

REGULATING DECENTRALISED FINANCE? A SINGAPORE PERSPECTIVE

The emergent phenomenon of decentralised finance (“DeFi”) can be understood as the performance of financial functions through applications that are built on distributed ledger technology and operate using cryptoassets and smart contracts, without the need for traditional centralised intermediaries. In what ways does DeFi challenge existing financial regulation, and how should regulation develop in light of the DeFi phenomenon? In addressing this question, this article provides an overview of DeFi, surveys the current regulatory landscape in Singapore, considers key regulatory issues and policy considerations associated with DeFi, and discusses some potential directions for the future development of the regulation of DeFi. It assesses (a) the justification for DeFi regulation; (b) the scope for applicability of traditional intermediary-based regulation of points of centralisation in the DeFi context; (c) the scope for introduction of new forms of DeFi regulation (such as “embedded regulation” and “compliance by design”); and (d) DeFi’s implications for traditional financial regulation – focusing particularly on DeFi in the context of Singapore.

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I. Introduction

1 The financial system, as Singapore’s former Prime Minister once put it, is “the cardiovascular system of an economy” – performing the vital function of allocating and channelling capital to economic activities.² Traditionally, the financial system is also characterised by centralisation: centralised intermediaries – such as banks, exchanges and

1 The author is most grateful to the anonymous reviewer and to the editors for their valuable feedback.

2 “Speech by Prime Minister Goh Chok Tong at OUB’S 50th Anniversary Celebration Dinner” *Monetary Authority of Singapore* (5 February 1999) <<https://www.mas.gov.sg/news/speeches/1999/speech-by-prime-minister-goh>>
(cont’d on the next page)

capital markets intermediaries – carry out many of its core functions.³ On the one hand, this form of financial intermediation generally facilitates efficient resource allocation and even the implementation of regulatory objectives.⁴ On the other hand, centralised intermediaries may be prone to fragility, mismanagement and opacity, and may restrict or exclude users from access to the financial system, among other concerns.⁵ In recent years, therefore, there has been movement towards decentralisation of financial functions – across financial intermediaries, infrastructure and instruments.⁶ As the former Managing Director of the Monetary Authority of Singapore (“MAS”) has remarked: there is decentralisation of *intermediaries*, as financial services are now being provided by firms formerly at the periphery or even outside of the traditional financial system, such as “BigTech” and “FinTech” firms; there is decentralisation of *infrastructure*, as decentralised applications or “dApps” allow users to transact on a peer-to-peer basis, without the need for intermediaries; and there is decentralisation of *instruments*, with the proliferation of private cryptocurrencies or digital payment tokens based on decentralised technologies.⁷ Given the vital functions of the financial system, especially in a financial centre like Singapore with a fairly dynamic DeFi landscape,⁸ it is crucial to assess the impact of such decentralisation, and determine whether these innovations require any corresponding shift in the regulatory response.

chok-tong-at-oub-s-50th-anniversary-celebration-dinner--05-feb-1999> (accessed 17 March 2025).

- 3 See, eg, Igor Makarov & Antoinette Schoar, “Cryptocurrencies and Decentralized Finance” (2022) BIS Working Papers No 1061 at p 1 <<https://www.bis.org/publ/work1061.pdf>> (accessed 17 March 2025).
- 4 See, eg, Niall Ferguson, *The Ascent of Money: A Financial History of the World* (Penguin Books, 2009) at p 313 and Igor Makarov & Antoinette Schoar, “Cryptocurrencies and Decentralized Finance” (2022) BIS Working Papers No 1061 at p 1 <<https://www.bis.org/publ/work1061.pdf>> (accessed 17 March 2025).
- 5 Campbell R Harvey, Ashwin Ramachandran & Joey Santoro, *DeFi and the Future of Finance* (Wiley, 2021) at pp 3–7; Igor Makarov & Antoinette Schoar, “Cryptocurrencies and Decentralized Finance” (2022) BIS Working Papers No 1061 at p 1 <<https://www.bis.org/publ/work1061.pdf>> (accessed 17 March 2025).
- 6 “Decentralised Finance and the Future of Money’ – Panel Remarks by Mr Ravi Menon, Managing Director, Monetary Authority of Singapore, at the Andrew Crockett Memorial Lecture by Mark Carney via Video Conference on 28 June 2021” *Monetary Authority of Singapore* (28 June 2021) <<https://www.mas.gov.sg/news/speeches/2021/decentralised-finance-and-the-future-of-money>> (accessed 17 March 2025).
- 7 “Decentralised Finance and the Future of Money’ – Panel Remarks by Mr Ravi Menon, Managing Director, Monetary Authority of Singapore, at the Andrew Crockett Memorial Lecture by Mark Carney via Video Conference on 28 June 2021” *Monetary Authority of Singapore* (28 June 2021) <<https://www.mas.gov.sg/news/speeches/2021/decentralised-finance-and-the-future-of-money>> (accessed 17 March 2025).
- 8 See paras 14–31 below.

2 This article focuses on the emergent phenomenon of decentralised finance or “DeFi”. DeFi can be understood as the performance of financial functions through applications that are built on distributed ledger technology (“DLT”) and operate using cryptoassets and smart contracts, without the need for traditional centralised intermediaries.⁹ DeFi purports to have notable advantages over the traditional financial system: among others, it purports to democratise and transform financial services by improving ease of access, efficiency and transparency.¹⁰ However, DeFi also challenges the existing paradigm of largely intermediary-focused regulation, and poses risks that are different in type and degree from traditional finance (“TradFi”). In what ways does DeFi challenge existing financial regulation and how should regulation develop in light of the DeFi phenomenon? This is the central question of this article, which focuses particularly on DeFi in the context of Singapore.

3 In this regard, at the outset, it is appropriate to address two motivational questions: why DeFi, and why Singapore? Situating DeFi within the larger context, decentralisation of *intermediaries* generally does not necessarily fundamentally alter the structure of the financial system; as such, it may require adjustments to but does not fundamentally challenge existing models of regulation.¹¹ As regards decentralisation of *instruments*, such is to some extent already addressed by Singapore’s current regulatory regime – notably, the digital payment token services regime under the Payment Services Act 2019¹² (“PS Act”), as well as MAS’s incoming stablecoin regulatory framework.¹³ These aspects of

9 Definition adapted from Macprudential Surveillance Department, Monetary Authority of Singapore, “Financial Stability Review” (November 2022) at p 96 <<https://www.mas.gov.sg/-/media/mas-media-library/publications/financial-stability-review/2022/financial-stability-review-2022.pdf>> (accessed 17 March 2025).

10 See para 13.

11 “Decentralised Finance and the Future of Money’ – Panel Remarks by Mr Ravi Menon, Managing Director, Monetary Authority of Singapore, at the Andrew Crockett Memorial Lecture by Mark Carney via Video Conference on 28 June 2021” *Monetary Authority of Singapore* (28 June 2021) <<https://www.mas.gov.sg/news/speeches/2021/decentralised-finance-and-the-future-of-money>> (accessed 17 March 2025).

12 2020 Rev Ed.

13 For a discussion of digital payment token services regulation in Singapore, see, eg, Josephine Law, “Singapore Payment Services” in *Payment Services Law and Practice* (John Casanova & Max Savoie eds) (Edward Elgar Publishing 2022) ch 11, especially at paras 11.032–11.041 and Aurelio Gurrea Martinez, “Financial Regulation” in *Law and Technology in Singapore* (Simon Chesterman, Goh Yihan & Andrew Boon Leong Phang gen eds) (Academy Publishing, 1st Ed, 2021) ch 15, at pp 387–389; and for a discussion of Singapore’s incoming stablecoin regulatory framework, see Monetary Authority of Singapore, “Response to Public Consultation on Proposed Regulatory Approach for Stablecoin-Related Activities” (2023) *(cont’d on the next page)*

decentralisation will be addressed as relevant. However, this article focuses primarily on decentralisation of *infrastructure* (so to speak, drawing on MAS's description discussed above¹⁴) – particularly, through DeFi. This is because it is here that especially noteworthy novel regulatory issues and challenges presently arise. Although DeFi is currently regarded as relatively nascent,¹⁵ the market has nevertheless been growing, with the Total Value Locked (“TVL”) on DeFi protocols estimated to exceed US\$81.22b.¹⁶ It is precisely at such a nascent stage that it is appropriate to assess present and forecast potential regulatory issues and options, and the need to do so is all the more justified by the trajectory of the DeFi market.

4 Next, to explain the choice of jurisdictional focus: Singapore is one of the leading financial centres and fintech hubs in the world;¹⁷ its financial regulator has a relatively dynamic approach to financial innovation;¹⁸ and its regulatory approach to DeFi has been of some interest in other jurisdictions, including the US.¹⁹ For these reasons, it is worthwhile to consider DeFi regulation particularly within the Singapore context. For context, the existing literature has discussed

<https://www.mas.gov.sg/-/media/mas-media-library/publications/consultations/pd/2023/response-to-consultation-on-stablecoins-regulation_15aug2023.pdf> (accessed 17 March 2025) as discussed, *eg*, in Rachel Phang, “Singapore’s Emerging Regulatory Approach to Stablecoins” (2023) 40 *Banking and Finance Law Review* 67.

