other regions.** Asia's large young generation of users, with their digital savviness and high levels of internet usage, could accelerate FinDig strategies in the region with relative ease. Seo and Yoo (2020) finds that the expansion of internet and mobile usage is related to the reduction in poverty rates and income inequality. The authors also observe that the introduction of digital inclusive finance in the region could be effective in lowering the digital divide between various population groups, such as urban and rural areas, for young and old, low and high incomes, and men and women.

Figure 6. ASEAN+3: Impact of All Global FinDig-related Driving Factors on Real GDP, Pre- and Post-Pandemic, by Economy
(Percent, annual average over the following 12 quarters pre- and post-pandemic)



Sources: OECD; Wind; World Bank; and AMRO staff estimates.
Note: Pre = Pre-pandemic, from end-2017 to end-2020, Post = Post-pandemic, from end-2021 to end-2024. BN = Brunei, KH = Cambodia, CN = China, HK = Hong Kong, ID = Indonesia, JP = Japan, KR = Korea, LA = Lao PDR, MY = Malaysia, MM = Myanmar, PH = Philippines, SG = Singapore, TH = Thailand, VN = Vietnam.

Figure 7. ASEAN+3: Impact of Global FinDig-related Driving Factors on the Real Output of the Biggest Beneficiary Industry, Pre- and Post-Pandemic, by Economy
(Percent, annual average over the following 12 quarters pre- and post-pandemic)



Sources: OECD; Wind; World Bank; and AMRO staff estimates.
Note: Pre = Pre-pandemic, from end-2017 to end-2020, Post = Post-pandemic, from end-2021 to end-2024. The telecommunications industry is the biggest beneficiary for Brunei and Japan; the electronics industry is the most advantaged in the rest of the ASEAN+3 economies. BN = Brunei, KH = Cambodia, CN = China, HK = Hong Kong, ID = Indonesia, JP = Japan, KR = Korea, LA = Lao PDR, MY = Malaysia, MM = Myanmar, PH = Philippines, SG = Singapore, TH = Thailand, VN = Vietnam.

III. Challenges of Financial Digitalization

37. **Digital innovation in the financial sector also carries risks for financial stability.** The growing share of unrecorded cross-border digital transactions could increasingly affect the ability of authorities to monitor and manage capital flows. The consequences could be significant for a country's exchange rate and foreign exchange reserves, especially given the potential speed of spillovers and contagion from developments in digital asset markets. The presence of unrecorded transactions and unregulated entities in the digital space could also be exploited for illegal transactions, such as money laundering, bypassing international sanctions, and the financing of terrorism. FinDig also has potential to reduce the overall efficiency of the international financial system if it leads to widespread fragmentation of processes, problems with interoperability, and/or gives rise to dominant players and products that challenge monetary sovereignty.

38. **Within ASEAN+3, user habits and infrastructure limitations have affected the development of FinDig.** AMRO staff discussions with authorities and private sector participants suggest that customer preferences are central in any resistance to the uptake of FinDig initiatives. Factors that have been difficult to overcome include weak digital finance awareness and literacy, the continuing desire to receive and spend physical cash, socially engineered frauds, and a lack of trust in digital services. Several economies in the region are also confronted by shortcomings in electronic know-your-customer (e-KYC), dispute resolution mechanisms for digital payments, and internet connectivity. They are also vulnerable to power shortages and geographical peculiarities (for example, archipelagos, mountainous terrain). Many interlocutors also see gaps in personal data protection systems and cyber security—which expose users of digital platforms to the theft of digital identity information—as important barriers to progress.

A. Balance of Payments

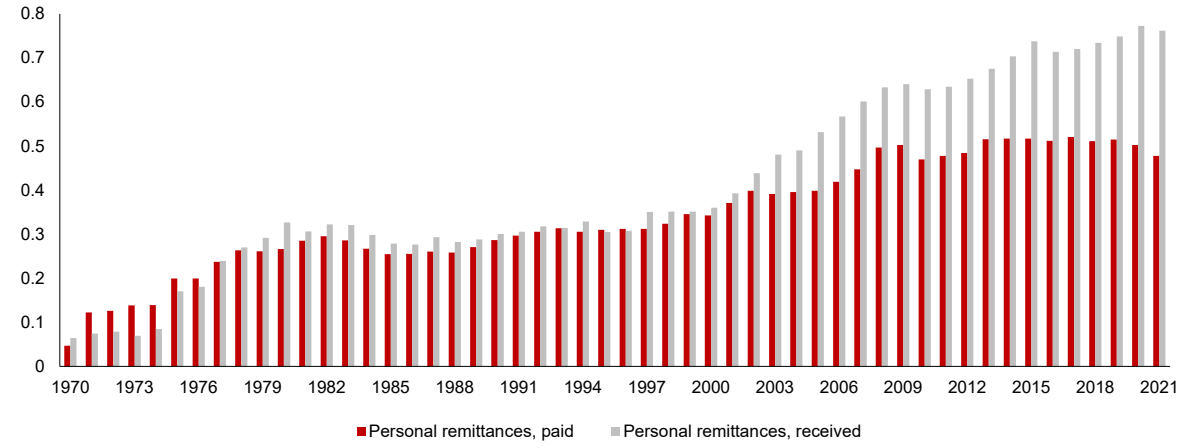
Capital Flow Measurement

39. **Standard methods for capturing cross-border payments in balance of payments (BoP) figures may not include some that use digital technology.** The outcome could be particularly important in accounting for international remittances, which already are difficult to measure in the BoP, as large recorded global discrepancies between receipts and payments would suggest (Figure 8). As it is, information on cross-border migrant remittances through informal channels—notably, physical cash and through unregistered agents—are hard for authorities to collect (IMF 2018a). New digital channels, including MoM, online platforms, and virtual assets, may exacerbate the long-standing gaps in source data for estimating remittances. Common data sources typically comprise reports on cross-border transactions from banks and money transfer operators (for example, Western Union, Money Gram), and household surveys. Although digital cross-border payments are still relatively small as a share of remittances, strong growth in new payment methods may increase the distortions in BoP statistics in just a few years.

40. **Hence, the development of cross-border services and payments using digital platforms could pose major measurement challenges for external sector statistics.** In this regard, IMF (2018a) recommends that statistical agencies should: (1) update assumptions concerning small transactions facilitated by digital ordering and delivery of services, (2) improve collection of information on cross-border services provided by or

through online platforms, and (3) develop methods for estimating international payments made through new kinds of digital channels.

Figure 8. World: Remittance Receipts and Payments
(Percent of GDP)



Source: World Bank.

41. **International MoM transfers represent a salient example of cross-border payments that may not be appropriately accounted for by existing BoP procedures.** International remittances via phone account payment systems—and corresponding cross-border flows—are sizable and growing (Kahn, Singh, and Alwazir 2022). However, these transactions would only be recorded if they passed through banks partnered with mobile money operators (MMOs), and not if made directly by those operators (IMF 2018a). Consequently, both international organizations and national authorities are taking steps to develop the recording of cross-border MoM (Appendix V).[16]

42. **Potential data sources have been identified to support the compilation of BoP statistics in countries where cross-border transactions involving MoM are particularly important.** First, dedicated surveys of telecommunications firms that have developed and marketed MoM could be a key source. Data on revenues received from nonresident telecommunications firms arising from inward MoM transfers from nonresidents to residents could also be collected from this source. The second source would be the resident "integration technical partner," which provides a host of real-time services and which telecommunications service providers typically use to facilitate the seamless operation of cross-border transactions (OECD, WTO, and IMF 2020). A third possibility is the International Transaction Reporting System,[17] provided that it is sufficiently well developed to enable the collection of such information.[18]

[16] As an example, MoM transfers are included in the Philippines' existing BoP accounting method, but challenges in recording remain—such as proper classification of specific transactions (whether they are transactions under telecommunications service or cash remittances).

[17] The International Transaction Reporting System is a system for collecting data on individual international settlements and/or transactions as reported by banks, enterprises and/or households.

[18] A member central bank observed that under an appropriate regulatory environment, the extrapolation of information from relevant sources could rapidly and cost-effectively close gaps in digital cross-border payment-related data in national accounts and in BoP statistics.

43. **Access to data in a payment system is determined by its policy and technical design.** A retail CBDC, for example, could operate like physical cash, which is private to all parties except the payee, who sees payer identity in many cases. At the retail point, payment service providers (PSPs) can access user data for transaction verification, authorization, and settlement. They would also need customer identification information and records of transactions for AML/CFT. PSPs may be required to submit transaction data to the central bank and other regulatory authorities through asynchronous transmission on a timely basis.

44. **The biggest challenge is the collection of data on virtual asset transactions and positions.** This exercise would require extensive international cooperation, given that these assets are traded P2P globally. Most virtual asset service providers (VASPs) are required to collect information on account holders, although standards vary greatly across countries. VASPs intermediate P2P trades only to the extent that they clear the internal transfer of claims on the exchange to virtual assets after payment by fiat money has been confirmed. This process allows VASPs to operate outside the financial regulatory framework in most countries, answering only to their home base regulators and potentially putting the tracking of transactions beyond the reach of national authorities (Graf von Luckner, Reinhart, and Rogoff 2021).

45. **Data collection from VASPs and wallet providers could be the most efficient and accurate way to track transactions and holdings.** Jurisdictions in which these VASPs and wallet providers are located should collect information on the country of residence of the counterparts in transactions (from wallet providers) and on positions in distinct types of virtual assets (from VASPs). Such information should ideally be provided to compilers in the respective countries through an international exchange (IMF 2018a). A common guideline relating to data collection from VASPs is the Crypto-Asset Reporting Framework and Amendments to the Common Reporting Standard (CARF) (OECD 2022). Data collected by VASPs may be made available in some cases, based on Financial Action Task Force (FATF) Recommendation 16, commonly known as the "Travel Rule" (Box 3).

46. **The presence of VASPs that are not regulated by domestic laws poses a greater challenge.** AMRO staff discussions with counterparts suggest that tools are available for regulators to collect transaction and position data on virtual assets for such transactions, but most of them lack interoperability and, in many cases, are prohibitively expensive. Regulators could also consider monitoring transfers from regulated financial entities to unregulated VASPs to capture suspicious transactions and construct a proxy for capital flows. However, classifying virtual asset flows under appropriate BoP categories may still be difficult—collecting data from the user about the purpose of any transfer may adversely impact user experience and privacy, and hence make users reluctant to provide such information. For general transaction analysis purposes, the data may not be completely reliable given that there is no information on the flows that cross borders.

Box 3. The FATF Travel Rule

The Travel Rule of the Financial Action Task Force (FATF) requires originator virtual asset service providers (VASPs) to obtain "required and accurate originator information and required beneficiary information" to share with beneficiary VASPs or financial institutions. Regulated VASPs make data available to relevant authorities. However, collection is typically limited to anti-money laundering/combating the

financing of terrorism (AML/CFT) objectives, notably, to facilitate monitoring of transactions to identify any evasion of sanctions using virtual assets.

AMRO staff discussions with market participants and regulators suggest that information from regulated VASPs may also be useful for taxation purposes and to obtain insights into the growth of virtual assets in the economy. In this context, a more useful source of information may be the OECD's Crypto-Asset Reporting Framework, which provides for the standardized reporting of tax information on transactions in virtual assets, with the view of facilitating information exchange between jurisdictions. That said, a common problem is the widespread use of unregulated-VASPs, whose size and other requisite information are not readily available to regulators.

The implementation of the Travel Rule within the regulatory framework of individual jurisdictions could be burdensome for VASPs. Some of the issues include: (1) non-uniformity across jurisdictions in the local implementation of the Travel Rule, resulting in miscommunication between VASPs (Sergeenkov 2022), (2) lack of interoperability between VASP communication systems to exchange transaction details, (3) data privacy and cyber security risks associated with transmitting users' information, and (4) counterparty identification that incurs additional layers of complexity and costs for VASPs (Reynolds 2020; Sergeenkov 2022).

VASPs are reportedly responding to these challenges by adopting specialized compliance solutions provided by RegTechs. These solutions facilitate the secure transfer and collection of encrypted data, through the use of a standardized data messaging format—the interVASP Messaging Standard (IVMS) 101—which has gained broad acceptance across the industry as the preferred protocol for Travel Rule compliance (Garver 2022; Sergeenkov 2022).

The author of this box is Hoang Nam Nguyen.

Capital Flow Management

47. **The use of digital assets could increase the volume and volatility of gross capital flows.** International capital markets could become more integrated as platform-based financial services reduce access costs and frictions and offer more risk-sharing opportunities. This development could enable the hedging of exposures but could also intensify spillover risks among increasingly integrated financial systems. Large gross international asset and liability positions imply greater valuation effects caused by changing asset prices or exchange rate fluctuations, especially for highly volatile assets—in this case, virtual assets—and could act as a channel through which financial crises are spread and amplified (Obstfeld 2012). Moreover, capital flow volatility could increase if the herd instinct among less-informed investors were to materialize (IMF 2021c).

48. **Greater capital flow volatility from increased trading in virtual assets could affect a country's exchange rate and foreign exchange reserves.** Over the 24/7 trading period of virtual asset markets, demand and supply for conversions could easily become unbalanced.[19] To clear effectively, some market makers must provide liquidity by trading more liquid pairs (for example, USD–Bitcoin and USD–local currency) to determine the price of the less liquid pair (local currency–Bitcoin). This type of triangular arbitrage is usually facilitated by institutional participants with access to larger liquidity pools (for example, offshore funding markets) and excludes domestic retail participants. In periods when

[19] The 24/7 nature of virtual asset markets could create regular pockets of low liquidity during periods when participants pull out of the market (for example, during weekends or holidays). Their mismatch with the standard business hours of many institutions, including banks, contributes to this friction. With banks closed on weekends, market participants may have trouble getting money into their VASP accounts, potentially exacerbating market liquidity problems (Beck 2021; Genç 2022).

domestic demand for virtual assets increases substantially, institutions could act as gateways for capital outflows through the conversion of virtual assets in the foreign exchange market (IMF 2021a).

49. **Consequently, small, open economies may seek to introduce or increase capital flow management measures (CFMs) to limit or offset such volatility.** However, they are unlikely to be completely successful in controlling any impact on the foreign exchange market. Measures could be implemented to isolate any effect by creating market segmentation (Makarov and Schoar 2020)—for example, premia for Bitcoin purchases in Korea were as high as 50 percent in 2018 due to strong domestic demand, and the restrictions in place were able defend against arbitrage activity. Such limitations on virtual asset trading may trigger new leakages as trading moves away from exchanges and over to P2P (for example, Binance or Remitano) and other less formal or visible channels (for example, Telegram, Discord, Twitter, or Facebook, depending on the geographic area).

50. **Existing CFMs could be circumvented by evolving digital forms of payments if design or regulation does not preclude this possibility.** New payment instruments and service providers may render existing mechanisms of transaction verification ineffective, especially if digital money is transmitted on platforms that are not covered by national CFMs. Existing regulations and implementation practices will need to be continually calibrated so that CFMs remain robust to evolving technologies. However, as noted in IMF (2021c), guidance in this area is missing entirely. On the other hand, Popescu (2022) observes that some of the technologies could be applied to enforce exchange and capital control regulations (for example, RegTech and SupTech).

51. **Indeed, the evasion of CFMs has been an important driver for the expansion of virtual asset markets.** According to (Yeung 2020), a common scheme to bypass CFMs involves: (1) using local fiat money to buy virtual assets from an exchange platform in country A, (2) transferring the virtual assets through blockchain to an exchange platform in country B, and (3) selling the virtual assets in country B for the local fiat currency. Although Bitcoin was previously the preferred choice for such transactions, stablecoins (such as the US dollar-linked Tether) became a popular alternative because of their—at the time—volatility-free/stable market values (Zhao 2021). Notwithstanding the anecdotal evidence, little was known—back then—about the scale of virtual asset-facilitated capital flight, its characteristics, and how to identify or measure it (Hu, Lee, and Putniņš 2021).

52. **The migration of virtual asset "mining" activity could also have important implications for capital flows.** Following a crackdown in China in early 2021, such activity started to shift to other parts of the world, including emerging and developing economies and the United States (Sigalos 2021). Mining revenues could be used to circumvent capital flow restrictions, given that miners' main operating costs (such as electricity) are normally paid domestically in local currency but their revenues are paid on-chain in virtual assets (IMF 2021a).[20]

53. **Hence, the design of CFMs needs to be reconsidered in a digital world.** Applying established regulatory tools to manage capital flows becomes more challenging when value is transmitted through new platforms that may not be bound by existing CFMs. Because of the way private entities organize or relocate their activities, the effectiveness of regulation,

[20] On-chain transactions are recorded and verified on a blockchain; off-chain transactions take place on a specific platform (for example, a VASP) and not on the blockchain.

supervision, and enforcement of CFMs faces challenges at jurisdictional levels, and cross-border collaboration and cooperation are crucial. For example, "host" authorities where stablecoins are in widely use should be encouraged to establish close coordination mechanisms with the "home" regulator in countries where stablecoin reserves are managed (IMF 2021a).

54. **CBDC adoption has potential to change the manner in which CFMs are implemented.** The increased efficiency and speed of CBDC transactions could result in increased volumes of cross-border transactions, which could be a challenge for traditional CFMs. For example, certain conventional measures, such as restricting the amount of money that private citizens are allowed to bring across the border, could be neutralized with the wide use of CBDCs, given that customs officials may not have the required expertise and training to supervise digital wallets adequately (Chen and Tsang 2021). The global advent of CBDC signals a possible revolution in the way cross-border capital flows would be measured and monitored (Box 4). In this regard, CBDC issuers could design features that facilitate regulatory compliance and make the case for international cooperation in this area.

Box 4. CBDCs and Capital Flow Management

Certain aspects of a central bank digital currency (CBDC) could have implications for the design of capital flow management measures (CFMs) by the issuing country. IMF (2021b) highlights the following considerations:

- **The effective identification of CBDC users is crucial to the design of CFMs.** If the CBDC design foresees some form of identification of users, allowing nonresidents to use it becomes a policy choice. For example, the issuing central bank could decide to grant access to CBDC-based wallets to residents only. Alternatively, the central bank could set conditions under which nonresidents can access their wallets. Another approach being considered, among others, by the People's Bank of China's (PBC's) e-CNY project is to link CBDC use to particular locations; that is, allow nonresidents to use a CBDC if those nonresidents (such as tourists or business travelers) are physically located within the issuing jurisdiction.

- **CFMs are likely to differ between wholesale and retail CBDCs, although dependent on the design of those CBDCs.** Under a wholesale CBDC arrangement, any application of CFMs is likely to fit more readily within the existing cross-border payments framework. Retail transactions would be aggregated and sent to regulated financial institutions, which would then authorize the cross-border payment through a CBDC. Consequently, CFMs would need to be imposed on a smaller number of larger transactions. In the case of a retail CBDC, which the public could directly transfer across borders, a much greater number of small, individual transactions would be involved. This departure from the existing international payments framework would put pressure on authorities' ability to supervise the implementation of CFMs.

- **The design of CBDCs and innovative technologies could help make the implementation of CFMs more effective, at least compared to cash.** CBDCs could be devised by issuing central banks to preclude or limit their use outside the issuing countries, or wallets in recipient countries could be designed to allow local authorities to implement certain CFMs. Moreover, the programmability of CBDCs offers the possibility of monitoring their use in real time, which could improve the effectiveness of CFMs.

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B. Currency Substitution

55. **Although other major currencies have struggled to displace the US dollar in the international monetary system, private digital money could eventually mount a stronger challenge.** Besides offering the improved efficiency and cost effectiveness of cross-border payments, digital money could eventually be seen as a stable store of value, leading to currency substitution in some countries. Those economies with questionable macroeconomic fundamentals and weak policy institutions and frameworks—where high inflation and volatile exchange rates weaken the value of the domestic currency—are most vulnerable to the crowding out of their domestic currencies by digital money which, in turn, could worsen exposures to currency mismatches (IMF 2020).

56. **Emphasis on digital connectedness could also lead to the establishment of digital currency areas that transcend national borders.** Those currencies would be linked to particular digital networks rather than to specific countries (Brunnermeier, James, and Landau 2021). Even in countries with sound fundamentals and credible policy institutions—especially smaller, more open economies—the rapid internationalization of digital assets may encourage their use in cross-border payments and settlements, and reinforce network effects with bigger partners (MAS 2021b).

57. **Widespread use of digital assets could erode the effectiveness of a country's monetary policy.** Conventionally, monetary authorities are able to influence domestic economic activity by affecting the rates at which banks can borrow and lend, through open market operations, setting reserve requirements and/or the discount window rate. However, the diminished role of banks with the increasing popularity of digital platform-based assets, could reduce monetary authorities' control over domestic financial conditions as a result of weakened transmission channels to domestic liquidity and aggregate demand (Adrian 2021b; Edwards 2021). The economy might instead be led by the business cycle of the foreign country issuing the CBDC or of the private firm issuing a virtual asset, either of which could be inconsistent with existing domestic conditions.

58. **Foreign digital payment systems could pose higher risks of digital currency substitution.** Digital payment systems, such as those offered by BigTech and in future the retail CBDCs of major economies, could impede the adoption of domestic forms of digital payments in smaller economies. Digital currency substitution risks emerge if international travelers and trading partners in major economies prefer to settle payments using their local payment systems, potentially affecting monetary policy and capital flow management by destination central banks. ASEAN+3 authorities are aware of this threat and have mandated domestic merchants to settle payments in local currency. Some authorities have also imposed licensing requirements to restrict the use of foreign payment services.

59. **To address the possible threat of currency substitution by foreign CBDCs and private digital currencies, the region's central banks are either experimenting with or studying how they would issue their own CBDCs, in part to protect monetary sovereignty.** Although retail CBDC projects are focused on domestic usage, the interoperability of CBDCs is equally important for international transactions as more countries adopt them (CPMI and others 2021). Central banks are also considering appropriate technology solutions such as mCBDC arrangements to simultaneously convert foreign CBDCs into the respective local currencies. Indeed, such arrangements have already been implemented through e-wallets and cross-border QR linkages that allow international

transactions to be settled in local currencies.[21] Ironically, while cross-border use of CBDCs may reduce frictions for existing cross-border payments and the resultant lower costs could make the CBDCs of established currencies more attractive, it could also contribute to the wider spread of currency substitution in some countries.

60. **Importantly, CBDC issuer central banks would need to consider the impact of volatile capital flows.** The extent to which inflows may be destabilizing could depend on the ability of destination financial markets to absorb those flows (Popescu 2022), and the sophistication of policies and policy making to prevent overheating or bubbles in asset markets. Issuer central banks would need to take account of the potential effects on their own monetary policies and financial stability objectives—swings in external demand for the currency could drive large movements in capital flows, leading to sterilization operations, and potential fluctuations in market liquidity and asset prices (IMF 2020). CBDC issuers may also need to consider ways of providing liquidity assistance to foreign counterparts or financial institutions when their CBDCs achieve significant penetration. CBDCs that are perceived to be safest could also attract deposits from commercial banks, with negative implications for bank lending and, consequently, for economic growth.

61. **For foreign exchange reserve holders, greater currency substitution—regardless of CBDC or virtual assets—could require these central banks to increase their reserves for precautionary reasons.** IMF (2020) observes that increased use of foreign digital currencies in trade and finance, especially if combined with greater exposure of financial institutions to exchange rate volatility, could shift reserves into the unit of account of those digital currencies. For the reserve issuers, supply incentives may vary—if internationalization is a policy objective, then they may attempt to meet the increased demand; otherwise a situation could arise where there is a shortage of safe assets, resulting in depressed risk premia and higher debt in the financial system (Caballero, Emmanuel, and Gourinchas 2017).

C. Financial Fragmentation

62. **FinDig could lead to increased fragmentation and fragility of the international financial system, even as they reduce frictions for cross-border payments.** Digital currencies associated with large platform ecosystems could see a rebundling of money in which payment services are packaged with a host of data services, resulting in product differentiation and lack of interoperability across platforms (Brunnermeier, James, and Landau 2021). AMRO staff discussions with analysts confirm that:

- Platform owners are often not incentivized to improve interoperability with other platforms, given that digital platforms typically require large upfront investment, with the aim of ensuring that consumers only utilize their respective platforms for all activities.

- Some platform owners are adopting aggressive expansion strategies to grow their networks, such as providing discounts to users, which could lead to inefficient competition and oligopolistic conditions.

[21] For example, payments can be done using AliPay (Chinese e-wallet) in CNY in Japan using the QR code provided by PayPay (Japanese e-wallet), but the amount credited to the account of the recipient would be in JPY using real time exchange rates.

And although these platforms have limited cross-border reach presently, the underlying technology offers potential for rapid geographic expansion. Moreover, to the extent that jurisdictions apply different regulatory frameworks, certain digital payment networks may be viable only within a restricted set of jurisdictions (BIS 2022).

63. **Private firms are also not incentivized to provide safeguards to ensure financial stability.** They are unlikely to make available emergency liquidity during periods of stress and may deliberately limit the convertibility of their respective currencies to those issued by rival firms (for example, by raising conversion costs), to discourage consumers from spending on other platforms (Brunnermeier, James, and Landau 2021). A country with high adoption of virtual assets faces credit, operational, and cyber risks associated with the issuer and/or the market infrastructure. Use of virtual assets could also create funding stress in the banking sector, which may have to compete for deposits and be forced to raise deposit rates to attract funds.

D. Contagion and Spillovers

64. **Growth of FinDig and its interlinkages with other parts of the financial system, both within and across borders, have raised concerns that it may undermine financial stability.** FinTech has become more integrated with the financial system through partnerships with financial institutions (PwC 2017). Connections have also become easier and faster, notably in payment processing (Franco and others 2020). To date, contagion and spillover effects have largely manifested in the market for virtual assets. Increased adoption among retail and institutional investors, especially in emerging market economies, appears to have moved virtual assets into the mainstream, with market capitalization increasing from less than $20 billion at the start of 2017 to more than $3 trillion by late-2021 and a twentyfold expansion between March 2020 and late-2021 (Iyer 2022). Although still small relative to the size of the global financial system as a whole, virtual assets represent potential risks to financial stability through their highly volatile prices, the increasing use of leverage in their trading, and the growing exposures of financial institutions.