14 “Decentralised Finance and the Future of Money’ – Panel Remarks by Mr Ravi Menon, Managing Director, Monetary Authority of Singapore, at the Andrew Crockett Memorial Lecture by Mark Carney via Video Conference on 28 June 2021” *Monetary Authority of Singapore* (28 June 2021) <<https://www.mas.gov.sg/news/speeches/2021/decentralised-finance-and-the-future-of-money>> (accessed 17 March 2025).

15 “Decentralised Finance and the Future of Money’ – Panel Remarks by Mr Ravi Menon, Managing Director, Monetary Authority of Singapore, at the Andrew Crockett Memorial Lecture by Mark Carney via Video Conference on 28 June 2021” *Monetary Authority of Singapore* (28 June 2021) <<https://www.mas.gov.sg/news/speeches/2021/decentralised-finance-and-the-future-of-money>> (accessed 17 March 2025).

16 “Overview” *DefiLlama* <<https://defillama.com/>> (accessed 14 October 2024).

17 In 2024, Singapore was ranked as the top fourth financial centre in the world and ranked second in the fintech industry: China Development Institute & Z/Yen Partners, “The Global Financial Centres Index 36” (2024) at pp 4 and 11 <https://www.longfinance.net/media/documents/GFCI_36_Report_2024.09.24_v1.1.pdf> (accessed 17 March 2025).

18 See paras 17–31 below.

19 See, *eg*, the testimony of Rebecca Rettig in “Hearing Entitled: Decoding DeFi: Breaking Down the Future of Decentralized Finance” (10 September 2024) at 40:25–41:11 <<https://www.youtube.com/watch?v=YEz4TgWNj-U>> (accessed 17 March 2025).

the regulation of DeFi on a non-jurisdiction-specific basis²⁰ or in the context of other specific jurisdictions,²¹ and various international and intergovernmental organisations have issued publications relating to DeFi (such as the Bank for International Settlements (“BIS”),²² the Organisation for Economic Co-operation and Development (“OECD”),²³ the International Monetary Fund (“IMF”),²⁴ the Financial Stability Board (“FSB”)²⁵ and the International Organization of Securities Commissions (“IOSCO”)²⁶). Indeed, in so far as DeFi is a cross-border phenomenon, effective regulation will require international standard-setting and cross-border collaboration.²⁷ Fundamentally, however, any such DeFi regulation must be implemented at a national level, and, especially at this

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- 20 Among the range of secondary literature cited in this article, see, *eg*, Matteo Aquilina, Jon Frost & Andreas Schrimpf, “Decentralized Finance (DeFi): A Functional Approach” (2024) 10(1) *Journal of Financial Regulation* 1 and Katrin Schuler, Ann Sofie Cloots & Fabian Schär, “On DeFi and On-Chain CeFi: How (Not) to Regulate Decentralized Finance” (2024) 10(2) *Journal of Financial Regulation* 213.
- 21 See, *eg*, publications by the French Financial Markets Authority (*Autorité des Marchés Financiers*): “Decentralised Finance (DeFi), Trading, Protocols and Governance Issues: Overview, Observed Trends, and Regulatory Discussion Points – AMF Discussion Paper” (2023) <<https://www.amf-france.org/sites/institutionnel/files/private/2023-06/AMF%20Discussion%20Paper%20on%20Decentralised%20Finance%20VEN.pdf>> (accessed 17 March 2025) and “Decentralised Finance (DeFi), Trading, Protocols and Governance Issues: Overview, Observed Trends, and Regulatory Discussion Points – Summary of Responses to the AMF Discussion Paper” (2024) <https://www.amf-france.org/sites/institutionnel/files/private/2024-07/2024_defi_synthese-papier-discussion-amf_veng.pdf> (accessed 17 March 2025).
- 22 See, *eg*, Alfred Lehar & Christine A Parlour, “Systemic Fragility in Decentralized Markets” (2022) BIS Working Papers No 1062 <<https://www.bis.org/publ/work1062.pdf>> (accessed 17 March 2025); Raphael Auer *et al*, “The Technology of Decentralized Finance (DeFi)” (2023) BIS Working Papers No 1066 <<https://www.bis.org/publ/work1066.htm>> (accessed 17 March 2025); and Rodney Garratt & Cyril Monnet, “An Impossibility Theorem on Truth-Telling in Fully Decentralised Systems” (2023) BIS Working Papers No 1117 <<https://www.bis.org/publ/work1117.pdf>> (accessed 17 March 2025).
- 23 OECD, “Why Decentralised Finance (DeFi) Matters and the Policy Implications” (2022) <<https://doi.org/10.1787/109084ae-en>> (accessed 17 March 2025).
- 24 Fabian Schär, “DeFi’s Promise and Pitfalls” [2022] *Finance & Development* 33; Michael Casey, “‘DeFi’ and ‘TradFi’ Must Work Together” [2022] *Finance & Development* 24.
- 25 Financial Stability Board, “The Financial Stability Risks of Decentralised Finance” (2023) <<https://www.fsb.org/uploads/P160223.pdf>> (accessed 17 March 2025).
- 26 The International Organization of Securities Commissions, “Final Report with Policy Recommendations for Decentralized Finance (DeFi)” (2023) <<https://www.iosco.org/library/pubdocs/pdf/IOSCOPD754.pdf>> (accessed 17 March 2025).
- 27 Macroprudential Surveillance Department, Monetary Authority of Singapore, “Financial Stability Review” (November 2022) at p 106 <<https://www.mas.gov.sg/-/media/mas-media-library/publications/financial-stability-review/2022/financial-stability-review-2022.pdf>> (accessed 17 March 2025).

nascent stage, it is still necessary to understand and develop the nation-level regulatory approach. This article therefore seeks to contribute to the existing literature by considering the regulation of DeFi with a focus on the Singapore context, and expanding on previous insightful discussions of the regulatory regime in Singapore.²⁸

5 To provide a roadmap for this article, Part II provides an overview of DeFi, defining DeFi and introducing the DeFi market landscape in Singapore. Part III then assesses the current regulatory landscape in Singapore. It analyses how DeFi presently is (or is not) regulated and briefly discusses the regulator's facilitation of and participation in DeFi experimentation. Next, Part IV considers key regulatory issues and policy considerations associated with DeFi. This includes new issues arising from DeFi's decentralised architecture, as well as existing regulatory issues that are exacerbated in the DeFi context. In light of these regulatory issues, Part V discusses some potential directions for the future development of the regulation of DeFi. It addresses the justification for DeFi regulation, the scope for applicability of traditional intermediary-based regulation of points of centralisation in the DeFi context, the scope for introduction of new forms of DeFi regulation and the implications for TradFi regulation. Part VI concludes.

II. Overview of DeFi

A. *Defining DeFi*

6 This Part defines and introduces DeFi, in order to provide the necessary background for the subsequent analysis. It contextualises DeFi in relation to TradFi and centralised finance ("CeFi"), and introduces the technological architecture, key features, common functions and purported benefits of DeFi.

7 There is no one definition of "DeFi". However, for present purposes, this article adopts a working definition that draws on previous statements made by MAS, Singapore's integrated financial regulator, and highlights key recurring elements of various conceptions of DeFi. Here, DeFi is defined as the performance of financial functions through applications that are built on DLT and operate using cryptoassets

28 Elaine Chan & Sion Yoong Tian, "Decentralised Finance (DeFi): A Game-changer or Just a Passing Fad?" [2022] *Butterworths Journal of International Banking and Financial Law* 39 at 41; Nydia Remolina, "DeFi and the Metaverse: Legal and Regulatory Challenges of Decentralization of Financial Services" in *Global Perspectives in the Metaverse* (Hung-Yi Chen, Pawee Jenweeranon & Nafis Alam eds) (Springer Nature Switzerland, 2024) at pp 247–248 and 250.

and smart contracts, without the need for traditional centralised intermediaries (such as exchanges, custodians and central clearing houses).²⁹ DeFi replicates many financial functions typically carried out by traditional financial intermediaries, such as borrowing and lending, trading, asset management and insurance (as will be discussed further below).³⁰

(1) *Contextualising DeFi in relation to TradFi and CeFi*

8 DeFi is often contrasted with TradFi and/or CeFi. Diagram 1 below illustrates the relationship between the three, drawing on previous work in this area.³¹ TradFi – which is typically used in contradistinction to DeFi³² – simply refers to the traditional financial system and how it connects financial market participants with and through financial institutions (such as banks, exchanges, clearing houses, capital markets intermediaries, fund managers, *etc.*).³³ TradFi typically relies on centralised intermediaries, and as such, Diagram 1 below represents TradFi as a subset of CeFi. However, CeFi is somewhat broader in scope, encompassing the provision of both traditional and non-traditional financial services by centralised parties. An entity or application may use technology that is decentralised in nature (such as DLT), yet the entity or application itself is centrally managed or operated; for the purposes of this article, this is regarded as CeFi. Such CeFi transactions typically – but not necessarily always – take place “off-chain”, such as through centralised services, rather than on the primary blockchain.³⁴ The scope

29 See, eg, Macroprudential Surveillance Department, Monetary Authority of Singapore, “Financial Stability Review” (November 2022) at p 96 <<https://www.mas.gov.sg/-/media/mas-media-library/publications/financial-stability-review/2022/financial-stability-review-2022.pdf>> (accessed 17 March 2025); Fabian Schär, “DeFi’s Promise and Pitfalls” [2022] *Finance & Development* 33.

30 Singapore Parl Debates; Vol 95, Sitting No 60; [4 April 2022].

31 Diagram 1 is partially inspired by: (a) *Autorité des Marchés Financiers*, “Decentralised Finance (DeFi), Trading, Protocols and Governance Issues: Overview, Observed Trends, and Regulatory Discussion Points – AMF Discussion Paper” (2023) at p 4, Figure 1 <<https://www.amf-france.org/sites/institutionnel/files/private/2023-06/AMF%20Discussion%20Paper%20on%20Decentralised%20Finance%20VEN.pdf>> (accessed 17 March 2025), which takes a slightly different perspective of the relationship; and (b) Katrin Schuler, Ann Sofie Cloots & Fabian Schär, “On DeFi and On-Chain CeFi: How (Not) to Regulate Decentralized Finance” (2024) 10(2) *Journal of Financial Regulation* 213 at 215, Figure 1.

32 See, eg, Michael Casey, “‘DeFi’ and ‘TradFi’ Must Work Together” [2022] *Finance & Development* 24.

33 *The Elgar Companion to Decentralized Finance, Digital Assets, and Blockchain Technologies* (Henrik Cronqvist & Desiree-Jessica Pely eds) (Edward Elgar Publishing 2024) at p 5.

34 *Autorité des Marchés Financiers*, “Decentralised Finance (DeFi), Trading, Protocols and Governance Issues: Overview, Observed Trends, and Regulatory Discussion
(*cont’d on the next page*)

of this article largely excludes the activities of centralised entities, even if such activities involve the use of decentralised technologies.³⁵

9 By contrast, although DeFi also uses smart contracts and DLT, with activities taking place “on-chain”,³⁶ as previously discussed, DeFi performs financial functions *without* the need for traditional centralised intermediaries. Still, certain DeFi protocols may nevertheless involve significant points of centralisation, blurring the boundaries between DeFi and CeFi. This has been referred to as “on-chain CeFi”³⁷ and is represented in Diagram 1 as the intersection between DeFi and CeFi. Its implications will be discussed further at paras 35 and 50–59 below.

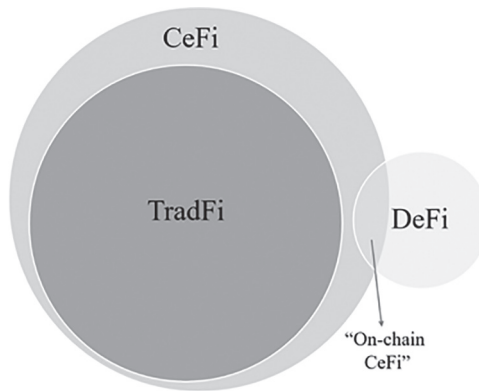


Diagram 1: TradFi, CeFi and DeFi

Points – AMF Discussion Paper” (2023) at p 4 <<https://www.amf-france.org/sites/institutionnel/files/private/2023-06/AMF%20Discussion%20Paper%20on%20Decentralised%20Finance%20VEN.pdf>> (accessed 17 March 2025).

35 A similar approach is taken, eg, in Macprudential Surveillance Department, Monetary Authority of Singapore, “Financial Stability Review” (November 2022) at p 96 <<https://www.mas.gov.sg/-/media/mas-media-library/publications/financial-stability-review/2022/financial-stability-review-2022.pdf>> (accessed 17 March 2025).

36 *Autorité des Marchés Financiers*, “Decentralised Finance (DeFi), Trading, Protocols and Governance Issues: Overview, Observed Trends, and Regulatory Discussion Points – AMF Discussion Paper” (2023) at p 4 <<https://www.amf-france.org/sites/institutionnel/files/private/2023-06/AMF%20Discussion%20Paper%20on%20Decentralised%20Finance%20VEN.pdf>> (accessed 17 March 2025).

37 Katrin Schuler, Ann Sofie Cloots & Fabian Schär, “On DeFi and On-Chain CeFi: How (Not) to Regulate Decentralized Finance” (2024) 10(2) *Journal of Financial Regulation* 213 at 215.

(2) *DeFi's technological architecture*

10 Having illustrated, on a high level, the relationship between DeFi, CeFi and TradFi, this section will now introduce the architecture of DeFi.³⁸ Policymakers and academics have drawn up various models of the “DeFi Stack”.³⁹ One such model, proposed by Schär, is that of a hierarchical multi-layer framework of DeFi, which comprises the following:

- (a) the settlement layer: the foundational layer that allows for secure recording of account and transaction information (eg, Ethereum (the most prominent DeFi blockchain), Avalanche, Polygon, Tron and Solana⁴⁰);
- (b) the asset layer: comprising assets, often referred to as tokens, which are native to the settlement layer (eg, Ether) or additionally issued on thereon. Such tokens may be fungible (eg, ERC-20 tokens) or non-fungible (eg, ERC-721 tokens) and may or may not be backed by other assets;
- (c) the protocol layer: comprising standards that enable the performance of particular financial functions (eg, trading, lending, asset management), typically through a set of smart contracts;
- (d) the application layer: comprising decentralised applications (“dApps”), which allow users to more easily interface with specific protocols; and
- (e) the aggregation layer: where aggregators connect various dApps and protocols, allowing users to compare information and complete complex tasks involving several protocols.⁴¹

38 For more details, see Raphael Auer *et al*, “The Technology of Decentralized Finance (DeFi)” (2023) BIS Working Papers No 1066 <<https://www.bis.org/publ/work1066.htm>> (accessed 17 March 2025).

39 See, eg, Raphael Auer *et al*, “The Technology of Decentralized Finance (DeFi)” (2023) BIS Working Papers No 1066 at p 5, Figure 1 <<https://www.bis.org/publ/work1066.htm>> (accessed 17 March 2025); *Autorité des Marchés Financiers*, “Decentralised Finance (DeFi), Trading, Protocols and Governance Issues: Overview, Observed Trends, and Regulatory Discussion Points – AMF Discussion Paper” (2023) at p 8 <<https://www.amf-france.org/sites/institutionnel/files/private/2023-06/AMF%20Discussion%20Paper%20on%20Decentralised%20Finance%20VEN.pdf>> (accessed 17 March 2025).

40 Raphael Auer *et al*, “The Technology of Decentralized Finance (DeFi)” (2023) BIS Working Papers No 1066 at p 6 <<https://www.bis.org/publ/work1066.htm>> (accessed 17 March 2025).

41 Fabian Schär, “Decentralized Finance: On Blockchain- and Smart Contract-Based Financial Markets” (2021) 103 *Federal Reserve Bank of St Louis Review* 153 at 155–156 (see Figure 2 at 156 for a diagrammatic representation of the “DeFi”
(*cont'd on the next page*)

The first four layers of this framework loosely correspond with the model that MAS's Project Guardian uses to describe a digital asset network (which uses the terminology of a platform layer, an asset layer, a service layer and an access layer).⁴² From a software development perspective, development necessarily begins with the settlement layer and then proceeds to each subsequent layer (*ie*, from (a) to (e)).⁴³ Conversely, from the user's perspective, a typical transaction is initiated on the aggregation or application layer, and its execution thereafter involves each successive underlying layer (*ie*, from (e) or (d) to (a)).⁴⁴ Notably, the different layers may involve varying levels of decentralisation⁴⁵ (as will be discussed further at paras 50–62 below).

11 To provide further background on some of the specific building blocks of DeFi mentioned above, “DLT” refers to the protocols and infrastructure that allow for the maintenance of a decentralised database, by enabling a network of nodes across different locations to propose and validate transactions, as well as record and update information on a synchronised basis.⁴⁶ Blockchain is a type of DLT that is so named because its ledger consists of separate but connected “blocks”, or batches of transactions.⁴⁷ As for smart contracts (referenced in relation to

Stack”); see also Katrin Schuler, Ann Sofie Cloots & Fabian Schär, “On DeFi and On-Chain CeFi: How (Not) to Regulate Decentralized Finance” (2024) 10(2) *Journal of Financial Regulation* 213 at 220.

42 Monetary Authority of Singapore & Bank for International Settlements, “Project Guardian: Enabling Open and Interoperable Networks” (2023) at pp 9–10 <<https://www.mas.gov.sg/-/media/mas-media-library/development/fintech/project-guardian/project-guardian-open-interoperable-network.pdf>> (accessed 17 March 2025).

43 *Autorité des Marchés Financiers*, “Decentralised Finance (DeFi), Trading, Protocols and Governance Issues: Overview, Observed Trends, and Regulatory Discussion Points – AMF Discussion Paper” (2023) at p 8 <<https://www.amf-france.org/sites/institutionnel/files/private/2023-06/AMF%20Discussion%20Paper%20on%20Decentralised%20Finance%20VEN.pdf>> (accessed 17 March 2025).