65. **Indeed, the empirical evidence points to rising interconnectedness and potential for spillovers between virtual assets and global financial markets.** According to Iyer (2022), the correlation between Bitcoin price volatility and S&P500 index volatility increased more than fourfold between 2017 and 2021, underpinned by easy financial conditions during the COVID-19 pandemic. The former's contribution to the variation in the latter rose by about 16 percentage points post-pandemic, with similar trends seen in their price returns. Correspondingly, the volatility correlation between Bitcoin and Ether and emerging market equities increased by similar magnitudes. Spillover metrics suggest that spillover effects from virtual assets to equities have increased, and vice-versa, in both the US and emerging markets, pointing to intensifying integration between risk assets, which tends to deepen during episodes of market stress.

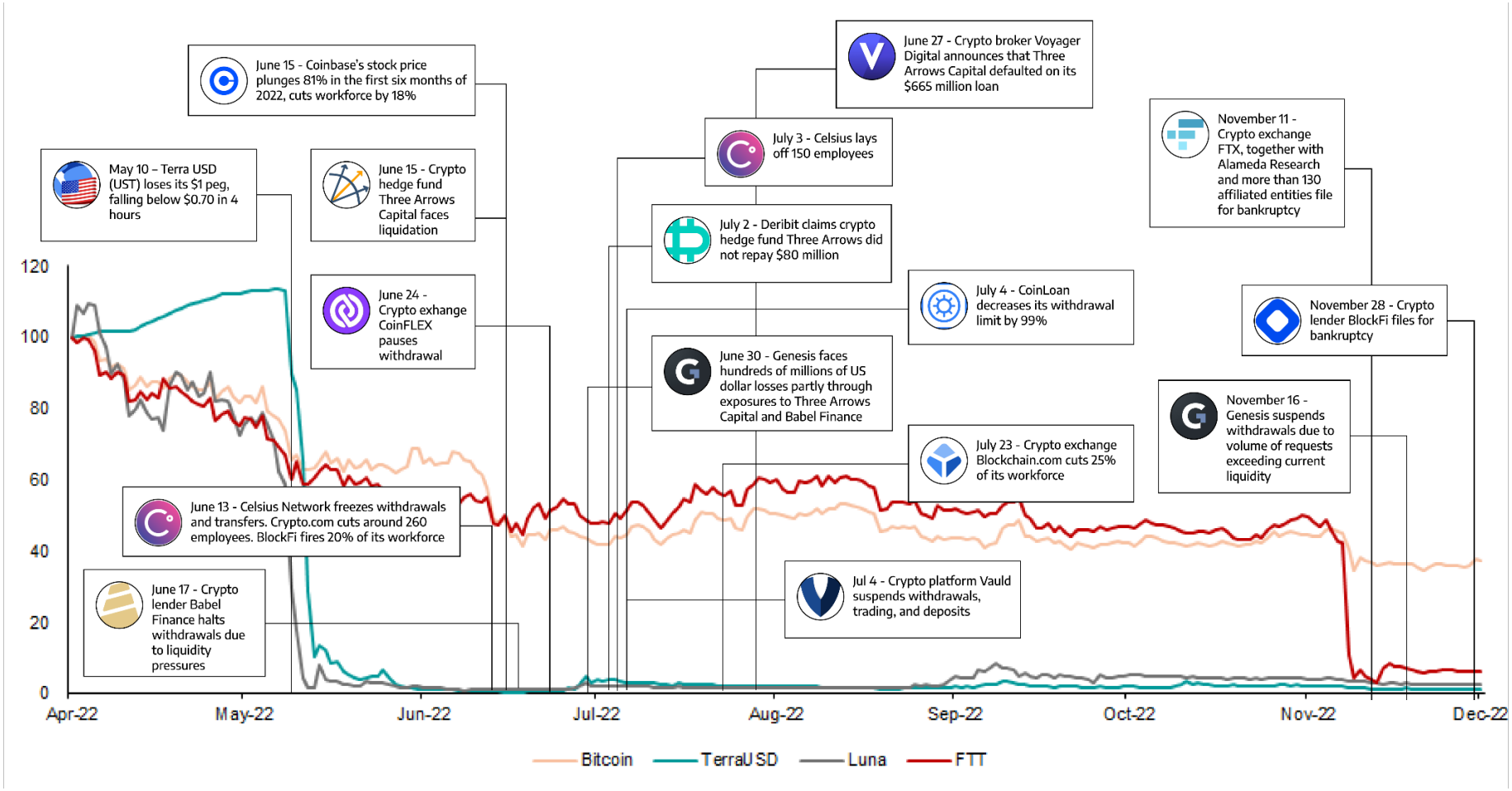
66. **The ructions in virtual asset markets in 2022 were the manifestation of one of the key risks associated with FinDig.** The bursting of the digital asset bubble mirrored the credit crisis that overwhelmed the traditional banking sector during the global financial crisis in the late 2000s. As in the subprime crisis that sparked contagion when the market for collateralized debt obligations imploded, virtual asset investors augmented their returns by taking out multiple loans against the same collateral (known as "recursive borrowing") in different projects (Oliver, Chipolina, and Shubber 2022). Rising inflation, frontloaded interest rate rises leading to tightening global financial conditions, and a geopolitical crisis that

exacerbated inflation brought the euphoria to a halt. Investors started withdrawing their assets while lenders called in their loans, and the domino of virtual asset projects that locked up customer money lost billions of US dollars (Box 5).

67. **The swiftness with which the cross-border virtual asset contagion occurred was amplified by the frictionless, real-time aspect of digital finance and the general lack of regulation.** Easy entry to virtual asset-based financial services enabled firms to attract a large worldwide user base, sometimes by introducing unsustainable incentives such as very high deposit rates. The regulation-light environment also allowed participants to take ubiquitously high-leveraged positions, even among high-profile virtual asset firms. Finally, the frictionless capability of the technology facilitated users' quick exit from their virtual asset positions during the crypto crisis, exacerbating the "bank run".

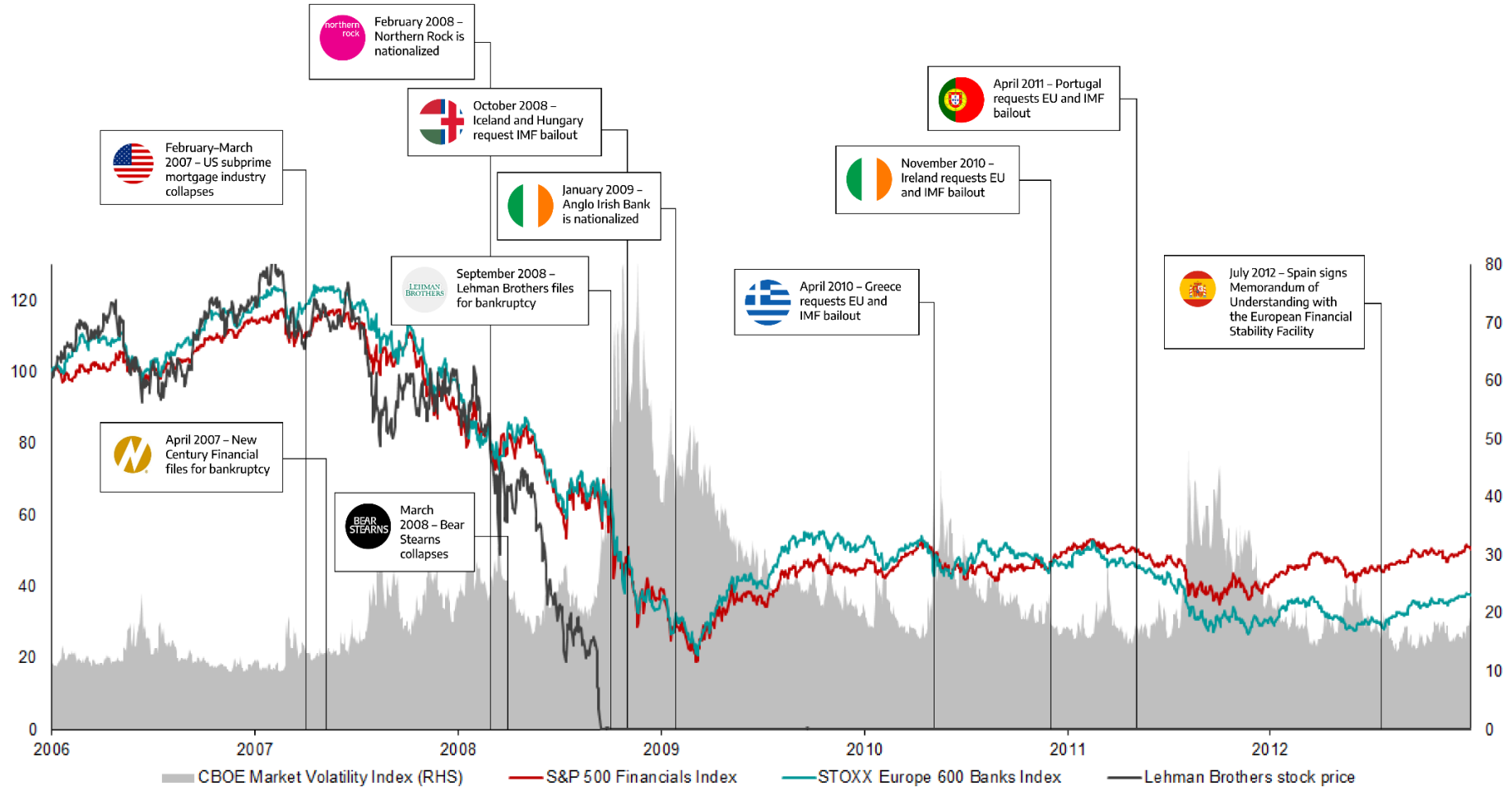
68. **A comparison of developments during the crypto crisis with those of the global financial crisis highlights the difference in transmission speeds between digital and conventional assets.** Following the depegging of the TerraUSD (UST) stablecoin on May 9, 2022, the virtual asset market lost nearly $700 billion—or 45 percent—in value in the following 37 days to June 15, 2022, when Three Arrows Capital, the first prominent virtual asset hedge fund, filed for bankruptcy. Terra Luna, the companion coin to UST, lost almost all its market value in a matter of days (Figure 9). In contrast, the more conventional banking and sovereign debt crises of the global financial crisis manifested more gradually. The major financials indexes—the S&P500 Financial Sector Index and the STOXX Europe 600 Banks Index— took around 24 months to fall to their nadir, following the bursting of the US housing bubble in March 2007 (Figure 10). During this period, Lehman Brothers, which had taken a large position in subprime mortgages, was forced into bankruptcy in September 2008, some 18 months after the subprime mortgage industry collapsed.

Figure 9. Crypto Crisis Timeline
(Market capitalization; April 1, 2022 = 100)



Sources: CoinMarketCap; various media sources; and AMRO staff compilation.

Figure 10. Global Financial Crisis Timeline
(Stock market price, January 2006 = 100; volatility index, percent)



Sources: Haver Analytics; Bloomberg Finance L.P.; and AMRO staff compilation.

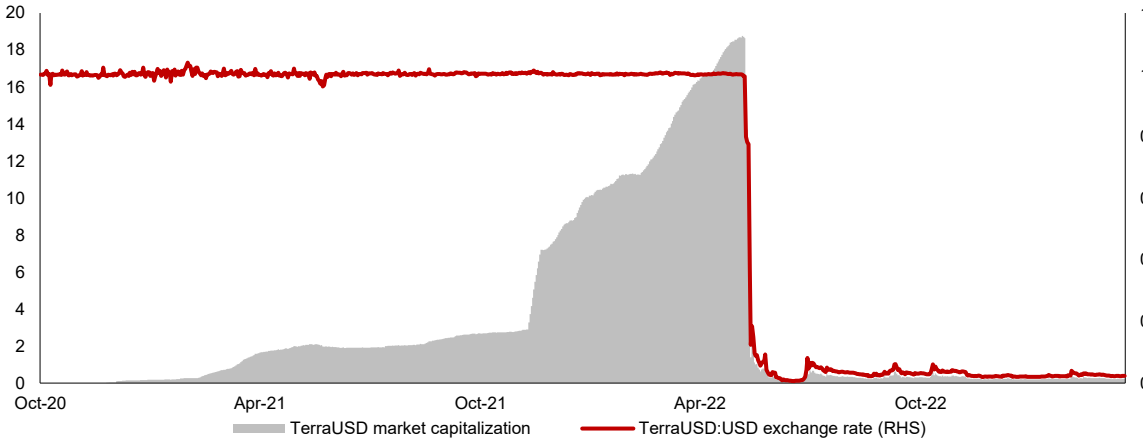
Box 5. The Crypto Crisis

The virtual asset market was already reflecting generally gloomy sentiment in international financial markets well before the crypto crisis. The slide in asset markets captured the multitude of factors overshadowing the global economy: supply chain disruptions from the COVID-19 pandemic stoking inflationary fears; tightening labor markets as economies re-opened; the impact of the war in Ukraine on global food and energy prices all leading to an increasingly hawkish US Fed and ECB. These developments spilled over into the highly-sensitive virtual asset market, which had started trending downward in November 2021.

The start of the crypto crisis could be traced back to the May 10, 2022 collapse of the Terra stablecoin (UST)—at its peak, the third-largest stablecoin by market value. UST is an algorithmic stablecoin, created based on the idea of a fully-decentralized currency. Its value is not backed by any issuer of assets; instead, it was pegged to the US dollar through a programmed algorithm. The stablecoin is connected to a companion token, Terra Luna, which was volatile but had a fixed rate of exchange with UST. The algorithm constantly kept the price of UST at the pegged value, through automated operations to create (mint) or destroy (burn) Luna tokens in circulation. UST and Luna had become popular as a result of the Anchor lending program, which promised annual yields of almost 20 percent.

In early May 2022, Anchor dropped its yields amid a risk-off environment as the US Federal Reserve raised interest rates and soon after, a large amount of UST was withdrawn from decentralized exchanges. These events led to a swift wave of reaction from UST depositors, resulting in a sharp drawdown of more than $2 billion of UST from Anchor on May 7 (Shen 2022). The UST-Luna exchange algorithm minted a vast supply of Luna in short order and caused the token's price to plunge sharply (Figure 5.1). However, there was a technical limit to this mechanism—only $100 million worth of UST could be exchanged for Luna on any one day,[1/] which quickly led to the breaking of the UST peg. Investors flocked to sell their UST and Luna, driving the prices down to being almost completely worthless in just a few days.

Figure 5.1. TerraUSD: Market Capitalization and Exchange Rate
($, billions; exchange rate against the US dollar)



Source: CoinGecko.

The effect was magnified once confidence in the value of stablecoins evaporated. The Singapore-based Three Arrows Capital (3AC), one of the most prominent virtual asset hedge funds, went into a liquidity crisis in June 2022. Apart from sizable leveraged investments in Bitcoin, Ethereum, and other major virtual assets—all of which had experienced enormous declines in the first half of 2022—3AC had significant exposures to UST and Luna, which had become virtually worthless. The firm continued to fail to meet its lenders' margin calls and had to file for bankruptcy, resulting in the manifestation of spillover risks to all parts of the market that had been exposed to the firm.

Another prominent virtual asset staking and lending platform, Celsius Network, became the next domino to fall. Celsius, identified as a P2P bank for virtual assets, offered its reportedly 1.7 million users yields of up to 18.63 percent on their deposits. Despite its claim to being a less risky alternative to a traditional bank, the firm reportedly had a leverage ratio of 1:19, while also issuing many undercollateralized loans (Quarmby 2022). The risky model soon took a toll on its business. In mid-June 2022, Celsius shocked the market by freezing all withdrawals, swaps, and transfers, locking up $12 billion worth of virtual assets

deposited by customers. It subsequently cut a quarter of its workforce, and finally declared bankruptcy on July 13, 2022.

High levels of interconnectedness that characterize the virtual asset industry continued to amplify the risks, with the failure of one firm cascading into others. On June 27, 2022, US lender Voyager Digital issued a notice of default against 3AC for failing to make the required payments on a loan reportedly worth more than $665 million (Shaban 2022). The virtual asset market slump, together with Voyager Digital's exposure to 3AC's failure, led to its inevitable bankruptcy. Genesis Trading, another virtual asset lender, reportedly faced losses of hundreds of millions US dollars due to its exposure to 3AC and the Hong Kong-based lender Babel Finance (Allison and Nelson 2022). Virtual asset exchanges such as FTX, Deribit, and BitMEX reportedly liquidated 3AC's positions soon after the hedge fund announced its failure to meet margin calls. Many VASPs, including BlockFi, Vauld, CoinLoan, CoinFLEX, and Voyager, announced restrictions or complete halts on withdrawals, citing extreme market conditions. Mass layoffs swept across the industry, including among some of the most well-known players, such as Blockchain.com, Coinbase, Crypto.com, and Gemini (Kharpal 2022; Velasquez 2022).

In November 2022, FTX, one of the major VASPs, declared bankruptcy when it could no longer honor investor withdrawals. Alameda Research, a virtual asset hedge fund owned by the FTX founder, held a significant amount of FTX exchange token (FTT) as collateral for further loans, which triggered a wave of withdrawals from FTX after the world's largest VASP, Binance, announced its intention to liquidate all FTT holdings (Allison 2022). FTT lost most of its value, and Binance backed out of talks to acquire the non-US business of FTX after concerns about corporate governance surfaced during due diligence (Reynolds 2022). The implosion of FTX had a rapid and significant impact on the market. VASPs such as BlockFi and Genesis revealed their exposures to FTX and, facing their own liquidity issues, filed for bankruptcy (Greifeld and Hajric 2022; Simauchi and Miller 2022). According to its bankruptcy filing, Genesis owed more than $3.5 billion to its top 50 creditors, including crypto exchange Gemini, at the time it went under (Alpher and Nelson 2023).

[1/] As announced on Terra's official Twitter account (@terra_money) on May 26, 2022.

The author of this box is Hoang Nam Nguyen.

E. Reserve Assets

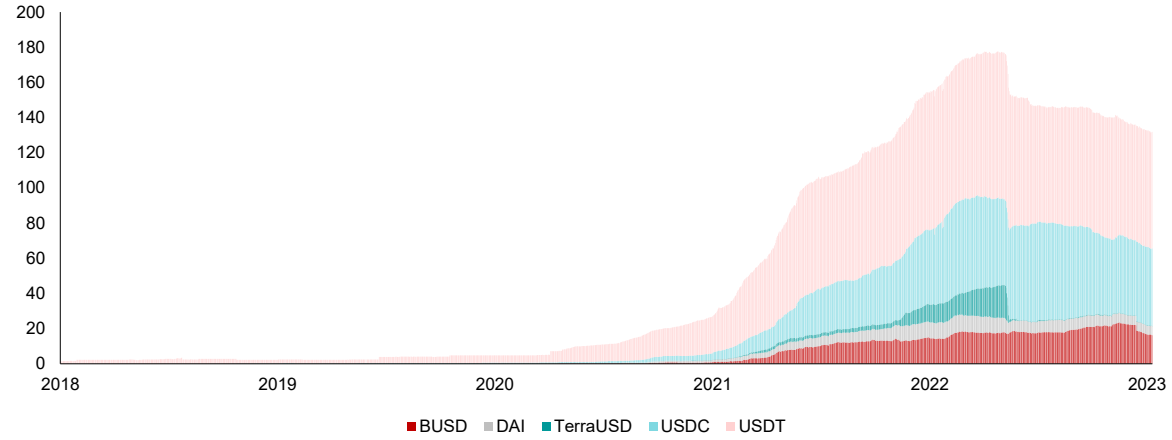
69. **Outside of a CBDC, which is backed by the issuing central bank, the stability of a virtual asset depends on the quality of its underlying reserve assets and backing entity.** Fiat-backed stablecoins are digital representations of the bank deposits behind them, but are still not equivalent to digital cash or electronic deposits. Ultimately, the credibility of a stablecoin peg is only as strong as its issuer and the quality of underlying assets, and will depend on an issuer adhering to the rules relating to the value, transparency, and liquidity of the backing portfolio (Gruenwald and others 2022). The ability of investors to access the underlying fiat assets during periods of extreme stress is important—issuers need to be able to facilitate redemption of their stablecoins for those assets on demand, and do so at par and at any time.

70. **In the market for virtual assets, stablecoins have been heavily used as a medium for trading and participating in blockchain projects.** Investors also use stablecoins as collateral for loans in fiat or to invest in decentralized finance (DeFi) projects. As of March 2023, stablecoins accounted for around 11 percent of virtual asset market capitalization, with total values having risen rapidly from less than $5 billion in 2020 to $133

billion (Figure 11).[22] Despite the dramatic growth, the underlying assets of some major stablecoins have not been sufficient to back the issued values.

71. **Lack of regulation and oversight on stablecoins has left these virtual assets undercollateralized, as exposed by the crypto crisis.** During the virtual asset meltdown in Q2 2022, declines in the values of Bitcoin and other major virtual assets resulted in major stablecoins breaking their pegs to the US dollar. For example, the value of UST—which was pegged to the US dollar using a reserve of Terra Luna tokens and Bitcoin—plunged from $1 to only a few cents (Box 5). At the same time, collateralized stablecoins issued and managed by private entities were not necessarily fully backed by high-quality, liquid assets, but rather by a combination of unsecured corporate debt instruments and own investments.[23]

Figure 11. Market Capitalization of Selected Stablecoins
($, billions)



Sources: CoinGecko; and AMRO staff calculations.

F. Privacy and Security

72. **The digitalization of information has exposed financial data to greater risks of cyberattack.** The use of internet services to store, transmit, and compute data in financial institutions, if not well designed, can create vulnerabilities. Attackers typically take advantage of the interconnectedness of digitalized financial systems to exploit individual weaknesses and scale quickly to damage the entire system. Financial institutions have been prime targets, with more than 200 incidents at public and private financial institutions reported worldwide since 2007 (CEIP 2022).

73. **Financial institutions and FinTech firms have invested heavily in cybersecurity and customer protection, but security risks from third-parties remain.** FinTech firms typically outsource certain technological needs to specialized third-parties which, in turn,

[22] Per CoinGecko (https://www.coingecko.com/), accessed March 20, 2023.

[23] As an example, MHA Cayman (2022) reported that 30 percent of the assets backing Tether comprise commercial paper, certificates of deposit, and the issuer's own investments (including digital tokens).

need to operate at a large scale to be efficient and effective.[24] However, interconnectivity between firms has also raised concerns over third-party cybersecurity risks, in which vulnerability in a single product outside of the organization could lead to system-wide disruptions.[25] In this regard, firms acknowledge that enforcing a nationwide cross-industry cybersecurity standard would represent an important foundation for FinDig security, both to encourage collaboration and ensure the safety of the industry. On the regulatory side, prudential measures that may be imposed to mitigate against potential fraud and malicious threats include: licensing requirements for institutions offering electronic services; outsourcing policies for those that engage third party services such as infrastructure providers; and business continuity and information security management.

74. **The lack of adequate digital and financial literacy is another threat to FinDig security.** As FinDig grows, digital frauds are commensurately evolving to become more sophisticated. AMRO staff discussions with FinTech firms reveal that technology and social engineering attacks are increasing, with engineering attacks representing a bigger threat. These attacks—some originating from overseas—are aimed at stealing important digital identity information and login credentials from customers, and are used to extract funds from customer accounts or to cause disruption. Financial institutions observe that effective efforts to combat financial fraud and protect customer privacy would require cross-industry and public–private cooperation. The cross-border nature of cybercrimes also emphasizes the need for international coordination to prevent illicit financial activities and to recover stolen user funds.

75. **Mass adoption of digital financial products has further exposed users to riskier digital investment, notably when products are unregulated.** Although the entry barriers to investment in virtual assets are typically very low, investors without adequate risk management strategies or financial planning skills could suffer significant losses. In this environment, regulators acknowledge that preventive measures are often ineffective because digital financial products are constantly changing. Instead, regulators focus on increasing public awareness and strengthening financial and digital literacy to mitigate risks, with some initiatives undertaken jointly with the private sector.

76. **Big Data generated by FinDig products can, in turn, enable firms to create better fraud detection and cybersecurity solutions, but regulatory barriers exist.** AMRO staff interactions with cybersecurity developers indicate that even though digital security infrastructure has been continuously improved, firms still need to access user data to fine-tune their security systems. The sheer number of participants on digital finance platforms has resulted in complex user behavior, and in turn, fraud patterns, which require a customized and targeted approach. Given that some FinTech firms lack the expertise and data capacity to build comprehensive cybersecurity systems, they typically need to bring in third-party cybersecurity experts. However, this cooperation creates policy implications

[24] For example, e-KYC services would require a large database of documents and facial data for effective and accurate implementation. Another example is cloud service, which could help firms reduce the cost of hardware infrastructure but the products themselves need to reach a certain operational scale to be profitable.

[25] As an example, the NotPetya attack in 2017 started off as an accounting software update and eventually spread to around 2,000 firms in Ukraine, including power plants, banks, and metro systems (Maynor, Olney, and Younan 2017).

regarding third-party access to private data and financial information, some of which are restricted by regulation.

77. **User privacy is another important consideration for FinDig initiatives.** As digital transactions inevitably generate a trail of data, FinTech products and CBDCs will not remain anonymous, unlike cash. In fact, FinDig participants would need to collect user data to facilitate transactions, comply with or enforce regulations, or generate customer insights. However, retail users may have different tolerance levels for data collection and would likely prefer a certain level of privacy, especially in a CBDC where the government is able to collect information about transactions. As an example, European citizens and professionals consider privacy to be the most important feature of a digital euro (ECB 2021). Separately, CBDC projects in ASEAN+3 have also discussed possible designs to afford users a degree of privacy while enabling oversight.

78. **VASPs and other FinTech firms are typically required to collect and manage user data sufficient for KYC and AML/CFT purposes.** In the cross-border payment industry, where the information flows from FinTech firms to banks and other institutions in various jurisdictions, these data requirements have given rise to the need to ensure user data privacy and security outside of the particular FinTech product. A common approach is to ensure that only requested data by partner banks are shared and the data flow is digitalized through APIs. For FinTech firms that also operate nonfinancial products on the same platform, such as car-hailing or food delivery, data access would have to be ring-fenced. Separately, although platform sharing allows firms to capitalize on larger user bases from other products, some users may lack adequate financial knowledge or proper digital security practices, leaving them vulnerable to financial fraud or digital hacks.

79. **Increasing data localization may become another barrier to cross-border FinDig.** Data localization refers to measures to regulate or limit the amount of data that can be sent to foreign entities, to address concerns over customer privacy and national security. These measures could be in the form of requiring data storage servers or data analysis services to be located domestically, or preventing data transfer to foreign entities without official approval. For private FinTech firms and international financial institutions, these data localization measures create higher costs and operational burdens that limit cross-border operations.

80. **Cross-border CBDC projects have introduced the need for cross-border data flow arrangements between participating institutions.** For mCBDC arrangements to operate, these institutions must be able to receive user data from their foreign counterparts for verification purposes. This process requires cross-border agreements among participant central and commercial banks, regulating how data are managed across institutions. Such agreements would require both regional coverage and alignment with the data regulations of every participant in the network. Any cross-border data flow arrangement should also establish standard data requirements to ensure that user privacy and system security are well-protected across multiple entry points within participating economies.

81. **For both retail and wholesale CBDC systems, the importance of cybersecurity is compounded by their finance-technology nature and roles in the overall financial system.** CBDC technology has to prevent not only theft of customer credentials through phishing attacks or malware, but also potential systematic attacks to steal confidential information or compromise critical infrastructure (Hansen and Delak 2022). From a financial

risk perspective, a CBDC needs to consider both transactional concerns (such as counterfeiting, fraud, and double spending) and systematic issues (such as AML/CFT, customer protection, and financial stability). Regardless of type of risk, any security breach in a CBDC system could cause damage beyond just the transactions it handles, in that it could jeopardize public trust in the central bank itself.

IV. Regulation and Policy

82. **The rapid development of FinDig offers opportunities but also poses risks to financial stability that require the vigilance of policymakers, regulators, and supervisors.** FSB (2017) observes that these issues are particularly important for FinTech, given that many innovations are yet to be tested through a full financial cycle, and the adequacy of existing regulatory frameworks would need to be continuously assessed as adoption increases. However, the limited availability of official and privately disclosed information makes assessments of materiality and risks in new areas challenging, especially with the rapid evolution of markets and products. The same considerations arguably would apply to FinDig.

83. **Last year's crypto crisis events underscore the need for regulatory authorities to design appropriate policies to mitigate potential systemic risks arising from future spillovers to financial institutions.** As foreshadowed by Iyer (2022), recent events have demonstrated the significant disruptions to financial markets that can be caused by price volatility of virtual assets that are outside the control of central banks and regulatory authorities. Fortunately, contagion from the crypto crisis has not extended to the traditional banking sector—an outcome attributable in part to bank regulators' ongoing vigilance and focus on safety, soundness, and consumer protection (Chipolina 2022).

84. **Although spillovers between virtual assets and traditional financial systems are limited to date, some policymakers advocate for greater regulation and guidance on virtual asset early on.** Virtual asset markets do not yet seem so large or interconnected with traditional financial systems as to pose systemic risk. However, banks are reported to be increasingly interested in entering virtual asset markets, to participate in revenues that corporate and institutional clients are generating through digital assets. Given the lack of transparency on how deeply intertwined the digital and traditional finance sectors may be, some policymakers argue that like risks should be subject to like regulatory outcomes and like disclosure—as this requirement would allow investors to better distinguish between genuine, responsible innovation and seemingly easy returns to contain any potential spillover to core financial systems (Brainard 2022).

A. International Developments

85. **In the EU, efforts are being made to provide regulatory certainty, reduce fragmentation, and support the development of a robust, well-functioning, and safer virtual asset market.** The Regulation on Markets in Virtual-Assets represents initial steps to adopt consistent standards throughout the bloc, instead of a patchwork of national rules (EC 2020). As a result, virtual asset service providers will require authorization from one of the EU's national market regulators in order to passport their services within the bloc, and local regulators will share information with the pan-regional European Securities and Markets Authority. Regulated firms will face higher consumer protection standards, be liable for loss of investor funds, and have to disclose information on the environmental impact of

virtual assets. Stablecoin issuers must have presence within the EU and carry "sufficiently liquid" reserves, and they will be overseen by the European Banking Authority.

86. **In the United States, the US Securities and Exchange Commission is reaching out to other financial agencies to close any gap in the regulation of virtual asset operators.** The commission has jurisdiction over platforms listing tokens that are deemed securities, but would send information on commodity-related tokens listed on its platforms over to the Commodity Futures Trading Commission. The shift envisions one rule book on the exchange that protects all trading, regardless of the type of token, against fraud, front-running, manipulation, and also provides transparency in order books to help build trust in these markets (Palma and Jenkins 2022).

87. **International regulatory bodies have also published views on a wide range of FinDig topics.** Specifically:

- After the FATF expanded AML/CFT requirements in 2018 to introduce the Travel Rule to cover virtual assets and VASPs (Box 3), it then published guidance on a risk-based approach to virtual assets and VASPs (FATF 2019). Updated guidance in 2021 required VASPs to comply with AML/CFT measures and provided clarification on the application of the Travel Rule (FATF 2021a).

- The Basel Committee on Banking Supervision (BCBS) issued a consultation paper on the prudential treatment of virtual asset exposure, laying out the general principle of "same risk, same activity, same treatment" in setting regulatory standards (BCBS 2021). The BCBS has also proposed a two-group classification of virtual assets determining their risk profiles and the types of prudential measures financial institutions must follow when they have virtual assets on their books (BCBS 2022).

- The International Organization of Securities Commissions (IOSCO) issued a report highlighting issues, risks, and regulatory considerations regarding VASPs (Board of the IOSCO 2020). The document provides an analysis of VASPs and key considerations for regulating them. IOSCO published a road map regulating virtual assets for 2022–23 (IOSCO 2022), highlighting plans to tackle the financial stability and other aspects of virtual assets and DeFi.

88. **Separately, the Financial Stability Board (FSB) has published research into areas such as stablecoins and other types of virtual asset, as well as on FinTech developments.** The FSB in 2020 issued 10 high-level recommendations to promote international collaboration in regulation, supervision, and oversight to set regulatory standards in preparation for the issuance of a "global stablecoin" (FSB 2020). These recommendations were set to be reviewed and updated in 2023. The FSB has also expressed concerns over the involvement of established financial institutions with virtual assets, noting that the fast-evolving nature of the virtual asset market could result in rapid escalation of risks to the financial system (FSB 2022). The report also highlights potential regulatory gaps, fragmentation, and arbitrage opportunities due to differences in regulatory developments across the world.

B. Private Sector Views

89. **Appropriate and proportionate regulation is needed to ensure sustainable growth in innovative technology.** Although virtual asset as speculative investments carry risks of fraud and financial volatility, the technology underpinning DLT and smart contracts offer potentially significant improvements to financial services and beyond.[26] However, as observed by blockchain participants, the dominance of the speculative aspects of virtual assets to date has crowded out the practical adoption of DLT. Interlocutors also note that the high prevalence of virtual asset scams/fraud—such as a "rug pull" or "pump-and-dump"—have discouraged both investors and developers from pursuing long-term projects; they have instead focused on short-term profits. In this regard, appropriate regulations are needed to limit speculative activities, enforce safeguards, and incentivize the adoption of longer-term initiatives.

90. **Presently, blockchain regulations in the ASEAN+3 region are perceived by some market participants to be either lacking in some areas or too harsh in others.** Most economies in the region do not recognize virtual assets as a means of payment, with some imposing fines or initiating criminal proceedings for conducting transactions with virtual assets. Some regulators have prevented or limited the adoption of virtual assets through banks, or even banned virtual asset infrastructure activities, such as mining (validating) Bitcoin, altogether. Although investments in blockchain as a technology have not been affected by the bans, market participants suggest that a lack of guidelines or regulations on blockchain-related businesses has limited participation by traditional institutions that are concerned about compliance and reputational risks.

91. **Meanwhile, non-blockchain FinTech participants consider existing licensing requirements and the pace of regulatory change to be roadblocks to rapid progress in FinDig.** Most private sector participants view adherence to regulations and licensing requirements as opportunities to gain more credibility with the customers. However, they may have slowed FinDig initiatives in some member economies. The reasons cited by interlocutors include: (1) an overly cautious approach by authorities, (2) unknown risks posed by new technologies, (3) protectionism to provide local champions with an advantage, and (4) fragmentation of regulatory responsibilities. To address the first two concerns, many private sector players have integrated their technology with local banking systems to ensure regulatory compliance. Market participants also acknowledge that, in many cases, regulators may take time to build the necessary capacity and capability to keep pace with the evolving technology, which could delay the roll out of regulations. They generally expect regulations to continue evolving along with the changing FinDig landscape in the region.

92. **Regulated VASPs have been the main source of data regarding the extent of the public's exposure to virtual assets.** For economies with VASP regulations in place, these firms provide users with legitimate entry/exit points to the market and are either responsible for ensuring appropriate KYC and AML/CFT measures, or have taken the initiative to do so. In some jurisdictions, the VASPs also provide information on user profiles, investor exposure to virtual assets, and trading activity to the authorities. The information is used for taxation purposes in jurisdictions that have relevant schemes in place. Moreover,

[26] For example, the International Finance Corp has explored the use of blockchain to trade carbon offsets (Jessop, Nasralla, and Horton 2022), while the city of Panchkula, India, has been testing a blockchain land registry system (Oprunenco and Akmeemana 2018).

the responsibilities of these VASPs have been expanded to include know-your-transaction (KYT) measures, to ensure compliance with the FATF Travel Rule and relevant sanctions.

93. **The public's ready access to unregulated VASPs and decentralized exchanges is a concern.** Although the exact number of unregulated VASPs and decentralized exchanges is unavailable, most authorities recognize the prevalent usage of these platforms in the domestic markets. In response, most ASEAN+3 economies have banned access to these exchanges and initiated public awareness campaigns. Nonetheless, some users still prefer unregulated over regulated VASPs, given that the former offer the ability to avoid government surveillance and provide access to more types of virtual assets. Some interviewees suggest that a well-integrated and regulated environment could allow regulated VASPs to compete with their unregulated competitors. As an example, enabling integration by regulated VASPs with national KYC programs and linkages to the banking sectors could facilitate onboarding procedures for users, which tend to be more burdensome on unregulated exchanges.

94. **More generally, government initiatives and regulations are important drivers of FinDig adoption.** Regulated financial institutions rely on the government to create a conducive environment for the adoption of digital financial products. One of their suggestions for making FinDig attractive is for governments to institutionalize and promote digital initiatives in their own operations. Initiatives may include digital tax collections, cashless payments for government support programs and public sector salaries, and subsidizing the use of digital services. Unsurprisingly, these financial institutions take the view that FinTech firms providing similar services to theirs should be subject to the same regulations.

95. **Private sector participants generally believe that the government should provide core underlying FinDig infrastructure to promote innovation and mitigate fragmentation**. Building certain infrastructure—such as a national payment system, a CBDC, or unified QR payment standard—requires large investments. Given the public goods nature of such projects—which tend to increase social benefits rather than business profits—the government is regarded as better placed to perform such tasks. A lead role for the official sector would enable the government to have more control over the data, as well as ensure interoperability across the financial system. The government could remove ambiguity and avoid duplication in investment by clarifying its FinDig development road map so that businesses can focus on developing supporting services around the infrastructure, including through public–private partnerships.

C. ASEAN+3 Official Sector Initiatives

96. **Apart from issuing and enforcing FinDig regulations and investing in infrastructure, regulators may also promote collaboration with the private sector.** Regulators generally aim to provide a level playing field in FinDig to ensure that participants can have access to basic infrastructure, while making every effort to prevent financial fragmentation and fraud. Most authorities in ASEAN+3 acknowledge the gaps between the regulatory environment in traditional financial services versus that in FinTech and FinDig, and are trying to keep pace with technological developments. Discussions with regulators across the region reveal that they are proactive in engaging with the private sector, either directly or through self-regulated organizations.

97. **At this stage of FinDig development, authorities around the region generally view customer protection as their primary objective in regulating FinDig initiatives**.

The focus on customer protection has led to stringent KYC requirements. Although some economies have advanced National Identification Systems, which facilitate efficient implementation of e-KYC, others are still developing these systems. By and large, most authorities have made progress, although to varying degrees, in ensuring customer data protection. The authorities—especially in developing economies—have made additional efforts to promote digital and financial literacy, to prepare customers against financial fraud.

98. **Authorities in ASEAN+3 are also trying to strike a balance that prioritizes healthy innovation and development of the FinDig ecosystem while minimizing financial stability risks.** One of the important areas for regulatory intervention is the promotion of fair competition within the FinTech industry. A key risk identified by authorities is the evolution of BigTech, which enjoys competitive advantage over smaller firms given its access to large amounts of customer data. Authorities in the region have adopted two (not mutually exclusive) approaches to ensure that conditions among competitors are fair. The first comprises personal data protection initiatives, which does not allow data sharing between businesses without the customer's consent. The second is through Open Data Initiatives, which provide data access to smaller firms, thus reducing the information gap with BigTech.

99. **Although digital finance remains nascent, the region's policymakers continue to be vigilant toward blockchain and virtual asset developments, and have further tightened their stance.** For example,

- Among Plus-3 members, China has banned virtual asset transactions as well as trading and mining activities. Japan and Korea allow such activities but have imposed regulations on VASPs, with clear KYC requirements. In 2022, Japan passed a law regulating stablecoin issuance. Separately, Korea has banned Initial Coin Offerings because of a lack of clarity in the international regulatory framework for such fund-raising.

- Among ASEAN members, most economies have banned the use of virtual assets as a means of payment. For example, Thailand's central bank, Securities and Exchange Commission, and Ministry of Finance in January 2022 announced regulatory actions to prevent virtual assets from being used to pay for goods and services (Bank of Thailand 2022).

- Although the purchase of virtual asset is not illegal, several ASEAN economies have introduced licensing guidelines for the operation of exchanges and most discourage public advertisement. Singapore, for example, has issued strong warnings against retail investment in virtual assets and proposed further measures to inhibit retail access to virtual assets. The MAS has furnished guidelines setting out expectations that providers of Digital Payment Token services should not promote their services to the Singapore public, and a requirement for businesses that offer regulated payment services (including DPT) to be licensed to do business in Singapore. In the Philippines, Bangko Sentral ng Pilipinas closed the regular application window for new VASP licenses for three years from August 2022 and may grant them only to existing banks.

100. **Finally, ASEAN+3 economies may have to strengthen efforts to harmonize initiatives and regulations for cross-border FinDig to work seamlessly.** Some

regulators observe that, to exploit the benefits of efficient and inclusive cross-border financial services, they may need to work together to improve interoperability across domestic payments systems. At the same time, streamlining taxation, legal, and regulatory frameworks for digital assets would promote intra-regional interoperability. A robust regulatory framework would also support the expansion of businesses that follow them, by enhancing firm reputation and strengthening customer confidence.

V. FinDig Implications for the Regional Financing Agreement and Other Issues

101. **FinDig could contribute significantly to economic activity and prosperity in the ASEAN+3 region if appropriately harnessed.** FinDig improves efficiency and reduces the costs of economic transactions. It introduces competition that raises the quality of services and incentivizes innovation, increases transparency, and facilitates accountability, thus building the credibility of and trust in certain products. It widens financial inclusion by expanding access to unbanked populations, and so improving capital allocation and increasing consumption. Benefits accrue from both domestic developments in FinDig and positive cross-border spillover effects, with the region set to gain most from its large, tech-savvy young generation.

102. **However, challenges and risks from FinDig should not and cannot be underestimated.** The embrace of digital money could significantly and swiftly increase both the volume and volatility of already-large gross capital flows, which current BoP methodologies are ill-equipped to capture, leaving a potentially huge "blind spot" for surveillance and risk mitigation measures (Box 6). For macroeconomic policy making, widespread use of a foreign country's digital currency could render a country's monetary policy ineffective and expose its financial system to liquidity stress. Additionally, rising financial interconnectedness and any cross-border spillover during market stress events could be magnified by the speed at which digital finance occurs, all of which point to the potential importance of the RFA in supporting the development of cross-border FinDig.

103. **Ultimately, the aim of ASEAN+3 is to realize the full benefits of financial innovation within the region while taking steps to safeguard financial stability.** AMRO staff research into in the FinDig sphere and discussions with public sector officials and private sector participants underscore the varying levels of development and sophistication in FinDig across ASEAN+3 economies as well as the policy positions adopted by authorities (Appendix VI). More important, the findings highlight the different areas in which AMRO may be able to support its members, and opportunities for regional cooperation on FinDig. Notable opportunities include:

- ***Revisiting the deployment of AMRO resources to account for rapid FinDig developments*** in the possible expansion or refocusing of surveillance coverage, and technical assistance for members who want to upscale digital finance skills, as well as the addition of a research function on the topic. Specifically:

    - The AMRO Surveillance Guidance Note currently provides a framework and guidance to staff on the surveillance process and content. The latter covers the important issues that are typically addressed as part of staff's surveillance of member economies, and should be revised to incorporate financial stability-related aspects of FinDig, such as the data gaps in the BoP, and the speed and size of any contagion and spillover. Several members have also indicated interest

in receiving intermittent updates on the progress of FinDig and innovative initiatives in the region.

- AMRO could introduce new options for technical assistance (under the Consultancy Program or Research Collaboration Program) to support countries interested in financial digitalization, by utilizing experts. Such assistance could include training and the introduction of best practices, along with further research to identify country-specific issues in areas that are a challenge for authorities to tackle (for example, financial inclusion, settlement systems, AML/CFT implementation, risk management, data privacy and security), to design a framework of common metrics to measure FinDig efforts and identify areas where members may require technical support. As a first step, AMRO staff could develop a framework for FinDig technical assistance that would be based on international FinDig principles and devised in consultation with members and through collaboration with other international organizations.

- ***Assessing the alternatives to the existing RFA.*** Options could include exploration of new financial support instruments and addressing FinDig risks to members' BoP. The RFA should become more responsive to situations where urgency to tap liquidity arises, given the potential exponential speed and impact of financial spillovers and contagion from FinDig.

- ***Considering other related areas for future collaboration,*** such as the (1) coordination of data collection of cross-border digital finance transactions, (2) joint exploration, knowledge sharing, and cooperation on technical standards, and legal and regulatory frameworks governing areas such as data security and privacy, competition policy, consumer protection, to promote interoperability and facilitate cross-border trade and finance, (3) development of a cooperative oversight framework to promote collaboration between home and host countries, (4) alignment of regional discussions on FinDig with international standards such as those of the FSB, and (5) development of a local currency transaction framework for cross-border payments.

Box 6. The Future of Digital Assets and ASEAN+3 Balance of Payments

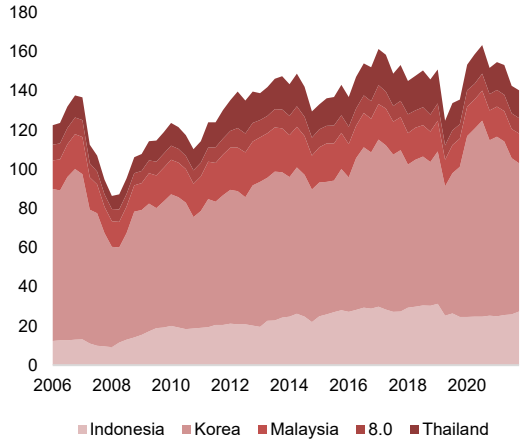
Global asset markets have continued to grow, as have nonresident positions taken in ASEAN+3 economies. Since the trough of the global financial crisis, short-term investments by nonresidents to member economies with more volatile capital flows—the ASEAN-4 and Korea—have gradually increased as a proportion of their growing foreign exchange reserves, raising their overall exposure to capital outflows. Portfolio investment to reserves has more than doubled (Figure 6.1); other investment (typically bank credit) has decreased relative to reserves since the global financial crisis, but has ticked up since the COVID-19 pandemic (Figure 6.2). In absolute amounts, nonresident portfolio positions in equity and debt securities have jumped by more than $900 billion to $1.3 trillion, while the outstanding amount of other investment is over $700 billion.

The potential explosion of digital assets in the coming years could further reduce the effectiveness of the RFA. Indeed, global virtual asset markets added an estimated $300 billion in value in the first month of 2023 alone, and total digital assets under management increased by almost 37 percent during this time (Chipolina 2023).[1/] Using a specialized machine learning technique for time series forecasting—the Nonlinear Autoregressive Neural Network with Exogenous Inputs (Leontaritis and Billings 1985a, 1985b)—several scenarios combining future global economic performance and the regulatory environment for virtual assets are set to project the possible different future paths of market capitalization for this asset class.[1/] The range of

outcomes suggests that the capitalization of the global virtual asset market alone could potentially grow by around 10 times by 2030, under very relaxed regulatory conditions and a more positive growth outlook, or it could grow at a much slower pace under very strict regulatory regimes and more pessimistic growth outcomes (Box Figure 6.3).

Box Figure 6.1. ASEAN-4 and Korea: Portfolio Investment Liabilities

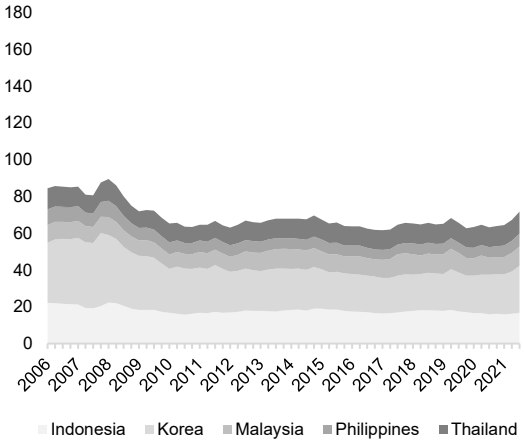
(Percent of foreign exchange reserves)



Sources: National authorities; and AMRO staff calculations.

Box Figure 6.2. ASEAN-4 and Korea: Other Investment Liabilities

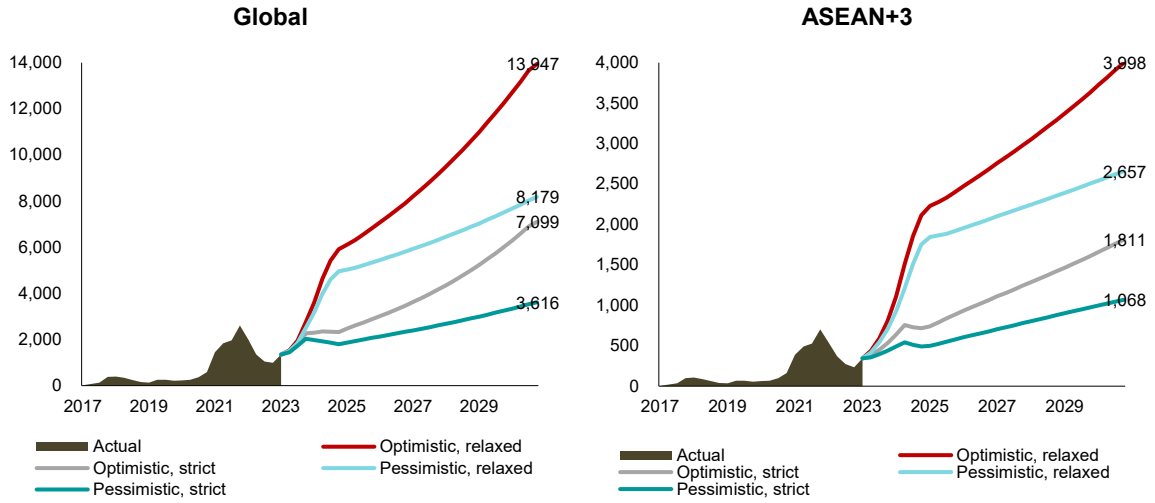
(Percent of foreign exchange reserves)



Sources: National authorities; and AMRO staff calculations.

Box Figure 6.3. Virtual Assets: Possible Scenarios and Future Paths of Market Capitalization

($, billions)



Sources: Bank for International Settlements, IMF, and national authorities through Haver Analytics and CEIC; CoinGecko; and AMRO staff estimates.

[1/] Combinations of different future paths for the four main indicators used in AMRO modeling result in four separate scenarios. The optimistic scenarios directly adopt the growth rates in IMF forecasts for the first two indicators: (1) nominal GDP, and (2) purchasing power parity GDP for ASEAN+3 economies, while the pessimistic scenarios assume only half those growth rates for each indicator. The third indicator, M2 money supply in US dollars, is assumed to grow at the same rate as nominal GDP, while the fourth indicator is estimated to represent the stringency of the regulatory environment for virtual assets in the ASEAN+3 region. Specific values are assigned to this indicator, through AMRO staff's assessment of virtual asset legality—policies and measures that are either very easy or very restrictive toward virtual assets in various countries (Ong and others 2023). Another data series necessary for projections of virtual asset market capitalization in the ASEAN+3 is the corresponding historical information about virtual assets. Global market capitalization of virtual assets, as reported by CoinGecko, is used as the basis for this estimation, which is derived by assuming similar proportionality with that of the region's share of aggregate global equity and bond market capitalization.

The authors of this box are Li Lian Ong, Alex Liyang Tang, and Toàn Long Quách.

Appendix I. Cross-Border Financial Digitalization Initiatives in the ASEAN+3

Appendix Table 1. ASEAN+3: Features of Cross-Border Payments and Settlements

Economy	Feature			
	Availability	**Efficiency**	**Regulation**	**Reporting Standards**
	Initiatives to synchronize settlements and operations between different banking systems or to enable 24/7 cross-border transactions	*Initiatives to realize overall improvements to provision of financial services, including payment services through digital means*	*Initiatives to establish regulatory frameworks to regulate foreign private money, foreign retail CBDCs or future cross-border transaction systems, such as cross-border wholesale CBDCs (wCBDCs)*	*Initiatives relevant for international standardization, including adoption of ISO20022, which contributes to smoother information exchange and reporting*
Brunei Darussalam	• N/A	• Implemented an RTGS system to help speed up interbank transfers and improve the efficiency of payments and settlements for cross-border transactions (2014).	• N/A	• Adopted SWIFT message delivery and ISO20022 messaging standards (July 2015).
Cambodia	• N/A	• Launched cross-border QR linkage with Thailand (February 2020). • Introduced real-time fund transfer service between Malaysia and Cambodia through the National Bank of Cambodia's Bakong e-wallet and Maybank's MAE app (August 2021). • Announced plans to expand linkage to Lao PDR and Vietnam (January 2022). [Private sector initiatives]	• N/A	• N/A
China	• Worked with the HKMA on the technical testing of using the e-CNY for cross-boundary payments between mainland China and Hong Kong. The first phase of technical pilot testing was completed in December 2020; the second phase of technical testing commenced in July 2022, involving more banks in Hong Kong and the use of the Faster Payment System (FPS) to top up e-CNY wallets (March 2023). • Participated in joint research project mBridge with the HKMA, CBUAE, BoT, and the BISIH (September 2021). In 2022, the BIS and the four central banks successfully completed a pilot on real-value transactions on the mBridge cross-border CBDC platform. • Announced holding of regular technical exchanges with the ECB on aspects such as	• Launched cross-border QR code payment service for Chinese visitors to Lao PDR (July 2019) and Malaysia (July 2020). [Private sector initiatives] • Facilitated a number of businesses, including multilevel receivable financing for supply chains, cross-border financing, international trade remittance supervision, and tax reporting on outward payments, through the PBC Trade Finance Platform (November 2021).	• Proposed amendments to the central bank law that will provide a legal basis the e-CNY as a form of statutory currency (October 2020). • Introduced the Data Security Law and the Personal Information Protection Law (August 2021). • Released a notice on mitigating the risks of virtual currency trading and speculation (September 2021).	• Established a joint venture limited firm with SWIFT to provide information services, including establishing and operating a local centralized node of financial messaging networks and local data warehouses (March 2021). • Proposed a set of global rules for central bank digital currencies, from how they could be used around the world to highly sensitive issues, such as monitoring and information sharing (March 2021). • Published the first report on CBDC and will actively respond to initiatives of the G20 and other international organizations on improving cross-border payments, and explore the applicability of CBDC in cross-border scenarios (July 2021).