44 *Autorité des Marchés Financiers*, “Decentralised Finance (DeFi), Trading, Protocols and Governance Issues: Overview, Observed Trends, and Regulatory Discussion Points – AMF Discussion Paper” (2023) at p 8 <<https://www.amf-france.org/sites/institutionnel/files/private/2023-06/AMF%20Discussion%20Paper%20on%20Decentralised%20Finance%20VEN.pdf>> (accessed 17 March 2025).

45 Fabian Schär, “DeFi’s Promise and Pitfalls” [2022] *Finance & Development* 33 at 34.

46 Bank for International Settlements, “BIS Quarterly Review September 2017: International Banking and Financial Market Developments” (2017) at p 58 <https://www.bis.org/publ/qtrpdf/r_qt1709.pdf> (accessed 17 March 2025); “Blockchain/Distributed Ledger Technology (DLT)” *Monetary Authority of Singapore* (19 March 2024) <<https://www.mas.gov.sg/development/fintech/technologies---blockchain-and-dlt>> (accessed 17 March 2025).

47 Bank for International Settlements, “BIS Quarterly Review September 2017: International Banking and Financial Market Developments” (2017) at p 58 <https://www.bis.org/publ/qtrpdf/r_qt1709.pdf> (accessed 17 March 2025).

layer (c) above), this refers to instructions in the form of code, which contain variables and conditions that determine whether or not pre-defined actions should be performed.⁴⁸ Smart contracts are “smart” in the sense that they are self-executing and may be regarded as “autonomous” in that they can operate without human intervention. Despite their name, however, smart contracts are not necessarily “contracts” in the sense of having legal effect. In DeFi, smart contracts perform the functions that intermediaries would in TradFi, relying on economic incentives to facilitate the performance of these functions.⁴⁹

(3) *DeFi's key features and functions*

12 DeFi can perform various financial functions. These include: (a) borrowing and lending, such as through collateralised debt protocols;⁵⁰ (b) trading, exchange and settlement of cryptoassets, crypto derivatives, or tokenised real-world assets – such as through decentralised exchanges or “DEXes” (which are currently the largest DeFi applications);⁵¹ (c) payment and transfer;⁵² (d) asset management, such as through staking, yield farming and liquidity mining protocols;⁵³ and (e) insurance.⁵⁴

13 Given its technological architecture, DeFi's key distinctive features include being autonomous, composable, open-access and

48 Fabian Schär, “DeFi's Promise and Pitfalls” [2022] *Finance & Development* 33; Macroprudential Surveillance Department, Monetary Authority of Singapore, “Financial Stability Review” (November 2022) at p 96 <<https://www.mas.gov.sg/-/media/mas-media-library/publications/financial-stability-review/2022/financial-stability-review-2022.pdf>> (accessed 17 March 2025).

49 Macroprudential Surveillance Department, Monetary Authority of Singapore, “Financial Stability Review” (November 2022) at p 96 <<https://www.mas.gov.sg/-/media/mas-media-library/publications/financial-stability-review/2022/financial-stability-review-2022.pdf>> (accessed 17 March 2025).

50 “FinTech in Its Element: Water, Metal, Fire, Wood, Earth’ – Speech by Mr Ravi Menon, Managing Director, Monetary Authority of Singapore, at the Singapore FinTech Festival 2022 on 3 November 2022” *Monetary Authority of Singapore* (3 November 2022) <<https://www.mas.gov.sg/news/speeches/2022/fintech-in-its-element>> (accessed 17 March 2025).

51 Fabian Schär, “DeFi's Promise and Pitfalls” [2022] *Finance & Development* 33 at 34.

52 Macroprudential Surveillance Department, Monetary Authority of Singapore, “Financial Stability Review” (November 2022) at p 97 <<https://www.mas.gov.sg/-/media/mas-media-library/publications/financial-stability-review/2022/financial-stability-review-2022.pdf>> (accessed 17 March 2025).

53 Fabian Schär, “DeFi's Promise and Pitfalls” [2022] *Finance & Development* 33 at 34.

54 Monetary Authority of Singapore, “Macroeconomic Review: Volume XX Issue 1 April 2021” (2021) at p 108 <<https://www.mas.gov.sg/-/media/mas/epg/mr/2021/apr/mrapr21.pdf>> (accessed 17 March 2025).

immutable.⁵⁵ These give rise to DeFi's purported advantages over TradFi and CeFi, such as increased efficiency, reduced cost,⁵⁶ transparency,⁵⁷ interoperability,⁵⁸ financial inclusivity and greater accessibility of financial services.⁵⁹

B. Singapore's DeFi market landscape

14 Having introduced DeFi, this section now briefly surveys – in very broad strokes – the nascent DeFi market landscape in Singapore. This overview is qualified by three caveats. First, DeFi – like the Internet – is inherently cross-border in nature, and the top DeFi protocols are generally international in origin and reach (such as Uniswap, Aave and MakerDAO).⁶⁰ It stands to reason that DeFi activity in Singapore is likewise dominated by such protocols, but it is difficult (if not impossible) to obtain country-specific data about their use. For this reason, and because the most dominant DeFi protocols have already been discussed elsewhere,⁶¹ this section does not discuss these protocols in detail, notwithstanding their ostensible local impact. Second, although DeFi is understood as not requiring the involvement of a centralised intermediary (as discussed above), most of the projects discussed in this section do involve some degree of centralisation and a regulated intermediary, and may be better characterised as “on-chain CeFi” rather than genuine DeFi in the strict sense (as discussed further at paras 35 and 50–62 below). Nevertheless, these projects are discussed herein as they are among the more prominent locally-based or initiated projects. Third, given the rapidity of change in the DeFi sphere, this section provides only a rough snapshot of aspects of the Singapore DeFi market landscape as of mid-October 2024.

15 Notably, certain major DeFi projects have Singapore connections. For example, Tron is one of the major blockchains on which DeFi

55 Campbell R Harvey, Ashwin Ramachandran & Joey Santoro, *DeFi and the Future of Finance* (Wiley, 2021) at p ix.

56 “FinTech in Its Element: Water, Metal, Fire, Wood, Earth” – Speech by Mr Ravi Menon, Managing Director, Monetary Authority of Singapore, at the Singapore FinTech Festival 2022 on 3 November 2022” *Monetary Authority of Singapore* (3 November 2022) <<https://www.mas.gov.sg/news/speeches/2022/fintech-in-its-element>> (accessed 17 March 2025).

57 Fabian Schär, “DeFi's Promise and Pitfalls” [2022] *Finance & Development* 33 at 34.

58 Campbell R Harvey, Ashwin Ramachandran & Joey Santoro, *DeFi and the Future of Finance* (Wiley, 2021) at p 65.

59 Fabian Schär, “DeFi's Promise and Pitfalls” [2022] *Finance & Development* 33 at 34.

60 “Top Protocols” *DefiLlama* <<https://defillama.com/top-protocols>> (accessed 14 October 2024).

61 See, eg, the discussion of MakerDAO, Aave and Uniswap in Campbell R Harvey, Ashwin Ramachandran & Joey Santoro, *DeFi and the Future of Finance* (Wiley, 2021) at pp 69–105.

protocols are built; according to DeFiLlama, Tron currently comes a very distant second to Ethereum in terms of TVL.⁶² Tron is overseen by the Tron Foundation, which is a Singapore company (and one of the entities against which the US Securities and Exchange Commission is presently taking enforcement action).⁶³

16 There are also several DeFi or DeFi-adjacent projects involving entities that are regulated by MAS in Singapore. One example is DigiFT, which operates an exchange for trading of on-chain real-world assets, and which has at points described itself as a “decentralised exchange (DEX) for digital assets”.⁶⁴ Another example is InvestaX, a platform for real world asset and security token offerings, which is operated by IC SG. InvestaX has partnered with IX Swap, a DeFi platform which it describes as “Uniswap for [real world asset/security token offerings]”, that provides infrastructure and liquidity for tokenised assets.⁶⁵ DigiFT and IC SG are both recognised market operators and capital markets services licensees.⁶⁶ Yet another example is Bake (formerly Cake DeFi), a platform headquartered in Singapore that seeks to provide access to DeFi services, and that markets itself as providing a “CeDeFi” experience.⁶⁷ As of October 2024, it held a transitional licensing exemption for providing digital payment token services newly regulated under the Payment Services (Amendment) Act 2021⁶⁸ (with a winding-up application against

62 “Top Protocols” *DeFiLlama* <<https://defillama.com/top-protocols>> (accessed 14 October 2024).

63 “Justin Sun, Tron Foundation Limited, BitTorrent Foundation Ltd, Rainberry, Inc, Austin Mahone, and Deandre Cortez Way: US Securities and Exchange Commission Litigation Release No 25803” *US Securities and Exchange Commission* (7 August 2023) <<https://www.sec.gov/enforcement-litigation/litigation-releases/lr-25803>> (accessed 17 March 2025); Aqil Hamzah, “US District Court Issues Summons to Crypto Mogul Justin Sun in Singapore” *The Straits Times* (13 April 2023) <<https://www.straitstimes.com/singapore/us-district-court-issues-summons-to-crypto-mogul-justin-sun-in-singapore>> (accessed 17 March 2025).