Economy	Feature			
	Availability	**Efficiency**	**Regulation**	**Reporting Standards**
	Initiatives to synchronize settlements and operations between different banking systems or to enable 24/7 cross-border transactions	*Initiatives to realize overall improvements to provision of financial services, including payment services through digital means*	*Initiatives to establish regulatory frameworks to regulate foreign private money, foreign retail CBDCs or future cross-border transaction systems, such as cross-border wholesale CBDCs (wCBDCs)*	*Initiatives relevant for international standardization, including adoption of ISO20022, which contributes to smoother information exchange and reporting*
	design, applications, and use of CBDCs (November 2021). • Achieved several milestones with eTradeConnect and the PBC trade finance platform, notably: ○ realized two-blockchain platform interoperability, which became the first case of different blockchain connection in China (2020). ○ implemented trade financing business use cases of import and export cross-border finance (2021). ○ cooperated with Phase II of mBridge, facilitating payment of cross-border trade (2022).			• Issued a five-year plan for financial standardization (February 2022).
Hong Kong	• Launched the FPS to enable instant fund transfer services across banks and stored value facilities (September 2018). • Developed a proof-of-concept of a cross-border wholesale central bank digital currency (wCBDC) corridor network that can operate 24/7, in Project Inthanon-LionRock with the BoT (January 2020). The project was renamed mBridge in the subsequent phase with the joining of CBUAE, PBC DCI, and BISIH (commenced February 2021). A real-value pilot settling actual cross-border transactions was completed in September 2022, and findings were reported in October 2022. • Announced the launch of various cross-borders links (to name the most recent): ○ DvP link with the Bank of Japan (BoJ) (April 2021). ○ PvP link with the BoT (July 2014). ○ PvP link with BI (January 2010). • Supported the PBC DCI on technical pilot testing of using the e-CNY to make cross-	• Announced that FPS would provide consumers and merchants with safe, efficient, and widely accessible payment services on a 24/7 basis. It also allows payments in multiple currencies—HKD and CNY—in real-time. The FPS has been well received since its launch in September 2018. As of end-February 2023, the number of FPS registrations reached 11.76 million, representing an increase of 18 percent or 1.8 million registrations compared to a year before. The average daily turnover reached 1.16 million real-time transactions (+41 percent year-over-year), worth HKD 8.2 billion and CNY 218 million. • Transaction time (per the findings of the mBridge project) could be reduced from 3–5 days to mere seconds, and costs could be reduced by up to half. • Launched AML Regtech Lab (AMLab) series, which provides a collaborative platform for banks to share operational experiences of AML RegTech approaches with peers. Three AMLabs have been organized since November 2021, covering	• Enacted the Payment Systems and Stored Value Facilities Ordinance, which provides the legal basis for the powers of the HKMA in relation to the licensing and supervision of Stored Value Facilities, as well as the designation and oversight of Retail Payment Systems (to the extent that such cross-border payments and remittances are conducted through the above operators, and involve participants in Hong Kong for payment transactions processed by the Retail Payment Systems) (November 2015). • Laid out clear rules, payment, and tariff schemes for merchants using FPS (January 2022). • Issued the consultation conclusion to the discussion paper on cryptoassets and stablecoins, summarizing the feedback received in relation to the paper and the HKMA's response (January 2023). • Introduced Anti-Money Laundering and Counter-Terrorist Financing (Amendment) Bill 2022 into the Legislative Council to implement a VASP licensing regime, to be	• [SWIFT] Introduced Alliance Messaging Hub, a platform that allows banks in Hong Kong to connect to FPS using ISO20022-based financial messages (November 2017).

Economy	Feature			
	Availability	**Efficiency**	**Regulation**	**Reporting Standards**
	Initiatives to synchronize settlements and operations between different banking systems or to enable 24/7 cross-border transactions	*Initiatives to realize overall improvements to provision of financial services, including payment services through digital means*	*Initiatives to establish regulatory frameworks to regulate foreign private money, foreign retail CBDCs or future cross-border transaction systems, such as cross-border wholesale CBDCs (wCBDCs)*	*Initiatives relevant for international standardization, including adoption of ISO20022, which contributes to smoother information exchange and reporting*
	boundary payments. The first phase of the technical pilot testing was completed in December 2020; the second phase of the technical testing commenced in July 2022, involving more banks in Hong Kong and the use of the FPS to top up e-CNY wallets (March 2023).	topics such as network analytics and low-barrier, easy-to-implement technologies. "Regtech Connect" sessions in AMLabs allow technology firms to demonstrate a range of RegTech tools and services to participating banks. • Developed a two-year road map to promote regulatory technology adoption in the Hong Kong banking sector. The objective is to drive local banks to explore the use of technology to enhance risk management and compliance (November 2020).	administered by the Securities and Futures Commission for certain virtual asset activities conducted on exchanges (July 2022).	
Indonesia	• N/A	• Launched instant cross-border QR payment linkages with Thailand (August 2021) and Malaysia (January 2022).	• Initiated QR Code Indonesian Standard for Cross-Border Payment. • Enacted Bank Indonesia Regulation PBI. 22/23/PBI/2020 about Payment System • Enacted Bank Indonesia Regulation No. 23/6/PBI/2021 regarding Payment Service Provider. • Enacted Bank Indonesia Regulation No. 23/11/PBI/2021 regarding Payment System National Standard. • Enacted Board of Governors Regulation No. 21/18/PADG/2019 concerning National Implementation Standards of Quick Response Code for Payments.	• Developed the Cross-Border QR Codes using the JSON API technical specification, based on REST JSON Standard and refers to ISO 20022.
Japan	• Launched a cross-border DvP link between BOJ-NET JGB Services and HKD CHATS (April 2021).	• Conducted joint multiphased research (Project Stella) with the ECB on the applicability of DLT for financial market infrastructures (Phases 1-4 published between September 2017 and February 2020). • Launched cross-border QR code payment service with Thailand (October 2020). [Private sector initiative] • Published "The Bank of Japan's Approach to Central Bank Digital Currency," explaining its approach to "general purpose" CBDC or	• N/A	• [BoJ-NET] Adopted International Messaging Standard ISO20022 (October 2015).

Economy	Feature			
	Availability	**Efficiency**	**Regulation**	**Reporting Standards**
	Initiatives to synchronize settlements and operations between different banking systems or to enable 24/7 cross-border transactions	*Initiatives to realize overall improvements to provision of financial services, including payment services through digital means*	*Initiatives to establish regulatory frameworks to regulate foreign private money, foreign retail CBDCs or future cross-border transaction systems, such as cross-border wholesale CBDCs (wCBDCs)*	*Initiatives relevant for international standardization, including adoption of ISO20022, which contributes to smoother information exchange and reporting*
		CBDC that is intended for a wide range of end users (October 2020).		
Korea	• Participated in discussions and surveys by the CPMI and EMEAP regarding enhancements to cross-border payments.	• N/A	• N/A	• Worked with international counterparts on the cooperative oversight of the Continuous Linked Settlement system, providing PvP settlement services for multiple currencies, and with SWIFT (August 2021). • ISO20022 is not fully adopted in BOK Wire+ but partially adopted for cross-border payments.
Lao PDR	• Signed a bilateral MoU on Cooperation in the Area of Financial Innovation and Payment Systems with Thailand (2019), Cambodia (November 2022), and Vietnam (January 2023). • Conducted a survey on a blockchain-based modern payment infrastructure, supported by JICA (2022). • Initiated preparation of a bilateral MoU on Cooperation in the area of AML/CFT programs and activities with Bank Indonesia (in progress).	• Introduced cross-border QR payments between PSPs in Lao PDR and China (June 2020) through acceptance of electronic payments through WeChat Pay, Alipay, and Unionpay QR. • Initiated preparation of cross-border QR code payment linkage with Thailand (between Retail Payment System in the two countries).	• Adopted International Messaging Standard ISO 20022 for Large Value Payment and Settlement System. • Issued BoL decision on Lao QR Code Standard for Payment No.74/BoL, January 28, 2020. • Initiated drafting of BoL Decision on Cross-border Payment (in progress). • Initiated amendment to Law on Payment Systems (in progress). • Initiated drafting of Standard of Message Specification and Business Rule (in progress).	• Issued instructions on Payment Systems Service Providers and Payment Systems service Provider Reporting No.077/PSD (January 2022); International Reporting Standards are yet to be adopted.
Malaysia	• Participated in Project Dunbar with the RBA, MAS, SARB, and the BISIH to develop prototypes of a multi-CBDC shared platform, to enhance the efficiency of cross-border payments (March 2022).	• Launched cross-border QR payment linkages with Thailand (Phase 2), and Indonesia (January 2022). • Pending cross-border QR payment linkage with Singapore (March 2023).	• Enacted the Financial Services Act (Act 758) to, among others, promote safe, efficient, and reliable payment systems and instruments (2013). • Entered into coordination arrangements with the Securities Commission Malaysia (SC) to ensure digital asset activities comply with the laws under the purview of both regulators, including AML/CFT and foreign exchange policy requirements.	• Since June 2022, the RTGS (RENTAS) is able to support dual standards—i.e., the new ISO 20022 messages and the old ISO 15022 messages through a central converter. The message specifications are aligned with the global market practice for implementing a high-value payment system (i.e., HVPS+).
Myanmar	• Issued guidance on CNY-MMK direct payment for China-Myanmar border trade—the participating banks will implement bilateral arrangements to enable direct	• Implemented transaction settlement on trade date T+0 or T+1.	• Issued two notifications (announcement on virtual asset in May 2019 and on digital currency in May 2020); CBDC is not yet allowed in Myanmar.	• Sent real time import and export trade transaction data of the MACCS to the CBM (since September 2019).

Economy	Feature			
	Availability	**Efficiency**	**Regulation**	**Reporting Standards**
	Initiatives to synchronize settlements and operations between different banking systems or to enable 24/7 cross-border transactions	*Initiatives to realize overall improvements to provision of financial services, including payment services through digital means*	*Initiatives to establish regulatory frameworks to regulate foreign private money, foreign retail CBDCs or future cross-border transaction systems, such as cross-border wholesale CBDCs (wCBDCs)*	*Initiatives relevant for international standardization, including adoption of ISO20022, which contributes to smoother information exchange and reporting*
	payment and reduce time (December 2021).			
Philippines	• Began studying the feasibility of using CBDC to facilitate cross-border payments (March 2021). • Signed an enhanced FinTech Cooperation Agreement to facilitate interoperable payments between Singapore and the Philippines, including linkages between real-time payment systems and national or prominent domestic QR code payment schemes in the two countries, to enhance the safety and efficiency of cross-border payments (November 8, 2021). • Engaged BI, BNM, MAS, and BoT to explore the creation of bilateral cross-border payment linkages (2021).	• Signed an MoU with BI to provide a framework for closer coordination between the two central banks in the area of payment systems and digital financial innovation (February 2020). • Signed an MoU with the United Kingdom on the Prosperity Fund, which formalizes the Philippines' participation in the UK-Cross-Government Prosperity Fund, to support activities such as FinTech development, among others (March 2021). • Implemented a next-generation RTGS payment system (August 2021). Dubbed the *PhilPaSS^{plus}*, the system can settle higher volumes of payment instructions at faster speed than the RTGS system that the central bank decommissioned, and provide more access channels for participating institutions. The *PhilPaSS^{plus}* also accepts messages that conform to the globally prescribed ISO20022 standard, which enables the Philippine financial system to integrate with both domestic and cross-border payment ecosystems. • Expressed clear intention in bilateral meetings to create a cross-border payment linkage with Malaysia (2022).	• Announced implementation of CBDCPh—a pilot project to build organizational capacity and hands-on knowledge in CBDC design, architecture, technology, and policy implications (April 2022). Pilot testing of the CBDCPh from 2022 to 2024 covers a wholesale CBDC, evaluated through a 'sandbox' learning environment.	• Started a review of the country's compliance with the Cross-Border Payments and Reporting Plus standard.
Singapore	• Assessed alternative models that could address challenges inherent in cross-border payments and settlements (including wCBDC) under Project Ubin phase 4, in collaboration with the Bank of Canada and the Bank of England (November 2018). • Demonstrated the feasibility of atomic settlement of a cross-border, cross-currency wholesale transaction without the need for a trusted third party by linking experimental wholesale CBDC networks of Singapore and	• Experimented with DvP prototype models in Project Ubin phase 3 that could reduce the settlement cycle of securities to T+1 or even real-time, and offer round-the-clock operation ability (November 2018). • Launched real-time payment system linkage between Singapore's PayNow and Thailand's PromptPay in April 2021. • Launched cross-border QR payment linkage between Singapore's NETS and Thailand's National ITMX in August 2022.	• Introduced the Payment Services Act 2019 that regulates digital payment token service providers (February 2019).	• Demonstrate how an integrated regulatory reporting and data analytics platform (including common data models for machine-executable reporting and advanced analytics) could enable supervision to be responsive to emerging risks under Project Ellipse (led by the BISIH Singapore Centre, in collaboration with MAS and the BoE) (March 2022).

Economy	Feature			
	Availability	**Efficiency**	**Regulation**	**Reporting Standards**
	Initiatives to synchronize settlements and operations between different banking systems or to enable 24/7 cross-border transactions	*Initiatives to realize overall improvements to provision of financial services, including payment services through digital means*	*Initiatives to establish regulatory frameworks to regulate foreign private money, foreign retail CBDCs or future cross-border transaction systems, such as cross-border wholesale CBDCs (wCBDCs)*	*Initiatives relevant for international standardization, including adoption of ISO20022, which contributes to smoother information exchange and reporting*
	Canada (based on different DLT platforms), through Jasper-Ubin in collaboration with the Bank of Canada (May 2019). • Launched the Proxtera platform jointly with Infocomm Media Development Authority to promote financial inclusivity and digitalization among small-and-medium enterprises (December 2020). • Facilitated the establishment of Partior by DBS, JPMorgan, and Temasek—an open industry platform to transform and accelerate interbank value movements, for payments, trade, and foreign exchange settlement through DLT (April 2021). • Published a technical blueprint for multilateral connectivity of fast payment systems under project Nexus (led by the BISIH Singapore Centre), and commenced a technical pilot involving multilateral connectivity of the fast retail payment systems of Singapore, Malaysia, and the Euro area (July 2021). • Signed an enhanced FinTech Cooperation Agreement with the Philippines to collaborate on interoperable payment systems (November 2021). • Developed two prototypes for a wholesale multi-CBDC platform that could facilitate direct settlement of cross-border, cross-currency transactions between financial institutions under project Dunbar (led by the BISIH Singapore Centre, in collaboration with RBA, BNM, MAS, and SARB), and which had significant potential to reduce the cost and increase the speed of cross-border settlements (March 2022).	• Launched real-time payment system linkage between Singapore's PayNow and India's Unified Payments Interface (PN-UPI) in February 2023. • Pending real-time payment system linkage with Malaysia, and cross-border QR payment linkage with Malaysia and Indonesia.		
Thailand	• Created a cross-border wCBDC system that can be operated 24/7, in proof-of-concept	• Launched cross-border QR payment platform for Thai consumers in Japan (December 2018). [Private sector initiative].	• The Payment Systems Act B.E. 2560 (2017) was enacted in 2018 to improve the	• Provided real-time reporting for all transaction types, (Inthanon-LionRock) (January 2020).

Economy	Feature			
	Availability	**Efficiency**	**Regulation**	**Reporting Standards**
	Initiatives to synchronize settlements and operations between different banking systems or to enable 24/7 cross-border transactions	*Initiatives to realize overall improvements to provision of financial services, including payment services through digital means*	*Initiatives to establish regulatory frameworks to regulate foreign private money, foreign retail CBDCs or future cross-border transaction systems, such as cross-border wholesale CBDCs (wCBDCs)*	*Initiatives relevant for international standardization, including adoption of ISO20022, which contributes to smoother information exchange and reporting*
	wCBDC Project Inthanon-LionRock with the HKMA (January 2020). • Renamed Project Inthanon-Lionrock "mBridge" with the joining of CBUAE, PBC DCI, and BISIH (February 2021).	• Signed an MoU with Lao PDR on developing a QR payment linkage (April 2019). • Introduced the PayNow-PromptPay linkage with the MAS that allows near-instant transfers of up to SGD 1,000 or THB 25,000 per user per day. Transaction speeds fell from about one or two working days to a few minutes (April 2021). • Launched cross-border QR payment linkage with Cambodia (February 2020), Vietnam (March 2021), Malaysia (June 2021), Indonesia (August 2021), and Singapore (September 2021).	oversight and supervision of the payment systems and payment services. • Ensured compliance with Thailand regulation on daily outstanding balance limit (Inthanon-LionRock) (January 2020).	
Vietnam	• N/A	• Launched the Interoperable QR Payment Linkage between Vietnam and Thailand (March 2021).	• Issued Regulation on QR Code Standardization: "QR Code Specifications Display from Accept Payment Unit in Vietnam" (October 2018).	• Adopted SWIFT message delivery and ISO15022 messaging standards. • Announced plan to adopt SWIFT ISO20022 between 2022 and 2025.

Sources: National authorities; and AMRO staff compilation.
AML/CFT = anti-money laundering/ combating the financing of terrorism, BI = Bank Indonesia, BIS = Bank for International Settlements, BISIH = Bank for International Settlements Innovation Hub, BNM = Bank Negara Malaysia, BoC = Bank of Canada, BoE = Bank of England, BoJ = Bank of Japan, BoT = Bank of Thailand, CBM = Central Bank of Myanmar, CBUAE = Central Bank of the UAE, CNY = Chinese yuan, CPMI = Committee on Payments and Market Infrastructures, DLT = distributed ledger technology, DvP = delivery-versus-payment, ECB = European Central Bank, EMEAP = Executives' Meeting of Asia-Pacific Central Banks, FPS = Faster Payment System, HKD = Hong Kong dollar, HKMA = Hong Kong Monetary Authority, IO = international organization, ISO = International Organization for Standardization, JICA = Japan International Cooperation Agency, MACCS = Myanmar Automated Cargo Clearance System, MAS = Monetary Authority of Singapore, MMK = Myanmar kyat, MoU = memorandum of understanding, PBC = People's Bank of China, PBC DCI = Digital Currency Institute of the People's Bank of China, PSP = payment service provider, PvP = payment-versus-payment, QR = Quick Response, RBA = Reserve Bank of Australia, RTGS = real-time gross settlement, SARB = South African Reserve Bank, SC = Securities Commission Malaysia , SGD = Singapore dollar, SWIFT = Society for Worldwide Interbank Financial Telecommunications, THB = Thai baht, wCBDC = wholesale CBDC.

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Appendix II. List of Project Interlocutors

Appendix Table 2. Interlocutors Based in the ASEAN+3 and Their Business Lines

Counterpart	Business
8Percent	P2P lending
Asosiasi Blockchain Indonesia	Trade association
Asosiasi Fintech Indonesia	Trade association
Bank Indonesia	Central bank
Bank Negara Indonesia	Commercial bank
Bank Negara Malaysia	Central bank
Bank of Japan	Central bank
Bank of Korea	Central bank
Bank of the Lao PDR	Central bank
Bangko Sentral Ng Pilipinas	Central bank
Banque Pour Le Commerce Exterieur Lao Public	Commercial bank
Binance	Virtual asset service provider
BIS Innovation Hub Centre	Developer of public goods in the technology space to support central banks
Bitqik	Virtual asset service provider
Brunei Darussalam Central Bank	Central bank
Cacco	Fraud detection
Central Bank of Myanmar	Central bank
Circle	Virtual asset and payment technology firm
Coinbase	Virtual asset service provider
CoinCheck	Virtual asset service provider
Coins.ph	Virtual asset service provider and e-wallet
Commodity Futures Trading Regulatory Agency Indonesia (Bappebti)	Supervisor and regulator
Crowd Credit	Cross-border P2P lending
DBS	Commercial bank
Deemoney	Remittance service
Dr. Akhis R. Hutabarat	Academic
Dr. Bongkyu Kim, Kangwon National University	Academic
Dr. Toshitaka Sekine, Hitotsubashi University	Academic
Dumanu	Virtual asset service provider
Future Institute of Research	Think tank
G+D Filia	Technology provider

Counterpart	Business
GLN International	Remittance and cross-border payment service
GoTo-Financial	E-wallet, buy-now-pay-later, FinTech technology provider
Grab	Technology firm
Ground X	Technology provider
HSBC	Commercial bank
Indonesia Financial Services Authority (OJK)	Supervisor and regulator
Japan Financial Services Agency	Supervisor and regulator
Japan Ministry of Finance	Supervisor and regulator
JP Morgan	Investment bank
KaKaoBank	Digital Bank
Klaytn Foundation	Blockchain developer and technology provider
Kookmin Bank	Commercial bank
Korea Financial Services Commission	Supervisor and regulator
Korea Financial Supervisory Service	Supervisor and regulator
Korea Fintech Association	Trade association
Korea Ministry of Economics and Finance	Finance ministry
Mizuho Bank	Commercial bank
Monetary Authority of Singapore	Central bank
MUFG Bank	Commercial bank
National Bank of Cambodia	Central bank
NIUM	Digital cross-border money transfer firm
Nomura Research Institute	Think tank
Opn	Digital payment service provider
OVO	E-wallet
PayPay	E-wallet
PDAX	Virtual asset service provider
The People's Bank of China	Central bank
R3	Blockchain infrastructure provider
Securities Commission Malaysia	Supervisor and regulator
Siam Commercial Bank	Commercial bank
Sigmaphi Research	Academic/ Analyst/ Researcher
Soramitsu	Blockchain infrastructure provider
State Bank of Vietnam	Central bank
Temasek	Sovereign wealth fund
Thailand FinTech Association	Trade association

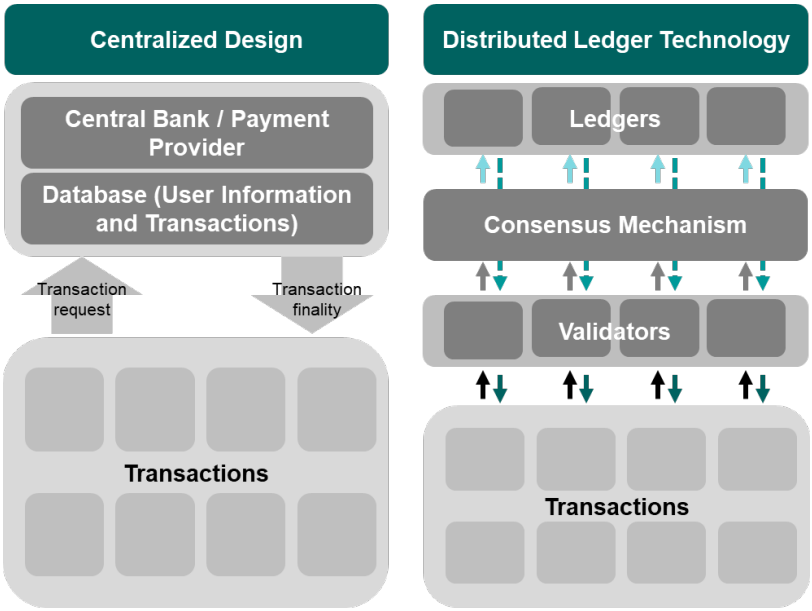
Counterpart	Business
The Securities and Exchange Commission, Thailand	Supervisor and regulator
Tonik Digital Bank	Digital bank
TrueMoney	E-wallet
U-money	E-wallet
UnionBank of the Philippines	Commercial bank
Payments Network Malaysia Sdn. Bhd.	National payments network
WireBarley	Remittance service
Xendit	Technology provider
ZendMoney	Remittance service

Appendix III. Relationship between Distributed Ledger Technology and Blockchain

Distributed Ledger Technology (DLT) refers to the infrastructure and protocols that enable multiple computers at different locations to validate, retrieve, update, and access information in a synchronized and immutable manner. Traditionally, such sharing would require a central entity to ensure the consistency of information and avoid data manipulation. This central entity would manage the master data copy and periodically update and broadcast to system participants. DLT, on the other hand, aims to enable a "decentralized" network that would allow information to be synchronized without a central entity.

A DLT system is managed by multiple entities, known as validators. In a public DLT system, such as that of Bitcoin, anyone can participate as a validator. Each validator stores a copy of the database and synchronizes with others through a coded mechanism in the system, known as a "consensus mechanism." This mechanism is used to decide how new information should be updated in the ledger and broadcast to the network (Appendix Figure 1). In a public DLT, the process has to be sufficiently robust to ensure transaction validity, thus affecting the efficiency of the network and increasing the costs. To date, CBDC implementations of DLT have tended to only allow limited validators, which both simplify the validation process and ensure that the validators are trusted (Pande and Quách 2022).

Appendix Figure 1. CBDC: Technological Architecture



Source: Pande and Quách (2022).

Blockchain, the technology behind virtual assets such as Bitcoin and Ethereum, is a type of DLT. In a blockchain system, transaction information is stored in an append-only manner. The time and sequence of each transaction are recorded and confirmed in blocks, along with transaction values and the participants' addresses. The validators will confirm the validity of a block, which contains multiple time-stamped transactions, and produce a hash as a unique identifier of all of the block information. Every block also contains the hash of the

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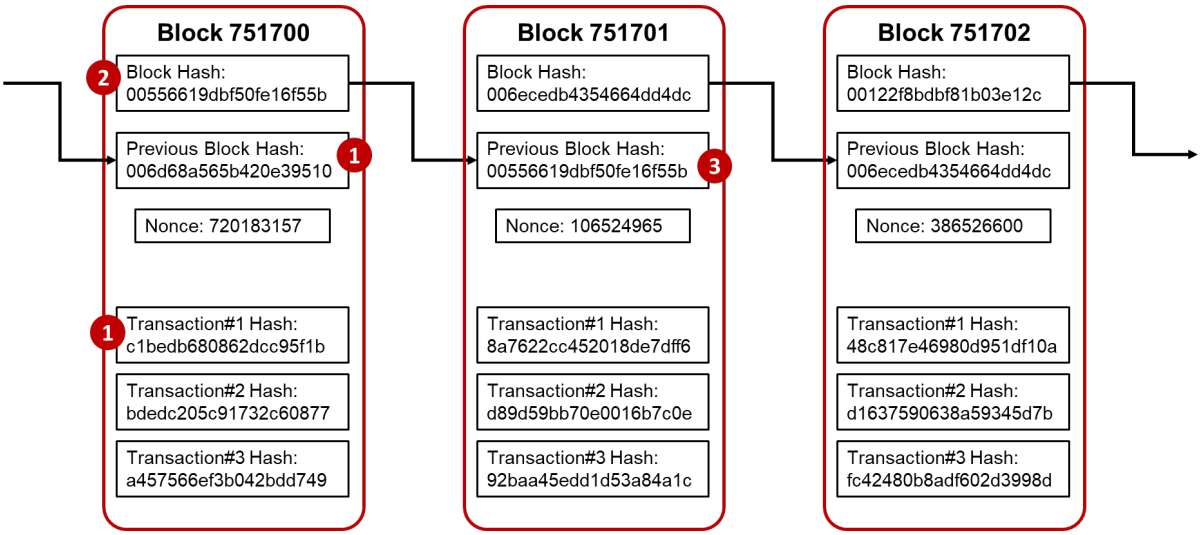
previous block, which is used with the transaction information to produce the current unique hash. This sequence of unique hashes connects blocks together and forms a time-ordered sequential chain of data (Appendix Figure 2). This feature creates the immutability of the blockchain, given that validated transactions can be manipulated only if all of the related blocks are manipulated.

The interconnected and immutable aspects of blockchain enable the absolute traceability of assets. Given that every transaction has to be validated and recorded in a block, anyone who has access to the ledger can obtain the full transaction history of an address, as well as its recipients and senders. This allows the possibility of mapping the flow of a certain fund as well as the users from end-to-end. In public blockchains, this traceability has allowed centralized exchanges to identify and freeze funds retrieved from illegal activities, such as hacks or scams. However, the recent development of blockchain masking services and decentralized exchanges have limited the ability to target fraud (Browne 2022).

Appendix Figure 2. Illustration of a Blockchain



Source: AMRO staff visualization.
Note: Multiple transactions and the previous block hash are stored in a new block "1." The information of each transaction, including the senders, receivers, time, and transaction amounts are encrypted into hashed codes. From this information, validators will produce a block hash "2," which will be used as one of the inputs that will form the next block "3."

Appendix IV. ASEAN+3: Modeling the Spillover Effects of Global Financial Digitalization

The large-scale, micro-founded dynamic stochastic general equilibrium (DSGE) AMRO Global Macro-Financial Model (AGMFM) is employed to simulate the benefits of worldwide FinDig for the ASEAN+3 region. The AGMFM is described in some detail in Tang (2022). It covers 48 economies, including all 14 ASEAN+3 members, and 45 industries to build a detailed global industrial input-output structure and model cross-country and cross-industry linkages, drawing on information from the OECD Inter-Country Input-Output (ICIO) Tables (OECD 2021).

The growth of the FinDig business segment in each economy is propelled by factors largely recognized in economic theory on FinDig development. They comprise the capital utilization rate, growth in labor force, private capital accumulation, productivity improvement, and public capital accumulation (Appendix Figure 3). Factors driving FinDig across all economies covered by the AGMFM are assumed to perform at their corresponding historically highest levels (from 1995–2018) over the following three years, from end-2017 to end-2020 for the pre-pandemic period, and from end-2021 to end-2024 for the post-pandemic period.[27] Consequently, the growth of a particular economy and its spillover effects to those of other economies are affected through the input-output relationships between all industries of all economies. Details of the exercise are as follows:

- The FinDig business segment of each economy covered by the AGMFM is extracted from the five major FinDig-related industries in those economies (Appendix Figure 4). The industries comprise electronics, financial services, information technology services, telecommunications, and wholesale and retail, based on evidence such as whether firms worldwide, in the 45 industries of the OECD ICIO Tables, have significant FinDig-related businesses.[28]

- The data set comprising 13,373 listed firms, covering the five FinDig-related industries in most of the economies represented in the DSGE model, is obtained from the Wind database. Calculations indicate that, on average, 9.8 percent of the world's financial service industry's production-related businesses may be classified as a FinDig business segment, as does 38.5 percent of the electronics industry, 21.5 percent of the telecommunications industry, 21.5 percent of the IT services industry, and 8.4 percent of the wholesale and retail industry.

- The World Bank's Global Findex Database filters out indicators reflecting differences in the level of the development and popularity of FinDig-related services (such as digital payments) in different economies (Demirgüç-Kunt and others 2018, 2022). It is used to adjust the percentages shown for the five FinDig-related industries that are

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[27] The historical interval from 1995–2018 is covered by OECD ICIO Tables used in the calibration of the AGMFM.

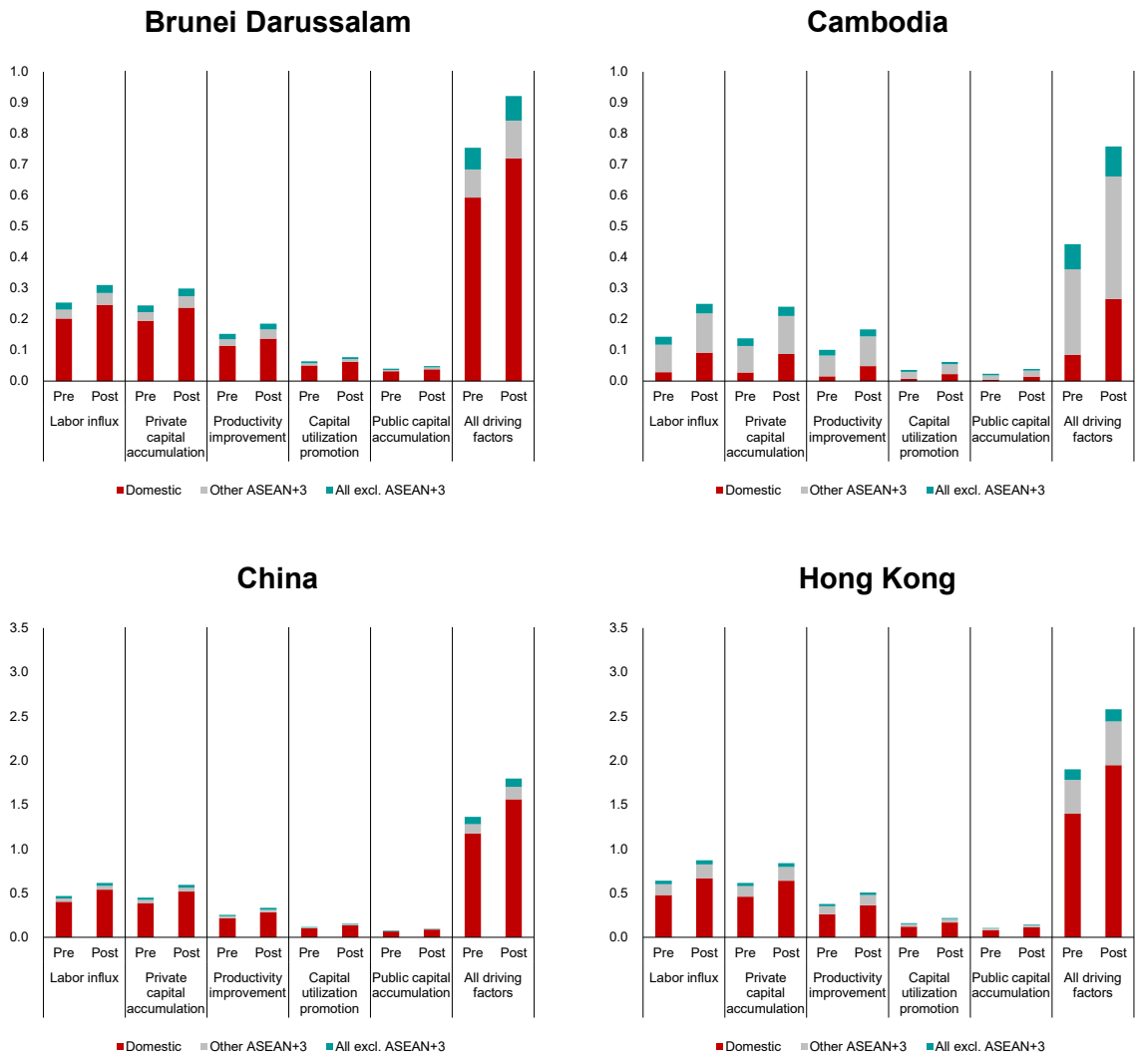
[28] For example, FinDig in China and some of the ASEAN+3 economies have been largely facilitated by their FinTech giants, such as Alibaba, Shopee, Lazada, and JD, which predominantly operate in the wholesale and retail industry, hence its inclusion as a key FinDig-related industry.

classified into a newly-constructed proxy FinDig business segment for each economy.

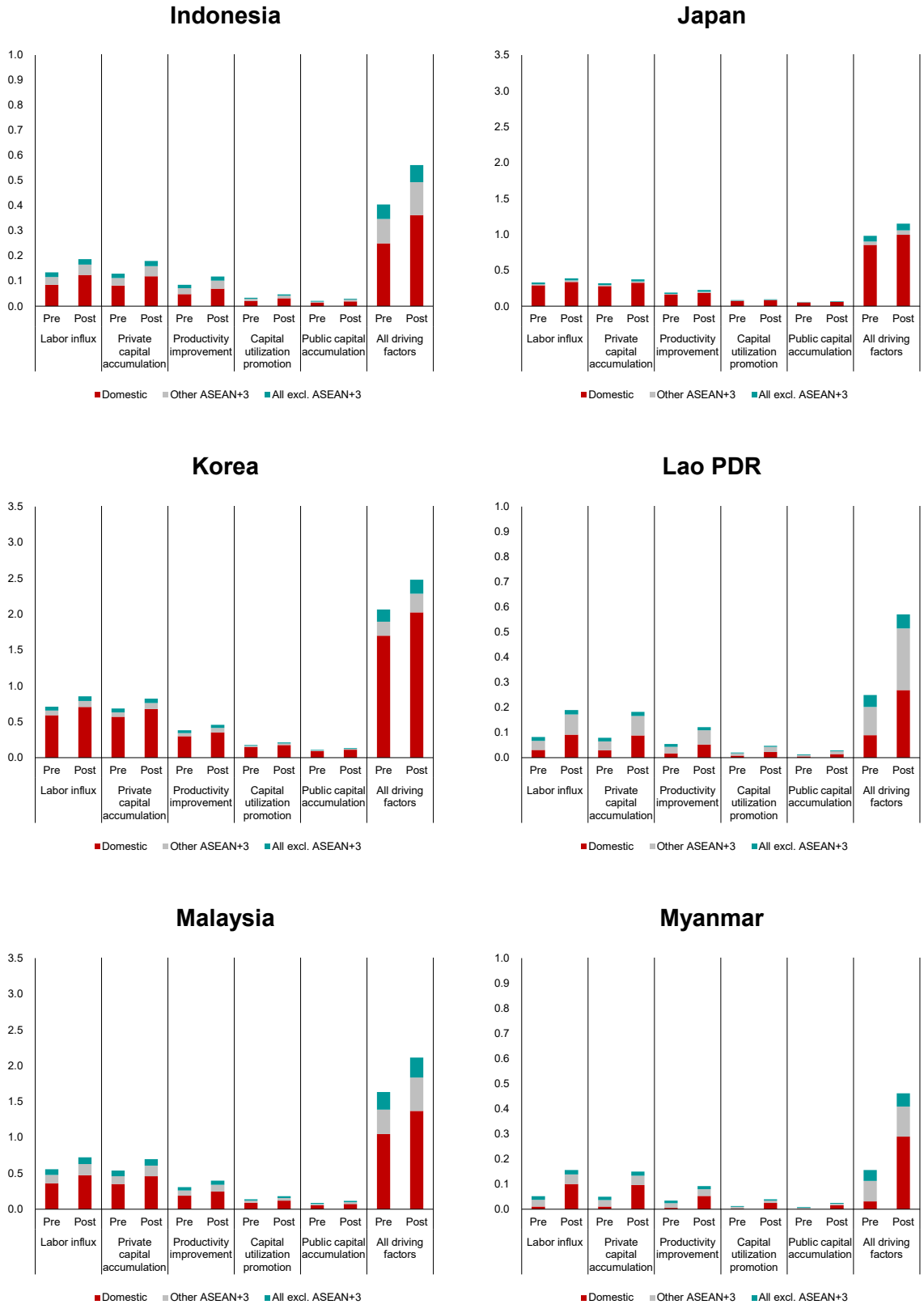
The newly constructed FinDig business segment of each economy constitutes the FinDig-related structure of that economy. Its input-output relationships with all other industries of all economies are based on the input-output relationships of the five FinDig-related industries in its economy with all other industries in all economies, which are published in the OECD ICIO Tables.

Appendix Figure 3. ASEAN+3: Impact of Global FinDig-Related Driving Factors on Real GDP, Pre- and Post-Pandemic

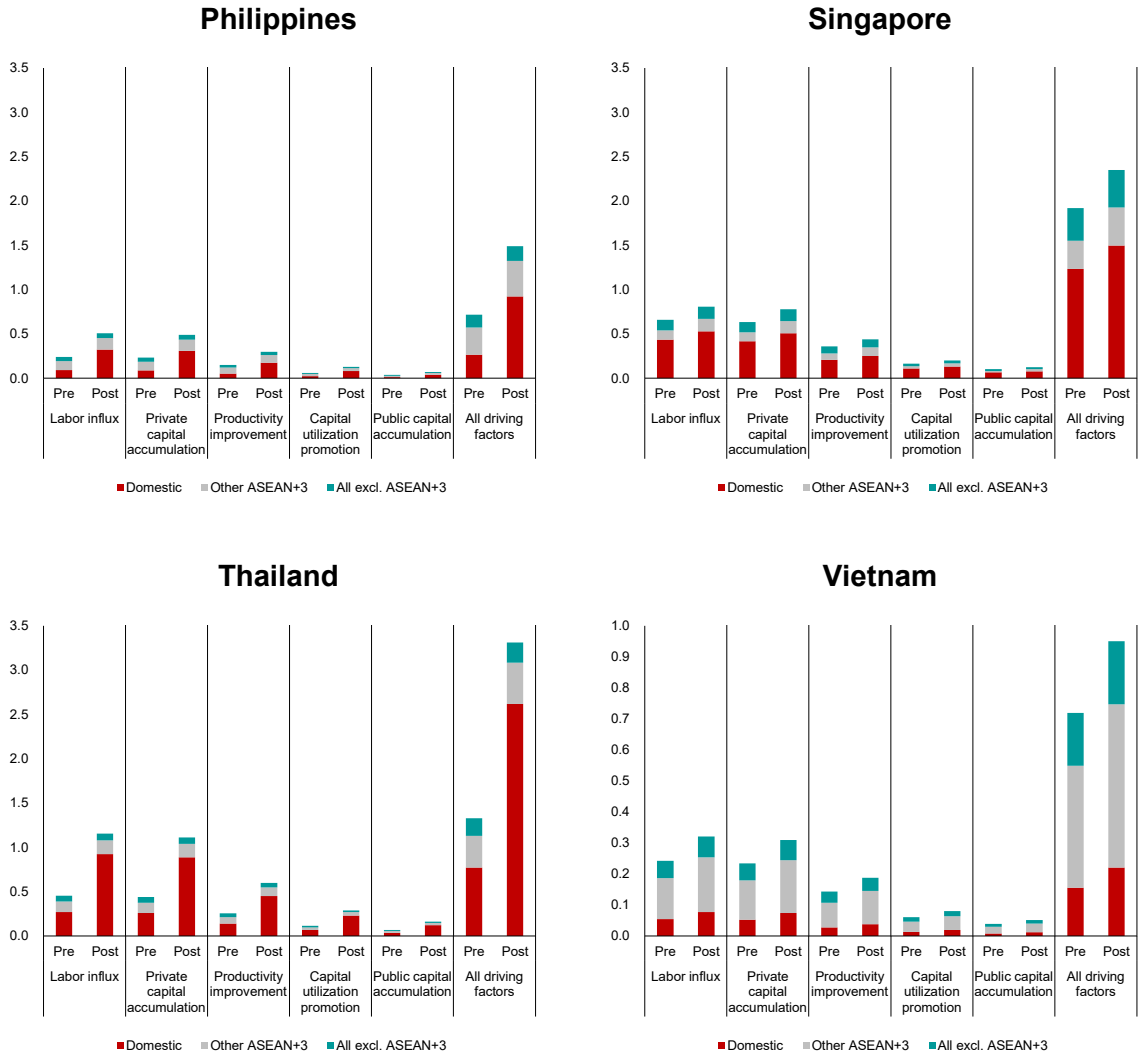
(Percent, annual average over the following 12 quarters pre- and post-pandemic)



Appendix Figure 3. Impact of Global FinDig-Related Driving Factors on Real GDP
(Percent, annual average over the following 12 quarters pre- and post-pandemic)
(Continued)



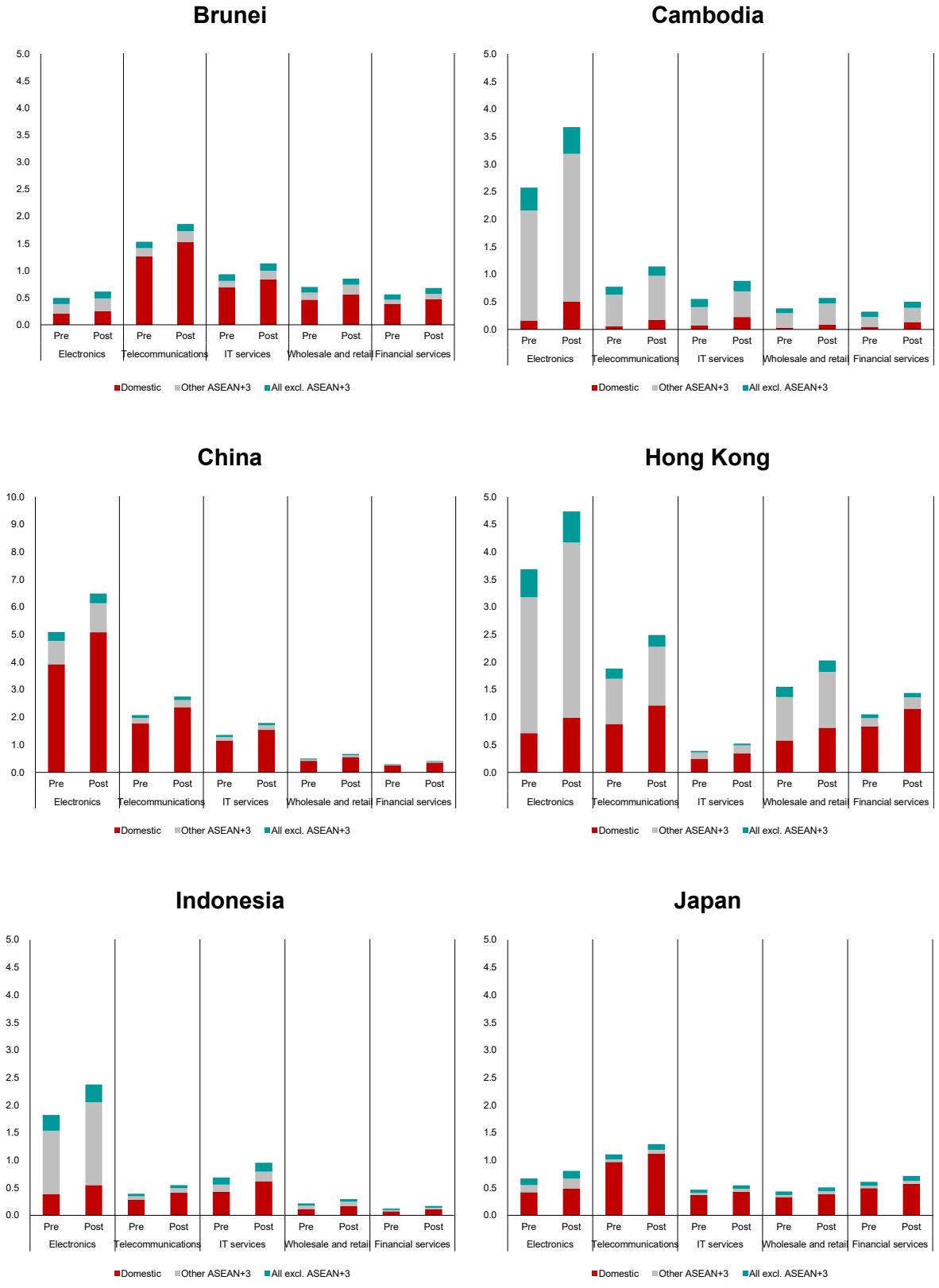
Appendix Figure 3. Impact of Global FinDig-Related Driving Factors on Real GDP
(Percent, annual average over the following 12 quarters pre- and post-pandemic)
(Continued)



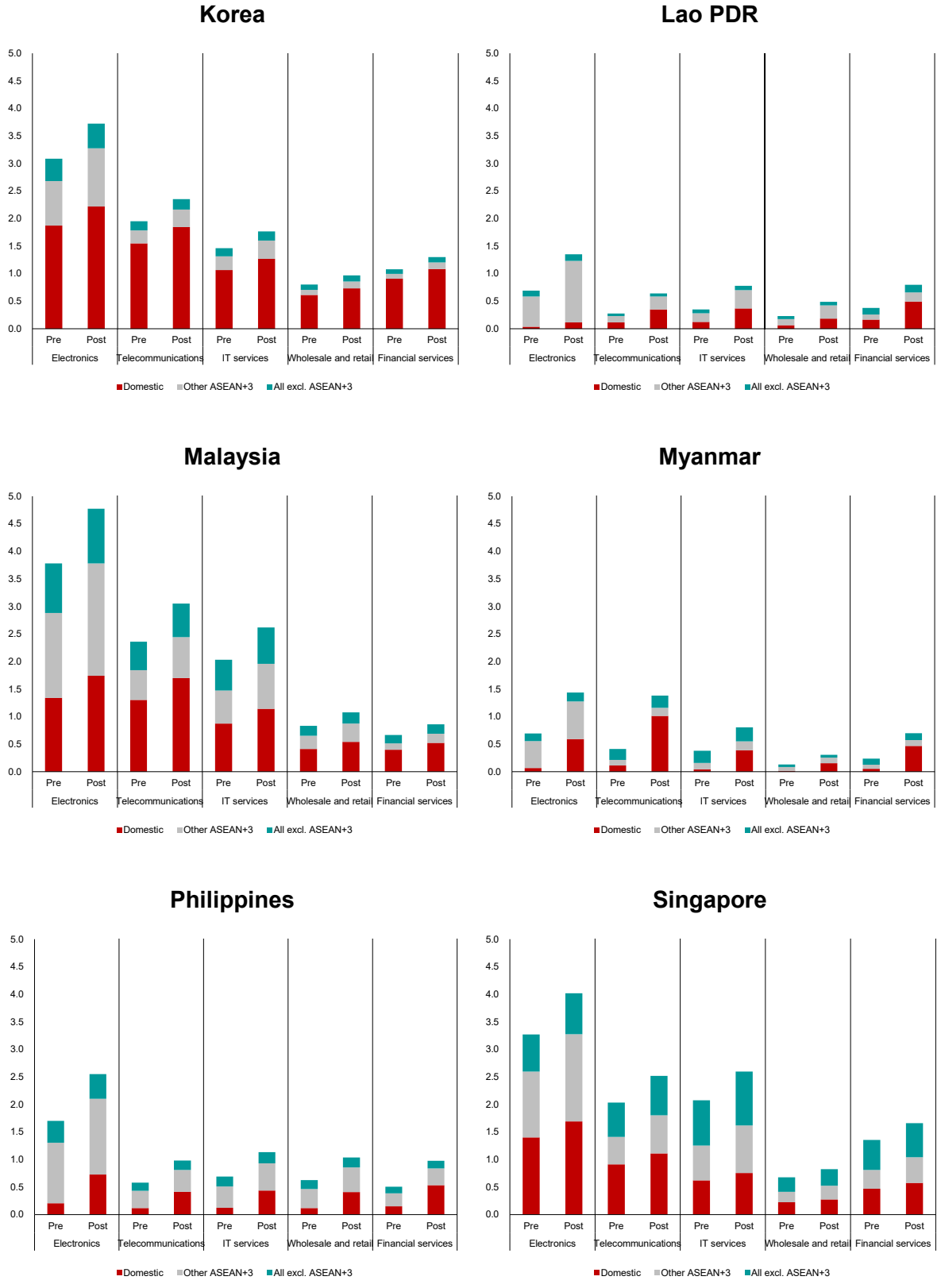
Sources: OECD; Wind; World Bank; and AMRO staff estimates.
Note: Pre = Pre-pandemic, from end-2017 to end-2020, Post = Post-pandemic, from end-2021 to end-2024.