64 “About” *DigiFT* <<https://www.digift.sg/aboutUs/index>> (accessed 17 March 2025); “Decentralised Digital Asset Exchange DigiFT Launches the First Fully Regulatory-Compliant US Treasury Token” *DigiFT* (10 August 2023) <<https://www.digift.sg/announcements/digift-press-dust.html>> (accessed 17 March 2025).

65 “About” *InvestaX* <<https://www.investax.io/about>> (accessed 17 March 2025); Shara Miran, “IX Swap Partners with InvestaX” *IX Swap* (23 July 2022) <<https://www.ixswap.io/news/ix-swap-partners-with-investax>> (accessed 17 March 2025).

66 “DigiFT Tech (Singapore) Pte Ltd” *Monetary Authority of Singapore* (31 July 2024) <<https://eservices.mas.gov.sg/fid/institution/detail/252967-DIGIFT-TECH-SINGAPORE-PTE-LTD>> (accessed 17 March 2025); “IC SG Pte Ltd” *Monetary Authority of Singapore* (29 January 2024) <<https://eservices.mas.gov.sg/fid/institution/detail/218349-IC-SG-PTE-LTD>> (accessed 17 March 2025).

67 “Cake Pte Ltd” *Singapore FinTech Association* (2024) <<https://membership.singaporefintech.org/company/201918368M>> (accessed 17 March 2025).

68 Act 1 of 2021; “Entities That Have Notified MAS Pursuant to the Payment Services (Amendment) Act 2021 (Saving and Transitional Provisions) Regulations 2024” (cont’d on the next page)

the Cake Group having been recently dismissed this year⁶⁹). Singapore, it can be seen, is home to several DeFi and/or DeFi-adjacent initiatives and entities, including MAS-regulated entities and entities connected with DeFi protocols that have wide international reach.

III. Regulatory landscape in Singapore

17 Having introduced DeFi, this Part now discusses the regulatory landscape in Singapore, taking into consideration MAS's regulatory and supervisory, as well as facilitative and even participatory roles in the space. It assesses how DeFi currently is (or is not) regulated. It also briefly discusses the regulator's initiatives directed at facilitating innovation, as well as MAS's own experimentation in the DeFi space.

A. *DeFi regulation: how DeFi is (or is not) regulated in Singapore*

18 At present, regulation is generally not DeFi-specific, but rather, depends on whether a given DeFi project falls within the ambit of any existing financial services laws and regulations. The determination as to whether a given DeFi project is regulated turns on three key questions, which loosely relate, respectively, to the relevant instruments, infrastructure and intermediaries involved:⁷⁰ (a) What is the *regulatory characterisation* of the token involved? (b) Does the DeFi project involve the conduct of any *regulated activities or services* involving that token?⁷¹ (c) *Who* (if anyone) is carrying on a business of providing such regulated activities or services?

(“Transitional Regulations 2024”) *Monetary Authority of Singapore* (11 October 2024) <<https://www.mas.gov.sg/regulation/payments/entities-that-have-notified-mas-pursuant-to-ps-amend-act-2021-stpr>> (accessed 17 March 2025).

69 Candice Lee, “High Court Dismisses Bid by Co-Founder and CTO to Liquidate Cake Group” *The Business Times* (26 April 2024) <<https://www.businesstimes.com.sg/startups-tech/startups/tech-in-asia-1high-court-dismisses-bid-co-founder-and-cto-liquidate-cake-group>> (accessed 17 March 2025).

70 See “Decentralised Finance and the Future of Money’ – Panel Remarks by Mr Ravi Menon, Managing Director, Monetary Authority of Singapore, at the Andrew Crockett Memorial Lecture by Mark Carney via Video Conference on 28 June 2021” *Monetary Authority of Singapore* (28 June 2021) <<https://www.mas.gov.sg/news/speeches/2021/decentralised-finance-and-the-future-of-money>> (accessed 17 March 2025).

71 See the factors identified in Elaine Chan & Sion Yoong Tian, “Decentralised Finance (DeFi): A Game-changer or Just a Passing Fad?” [2022] *Butterworths Journal of International Banking and Financial Law* 39 at 41.

(1) *Regulatory characterisation of token*

19 The answer to the first question – of the regulatory characterisation of the token involved – generally determines the subsequent regulatory treatment of the DeFi project. This analysis often takes place at the “asset layer” (as described at para 10 above) and relates to the nature of the “asset” in question. This section focuses on the more common regulatory characterisations.

(a) *Digital payment token*: DeFi applications typically involve the use of cryptocurrencies (such as Ether, USD Coin and Dai). Such cryptocurrencies would tend to be characterised as “digital payment tokens”⁷² under the PS Act⁷³ – although at this stage, it is important to caveat that this cannot be assumed, and the regulatory characterisation of each token must be individually assessed, taking into account its specific functions and features. In so far as a DeFi application involves the use of a digital payment token, the pertinent statutes in Singapore are the PS Act⁷⁴ (and prospectively, the Financial Services and Markets Act 2022⁷⁵ (“FSMA”), which defines the term “digital token” as including a “digital payment token”⁷⁶). These statutes regulate the provision of digital payment token services and digital token services, respectively (as discussed further below). It bears noting that even so-called stablecoins (such as USD Coin and Tether), which purport to maintain a stable value relative to a given currency or other asset(s),⁷⁷ are presently generally also characterised by MAS as digital payment tokens⁷⁸ (although MAS has proposed

72 A “digital payment token” is statutorily defined as “any digital representation of value (other than an excluded digital representation of value) that — (a) is expressed as a unit; (b) is not denominated in any currency, and is not pegged by its issuer to any currency; (c) is, or is intended to be, a medium of exchange accepted by the public, or a section of the public, as payment for goods or services or for the discharge of a debt; (d) can be transferred, stored or traded electronically; and (e) satisfies such other characteristics as the [MAS] may prescribe”: Payment Services Act 2019 (2020 Rev Ed) s 2(1).

73 2020 Rev Ed.

74 2020 Rev Ed.

75 Act 18 of 2022; see especially Pt 9 (which has not yet come into effect as of the date of writing, although the statute as a whole has been passed by Parliament and assented to by the President).

76 Financial Services and Markets Act 2022 (Act 18 of 2022) s 136(1) (which has not yet come into effect as of the date of writing).

77 Financial Stability Board, “Regulatory Issues of Stablecoins” (18 October 2019) at p 1 <<https://www.fsb.org/wp-content/uploads/P181019.pdf>> (accessed 17 March 2025).

78 Monetary Authority of Singapore, “Payment Services Act 2019: Frequently Asked Questions on the Payment Services Act” (19 April 2024) at paras 23.1–23.8 <<https://www.mas.gov.sg/-/media/mas-media-library/regulation/faqs/pd/faqs-on-payment-services-act-2019/payment-services-act-faq--19-april-2024.pdf>> (accessed *cont'd on the next page*)

the introduction of a new label, “MAS-regulated stablecoins”, to refer to stablecoins that are to be regulated under its incoming framework for a subset of single-currency stablecoins⁷⁹).

(b) *Capital markets product*: DeFi applications may also involve the use of tokens that represent interests in “capital markets products” (such as “securities” or units in a “collective investment scheme”), as such terms are defined in the Securities and Futures Act 2001⁸⁰ (“SFA”). If so, the question arises as to whether the DeFi project attracts regulation under the SFA (or, prospectively, the FSMA, which defines the term “digital token” as including “a digital representation of a capital markets product” that has certain specified characteristics⁸¹).

The regulatory characterisation of the token used in the DeFi project, therefore, is a key starting point for the analysis of whether – and if so, how – the DeFi project is regulated.

(2) *Regulated activities or services*

20 Having determined the regulatory characterisation of the token involved, the second key question is whether the DeFi project entails the conduct of any *regulated activities or services* involving that token. Some DeFi activities may appear to come within the scope of various activities or services regulated under statutes administered by MAS, while other DeFi activities do not. For example, regulated activities and services may include:

(a) *Digital payment token services*: Where the token involved is a digital payment token, the question arises as to whether the DeFi project entails the provision of any “digital payment token service” under the PS Act (or prospectively, any “digital token

17 March 2025); and see further Rachel Phang, “Singapore’s Emerging Regulatory Approach to Stablecoins” (2023) 40 *Banking and Finance Law Review* 67 at 79–86.

79 The proposed framework is to apply to single-currency stablecoins that fulfil certain criteria, such as being (a) pegged to the Singapore dollar or a Group of Ten (“G10”) currency; and (b) issued in Singapore: Monetary Authority of Singapore, “Response to Feedback Received on Proposed Regulatory Approach for Stablecoin-related Activities” (15 August 2023) at paras 2.1 and 2.18 <https://www.mas.gov.sg/-/media/mas-media-library/publications/consultations/pd/2023/response-to-consultation-on-stablecoins-regulation_15aug2023.pdf> (accessed 25 April 2025).

80 (2020 Rev Ed) s 2(1).

81 Specifically, the statute defines a “digital token” as including “a digital representation of a capital markets product which — (i) can be transferred, stored or traded electronically; and (ii) satisfies such other characteristics as the [MAS] may prescribe”: Financial Services and Markets Act 2022 (Act 18 of 2022) s 136(1). However, this provision has not yet come into effect as of the date of writing.

service” under the FSMA⁸²). Digital payment token services include, among others, the services of “dealing in” digital payment tokens, “facilitating the exchange of” digital payment tokens, arranging for the transmission of digital payment tokens, or safeguarding digital payment tokens (where the service provider has control over such tokens).⁸³ Where a DEX is concerned, for instance, the question may arise as to whether the DEX involves the provision of any of these digital payment token services.