Appendix Figure 4. ASEAN+3: Impact of Global FinDig on the Real Output of Selected Industries, Pre- and Post-Pandemic

(Percent, annual average over the following 12 quarters pre- and post-pandemic)

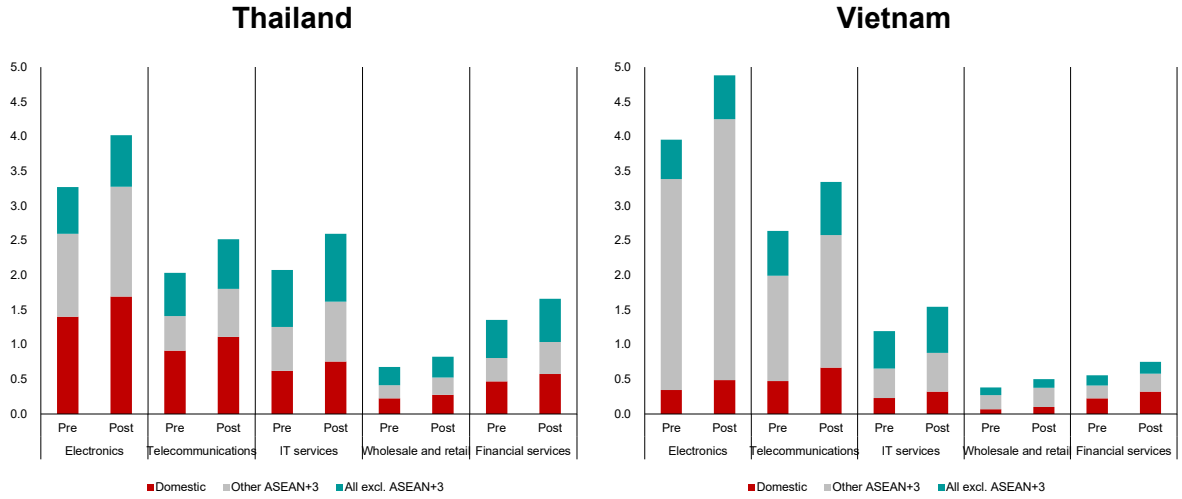


Appendix Figure 4. ASEAN+3: Impact of Global FinDig on the Real Output of Selected Industries
(Percent, annual average over the following 12 quarters pre- and post-pandemic)
(Continued)



Appendix Figure 4. ASEAN+3: Impact of Global FinDig on the Real Output of Selected Industries

(Percent, annual average over the following 12 quarters pre- and post-pandemic)
(Continued)



Sources: OECD; Wind; World Bank; and AMRO staff estimates.
Note: Pre = Pre-pandemic, from end-2017 to end-2020, Post = Post-pandemic, from end-2021 to end-2024. All the major FinDig-related industries are based on the classification standard of the OECD ICIO Tables (OECD 2021). "Electronics" is an abbreviation for the computer, electronic, and optical equipment industry; "financial services" is an abbreviation for the financial and insurance activities industry; "telecommunications" is an abbreviation for the telecommunications industry; "IT services" is an abbreviation for the IT and other information services industry; "wholesale and retail" is an abbreviation for the wholesale and retail trade and repair of motor vehicles industry.

Appendix V. Recording Mobile Money Remittances in the Balance of Payments

Cross-border FinDig could see increasing inaccuracies in the BoP. The emergence of nonbank entities and increasing popularity of mobile money (MoM), virtual assets, and FinTech suggest that the share of unrecorded cross-border transactions could keep growing—at least until adjustments are eventually made to the current reporting system. According to IMF (2009), the International Transactions Reporting System—a data collection system that obtains data from reporters at the level of individual transactions—only covers institutions regulated by the central bank, which include the banking sector (including the central bank) and selected firms ("direct reporters") that report directly to the institution compiling a country's balance of payments (BoP). At this stage, many of the private firms involved in FinDig remain largely outside the purview of financial supervisors.

To address the reporting issue, OECD, WTO, and IMF (2020) proposes a mechanism for sharing existing national and international efforts to measure digital trade and/or dimensions of it, to identify and develop best practices. The report provides an example of how transactions for an economy whose residents receive or send money abroad through mobile services would be recorded in the BoP. A big challenge for the BoP compiling institution is that these operations are usually packaged as a single product, although they actually cover several very distinct areas: telecommunications, financial, and technical intermediation services. These services may vary, from those related to the deposit, withdrawal, transfer, and foreign exchange conversions of money, to the transmission of messages notifying senders and recipients of transferred funds and account balances, and even cover fees for agents that facilitate the conversion of MoM to cash, and vice versa.

International MoM services cover the transfer of funds between residents and nonresidents with the help of telecommunications firms. These services are not confined to national borders—residents can use the roaming network services of a nonresident telecommunications firm for MoM transactions, and vice versa. Residents and nonresidents may also use the MoM services of their respective telecommunications firms to arrange for such cross-border transactions. During a cross-border transfer, funds are credited to and debited from the respective MoM accounts of the recipient and sender in the two jurisdictions where they each reside. Besides the resident and nonresident telecommunications firms, which typically represent the MoM service provider, other third parties commonly involved in this operation are:

- An MoM agent, which is usually owned by the telecommunications firm that provides a mobile MoM and has the authority to register MoM customers, make deposits of virtual money into registered customers' accounts, and process cash withdrawal requests from accounts that have virtual money.
- A technical integration partner.
- Commercial banks that provide the accounts where the actual float is maintained.

Revenues from cross-border transactions are shared between the multiple resident and nonresident commercial players involved, based on a preexisting agreement. Information on the overall size of the collected fees and commissions and how they are

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shared among the different agents involved in executing international transactions is not always available. The commercial banks reportedly do not receive any share of the transaction fee. OECD, WTO, and IMF (2020) describes the potential transactions that should be recorded in the BoP of the resident's country when a cross-border transfer of MoM occurs. The debit and credit entries arise from the transaction fees first collected by the sender's telecommunications firm and then shared with the nonresident service providers involved in the transaction, based on their established revenue-sharing agreement (Appendix Table 2). These fees include roaming services, charges for acquisition, transfer, conversion, withdrawal and spending of virtual money, and other commissions:

- Scenarios 1–4 assume that residents and nonresidents use the MoM services of their respective telecommunications service providers to carry out the transaction. When a resident in the reporting country sends MoM abroad through the platform of a resident telecommunications firm, there is a debit transaction to be recorded in the BoP to account for the fees/commissions charged by the nonresident telecommunications firm of the recipient. Where the resident telecommunications firm uses the services of a nonresident integration technical partner, the latter's share of revenue also needs to be recorded in the debit column. Similarly, for residents receiving MoM from abroad using a telecommunications firm resident in the reporting country, credits should be recorded for the transaction.

- Scenarios 5–8 assume that residents may use a foreign telecommunications firm's roaming network for transfers of MoM, similar to nonresidents. The debit transactions for the reporting country arise when residents send or receive MoM across borders using a MoM platform that is resident in another country. The opposite cases for nonresidents would prompt changes to the credit column.

- Scenarios 9–10 show that in cases when the customer uses a foreign MoM service provider, spending or withdrawal of MoM could incur certain costs charged by the nonresident telecommunications firm, which should also be recorded in the BoP.

Appendix Table 3. Balance of Payments: Treatment of Mobile Money Transactions through Nonbank Entities

Cross-Border Mobile Money Transaction Scenario	Recording in the Balance of Payments of the Resident Economy	
	Credit	Debit
1. Residents **sending** mobile money (MoM) using the services of a **resident** telecommunications firm.		Charges levied by the resident telecommunications firm are then shared with the recipient's telecommunications firm.
2. Residents **receiving** MoM using the services of a **resident** telecommunications firm.	Revenues collected by the sender's telecommunications firm are then shared with the resident telecommunications firm.	
3. Residents **sending** MoM using the services of a resident telecommunications firm, which uses a **nonresident** integration technical partner.		Charges levied by the resident telecommunications firm are shared with the recipient's telecommunications firm and the nonresident integration technical partner.
4. Residents **receiving** MoM using the services of a resident telecommunications firm, which uses a **resident** integration technical partner.	Revenues collected by the sender's telecommunications firm are then shared with the resident telecommunications firm and the resident integration technical partner.	
5. Residents **sending** MoM using the services of a **nonresident** telecommunications firm.		Charges are levied by the nonresident telecommunications firm.
6. Residents **receiving** MoM using the services of a **nonresident** telecommunications firm.		Charges are levied by the nonresident telecommunications firm.
7. Nonresidents **receiving** MoM using the services of a **resident** telecommunications firm.	Revenues are collected by the resident telecommunications firm.	
8. Nonresidents **sending** MoM using the services of a **resident** telecommunications firm.	Revenues are collected by the resident telecommunications firm.	
9. Residents **spending/ withdrawing** MoM using the services of a **nonresident** telecommunications firm.		Charges are levied by the nonresident telecommunications firm.
10. Nonresidents **spending/ withdrawing** MoM using the services of a **resident** telecommunications firm.	Revenues levied by the resident telecommunications firm.	

Sources: OECD, WTO, and IMF (2020); and AMRO staff compilation.

Appendix VI. A Comparison of Financial Digitalization Developments in the ASEAN+3 Region

Appendix Table 4. ASEAN+3: Cross-Border Financial Digitalization Positions and Perspectives

Member	Dimension								
	Roadmap/Masterplan and Responsible Agency	**Stance on CBDC**	**Stance on Virtual Assets**	**Adoption of Virtual Assets**	**Stance on the Role of Public versus Private Sectors**	**Cross-Border Virtual Asset Transactions**	**Currency Substitution Concerns**	**International Collaboration**	**Wish List for Project Outcome**
	Existence of formal strategy and agency(ies) responsible for execution and regulation	*Position on issuance of wholesale/retail CBDC*	*Position on virtual assets*	*Degree of adoption of virtual assets by the public*	*Position on public and private sector roles in developing FinDig*	*Experiences with and positions on cross-border virtual asset transactions*	*Strategy(ies) to guard against currency substitution by virtual assets and foreign payment systems*	*International memberships and initiatives taken in collaboration with other jurisdictions*	*Possible area(s) for regional cooperation and collaboration*
Brunei Darussalam	• There is a road map/ masterplan: Digital Economy Masterplan 2025, published by the Digital Economy Council. • FinTech activities and the payment system are regulated by the BDCB. • The FinTech Regulatory Sandbox was introduced in 2017.	• There is no official position.	• Virtual assets are not regulated and virtual asset transaction data are not collected. • Customer protection is prioritized and warnings on virtual asset trading and activities has been issued.	• Virtual assets are held by an estimated 0.8 percent of the total population (triple-A).	• The public sector aims to provide policy direction for digital infrastructure, prioritizing safety and stability. • The private sector focuses on product implementation and innovation, and leverages its understanding of customer segments.	• Regulations around reporting standards and customer identification are in progress. • Alternate payment systems, such as BNPL and BigTech, are not a concern presently.	• Currency substitution is not considered a significant risk presently. • Foreign e-wallet payments are limited to some foreign workers only.	• Application for membership of The Global Financial Innovation Network has been submitted. • Recommendations made by FATF and other such bodies are closely adhered to.	• The FinDig project should evolve to: o provide updates on FinDig progress in the region and discuss regulatory implications; o provide information on related ASEAN+3 working groups and committees; o advise on regulatory approaches and data collection; o develop a framework of common metrics to measure FinDig efforts.
Cambodia	• There are two road maps/masterplans: Cambodia Digital Economy and Society Framework 2021–2035, and Cambodian Digital Government Policy 2022–2035.	• There is no official position.	• Virtual assets are not regulated and virtual asset transaction data are not collected.	• Virtual assets are held by an estimated 3.3 percent of the total population (triple-A).	• Public-private-partnerships are encouraged. • The promulgation of regulations and maintenance of the payment system should be the purview of the public sector. • Communications between the public and the private sectors are facilitated through fora and trade associations.	• Daily cross-border transaction amounts through cross-border payment applications are limited.	• Currency substitution is not considered a significant risk presently. • Foreign e-wallets are required to partner with local licensed institutions and follow domestic regulations.	• A cross-border payment initiative with Thailand is in progress.	• N/A
China	• There is a road map/ masterplan: FinTech Development Plan 2022–25. • Introduced the FinTech Innovation Regulatory Trials in 2019. • The PBC DCI is responsible for the development and promotion of the e-CNY.	• A CBDC should take the role of a universal payment instrument, covering the total population and every type of business. • Issued a paper discussing the progress of research and development of e-CNY. • The PBC DCI is responsible for the development and promotion of the e-CNY.	• Implemented a total ban on virtual asset transactions in 2021.	• Virtual assets are held by an estimated 5.5 percent of the total population (triple-A); an estimated 9 percent of surveyed adults owned or used virtual assets in 2022 (Statista).	• The public sector ensures that participants are treated equally and provides the infrastructure to improve financial inclusion and avoid fragmentation.	• Virtual assets are banned.	• Currency substitution is not a concern. • Any use of CBDC should follow the do-no-harm principle. • The interoperability of cross-border payments should be enhanced to promote and ensure conversion of transactions to local currency.	• Participated in Project mBridge, in which real-value cross-border transactions were settled, to explore the cross-border uses of CBDC. • Cross-border development of CBDC should follow three principles: (1) do no harm, (2) ensure compliance with domestic and international regulations, and (3) ensure interoperability between cross-border	• N/A

Member	Dimension								
	Roadmap/Masterplan and Responsible Agency	**Stance on CBDC**	**Stance on Virtual Assets**	**Adoption of Virtual Assets**	**Stance on the Role of Public versus Private Sectors**	**Cross-Border Virtual Asset Transactions**	**Currency Substitution Concerns**	**International Collaboration**	**Wish List for Project Outcome**
	Existence of formal strategy and agency(ies) responsible for execution and regulation	*Position on issuance of wholesale/retail CBDC*	*Position on virtual assets*	*Degree of adoption of virtual assets by the public*	*Position on public and private sector roles in developing FinDig*	*Experiences with and positions on cross-border virtual asset transactions*	*Strategy(ies) to guard against currency substitution by virtual assets and foreign payment systems*	*International memberships and initiatives taken in collaboration with other jurisdictions*	*Possible area(s) for regional cooperation and collaboration*
		• Launched a large-scale retail CBDC pilot in 2020.						CBDC systems and domestic system.	
Hong Kong	• Announced seven Smart Banking initiatives in 2017. • There is a road map/ masterplan: Fintech 2025. • Issued a policy statement on the development of virtual assets in Hong Kong. • FinTech activities and the payment system are regulated by regulators such as the Securities and Futures Commission and the Hong Kong Monetary Authority.	• Wholesale CBDC: A common multi-CBDC platform can improve cross-border payment speed and efficiency, reduce settlement risks, and support the use of local currencies in international payments. Project mBridge completed a pilot in September 2022, in which real-value cross-border transactions were settled. The report was published in October 2022. • Retail CBDC: It is necessary to start paving the way for possible future implementation of an e-HKD. The HKMA is laying the groundwork for potential implementation through the adoption of a three-rail approach. A technical whitepaper and a policy discussion paper were published in October 2021 and April 2022. A position paper was published in September 2022 and an e-HKD pilot program was launched in November 2022.	• The government and financial regulators are working toward providing a conducive environment for sustainable and responsible development of the virtual asset sector, based on the "same activity, same risks, same regulation" principle, with guardrails to mitigate risks in line with international standards. • Retail distribution is presently allowed for a limited suite of virtual asset-related derivative products—traded on specified, conventional exchanges and, in the case of funds, approved for retail offering in designated jurisdictions. Public consultation is under way on allowing retail access to licensed virtual asset trading platforms subject to robust investor protection measures. • The HKMA issued the consultation conclusion to the discussion paper on cryptoassets and stablecoins, summarizing the feedback received in relation to the paper and its own response; the HKMA proposes to bring certain activities relating to stablecoins into the regulatory perimeter, and indicates the expected regulatory scope and key regulatory requirements.	• Virtual assets are held by an estimated 2.3 percent of the total population (triple-A); 4 percent of the public held virtual assets in the 12 months to April 2022, while 9 percent expressed interest in holding virtual assets in the following 12 months (Investor and Financial Education Council).An estimated 16 percent of surveyed adults owned or used virtual assets in 2022 (Statista). • A small number of banks plan to or are offering to distribute virtual asset-related investment products.	• Hard infrastructure, such as payment system, and soft infrastructure, such as a fair and level playing operating environment and robust regulations, should be put in place by the public sector to promote innovation and digitalization by the private sector. • Customer-facing activities and innovation should be the purview of the private sector. • Innovation should be the purview of both the public and private sectors. • Close collaboration between the public and private sectors is critical for the development of FinDig.	• Licensed virtual asset trading platforms and intermediaries should ensure that they comply with the applicable laws and regulations (e.g., selling restrictions) in the jurisdictions in which they provide services or where their clients are located.	• None—the Hong Kong dollar is pegged to the US dollar through a currency board system.	• There are multiple initiatives to facilitate cross-border collaboration, for example: ○ The HKMA was a cofounder of the Global Financial Innovation Network; ○ With the HKMA's facilitation, the BIS Innovation Hub Hong Kong Centre was the first center in operation; ○ The HKMA has participated in various BIS Innovation Network working groups to contribute to knowledge sharing among central banks; ○ The HKMA launched initiatives such as Project mBridge and Project Sela in collaboration with other jurisdictions. • Regulatory discussions are held in international fora, such as those by the FSB, BCBS, CPMI, and FATF.	• The FinDig project should evolve to identify new and innovative cross-border FinDig initiatives to benefit all member jurisdictions in ASEAN+3.

Member	Dimension								
	Roadmap/Masterplan and Responsible Agency	**Stance on CBDC**	**Stance on Virtual Assets**	**Adoption of Virtual Assets**	**Stance on the Role of Public versus Private Sectors**	**Cross-Border Virtual Asset Transactions**	**Currency Substitution Concerns**	**International Collaboration**	**Wish List for Project Outcome**
	Existence of formal strategy and agency(ies) responsible for execution and regulation	*Position on issuance of wholesale/retail CBDC*	*Position on virtual assets*	*Degree of adoption of virtual assets by the public*	*Position on public and private sector roles in developing FinDig*	*Experiences with and positions on cross-border virtual asset transactions*	*Strategy(ies) to guard against currency substitution by virtual assets and foreign payment systems*	*International memberships and initiatives taken in collaboration with other jurisdictions*	*Possible area(s) for regional cooperation and collaboration*
Indonesia	• There is a road map/ masterplan: Indonesia Payment Systems Blueprint 2025, and Blueprint for Money Market Development 2025. • VASPs are regulated by Bappebti. • FinTech firms are regulated by OJK and BI.	• Initiated Project Garuda in November 2022 and issued a whitepaper for Digital Rupiah, outlining potential designs, considerations, and road map for wholesale and retail CBDCs. • Any decision on CBDC issuance and further considerations will be made after public consultations and pilots.	• Trading of virtual assets is allowed but they cannot be used as a medium of payment. • Virtual assets are classified as a commodity and regulated accordingly. • Regulation of VASPs is being strengthened to prevent FTX-type incidents.	• Virtual assets are held by an estimated 4.3 percent of the total population (triple-A); an estimated 19 percent of surveyed adults owned or used virtual assets in 2022 (Statista). • Virtual assets represent the third largest investment product after mutual funds and domestic stocks.	• Infrastructure issues in secluded areas of the archipelago, regulation with the aim of data protection and cybersecurity, and digital literacy initiatives should be addressed by the public sector. • Regulators could work with the private sector through direct communication or representatives, and give the private sector room to drive innovation.	• N/A	• Currency substitution is not considered a significant risk presently.	• The Basel II mechanism for credit risk mitigation (PvP for foreign exchange settlement) is used for payments; the RTGS is connected to Hong Kong for IDR and USD settlement. • Established agreements with other countries for Local Currency Settlements. • Recommendations of international bodies such as the BCBS and FATF (notably, KYT and the Travel Rule) are adhered to. • Bilateral MoUs for cross-border regulations are in progress.	• Future FinDig analyses should consider: ○ The impact of FinDig on GDP, trade, fiscal, and BoP; and ○ Developing a framework to estimate the degree of digitalization, and identifying members that are lagging in this area so that technical assistance may be provided.
Japan	• There is presently no formal road map for FinDig. • VASPs are regulated by the FSA.	• Conducted joint multiphased research (Project Stella) with the ECB on the applicability of DLT for financial market infrastructures (Phases 1–4 published between September 2017 and February 2020). • Published "The Bank of Japan's Approach to Central Bank Digital Currency," which explains its approach to "general purpose" CBDC or CBDC that is intended for a wide range of end users (October 2020). • Commenced Proof-of-Concepts in April 2021, which were conducted in 2 phases: Completed the first phase in March 2022 and the second in March 2023, as initially scheduled, focused on confirming the technical feasibility of the basic functions of a CBDC. • Launched a pilot program in April 2023.	• Trading of virtual assets is allowed. • Payment services using virtual assets are strictly regulated (Global Legal Insights and FSA).	• Virtual assets are held by an estimated 4.0 percent of the total population (triple-A); an estimated 13 percent of surveyed adults owned or used virtual assets in 2022 (Statista).	• Foundation infrastructure should be provided by the public sector to mitigate against financial fragmentation, improve efficiency, and encourage competition. • Innovation should be led by the private sector.	• N/A	• Currency substitution is not considered a significant risk presently—any transaction between private sector players (e.g., PayPay) and foreign payment providers (e.g., AliPay) would be settled in local currency.	• Recommendations by the FATF are adhered to. • Introduced regulations in accordance with G7 and G20 agreements.	• N/A

Member	Dimension								
	Roadmap/Masterplan and Responsible Agency	**Stance on CBDC**	**Stance on Virtual Assets**	**Adoption of Virtual Assets**	**Stance on the Role of Public versus Private Sectors**	**Cross-Border Virtual Asset Transactions**	**Currency Substitution Concerns**	**International Collaboration**	**Wish List for Project Outcome**
	Existence of formal strategy and agency(ies) responsible for execution and regulation	*Position on issuance of wholesale/retail CBDC*	*Position on virtual assets*	*Degree of adoption of virtual assets by the public*	*Position on public and private sector roles in developing FinDig*	*Experiences with and positions on cross-border virtual asset transactions*	*Strategy(ies) to guard against currency substitution by virtual assets and foreign payment systems*	*International memberships and initiatives taken in collaboration with other jurisdictions*	*Possible area(s) for regional cooperation and collaboration*
Korea	• There is a road map/ masterplan: 2019 Financial Policy Roadmap. • VASPs are regulated by the FSC.	• There is no timeline nor official position on CBDC issuance. • Technical and institutional research on the adoption of CBDC and experiments on various cases of utilization are continuing.	• Trading of virtual assets is allowed but virtual assets are not legal tender. • ICOs are banned given the lack of clear international standards.	• Virtual assets are held by an estimated 4.0 percent of the population (triple-A); an estimated 19 percent of surveyed adults owned or used virtual assets in 2022 (Statista)—the BOK cannot vouch for the accuracy of statistics produced by private sector sources.	• N/A	• N/A	• Currency substitution is not considered a significant risk presently.	• Recommendations by FATF and FSB, and regulatory developments in the US and EU (including the Travel Rule) are closely followed.	• N/A
Lao PDR	• There is a road map/ masterplan: Payment Systems Development Strategy for Banking and Financial Sector 2021–2025 (2021). • The BoL is responsible for promoting electronic payments. • VASPs are regulated by the BoL. • Infrastructure investment activity in virtual assets is regulated by the Ministry of Technology and Communications	• Commenced initial research on CBDC.	• Launched a pilot project with a three-year trial period for trading of virtual assets and building of virtual asset infrastructure, such as Bitcoin mining.	• Virtual assets are held by an estimated 1.3 percent of the total population (triple-A).	• The development of FinDig regulations should be the responsibility of the public sector. • Both the public and the private sectors should work together to improve digital literacy and infrastructure.	• N/A	• N/A	• N/A	• The FinDig project should lead to TA opportunities for members.
Malaysia	• There is a road map/ masterplan: Digital Economy Blueprint (2021). • BNM is responsible for promoting electronic payments. • VASPs are regulated by the SC. • BNM and SC are the key FinTech regulators.	• There is no immediate plan to issue CBDC. The domestic payment systems continue to be safe and highly efficient and the existing monetary and financial policy tools remain effective in safeguarding monetary and financial stability. • Research and experiments on CBDC are being conducted to support any decision in future; participated in Project Dunbar (cross-border CBDC) and has embarked on wholesale domestic CBDC exploration.	• Trading of virtual assets is allowed but the *caveat emptor* rule is applied on virtual assets use as a means of payment. • Virtual asset providers, either VASPs or technology firms, are required to follow the do-no-harm principle. • The onboarding/ off boarding channels at local intermediaries are regulated.	• Virtual assets are held by an estimated 2.9 percent of the total population owns virtual assets (triple-A); an estimated 20 percent of surveyed adults owned or used virtual assets in 2022 (Statista). • Very few businesses accept virtual assets as a means of payment (iMoney Malaysia)	• The government should ensure interoperability and mitigate financial fragmentation so that firms can focus on competition and products. • Collaboration between the private and public sectors is encouraged, wherein the private sector provides technology expertise and innovation. • The authorities should collaborate closely with industry and move away from the "regulator knows best" mindset.	• Home country regulations and local financial institutions could be leveraged upon to mitigate risks arising from foreign payment services.	• Currency substitution is not considered a significant risk presently—any transaction between private sector players and foreign payment providers would be settled in local currency.	• Coordinated policy on virtual assets within the region is sought to plug regulatory gaps.	• The FinDig project should evolve to support the development of a cooperative oversight framework, in particular, promote collaboration between home and host countries.
Myanmar	• There is no formal road map/ masterplan. • The CBM is responsible for regulating and promoting FinDig in Myanmar.	• A working group on CBDC is being established.	• Trading of virtual assets is prohibited and punishable by the law. • Transaction data are not collected.	• Virtual assets are held by an estimated 1.4 percent of the total population (triple-A).	• The provision of digital infrastructure and promotion of FinDig and FinTech usage among firms and individuals should be	• e-KYC is allowed and KYC implementation is supervised across all stages.	• Efforts are being made to incorporate both financial institutions and nonbank financial firms into the current payment system.	• Partnerships with neighboring economies are being sought.	• The FinDig project should lead to opportunities for technical support on issues such as regulating virtual assets, implementing

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	Existence of formal strategy and agency(ies) responsible for execution and regulation	*Position on issuance of wholesale/retail CBDC*	*Position on virtual assets*	*Degree of adoption of virtual assets by the public*	*Position on public and private sector roles in developing FinDig*	*Experiences with and positions on cross-border virtual asset transactions*	*Strategy(ies) to guard against currency substitution by virtual assets and foreign payment systems*	*International memberships and initiatives taken in collaboration with other jurisdictions*	*Possible area(s) for regional cooperation and collaboration*
					the purview of the public sector. • Digital risks should also be addressed by the public sector through regulation.		• The aim is to ensure that even when foreign e-wallets are used, the transactions will be settled in the local currency.		AML/CFT, and fraud and cyber risk assessment and management.
Philippines	• There is a road map/ masterplan: BSP Digital Payments Transformation Roadmap 2020–2023. • The BSP is responsible for managing FinTech, while the SEC PH, under the guidance of the BSP, regulates the VASPs. The BSP works closely with other regulators, such as the SEC PH through the Financial Sector Forum's Financial Technology Committee, on the oversight of FinTechs. Other members of the working group include the Insurance Commission and the Philippine Deposit Insurance Corp. The committee provides a platform for discussing issues across the financial sector and facilitates alignment of actions and expectations among agencies, which enables a coordinated approach in overseeing the wide-ranging spectrum of FinTech activities and establishes a cohesive and consistent approach to FinTech innovation in the areas of regulation, supervision, and policy-making. • VASPs are considered money service businesses that are subject to the regulatory authority and examination powers of the BSP under Philippine Republic Act No. 7653,	• Research is being conducted by the BSP to better understand potential designs and architecture.	• Trading of virtual assets is allowed. • Virtual assets cannot be considered legal tender (AMLC). • VASPs are considered money service businesses that are subject to the regulatory authority and examination powers of the BSP under Philippine Republic Act No. 7653, as amended by Republic Act No. 11211, which covers all VASPs that offer their services or engage in VASP activities in the Philippines. • The BSP's mandate does not necessarily cover businesses involved in the participation and provision of financial services related to an issuer's offer and/or sale of a virtual asset. ICOs are within the regulatory purview of the SEC PH. Entities that intend to or are engaging in virtual asset-related service offerings outside the BSP's jurisdiction may be required to obtain necessary authority / additional licenses to satisfy relevant policies of the concerned financial regulator/s. • The BSP's Advisory on the Use of Virtual Currencies (now referred to as virtual assets) dated December 29, 2017 reiterates that the BSP does not endorse	• Virtual assets are held by an estimated 13.0 percent of the total population (triple-A); an estimated 29 percent of surveyed adults owned or used virtual assets in 2022 (Statista). • The average allocation of personal investments to virtual assets is projected to rise from 1–2 percent to 3–5 percent over the next five years (Bloomberg Finance L.P.). • The adoption of virtual assets in payments and remittances has increased (FinTech Alliance.ph and Fintech News Network).	• Access to a national payment infrastructure for all participants should be provided by the public sector, which wants to ensure interoperability between banks and nonbank participants. • The public sector should have a cooperative role wherein it provides services such as clearing and settlement, while focusing on governance, inclusivity, and efficiency. • The private sector should be competitive in providing pricing, products, and services.	• Identified frictions such as cost, convenience, speed, access, and transparency as key challenges for cross-border transactions. • The establishment of linkages for specific use cases, such as tourism, trade and remittances is being sought, and regulations may need to be harmonized accordingly.	• The authorities do not see currency substitution or financial stability risks from foreign CBDCs or payment systems	• Collaboration with Malaysia, Singapore, and Thailand is under way to establish a regional payment connectivity network. • Approved for membership in the ASEAN+3 Working Group 4 on October 20, 2022; the group focuses on the development of a FinTech regulatory framework that supports open banking initiatives in the region.	• The FinDig project should evolve to provide updates on cross-country developments in this area, as well as discuss challenges faced by other jurisdictions.

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	Roadmap/Masterplan and Responsible Agency	**Stance on CBDC**	**Stance on Virtual Assets**	**Adoption of Virtual Assets**	**Stance on the Role of Public versus Private Sectors**	**Cross-Border Virtual Asset Transactions**	**Currency Substitution Concerns**	**International Collaboration**	**Wish List for Project Outcome**
	Existence of formal strategy and agency(ies) responsible for execution and regulation	*Position on issuance of wholesale/retail CBDC*	*Position on virtual assets*	*Degree of adoption of virtual assets by the public*	*Position on public and private sector roles in developing FinDig*	*Experiences with and positions on cross-border virtual asset transactions*	*Strategy(ies) to guard against currency substitution by virtual assets and foreign payment systems*	*International memberships and initiatives taken in collaboration with other jurisdictions*	*Possible area(s) for regional cooperation and collaboration*
	as amended by Republic Act No. 11211.		virtual assets as currency or investment instrument given its highly-speculative and risky nature. • The *caveat emptor* buyer beware) principle is applied when dealing with foreign VASPs.						
Singapore	• There is a road map/ masterplan: Financial Services Industry Transformation Map 2017 and 2025. • The MAS is leading FinDig efforts and managing FinTech.	• Completed Project Ubin (2016-2020), which explored various aspects of both retail and wholesale CBDCs. • Participated in cross-border CBDC research, such as Project Dunbar (2022). • Launched Project Ubin+ to expand international collaboration on using wholesale CBDC. • The potential of wholesale CBDC is being considered, especially for cross-border payments and settlements. Retail CBDC is not an urgent priority but relevant design, technical, and policy explorations are being undertaken.	• Limited retail access to virtual assets to protect customers from attendant volatilities and risks. • Innovation, including the use of DLT technology, is encouraged.	• Virtual assets are held by an estimated 11.0 percent of the total population (triple-A); an estimated 25 percent of surveyed adults owned or used virtual assets in 2022 (Statista).	• "Goods" that may not be commercially attractive or may have a lengthy decision process should be provided by the public sector.	• N/A	• SGD transactions in digital domains are ensured by improving the payment system.	• ASEAN Working Committee on Payment and Settlement Systems is working on the ASEAN multilateral payment linkage framework. • Pilot of an inclusive ASEAN multilateral payments network is to be implemented by 2025. • Established bilateral FAST payment linkages with Thailand (April 2021), India (February 2023); pending linkage with Malaysia.	• N/A
Thailand	• There is a road map/ masterplan: Published a series of consultation and directional papers (2022). • VASPs are regulated by the SEC TH. • The BoT drives international collaboration and payment system development.	• Participated in both wholesale and retail CBDC projects: – Wholesale: Participated in conducting the pilot of cross-border payments using CBDC in Project mBridge; the real-value pilot was completed in 2022; – Retail: Developed and conducted retail CBDC pilot, within limited areas and scale of approximately 10,000 retail users, along with PSPs; the pilot was launched at the end of 2022	• Trading of virtual assets is allowed but consumer protection is a priority. • The use of virtual assets for payment is banned. • Virtual assets are categorized as securities, and VASPs are regulated by the SEC TH.	• Virtual assets are held by an estimated 9.3 percent of the total population (triple-A); an estimated 44 percent of surveyed adults owned or used virtual assets in 2022 (Statista).	• Ensuring equal treatment and overseeing public–private partnership initiatives should be the purview of the public sector. • The government should focus on infrastructure and not compete with the private sector.	• Regulatory differences across countries are an important issue (for example, cross-border harmonization of regulations to integrate PromptPay/ PayNow took months to achieve.).	• Currency substitution is not considered a significant risk presently; nonetheless, preemptive measures are taken to contain this risk by imposing currency restrictions, that is, foreign CBDCs cannot be used in domestic payments.	• Harmonization of regulations across the region are being studied. .	• N/A

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	Existence of formal strategy and agency(ies) responsible for execution and regulation	*Position on issuance of wholesale/retail CBDC*	*Position on virtual assets*	*Degree of adoption of virtual assets by the public*	*Position on public and private sector roles in developing FinDig*	*Experiences with and positions on cross-border virtual asset transactions*	*Strategy(ies) to guard against currency substitution by virtual assets and foreign payment systems*	*International memberships and initiatives taken in collaboration with other jurisdictions*	*Possible area(s) for regional cooperation and collaboration*
		and is expected to run until Q3 2023.							
Vietnam	• Roadmap/ masterplan on digital transformation: Decision on National Digital Transformation Program through 2025 (2020); Decision on Plan on Digital Transformation of Banking Sector by 2025, with the Orientation Towards 2030 (2021); and Decision on Plan on Digital Transformation of VMOF by 2025, with the Orientation Towards 2030 (2021). • Roadmap/ masterplan on payment system development: Decision on Approving the Scheme on Development of Non-Cash Payment in Vietnam during 2021–2025 (2021). • FinDig initiatives in the payment and banking sectors are regulated by the State Bank of Vietnam. • FinDig initiatives in the finance/ insurance sector and virtual assets are regulated by the VMOF.	• Commenced initial research on CBDC.	• Virtual assets are not regulated and virtual assets data are not collected.	• Virtual assets are held by an estimated 26.0 percent of the total population (triple-A); an estimated 27 percent the surveyed adults owned or used (Statista).	• The government will ensure interoperability, avoid fragmentation, and provide conditions for fair competition among participants.	• N/A	• N/A	• N/A	• The FinDig project should evolve to provide updates on cross-country developments in this area.

Sources: Bloomberg Finance L.P.; FinTech Alliance.ph; FinTech News Network; Global Legal Insights; iMoney Malaysia; Investor and Financial Education Council; national authorities; Statista; triple-A (as of January 4, 2023); and AMRO staff compilations.
Note: AML/CFT = anti-money laundering/ combating the financing of terrorism, AMLC = Anti-Money Laundering Council Philippines, Bappebti = Commodity Futures Trading Authority Indonesia, BCBS = Basel Committee on Banking Supervision, BDCB = Brunei Darussalam Central Bank, BI = Bank Indonesia, BNM = Bank Negara Malaysia, BNPL = buy-now-pay-later, BoL = Bank of the Lao PDR, BoT = Bank of Thailand, BSP = Bangko Sentral ng Pilipinas, BoP = balance of payments, CBDC = central bank digital currency, CBM = Central Bank of Myanmar, CPMI = Committee on Payments and Market Infrastructures, DLT = distributed ledger technology, ECB = European Central Bank, e-KYC = electronic know-your-customer, e-CNY = electronic Chinese yuan, EU = European Union, FATF = Financial Action Task Force, FinDig = financial digitalization, FSA = Financial Services Agency Japan, FSB = Financial Stability Board, FSC = Financial Services Commission, Korea, HKD = Hong Kong dollar, HKMA = Hong Kong Monetary Authority, ICO = Initial Coin Offering, IDR = Indonesian Rupiah, KYC = know-your-customer, KYT = know-your-transaction, MAS = Monetary Authority of Singapore, MoU = memorandum of understanding, OJK = Financial Services Authority, Indonesia, SEC PH = Securities and Exchange Commission, Philippines, SEC TH = Securities and Exchange Commission, Thailand, PBC DCI = Digital Currency Institute of the People's Bank of China, PSP = payment service provider, PvP = payment-versus-payment, RTGS = real-time gross settlement, SC = Securities Commission Malaysia, SEC PH = Securities and Exchange Commission, the Philippines, SEC TH = Securities and Exchange Commission, Thailand, SGD = Singapore dollar, USD = US dollar, VASP = virtual asset service provider, VMOF = Vietnam Ministry of Finance.

References

Adrian, Tobias. 2020. "Evolving to Work Better Together: Public-Private Partnerships for Digital Payments." International Monetary Fund, Speech delivered at the "Building CBDC: A Race to Reality" Conference sponsored by R3, Virtual, July 22. https://www.imf.org/en/News/Articles/2020/07/22/sp072220-public-private-partnerships-for-digital-payments.

———. 2021a. "BigTech in Financial Services." Speech at the 7th Meeting of the FinTech Working Group, European Parliament, Virtual, June 16. https://www.imf.org/en/News/Articles/2021/06/16/sp061721-bigtech-in-financial-services.

———. 2021b. "Digital Technology: How It Could Transform the International Monetary System." International Monetary Fund, Remarks to the 29th International Financial Congress, The Bank of Russia, Moscow, June 20. https://www.imf.org/en/News/Articles/2021/06/30/sp063021-digital-technology-how-it-could-transform-the-international-monetary-system.

Allison, Ian, and Danny Nelson. 2022. "Genesis Faces 'Hundreds of Millions' in Losses as 3AC Exposure Swamps Crypto Lenders: Sources." CoinDesk, June 30. https://www.coindesk.com/business/2022/06/29/genesis-faces-hundreds-of-millions-in-losses-as-3ac-exposure-swamps-crypto-lenders-sources/.

Allison, Ian. 2022. "Divisions in Sam Bankman-Fried's Crypto Empire Blur on His Trading Titan Alameda's Balance Sheet." CoinDesk, November 2. https://www.coindesk.com/business/2022/11/02/divisions-in-sam-bankman-frieds-crypto-empire-blur-on-his-trading-titan-alamedas-balance-sheet/.

Alpher, Stephen, and Danny Nelson. 2023. "Genesis' Crypto Lending Businesses File for Bankruptcy Protection." CoinDesk, January 20. https://www.coindesk.com/business/2023/01/20/genesis-global-files-for-bankruptcy-protection/.

Appaya, Mandepanda Sharmista, Helen Luskin Gradstein, and Mahjabeen Haji Kanz. 2020. "Global Experiences from Regulatory Sandboxes." Fintech Note No. 8. Washington, DC: World Bank Group. http://documents.worldbank.org/curated/en/912001605241080935/Global-Experiences-from-Regulatory-Sandboxes.

Auer, Raphael, Codruta Boar, Giulio Cornelli, John Frost, Henry Holden, and Andreas Wehrli. 2021. "CBDCs beyond Borders: Results from a Survey of Central Banks." BIS Paper No. 116, Bank for International Settlements, Basel, June. https://www.bis.org/publ/bppdf/bispap116.htm.

Auer, Raphael, Holti Banka, Nana Yaa Boakye-Adjei, Ahmed Faragallah, Jon Frost, Harish Natarajan, and Jermy Prenio. 2022. "Central Bank Digital Currencies: A New Tool in the Financial Inclusion Toolkit?" FSI Insights on Policy Implementation No. 41, World Bank Group and Bank for International Settlements, Washington, DC and Basel, April. https://www.bis.org/fsi/publ/insights41.htm.

Bain & Company, Google, and Temasek. 2019. *Fulfilling Its Promise: The Future of Southeast Asia's Digital Financial Services*. Bain & Company, Singapore, October. https://www.bain.com/insights/fufilling-its-promise/.

Bank for International Settlements (BIS). 2021. "Chapter III. CBDCs: An Opportunity for the Monetary System." *BIS Annual Economic Report 2021*. Basel, June. https://www.bis.org/publ/arpdf/ar2021e.htm.

———. 2022. "Chapter III. The Future Monetary System." *BIS Annual Economic Report 2022*. Basel, June. https://www.bis.org/publ/arpdf/ar2022e.htm.

Basel Committee on Banking Supervision (BCBS). 2018. "Implications of Fintech Developments for Banks and Bank Supervisors." Sound Practices, Basel, February. https://www.bis.org/bcbs/publ/d431.htm.

———. 2021. "Prudential Treatment of Cryptoasset Exposures." Consultative Document, Basel, June. https://www.bis.org/bcbs/publ/d519.htm.

———. 2022. "Second Consultation on the Prudential Treatment of Cryptoasset Exposures." Consultative Document, Basel, June. https://www.bis.org/bcbs/publ/d533.htm.

BIS Innovation Hub Hong Kong Centre, Hong Kong Monetary Authority (HKMA), Bank of Thailand, Digital Currency Institute of the People's Bank of China, and Central Bank of the United Arab Emirates. 2021. "Inthanon-LionRock to mBridge: Building a Multi CBDC Platform for International Payments." Hong Kong, Bangkok, Beijing, and Abu Dhabi, September 28. https://www.bis.org/publ/othp40.htm.

———. 2022. "Project mBridge: Connecting Economies through CBDC." Hong Kong, Bangkok, Beijing, and Abu Dhabi, October 26. https://www.bis.org/publ/othp59.htm.

BIS Innovation Hub Singapore Centre, Reserve Bank of Australia (RBA), Bank Negara Malaysia (BNM), Monetary Authority of Singapore (MAS), and South African Reserve Bank (SARB). 2022. "Project Dunbar: International Settlements Using Multi-CBDCs." Singapore, Sydney, Kuala Lumpur, and Pretoria. March 22. https://www.bis.org/publ/othp47.htm.

Bank of Canada (BoC), Bank of England (BoE), and Monetary Authority of Singapore (MAS). 2018. "Cross-Border Interbank Payments and Settlements: Emerging Opportunities for Digital Transformation." Ottawa, London, and Singapore, November 15. https://www.mas.gov.sg/news/media-releases/2018/assessment-on-emerging-opportunities-for-digital-transformation-in-cross-border-payments.

Bank of Canada (BoC) and Monetary Authority of Singapore (MAS). 2019. "Jasper-Ubin Design Paper: Enabling Cross-Border High Value Transfer Using Distributed Ledger Technologies." Ottawa and Singapore, May 2. https://www.mas.gov.sg/news/media-releases/2019/central-banks-of-canada-and-singapore-conduct-successful-experiment-for-cross-border-payments.

Bank of Thailand. 2022. “Joint Press Release: BOT, SEC, and MOF to Jointly Set Guidelines on the Usage of Digital Assets as a Means of Payment for Goods and Services.” Bangkok, January 25. https://www.bot.or.th/English/AboutBOT/Activities/Pages/JointPress_25012022.aspx.

———, and Hong Kong Monetary Authority (HKMA). 2020. “Inthanon-LionRock: Leveraging Distributed Ledger Technology to Increase Efficiency in Cross-Border Payments.” Bangkok and Hong Kong, January 22. https://www.hkma.gov.hk/eng/news-and-media/press-releases/2020/01/20200122-4/.

Bangko Sentral ng Pilipinas. 2021. “Governor Diokno Confident BSP will Achieve Digitalization, Inclusive Growth Targets.” Press Release, Manila, April 21. https://www.bsp.gov.ph/SitePages/MediaAndResearch/MediaDisp.aspx?ItemId=5752

Beau, Denis. 2021. “The Digitalization of the Financial Sector—New Challenges, New Levers.” Speech at the 4th Assises des Technologies Financières, Banque de France, September 30. https://acpr.banque-france.fr/en/intervention/digitalisation-financial-sector-new-challenges-new-levers.

Beck, Thorsten. 2021. “Digital Technology and Financial Innovation: A Literature Survey.” In *Fostering FinTech for Financial Transformation: The Case of South Korea*, edited by Thorsten Beck and Yung Chul Park, Chapter 2. London: CEPR Press. https://cepr.org/chapters/digital-technology-and-financial-innovation-literature-survey.

Beck, Thorsten, and W. Scott Frame. 2018. “Chapter 13. Technological Change, Financial Innovation, and Economic Development.” In *Handbook of Finance and Development*, edited by Thorsten Beck and Ross Levine. Cheltenham and Northampton: Edward Elgar Publishing.

Beck, Thorsten, Haki Pamuk, Ravindra Ramrattan, and Burak Uras. 2015. “Mobile Money, Trade Credit, and Economic Development: Theory and Evidence.” Discussion Paper Series No. 2015–023, Center for Economic Research, Tillburg University, Tilburg. https://ideas.repec.org/p/tiu/tiucen/3d35ab30-05ef-4a31-8710-f845325b8ce4.html.

Berg, Tobias, Valentin Burg, Ana Gombović, and Manju Puri. 2020. “On the Rise of FinTechs: Credit Scoring Using Digital Footprints.” *The Review of Financial Studies* 33 (7): 2845–97. https://academic.oup.com/rfs/article/33/7/2845/5568311.

Bhattacharyya, Suman. 2021. “Fintechs Attack Cross-Border Business Payments as Banks and Legacy Players Rush to Innovate.” *PaymentsDive*, May 25. https://www.paymentsdive.com/news/fintech-cross-border-banks-coopetition-american-express-ripple-zelle-venmo/600729/.

Björkegren, Daniel, and Darrell Grissen. 2019. “Behavior Revealed in Mobile Phone Usage Predicts Credit Repayment.” *World Bank Economic Review* 34 (3): 618–34. https://elibrary.worldbank.org/doi/10.1093/wber/lhz006.

Bloomberg News. 2019. “Jack Ma’s $290 Billion Loan Machine is Changing Chinese Banking.” July 28.

Board of the International Organization of Securities Commissions (IOSCO). 2020. "Issues, Risks and Regulatory Considerations Relating to Crypto-Asset Trading Platforms: Final Report." International Organization of Securities Commissions, Madrid, February. https://www.iosco.org/library/pubdocs/pdf/IOSCOPD649.pdf.

Borio, Claudio, Stijn Claessens, and Nikola Tarashev. 2022. "Entity-Based vs Activity-Based Regulation: A Framework and Applications to Traditional Financial Firms and Big Techs." BIS Occasional Paper No. 19, Bank of International Settlements, Basel, August 3. https://www.bis.org/fsi/fsipapers19.htm.

Brainard, Lael. 2022. "Crypto-Assets and Decentralized Finance through a Financial Stability Lens." Board of Governors of the Federal Reserve System, Remarks at the Bank of England Conference, London, July 8. https://www.federalreserve.gov/newsevents/speech/brainard20220708a.htm.

Browne, Ryan. 2022. "US Officials Link North Korean Hackers to $615 Million Cryptocurrency Heist." CNBC, New Jersey, April 15. https://www.cnbc.com/2022/04/15/ronin-hack-north-korea-linked-to-615-million-crypto-heist-us-says.html.

Brunnermeier, Markus K., Harold James, and Jean-Pierre Landau. 2021. "The Digitalization of Money." BIS Working Paper No. 941, Bank of International Settlements, Basel, May. https://www.bis.org/publ/work941.htm.

Buckley, Ross, Douglas Arner, and Janos Barberis. 2016. "The Evolution of Fintech: A New Post-Crisis Paradigm?" *Georgetown Journal of International Law* 47: 1271–1319.

Caballero, Ricardo, Emmanuel Farhi, and Pierre-Olivier Gourinchas. 2017. "The Safe Assets Shortage Conundrum." *Journal of Economic Perspectives* 31 (3): 29–46.

Camdessus, Michel. 1999. "International Financial and Monetary Stability: A Global Public Good?" International Monetary Fund, Remarks at the IMF/Research Conference, "Key Issues in Reform of the International Monetary and Financial System," Washington, DC, May 28. https://www.elibrary.imf.org/display/book/9781557758354/ch002.xml.

Caragea, Doina, Theodor Cojoianu, Mihai Dobri, and Andreas G. F. Hoepner, Oana Peia, and Davide Romelli. 2022. "Competition and Innovation in the Financial Sector: Evidence from the Rise of Fintech Start-Ups." UCD Centre for Economic Research Paper 2022/01, University College Dublin, January. https://researchrepository.ucd.ie/handle/10197/12774.

Carnegie Endowment for International Peace (CEIP). 2022. "Timeline of Cyber Incidents Involving Financial Institutions." Washington, DC, accessed July 28, 2022. https://carnegieendowment.org/specialprojects/protectingfinancialstability/timeline.

Casu, Barbara, and Ruth Wandhöfer. 2018. “The Future of Correspondent Banking Cross-Border Payments.” SWIFT Institute Working Paper No. 2017-001, SWIFT, La Hulpe, October 10. https://swiftinstitute.org/research/the-future-of-correspondent-banking/.

CBInsights. 2022. “What are Stablecoins?” Research Report, New York, January 25. https://www.cbinsights.com/research/report/what-are-stablecoins.

Cecchetti, Stephen G., and Kermit L. Schoenholtz. 2021. “Chapter 1. Finance and Technology: What is Changing and What is Not.” In *Fostering FinTech for Financial Transformation: The Case of South Korea*, edited by Thorsten Beck and Yung Chul Park. London: CEPR Press. https://cepr.org/chapters/finance-and-technology-what-changing-and-what-not.

Chase. 2021. “Digital Banking Attitudes Study.” New York, December.

Chen, Ping-Kuei, and Cheng-Yun Tsang. 2021. “What to Expect When Central Bank Digital Currencies Cross Borders—The Spillover Effects and Corresponding Policy Responses.” The FinReg Blog, Global Financial Markets Center, Duke University School of Law, Durham, North Carolina, August 20. https://sites.law.duke.edu/thefinregblog/2021/08/20/what-to-expect-when-central-bank-digital-currencies-cross-borders-the-spillover-effects-and-corresponding-policy-responses/.

Chipolina, Scott. 2022. “Can Crypto Contagion Infect Mainstream Finance?” *Financial Times*, June 30.

———. 2023. “Crypto is Back with $300 Bn Frenzy.” *Financial Times*, London, February 3.

Choi, Jungkiu, Prasanna Santhanam, Pauline Wray, Shobhit Shubhankar, and Jeroen Vandensteen. 2020. “The Rise of Digital Banking in Southeast Asia.” Boston Consulting Group, Singapore, December 9. https://www.bcg.com/en-sea/the-rise-of-digital-banking-in-southeast-asia.

Coeuré, Benoit. 2019. “Digital Challenges to the International Monetary and Financial System.” European Central Bank, Panel Remarks at the Banque Centrale du Luxembourg-Toulouse School of Economics Conference on “The Future of the International Monetary System,” Luxembourg, September 17. https://www.bis.org/review/r190918b.htm.

Cointelegraph Research. 2022. "Does the Future of DeFi still belong to the Ethereum Blockchain?" Cointelegraph, March 9. https://cointelegraph.com/news/does-the-future-of-defi-still-belong-to-the-ethereum-blockchain.

Committee on Payments and Market Infrastructures (CPMI), BIS Innovation Hub, International Monetary Fund (IMF), and World Bank Group. 2021. “Central Bank Digital Currencies for Cross-Border Payments.” Joint Report to the G20, Basel and Washington, DC, July. https://www.bis.org/publ/othp38.htm.

Crisanto, Juan Carlos, and Johannes Ehrentraud. 2021. “The Big Tech Risk in Finance.” *Finance & Development*, International Monetary Fund, Washington, DC, May. https://www.imf.org/external/pubs/ft/fandd/2021/05/big-tech-fintech-and-financial-regulation-crisanto-ehrentraud.htm.

Deloitte. 2020. “Fintech—On the Brink of Further Disruption.” December. https://www2.deloitte.com/nl/nl/pages/financial-services/articles/fintech-on-the-brink-of-further-disruption.html.

Demirgüç-Kunt, Asli, Leora Klapper, Dorothe Singer, and Saniya Ansar. 2022. *The Global Findex Database 2021: Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19*. Washington DC: World Bank Group. https://www.worldbank.org/en/publication/globalfindex/Report.

Demirgüç-Kunt, Asli, Leora Klapper, Dorothe Singer, Saniya Ansar, and Jake Hess. 2018. *The Global Findex Database 2017: Measuring Financial Inclusion and the Fintech Revolution*. Washington DC: World Bank Group. https://openknowledge.worldbank.org/handle/10986/29510.