(b) *Operation of organised market or dealing in capital markets products*: Where the token involved is a tokenised capital market product, and where the DeFi application allows for the trading of this token (such as on a DEX) – the question may arise as to whether this involves the operation of an organised market or the regulated activity of dealing in capital markets products under the SFA⁸⁴ (or prospectively, any digital token service under the FSMA⁸⁵).

21 Conversely, other DeFi activities are not regulated activities or services. For example:

(a) *Lending and staking of digital payment tokens*: The PS Act does not regulate the lending and staking of digital payment tokens.⁸⁶ Lending and borrowing of digital payment tokens generally would also fall outside the ambit of the Banking Act 1970. This is especially in so far as such tokens are not

82 Financial Services and Markets Act 2022 (Act 18 of 2022) s 136(1); First Schedule, Pt 1. These provisions have not yet come into effect as of the date of writing.

83 Payment Services Act 2019 (2020 Rev Ed) s 2(1); First Schedule, Pts 1 and 3 (which defines a “digital payment token service” as referring to any of nine listed services, and defines related terms, such as “dealing in” and “facilitating the exchange of”).

84 Securities and Futures Act 2001 (2020 Rev Ed) ss 2(1), 7 and 82; Second Schedule, Pts 1–2.

85 Financial Services and Markets Act 2022 (Act 18 of 2022) s 136(1); First Schedule, Pt 1. These provisions have not yet come into effect as of the date of writing.

86 Monetary Authority of Singapore, “Response to Public Consultation on Proposed Regulatory Measures for Digital Payment Token Services (Part 1)” (3 July 2023) at para 3.9 <<https://www.mas.gov.sg/-/media/mas/news-and-publications/consultation-papers/2022-proposed-regulatory-measures-for-dpt-services/response-to-public-consultation-on-proposed-regulatory-measures-for-dpt-services-part-1.pdf>> (accessed 17 March 2025); see also “The Risks You Are Exposed to When Trading in Cryptocurrencies and Their Derivatives” *MoneySense* (31 July 2024) <<https://www.moneysense.gov.sg/the-risks-you-are-exposed-to-when-trading-in-cryptocurrencies-and-their-derivatives/>> (accessed 17 March 2025) (warning that “MAS does not licence or regulate ... DeFi ... applications which can be used ... to engage in activities involving cryptocurrencies such as ... lending and borrowing, staking, and yield farming”).

“money” as contemplated therein,⁸⁷ as the statute’s definitions of “banking business” and “deposit-taking business” both refer to the receipt of “money”.⁸⁸ Moreover, the definition of banking business also has been construed as involving all of the functions listed in the statutory definition (including, for instance, paying and collecting cheques),⁸⁹ and hence is very unlikely to be satisfied in the DeFi context.

(b) *Trading of digital payment token derivatives:* Additionally, the trading of digital payment token derivatives is not regulated in Singapore (apart from the exceptional case of digital payment token derivatives that are listed on an approved exchange).⁹⁰

22 The regulatory status of a DeFi project hence turns also on this second question of whether it involves any regulated activities or services.

(3) *Intermediary involvement*

23 Even if a DeFi project involves a regulated instrument and a regulated activity, a third crucial question still remains: who – if anyone – is carrying on a business of providing such a regulated activity or service?

87 The question as to whether a token constitutes “money” is outside the scope of this paper. Nevertheless, it briefly bears noting that discussion of this question has generally focused not on tokens in general, but on the specific subset of tokens that are intended to function as money: UK Law Commission, “Digital Assets: Final Report” (2023) Law Com No 412 at para 6.71 <<https://s3-eu-west-2.amazonaws.com/cloud-platform-e218f50a4812967ba1215eaecede923f/uploads/sites/30/2023/06/Final-digital-assets-report-FOR-WEBSITE-2.pdf>> (accessed 17 March 2025). Moreover, although the term “money” is not defined in the Banking Act 1970 (2020 Rev Ed), under the Payment Services Act 2019 (2020 Rev Ed) s 2(1), “money” is defined as excluding any digital payment token.

88 (2020 Rev Ed) ss 2(1) and 4B(7).

89 *Vernes Asia Ltd v Trendale Investment Pte Ltd* [1988] 1 SLR(R) 21 at [32].

90 Monetary Authority of Singapore, “Guidelines on Provision of Digital Payment Token Services to the Public, Guideline No PS-G02” (17 January 2022) at para 4.1 <<https://www.mas.gov.sg/-/media/mas-media-library/regulation/guidelines/pso/ps-g02-guidelines-on-provision-of-digital-payment-token-services-to-the-public/guidelines-on-provision-of-digital-payment-token-services-to-the-public-ps-g02.pdf>> (accessed 17 March 2025); “The Risks You Are Exposed to When Trading in Cryptocurrencies and Their Derivatives” *MoneySense* (31 July 2024) <<https://www.moneysense.gov.sg/the-risks-you-are-exposed-to-when-trading-in-cryptocurrencies-and-their-derivatives/>> (accessed 17 March 2025) (warning that “Crypto derivatives traded on DeFi applications are not regulated”); see further Rachel Phang, “Regulating Cryptocurrency Derivatives: A Comparative Analysis of Approaches in the UK, the EU and Singapore” (2023) 3 *Journal of Business Law* 222 at 236–242.

24 Generally, financial regulation is in large part intermediary-focused: the regulator imposes licensing requirements on firms that provide financial services, with these licensing regimes being “[t]o a large degree ... simply a means of enforcing ... other firm-based regulatory techniques”.⁹¹ Singapore is no different. For instance, in the context of securities, the licensing regime targets the traditional “gatekeepers” to the industry, and it is by this means that the regulator controls entry into and participation in the securities industry, as well as imposes standards on licensed entities.⁹² Indeed, two out of MAS’s six overall objectives of financial sector oversight pertain to financial intermediaries, with MAS stating, *eg*, that the safety and soundness of such intermediaries is “[t]he focus of much of MAS’s regulation and supervision”.⁹³

25 This is reflected in the pertinent statutes. Even where a DeFi activity comes within the scope of a regulated activity or service under the relevant statutes, the licensing and approval provisions therein contemplate and apply to a “person” who carries on business in these activities (whether of providing a digital payment token service, establishing or operating an organised market, dealing in capital markets products, transacting banking business, or carrying on deposit-taking business or insurance business).⁹⁴

26 Certain platforms purport to be DeFi platforms yet nonetheless do indeed involve a centralised intermediary to whom these licensing provisions will apply. For example, DigiFT, which has described itself as “a decentralised exchange (DEX) for digital assets”,⁹⁵ nevertheless is regulated as a capital markets services licensee and a recognised market operator under the SFA.⁹⁶

91 John Armour *et al*, *Principles of Financial Regulation* (Oxford University Press, 2016) at p 74.

92 Hans Tjio, Wan Wai Yee & Kwok Hon Yee, *Principles and Practice of Securities Regulation in Singapore* (LexisNexis, 3rd Ed, 2017) at para 7.01.

93 Monetary Authority of Singapore, “Objectives and Principles of Financial Sector Oversight in Singapore” (April 2004, revised in September 2015) at pp 4 and 6–7 <<https://www.mas.gov.sg/-/media/mas/news-and-publications/monographs-and-information-papers/monograph--objectives-and-principles-of-financial-sector-oversight-in-singapore.pdf>> (accessed 17 March 2025).

94 See Payment Services Act 2019 (2020 Rev Ed) s 5(1); Securities and Futures Act 2001 (2020 Rev Ed) ss 7(1) and 82(1) read with Pt 1 of the Second Schedule; Banking Act 1970 (2020 Rev Ed) s 4(1); and Insurance Act 1966 (2020 Rev Ed) s 4(1).

95 “Decentralised Digital Asset Exchange DigiFT Launches the First Fully Regulatory-Compliant US Treasury Token” *DigiFT* (10 August 2023) <<https://www.digift.sg/announcements/digift-press-dust.html>> (accessed 17 March 2025).

96 “DigiFT Tech (Singapore) Pte Ltd” *Monetary Authority of Singapore* (31 July 2024) <<https://eservices.mas.gov.sg/fid/institution/detail/252967-DIGIFT-TECH-SINGAPORE-PTE-LTD>> (accessed 17 March 2025); “Our License” *DigiFT* <<https://digift.gitbook.io/docs/general-information/our-license>> (accessed 17 March 2025).

27 However, in the DeFi context, the crux of the matter is that there often may be *no* such centralised intermediary. In such an event, there is no “person” to whom the licensing (and attendant conduct of business) requirements can attach. Where the DeFi users who transact on a peer-to-peer basis are concerned, to the extent that these users do not “carry on a business” in the relevant regulated activity and/or are not engaging in this activity by way of “providing [a] service”,⁹⁷ the relevant licensing requirements should not apply. Moreover, if smart contracts and DLT genuinely completely replace the functions that in TradFi would have been fulfilled by an intermediary, then there would indeed be no person to whom the licensing requirements can attach. This is one core way in which DeFi challenges the prevailing financial regulatory paradigm.

28 As such, MAS has on occasion described the DeFi space as “unregulated”.⁹⁸ As discussed above, a given DeFi project may be unregulated either (a) because it entails activities that fall outside the regulatory ambit, or (more crucially) (b) because even if it involves the conduct of regulated activities, there is no centralised intermediary to whom licensing and regulatory requirements may attach. This largely unregulated nature of the DeFi sphere has, for instance, inspired statements such as that by MoneySense, Singapore’s national financial education programme, that “MAS does not license or regulate Decentralised Finance (DeFi) applications which can be used ... to engage in activities involving cryptocurrencies such as trading, lending and borrowing, staking, and yield farming, without the need for an intermediary or

97 See, eg, Payment Services Act 2019 (2020 Rev Ed) s 5(1) and Securities and Futures Act 2001 (2020 Rev Ed) s 82(1). For details on what constitutes carrying on a business in a regulated activity, see eg, Monetary Authority of Singapore, “Payment Services Act 2019: Frequently Asked Questions on the Payment Services Act” (19 April 2024) at para 13.2 <<https://www.mas.gov.sg/-/media/mas-media-library/regulation/faqs/pdf/faqs-on-payment-services-act-2019/payment-services-act-faq--19-april-2024.pdf>> (accessed 17 March 2025) (clarifying that when determining whether a person is carrying on a business of providing a payment service, the Monetary Authority of Singapore will consider whether the person is doing so with “system, continuity and repetition”); Monetary Authority of Singapore, “Frequently Asked Questions on Licensing and Business Conduct (Other than for Fund Management Companies)” (24 January 2025) at para A14 <<https://www.mas.gov.sg/-/media/mas-media-library/regulation/faqs/cmi/faqs-on-securities-and-futures-licensing-and-conduct-of-business-regulations/faqs-on-licensing-and-business-conduct-other-than-for-fund-management-companies-2.pdf>> (accessed 17 March 2025).

98 Monetary Authority of Singapore, “Proposed Regulatory Measures for Digital Payment Token Services” (October 2022) Consultation Paper P008 – 2022 at para 4.12 <<https://www.mas.gov.sg/-/media/mas/news-and-publications/consultation-papers/2022-proposed-regulatory-measures-for-dpt-services/consultation-paper-on-proposed-regulatory-measures-for-digital-payment-token-services-v3.pdf>> (accessed 25 April 2025).

service provider”⁹⁹. In the final analysis, absent DeFi-specific regulation, DeFi is presently largely *unregulated* under existing financial services laws, due to the lack of a centralised intermediary that is capable of being regulated. The exception is purported DeFi projects that *are* regulated, because they involve centralised intermediaries that carry on business in regulated activities; that said, it has been argued that such should be more accurately characterised as “on-chain CeFi” rather than genuine DeFi¹⁰⁰ (as will be discussed further at paras 35 and 50–62 below).

B. *DeFi experimentation: MAS’s facilitative and participatory roles*

29 Although there is presently no DeFi-specific regulation, it bears noting that MAS has nevertheless taken on facilitative – and even participatory – roles when it comes to DeFi innovation.

30 Under the MAS FinTech Regulatory Sandbox framework, firms may apply to enter a “sandbox” within which they may experiment with innovative financial services, and where, depending on the financial service concerned, MAS may decide to relax certain legal and regulatory requirements.¹⁰¹ MAS has expressly noted that such live experiments may encompass testing the feasibility of DeFi.¹⁰²

31 Moreover, MAS has itself directly and actively experimented with elements of DeFi. Through Project Guardian, MAS has collaborated with the financial industry to investigate potential DeFi applications in wholesale funding markets, as well as put in place “institutional grade”

99 “The Risks You Are Exposed to When Trading in Cryptocurrencies and Their Derivatives” *MoneySense* (31 July 2024) <<https://www.moneysense.gov.sg/the-risks-you-are-exposed-to-when-trading-in-cryptocurrencies-and-their-derivatives/>> (accessed 17 March 2025).

100 Katrin Schuler, Ann Sofie Cloots & Fabian Schär, “On DeFi and On-Chain CeFi: How (Not) to Regulate Decentralized Finance” (2024) 10(2) *Journal of Financial Regulation* 213 at 215.

101 Monetary Authority of Singapore, “FinTech Regulatory Sandbox Guidelines” (November 2016) at paras 2.2–2.3 <<https://www.mas.gov.sg/-/media/mas-media-library/development/regulatory-sandbox/sandbox/fintech-regulatory-sandbox-guidelines-jan-2022.pdf>> (accessed 17 March 2025).

102 “Speech by Mr Heng Swee Keat, Deputy Prime Minister and Coordinating Minister for Economic Policies, at the Opening of Point Zero Forum on 22 June 2022” *Monetary Authority of Singapore* (22 June 2022) at para 23(b) <<https://www.mas.gov.sg/news/speeches/2022/speech-by-mr-heng-swee-keat-deputy-prime-minister-and-coordinating-minister-for-economic-policies-at-the-opening-of-point-zero-forum-on-22-june-2022>> (accessed 17 March 2025).

security and compliance measures within DeFi protocols.¹⁰³ In addition to partnering with the private sector, MAS has also collaborated with other central banks and international organisations. This includes, for instance, Project Mariana, which tested DeFi elements such as automated market makers within the context of cross-border trading and settlement of wholesale central bank digital currencies.¹⁰⁴ These initiatives are broadly directed at developing future financial infrastructure.¹⁰⁵ MAS has made clear that such experimentation does not evince endorsement of DeFi,¹⁰⁶ but has contemplated that experimentation is necessary given the nascent state of DeFi technologies.¹⁰⁷

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- 103 Monetary Authority of Singapore & Bank for International Settlements, “Project Guardian: Enabling Open and Interoperable Networks” (2023) at p 9 <<https://www.mas.gov.sg/-/media/mas-media-library/development/fintech/project-guardian/project-guardian-open-interoperable-network.pdf>> (accessed 17 March 2025); “Speech by Mr Heng Swee Keat, Deputy Prime Minister and Coordinating Minister for Economic Policies, at the Asia Tech X Singapore Summit on 31 May 2022” *Monetary Authority of Singapore* (31 May 2022) at para 11(d) <<https://www.mas.gov.sg/news/speeches/2022/speech-by-mr-heng-swee-keat-deputy-prime-minister-and-coordinating-minister-for-economic-policies-at-the-asia-tech-x-singapore-summit-on-31-may-2022>> (accessed 17 March 2025); “FinTech in Its Element: Water, Metal, Fire, Wood, Earth’ – Speech by Mr Ravi Menon, Managing Director, Monetary Authority of Singapore, at the Singapore FinTech Festival 2022 on 3 November 2022” *Monetary Authority of Singapore* (3 November 2022) <<https://www.mas.gov.sg/news/speeches/2022/fintech-in-its-element>> (accessed 17 March 2025).
- 104 “BIS and Central Banks of France, Singapore and Switzerland Successfully Test Cross-Border Wholesale CBDCs” *Monetary Authority of Singapore* (28 September 2023) at para 1 <<https://www.mas.gov.sg/news/media-releases/2023/bis-and-central-banks-successfully-test-cross-border-wholesale-cbdc>> (accessed 17 March 2025).
- 105 “Speech by Mr Heng Swee Keat, Deputy Prime Minister and Coordinating Minister for Economic Policies, at the Asia Tech X Singapore Summit on 31 May 2022” *Monetary Authority of Singapore* (31 May 2022) at para 11(d) <<https://www.mas.gov.sg/news/speeches/2022/speech-by-mr-heng-swee-keat-deputy-prime-minister-and-coordinating-minister-for-economic-policies-at-the-asia-tech-x-singapore-summit-on-31-may-2022>> (accessed 17 March 2025).
- 106 “BIS and Central Banks of France, Singapore and Switzerland Successfully Test Cross-Border Wholesale CBDCs” *Monetary Authority of Singapore* (28 September 2023) at para 7 <<https://www.mas.gov.sg/news/media-releases/2023/bis-and-central-banks-successfully-test-cross-border-wholesale-cbdc>> (accessed 17 March 2025).
- 107 “BIS and Central Banks of France, Singapore and Switzerland Successfully Test Cross-Border Wholesale CBDCs” *Monetary Authority of Singapore* (28 September 2023) at para 6 <<https://www.mas.gov.sg/news/media-releases/2023/bis-and-central-banks-successfully-test-cross-border-wholesale-cbdc>> (accessed 17 March 2025).

IV. Regulatory issues arising from DeFi

32 Having surveyed the current regulatory landscape in Singapore, this article now turns its outlook to the potential contours of the future regulatory landscape. To this end, this Part discusses key regulatory issues and policy considerations associated with DeFi. Notably, the very features of DeFi that give rise to the advantages discussed above (at para 13) also exacerbate existing or engender new regulatory risks. First, this Part addresses new regulatory issues that arise due to the decentralised architecture of DeFi, including issues associated with disintermediation, dispersed governance and “decentralisation theatre”.¹⁰⁸ Second, it assesses types of risk that arise in the contexts of both DeFi and TradFi, yet which may differ in degree where DeFi is concerned.