Edwards, Sebastian. 2021. “Central Bank Digital Currencies and the Emerging Markets: The Currency Substitution Challenge.” *Challenge* 64 (5–6): 413–24.

European Central Bank (ECB). 2021. “Eurosystem Report on the Public Consultation on a Digital Euro.” Frankfurt, April. https://www.ecb.europa.eu/paym/digital_euro/html/pubcon.en.html.

European Central Bank and Bank of Japan. 2018. “STELLA – Securities Settlement Systems: Delivery-versus-Payment in a Distributed Ledger Environment.” Frankfurt and Tokyo, March 27. https://www.ecb.europa.eu/pub/pdf/other/stella_project_report_march_2018.pdf.

European Commission (EC). 2018. “Glossary: Mobile Network Operator (MNO).” Eurostat, Brussels, accessed February 20, 2023. https://ec.eucropa.eu/eurostat/cros/content/Glossary:Mobile_network_operator_(MNO).

———. 2020. “Proposal for a Regulation of the European Parliament and of the Council on Markets In Crypto-assets, and Amending Directive (EU) 2019/1937.” Brussels, September 24. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52020PC0593.

Feyen, Erik, Jon Frost, Leonardo Gambacorta, Harish Natarajan, and Matthew Saal. 2021. “Fintech and the Digital Transformation of Financial Services: Implications for Market Structure and Public Policy.” BIS Paper No. 17, Bank for International Settlements, Basel, July. https://www.bis.org/publ/bppdf/bispap117.htm.

Fidelity National Information Services (FIS). 2022. *The Global Payments Report: For Financial Institutions and Merchants*. Jacksonville, Florida. https://worldpay.globalpaymentsreport.com/en.

Financial Action Task Force (FATF). 2019. “Guidance for a Risk-Based Approach: Virtual Assets and Virtual Asset Service Providers.” Paris, June. https://www.fatf-gafi.org/en/publications/Fatfrecommendations/Guidance-rba-virtual-assets.html.

———. 2021a. “Updated Guidance for a Risk-Based Approach: Virtual Assets and Virtual Asset Service Providers.” Paris, October. https://www.fatf-gafi.org/en/publications/Fatfrecommendations/Guidance-rba-virtual-assets-2021.html.

———. 2021b. “Cross-Border Payments: Survey Results on Implementation of the FATF Standards.” Paris, October. https://www.fatf-gafi.org/en/publications/Fatfrecommendations/Cross-border-payments.html.

Financial Stability Board (FSB). 2017. “Financial Stability Implications from FinTech: Supervisory and Regulatory Issues that Merit Authorities’ Attention.” Basel, June 27. https://www.fsb.org/2017/06/financial-stability-implications-from-fintech/.

———. 2019. “FinTech and Market Structure in Financial Services: Market Developments and Potential Financial Stability Implications.” Basel, February 14. https://www.fsb.org/2019/02/fintech-and-market-structure-in-financial-services-market-developments-and-potential-financial-stability-implications/.

———. 2020. “Regulation, Supervision and Oversight of ‘Global Stablecoin’ Arrangements.” Basel, October 13. https://www.fsb.org/2020/10/regulation-supervision-and-oversight-of-global-stablecoin-arrangements/.

———. 2022. “Assessment of Risks to Financial Stability from Crypto-assets.” Basel, February 16. https://www.fsb.org/2022/02/assessment-of-risks-to-financial-stability-from-crypto-assets/.

Franco, Lavinia, Ana Laura Garcia, Vigor Husetović, and Jessica Lassiter. 2020. “Does Fintech Contribute to Systemic Risk? Evidence from the US and Europe.” ADBI Working Paper No. 1132, Asian Development Bank Institute, Tokyo. https://www.adb.org/publications/does-fintech-contribute-systemic-risk-evidence-us-europe.

Frost, Jon, Leonardo Gambacorta, Yi Huang, Hyun Song Shin, and Pablo Zbinden. 2019. “BigTech and the Changing Structure of Financial Intermediation.” BIS Working Paper No. 779, Bank for International Settlements, Basel, April. https://www.bis.org/publ/work779.htm.

Fuster, Andreas, Matthew Plosser, Philipp Schnabel, and James Vickery. 2019. “The Role of Technology in Mortgage Lending.” *Review of Financial Studies* 32 (5): 1854–99.

Gambacorta, Leonardo, Yiping Huang, Zhenhua Li, Han Qiu, and Shu Chen. 2020. “Data vs. Collateral.” BIS Working Paper No. 881, Bank for International Settlements, Basel, September. https://www.bis.org/publ/work881.htm.

Garver, Rob. 2022. “Few Crypto Firms Even Trying to Comply with FATF's ‘Travel Rule’.” CoinDesk, January 27. https://www.coindesk.com/layer2/privacyweek/2022/01/27/few-crypto-firms-even-trying-to-comply-with-fatfs-travel-rule/.

Genç, Ekin. 2022. “Is There a 'Best' Time to Trade Crypto? Here’s What the Data Says.” CoinDesk, New York, April 26. https://www.coindesk.com/learn/is-there-a-best-time-to-trade-crypto-heres-what-the-data-says/.

Georgieva, Kristalina. 2022. “Confronting Fragmentation: How to Modernize the International Payment System.” International Monetary Fund, Concluding remarks at the IMF-Swiss National Bank High-Level Conference, Zurich. May 10. https://www.imf.org/en/News/Articles/2022/05/10/sp051022-md-concluding-remarks-at-the-snb-high-level-conference.

Gilmour, Christian, Christoph Kunzle, Lissa Toh, Benjamin Tan Jin Hong, and Felicia Khoo. 2019. “Robots are Here: The Rise of Robo-Advisers in Asia Pacific.” Deloitte, Southeast Asia and Switzerland. https://www2.deloitte.com/vn/en/pages/financial-services/articles/robo-advisers-asia-pacific.html.

Graf von Luckner, Clemens, Carmen M. Reinhart, and Kenneth Rogoff. 2021. “Decrypting New Age International Capital Flows.” Policy Research Working Paper No. 9794, World Bank, Washington, DC, October. https://openknowledge.worldbank.org/handle/10986/36345.

Grameen Foundation. 2021. “Grameen Foundation Launches Blockchain-Enabled Cash Support and Training Program to Help 800 Filipino Workers Hit Hardest by COVID-19.” Press Release, Manila, July 13. https://grameenfoundation.org/stories/press-releases/grameen-foundation-blockchain-enabled-program-filipino-workers-covid-19.

Greifeld, Katherine, and Vildana Hajric. 2022. “Silbert’s Once-$10 Billion Crypto Empire is Showing Cracks.” Bloomberg News, November 17.

Gruenwald, Paul, Mohamed Damak, Harry Hu, Girogio Baldassarri, Charles Mounts, Alexandre Birry, and David Easthope. 2022. “Stablecoins: Common Promises, Diverging Outcomes.” S&P Global, New York, United Arab Emirates, Hong Kong, London, and Chicago, June 15. https://www.spglobal.com/ratings/en/research/pdf-articles/220615-stablecoins-common-promises-diverging-outcomes-101562202.

Hansen, Tarik, and Katya Delak. 2022. "Security Considerations for a Central Bank Digital Currency." FEDS Notes, Board of Governors of the Federal Reserve System, Washington, DC, February 3. https://www.federalreserve.gov/econres/notes/feds-notes/security-considerations-for-a-central-bank-digital-currency-20220203.html.

He, Dong, Ross Leckow, Vikram Haksar, Tommaso Mancini-Griffoli, Nigel Jenkinson, Mikari Kashima, Tanai Khiaonarong, Céline Rochon, and Hervé Tourpe. 2017. "Fintech and Financial Services: Initial Considerations." IMF Staff Discussion Note 17/05, International Monetary Fund, Washington, DC, June. https://www.imf.org/en/Publications/Staff-Discussion-Notes/Issues/2017/06/16/Fintech-and-Financial-Services-Initial-Considerations-44985.

Hu, Maggie, Adrian D. Lee, and Tālis J. Putniņš. 2021. "Evading Capital Controls via Cryptocurrencies: Evidence from the Blockchain." Working Paper, December 22. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3956933.

International Monetary Fund (IMF). 2009. *Balance of Payments and International Investment Position Manual*. Sixth Edition. Washington, DC. https://www.imf.org/external/pubs/ft/bop/2007/bopman6.htm.

———. 2018a. "Measuring the Digital Economy." IMF Policy Paper, Washington, DC, February. https://www.imf.org/en/Publications/Policy-Papers/Issues/2018/04/03/022818-measuring-the-digital-economy.

———. 2018b. "The Bali Fintech Agenda." IMF Policy Paper, Washington, DC, October. https://www.imf.org/en/Publications/Policy-Papers/Issues/2018/10/11/pp101118-bali-fintech-agenda.

_____. 2019. *Financial Access Survey Guidelines and Manual*. Washington, DC, March. https://data.imf.org/?sk=E5DCAB7E-A5CA-4892-A6EA-598B5463A34C&sId=1460040555909.

———. 2020. "Digital Money across Borders: Macro-Financial Implications." IMF Policy Paper, Washington, DC, October. https://www.imf.org/en/Publications/Policy-Papers/Issues/2020/10/17/Digital-Money-Across-Borders-Macro-Financial-Implications-49823.

———. 2021a. "The Crypto Ecosystem and Financial Stability Challenges." In *Global Financial Stability Report: Navigating Challenging Transitions*, Chapter 2. Washington, DC, October. https://www.imf.org/en/Publications/GFSR/Issues/2021/10/12/global-financial-stability-report-october-2021.

———. 2021b. "Central Bank Digital Currencies for Cross-Border Payments." IMF Policy Paper, Washington, DC, July. https://www.imf.org/en/Publications/Policy-Papers/Issues/2021/07/09/Central-bank-digital-currencies-for-cross-border-payments-461850.

———. 2021c. “The Rise of Digital Money: A Strategic Plan to Continue Delivering on the IMF’s Mandate.” IMF Policy Paper, Washington, DC, July. https://www.imf.org/en/Publications/Policy-Papers/Issues/2021/07/28/The-Rise-of-Digital-Money-462914.

———. 2022. “The Rapid Growth of Fintech: Vulnerabilities and Challenges for Financial Stability.” In *Global Financial Stability Report: Shockwaves from the War in Ukraine Test the Financial System’s Resilience,* Chapter 3. Washington, DC, April. https://www.imf.org/en/Publications/GFSR/Issues/2022/04/19/global-financial-stability-report-april-2022.

International Organization of Securities Commissions (IOSCO). 2022. “IOSCO Crypto-Asset Roadmap for 2022-2023.” Madrid, July 7. https://www.iosco.org/library/pubdocs/pdf/IOSCOPD705.pdf.

Iyer, Tara. 2022. “Cryptic Connections: Spillovers between Crypto and Equity Markets.” Global Financial Stability Note No. 2022/01, International Monetary Fund, Washington, DC, January. https://www.imf.org/en/Publications/global-financial-stability-notes/Issues/2022/01/10/Cryptic-Connections-511776.

Jessop, Simon, Shadia Nasralla, and Cole Horton. 2022. “World Bank's IFC Taps Blockchain for Carbon Offsets.” Reuters, London and New York, August 17. https://www.reuters.com/business/environment/exclusive-world-banks-ifc-taps-blockchain-carbon-offsets-2022-08-17/.

Jones, Dan, Anosh Pardiwalla, and Sara Zanichelli. 2021. "The Rise of Banking as a Service: New Opportunities and Growing Urgency for Financial Institutions." Oliver Wyman. https://www.oliverwyman.com/our-expertise/insights/2021/mar/the-rise-of-banking-as-a-service.html.

JPMorgan. 2021. “Three Megatrends Disrupting the Cross-Border Payments Landscape.” Insights. https://www.jpmorgan.com/solutions/treasury-payments/insights/three-megatrends-disrupting-cross-border-payments.

Kahn, Charles, Manmohan Singh, and Jihad Alwazir. 2022. “Digital Money and Central Bank Operations.” IMF Working Paper 22/85, International Monetary Fund, Washington, DC, May. https://www.imf.org/en/Publications/WP/Issues/2022/05/06/Digital-Money-and-Central-Bank-Operations-517534.

Kharpal, Arjun. 2022. “Crypto Hedge Fund Three Arrows Capital Plunges into Liquidation as Market Crash Takes Toll.” CNBC, June 29. https://www.cnbc.com/2022/06/29/crypto-hedge-fund-three-arrows-capital-plunges-into-liquidation.html.

Kitsios, Emmanouil, João Tovar Jalles, and Genevieve Verdier. 2020. “Tax Evasion from Cross-Border Fraud: Does Digitalization Make a Difference?” IMF Working Paper 20/245, International Monetary Fund, Washington, DC, November. https://www.imf.org/en/Publications/WP/Issues/2020/11/13/Tax-Evasion-from-Cross-Border-Fraud-Does-Digitalization-Make-a-Difference-49857.

Koh, Annie, Dave Fernandez, and Sin Mei Cheah, 2020. “Leveraging Fintech to Disrupt Cross-Border Remittance Services.” Highlights, Singapore Management University, Singapore, June 5. https://news.smu.edu.sg/news/2020/06/05/leveraging-fintech-disrupt-cross-border-remittance-services.

Leontaritis, I.J. and Stephen A. Billings. 1985a. “Input-Output Parametric Models for Non-Linear Systems—Part I: Deterministic Non-Linear Systems.” *International Journal of Control* 41 (2): 303–28.

———. 1985b. “Input-Output Parametric Models for Non-Linear Systems—Part II: Stochastic Non-Linear Systems.” *International Journal of Control* 41 (2): 329–44.

Li, Jianwei, Na Li, and Xiang Cheng. 2021. “The Impact of Fintech on Corporate Technology Innovation Based on Driving Effects, Mechanism Identification, and Heterogeneity Analysis.” *Discrete Dynamics in Nature and Society* 2021: 1–11. https://www.hindawi.com/journals/ddns/2021/7825120/.

Makarov, Igor, and Antoinette Schoar. 2020. “Trading and Arbitrage in Cryptocurrency Markets.” *Journal of Financial Economics* 135 (2): 293–319.

Maynor, David, *Matt* Olney, and Yves Younan. 2017. “The MeDoc Connection.” Talos Blog, July 5. https://blog.talosintelligence.com/the-medoc-connection/.

McKinsey & Company. 2020. “How COVID-19 Has Pushed Companies over the Technology Tipping Point—and Transformed Business Forever.” Survey, October 5. https://www.mckinsey.com/business-functions/strategy-and-corporate-finance/our-insights/how-covid-19-has-pushed-companies-over-the-technology-tipping-point-and-transformed-business-forever.

MHA Cayman. 2022. *Tether Assurance Consolidated Reserves Report.* Cayman Islands, March 21. https://tether.to/en/transparency/#reports.

Monetary Authority of Singapore (MAS). 2021a. “Singapore and Thailand Launch World's First Linkage of Real-Time Payment Systems.” Media Release, Singapore, April 29. https://www.mas.gov.sg/news/media-releases/2021/singapore-and-thailand-launch-worlds-first-linkage-of-real-time-payment-systems.

———. 2021b. “A Retail Central Bank Digital Currency (CBDC): Economic Considerations in the Singapore Context.” Information Paper, Economic Policy Group, Singapore, November. https://www.mas.gov.sg/publications/monographs-or-information-paper/2021/retail-cbdc-paper.

Monetary Authority of Singapore (MAS) and Singapore Exchange (SGX). 2018. “Project Ubin Phase 3: Delivery versus Payment.” Singapore. https://www.mas.gov.sg/publications/monographs-or-information-paper/2021/project-ubin-phase-3.

Nakamoto, Satoshi. 2008. “Bitcoin: A Peer-to-Peer Electronic Cash System.” https://www.ussc.gov/sites/default/files/pdf/training/annual-national-training-seminar/2018/Emerging_Tech_Bitcoin_Crypto.pdf.

Obstfeld, Maurice. 2012. “Financial Flows, Financial Crises, and Global Imbalances.” *Journal of International Money and Finance* 31 (3): 469–80.

Oliver, Joshua, Scott Chipolina, and Kadhim Shubber. 2022. “Crypto Feels the Shockwaves from Its Own ‘Credit Crisis’.” *Financial Times*, London, June 25. https://www.ft.com/content/032b95dc-7feb-4a2d-8eac-c71235643c07.

Ong, Li Lian, Hoang Nam Nguyen, Prashant Pande, Alex Liyang Tang, and Toàn Long Quách. 2023. “The Failure of SVB and the Bank-Tech Nexus: What Does It Foreshadow for the ASEAN+3?” ASEAN+3 Macroeconomic Research Office, Singapore, March 21. https://www.amro-asia.org/the-failure-of-svb-and-the-bank-tech-nexus-what-does-it-foreshadow-for-the-asean3/.

Oprunenco, Alexandru, and Chami Akmeemana. 2018. “Using Blockchain to Make Land Registry More Reliable in India.” United Nations Development Programme (UNDP) Blog, New York, May 1. https://www.undp.org/blog/using-blockchain-make-land-registry-more-reliable-india.

Organisation for Economic Co-operation and Development (OECD). 2020. “Digital Disruption in Banking and its Impact on Competition.” Paris. http://www.oecd.org/daf/competition/digital-disruption-in-financial-markets.htm.

———. 2021. “OECD Inter-Country Input-Output (ICIO) Tables and Database.” Paris, November. http://oe.cd/icio.

———. 2022. *Crypto-Asset Reporting Framework and Amendments to the Common Reporting Standard*. Paris, October 10. https://www.oecd.org/tax/exchange-of-tax-information/crypto-asset-reporting-framework-and-amendments-to-the-common-reporting-standard.htm.

———, World Trade Organization (WTO), and International Monetary Fund (IMF). 2020. *Handbook on Measuring Digital Trade, Version 1*. Paris: OECD. https://www.oecd.org/sdd/its/Handbook-on-Measuring-Digital-Trade.htm.

Palma, Stefania, and Patrick Jenkins. 2022. “SEC Chair Urges ‘One Rule Book’ for Crypto to Avoid Gaps in Oversight.” *Financial Times*, London, June 24. https://www.ft.com/content/b9466a10-a2a6-412d-acf4-086609283df2.

Pande, Prashant, and Toàn Long Quách. 2022. “The ABCs of CBDCs and ASEAN+3 Developments.” AMRO Analytical Note, ASEAN+3 Macroeconomic Research Office, Singapore, January 19. https://www.amro-asia.org/the-abcs-of-cbdcs-and-asean3-developments/.

Popescu, Adina. 2022. “Cross-Border Central Bank Digital Currencies, Bank Runs, and Capital Flows Volatility.” IMF Working Paper 22/83, International Monetary Fund, Washington, DC, May. https://www.imf.org/en/Publications/WP/Issues/2022/05/06/Cross-Border-Central-Bank-Digital-Currencies-Bank-Runs-and-Capital-Flows-Volatility-517625.

PwC. 2017. “Redrawing the Lines: FinTech’s Growing Influence in Financial Services.” *Global FinTech Report 2017*. London and San Francisco. https://www.pwc.com/jg/en/publications/fintech-growing-influence-financial-services.html.

Quarmby, Brian. 2022. “Contagion: Genesis Faces Huge Losses, BlockFi’s $1B Loan, Celsius’s Risky Model.” Cointelegraph, June 30. https://cointelegraph.com/news/contagion-genesis-faces-huge-losses-blockfi-s-1b-loan-celsius-s-risky-model.

Reynolds, Brandi. 2020. “Compliance Challenges: Crypto and the Travel Rule.” Corporate Compliance Insights, November 16. https://www.corporatecomplianceinsights.com/compliance-challenges-crypto-and-the-travel-rule/.

Reynolds, Kevin. 2022. “Binance Walks Away From Deal to Acquire FTX.” CoinDesk, November 10. https://www.coindesk.com/business/2022/11/09/binance-walks-away-from-ftx-deal-wsj/.

Ringe, Wolf-George, and Christopher Ruof. 2018. “A Regulatory Sandbox for Robo Advice.” European Banking Institute Working Paper Series 2018 – No. 26, Frankfurt, May 31. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3188828.

Sahay, Ratna, Ulric Eriksson von Allmen, Amina Lahreche, Purva Khera, Sumiko Ogawa, Majid Bazarbash, and Kim Beaton. 2020. “The Promise of Fintech: Financial Inclusion in the Post-Covid-19 Era.” Monetary and Capital Markets Departmental Paper No. 20/09, International Monetary Fund, Washington, DC. https://www.imf.org/en/Publications/Departmental-Papers-Policy-Papers/Issues/2020/06/29/The-Promise-of-Fintech-Financial-Inclusion-in-the-Post-COVID-19-Era-48623.

Seeh, Florian. 2021. “How New Entrants are Redefining Cross-Border Payments.” Ernst and Young, February. https://www.ey.com/en_sg/banking-capital-markets/how-new-entrants-are-redefining-cross-border-payments.

Seo, Eunsook, and Kyeong-Won Yoo. 2020. "Financial Inclusion through Fintech in the Digital Economy." KIEP Research Paper, APEC Study Series 20-03, Korea Institute for International Economic Policy, Sejong-si, December. http://hdl.handle.net/11540/13282.

Sergeenkov, Andrey. 2022. "What's the Crypto 'Travel Rule', and What Does It Mean for You?" CoinDesk, May 27. https://www.coindesk.com/learn/whats-the-crypto-travel-rule-and-what-does-it-mean-for-you/.

Shaban, Hamza. 2022. "Crypto Hedge Fund Three Arrows Capital in Default on $665 Million Loan." *The Washington Post*, June 27. https://www.washingtonpost.com/business/2022/06/27/three-arrows-capital-default-crypto-voyager-digital/.

Shang, Qiuyun, and Allison Price. 2019. "A Blockchain-Based Land Titling Project in the Republic of Georgia: Rebuilding Public Trust and Lessons for Future Pilot Projects." *Innovations: Technology, Governance, Globalization* 12 (3–4): 72–78. https://direct.mit.edu/itgg/article/12/3-4/72/9852/A-Blockchain-Based-Land-Titling-Project-in-the.

Sharma, Yogesh, B. Balamurguan, and Firoz Khan. 2022. "Blockchain and Distributed Ledger System." In *Blockchain, Big Data and Machine Learning: Trends and Applications*, edited by Neeraj Kumar, N. Gayathri, Md. Arafatur Rahman, and B. Balamurugan, Chapter 7, 177–204. Boca Raton: CRC Press.

Shen, Muyao. 2022. "How $60 Billion in Terra Coins Went Up in Algorithmic Smoke." Bloomberg News, May 21.

Sigalos, MacKenzie. 2021. "How the US Became the World's New Bitcoin Mining Hub." Crypto Decoded, CNBC, July 17. https://www.cnbc.com/2021/07/17/bitcoin-miners-moving-to-us-carbon-footprint.html.

Simauchi, Kevin, and Hannah Miller. 2022. "Crypto Lender BlockFi Goes Bankrupt in Wake of FTX's Fall." Bloomberg News, November 28.

Tang, Alex Liyang. 2022. "Introduction to the Large-Scale AMRO Global Macro-Financial (DSGE) Model." AMRO Working Paper WP/22-05, ASEAN+3 Macroeconomic Research Office, Singapore, July. https://www.amro-asia.org/introduction-to-the-large-scale-amro-global-macro-financial-dsge-model/.

Thompson, Zach. 2022. "Mambu Report Shows 68 Percent of SMEs Struggle to Secure Funding." *CFOtech Asia*, March 10. https://cfotech.asia/story/mambu-report-shows-68-of-smes-struggle-to-secure-funding.

Tiwari, Dheeraj. 2021. "Jan Dhan 3.0 to Focus on Digital, Doorstep Banking." *Economic Times Bureau*, Mumbai, November 24. https://economictimes.indiatimes.com/industry/banking/finance/banking/jan-dhan-3-0-to-focus-on-digital-doorstep-banking/articleshow/87878880.cms.

Tok, Yoke Wang, and Dyna Heng. 2022. “Fintech: Financial Inclusion or Exclusion?” IMF Working Paper 22/80, International Monetary Fund, Washington, DC, May. https://www.imf.org/en/Publications/WP/Issues/2022/05/06/Fintech-Financial-Inclusion-or-Exclusion-517619?cid=em-COM-123-44745.

Velasquez, Fran. 2022. “Crypto Layoffs: OpenSea, Blockchain.com, Coinbase, Gemini Among Firms Forced to Make Mass Job Cuts.” CoinDesk, July 22. https://www.coindesk.com/business/2022/07/21/crypto-layoffs-opensea-blockchaincom-coinbase-gemini-among-firms-forced-to-make-mass-job-cuts/.

Visa. 2022. “Visa Study: Small Businesses Optimistic, Looking to Digital Payments for Growth in New Year.” Press Release, San Francisco, January 12. https://usa.visa.com/about-visa/newsroom/press-releases.releaseId.18711.html.

Walsh, Colin. 2021. “What Is Fintech 2.0? How Companies Can Succeed in the ‘Rebundling’ Age.” *Forbes*, November 4. https://www.forbes.com/sites/forbesfinancecouncil/2021/11/04/what-is-fintech-20-how-companies-can-succeed-in-the-rebundling-age.

World Bank. 2022. “Remittance Prices Worldwide Quarterly: An Analysis of Trends in Cost of Remittance Services.” Issue 43, Washington, DC, December. https://remittanceprices.worldbank.org/.

World Economic Forum (WEF). 2022. “Regulatory Technology for the 21st Century.” In collaboration with the Global Future Council on Agile Governance, White Paper, March. https://www.weforum.org/whitepapers/regulatory-technology-for-the-21st-century/.

Yeung, Karen. 2020. “Cryptocurrencies Help Chinese Evade Capital Controls in Moving Money Abroad.” *South China Morning Post*, August 26.

Zamil, Raihan, and Aidan Lawson. 2022. “Gatekeeping the Gatekeepers: When Big Techs and Fintechs Own Banks—Benefits, Risks and Policy Options.” FSI Insights on Policy Implementation No. 39, Financial Stability Institute, Basel, January. https://www.bis.org/fsi/publ/insights39.htm.

Zhao, Wolfie. 2021. “Chinese Police Freezing OTC Traders’ Bank Accounts over ‘Tainted’ Crypto Transactions.” CoinDesk, September 14. https://www.coindesk.com/markets/2020/06/08/chinese-police-freezing-otc-traders-bank-accounts-over-tainted-crypto-transactions/.

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