A. *New regulatory issues arising from DeFi’s decentralised architecture*

33 The decentralised architecture of DeFi gives rise to certain new regulatory issues. First, one key issue is disintermediation: in so far as DeFi involves peer-to-peer transacting and eliminates the need for intermediaries, this may undermine the efficacy of traditional intermediary-focused financial regulation (as discussed at paras 23–28 above). As MAS has noted, DeFi “has the potential to disintermediate financial institutions”.¹⁰⁹ With TradFi, if there is a breach of regulatory requirements, the supervisor may take enforcement action against the errant entity and/or its board, management and officers.¹¹⁰ However, as the former Managing Director of MAS has observed, “In a DeFi world, there is no responsible entity or individual. How does one take enforcement action against an algorithm?”¹¹¹ To the extent that DeFi involves decentralised operations, without the involvement of legally identifiable entities, it poses inherent challenges for financial regulation and supervision.¹¹²

108 Fabian Schär, “DeFi’s Promise and Pitfalls” [2022] *Finance & Development* 33 at 35.

109 Monetary Authority of Singapore, “Macroeconomic Review: Volume XX Issue 1 April 2021” (2021) at p 108 <<https://www.mas.gov.sg/-/media/mas/epg/mr/2021/apr/mrapr21.pdf>> (accessed 17 March 2025).

110 See, eg, ss 90–92 of the Payment Services Act 2019 (2020 Rev Ed).

111 “FinTech in Its Element: Water, Metal, Fire, Wood, Earth’ – Speech by Mr Ravi Menon, Managing Director, Monetary Authority of Singapore, at the Singapore FinTech Festival 2022 on 3 November 2022” *Monetary Authority of Singapore* (3 November 2022) <<https://www.mas.gov.sg/news/speeches/2022/fintech-in-its-element>> (accessed 17 March 2025).

112 Macroprudential Surveillance Department, Monetary Authority of Singapore, “Financial Stability Review” (November 2022) at p 103 <<https://www.mas.gov.sg/-/media/mas-media-library/publications/financial-stability-review/2022/financial-stability-review-2022.pdf>> (accessed 17 March 2025).

34 Second, and relatedly, DeFi may involve models of dispersed or decentralised governance, which may give rise to additional challenges in the event of failures or disruptions.¹¹³ For instance, governance may be dispersed in the sense that if changes to the code of the smart contract are desired or required, developers may propose these changes and holders of governance tokens are able to approve or reject this proposal.¹¹⁴ Even though decisions can be made through these governance structures, one difficulty is that in the event of an operational disruption, the dispersed governance model may potentially result in inconsistent or untimely resolution, as compared with CeFi where the responsible entity is able to intervene swiftly and decisively.¹¹⁵

35 Third, despite the purported and eponymous decentralised nature of DeFi, one more insidious issue is the risk that the appearance of decentralisation is deceptive. This has been referred to as “decentralization theatre”.¹¹⁶ The same economic incentives that impel centralisation in CeFi are also extant in DeFi, and the difference may merely be that centralisation – and its attendant issues and inefficiencies – are “relocated” to different layers in the DeFi infrastructure, resulting in re-concentration elsewhere on the value chain.¹¹⁷ For instance, Makarov and Schoar argue that validators of blockchain transactions often have fixed costs and co-insurance benefits, which incentivise concentration of mining and validator capacity in proof-of-work and proof-of-stake protocols, respectively.¹¹⁸ Moreover, despite claims of dispersed governance, DeFi protocols may in actuality be subject to the influence of persons with

113 “FinTech in Its Element: Water, Metal, Fire, Wood, Earth’ – Speech by Mr Ravi Menon, Managing Director, Monetary Authority of Singapore, at the Singapore FinTech Festival 2022 on 3 November 2022” *Monetary Authority of Singapore* (3 November 2022) <<https://www.mas.gov.sg/news/speeches/2022/fintech-in-its-element>> (accessed 17 March 2025).

114 Macroprudential Surveillance Department, Monetary Authority of Singapore, “Financial Stability Review” (November 2022) at p 100 <<https://www.mas.gov.sg/-/media/mas-media-library/publications/financial-stability-review/2022/financial-stability-review-2022.pdf>> (accessed 17 March 2025).

115 Macroprudential Surveillance Department, Monetary Authority of Singapore, “Financial Stability Review” (November 2022) at p 100 <<https://www.mas.gov.sg/-/media/mas-media-library/publications/financial-stability-review/2022/financial-stability-review-2022.pdf>> (accessed 17 March 2025).

116 Fabian Schär, “DeFi’s Promise and Pitfalls” [2022] *Finance & Development* 33 at 35.

117 Igor Makarov & Antoinette Schoar, “Cryptocurrencies and Decentralized Finance” (2022) BIS Working Papers No 1061 at p 2 <<https://www.bis.org/publ/work1061.pdf>> (accessed 17 March 2025); Dirk A Zetsche, Douglas W Arner & Ross P Buckley, “Decentralized Finance” (2020) 6 *Journal of Financial Regulation* 172 at 174.

118 Igor Makarov & Antoinette Schoar, “Cryptocurrencies and Decentralized Finance” (2022) BIS Working Papers No 1061 at p 2 <<https://www.bis.org/publ/work1061.pdf>> (accessed 17 March 2025).

“admin keys”, or who hold a high proportion of the governance tokens.¹¹⁹ There may also be potential centralisation in so far as DeFi protocols rely on centralised external oracles for data.¹²⁰ Such centralisation is not in itself detrimental (as the CeFi system attests). However, issues may arise where centralisation is obfuscated by the appearance of decentralisation.¹²¹ One concern is a lack of transparency.¹²² Another concern is that such re-concentration may give rise to the same regulatory issues as traditional centralisation, yet goes unregulated as it takes place outside of the ambit of current regulatory oversight.¹²³ Yet another concern is that the appearance of decentralisation may potentially allow a centralised intermediary to evade the regulation to which it is rightly subject under the prevailing regime. DeFi’s decentralised architecture hence engenders certain new regulatory issues that would not otherwise arise in the CeFi context.

B. Existing regulatory issues exacerbated in the DeFi context

36 In addition to these new risks, certain existing types of risk arise in the contexts of both DeFi and TradFi, but in the DeFi context, these risks are exacerbated and/or arise in new or different ways.

37 First, money laundering (“ML”) and terrorism financing (“TF”) (collectively, “ML/TF”) risks may be exacerbated due to the pseudonymous nature of the cryptoassets used in DeFi.¹²⁴ DeFi’s ML/TF risks have been highlighted, notably, by the Financial Action Task Force.¹²⁵ According to a report by Elliptic, which has been cited in a white paper by MAS,¹²⁶

119 Fabian Schär, “DeFi’s Promise and Pitfalls” [2022] *Finance & Development* 33 at 35.

120 Fabian Schär, “DeFi’s Promise and Pitfalls” [2022] *Finance & Development* 33 at 35.

121 Fabian Schär, “DeFi’s Promise and Pitfalls” [2022] *Finance & Development* 33 at 35.

122 Dirk A Zetzsche, Douglas W Arner & Ross P Buckley, “Decentralized Finance” (2020) 6 *Journal of Financial Regulation* 172 at 174.

123 Dirk A Zetzsche, Douglas W Arner & Ross P Buckley, “Decentralized Finance” (2020) 6 *Journal of Financial Regulation* 172 at 174.

124 Financial Action Task Force, “Updated Guidance for a Risk-Based Approach to Virtual Assets and Virtual Asset Service Providers” (October 2021) at pp 16 and 102 <<https://www.fatf-gafi.org/content/dam/fatf-gafi/guidance/Updated-Guidance-VA-VASP.pdf.coredownload.inline.pdf>> (accessed 25 April 2025).

125 Financial Action Task Force, “Targeted Update on Implementation of the FATF Standards on Virtual Assets and Virtual Asset Service Providers” (June 2023) at pp 28–32 <<https://www.fatf-gafi.org/content/dam/fatf-gafi/guidance/June2023-Targeted-Update-VA-VASP.pdf.coredownload.inline.pdf>> (accessed 17 March 2025).

126 Monetary Authority of Singapore, “Interlinking Networks – Technical Whitepaper” (November 2023) at p 19 <<https://www.mas.gov.sg/-/media/mas-media-library/development/fintech/guardian/interlinking-networks-technical-paper-vfinal.pdf>> (accessed 17 March 2025).

as of July 2023, DEXes had processed almost US\$4b of illicit funds.¹²⁷ The report observes that DEXes may be used for conversion of obscure tokens to more mainstream tokens (eg, ETH) and of freezable tokens (eg, USDT and USDC) to non-freezable tokens (eg, DAI).¹²⁸ Specific case studies discussed in the report include the use of DEX limit orders (particularly, the use of the 1inch limit order protocol on Avalanche) and crypto derivatives (particularly, the derivatives protocol Synthetix) to conceal illicit fund flows.¹²⁹ ML/TF risks, an important focus of financial regulation, hence are exacerbated in the DeFi context.

38 Second, market integrity risks may be impacted by DeFi practices. For example, Auer *et al*, in a publication by BIS, describe how miners, which verify transactions and update the ledger, are able to engage in practices that in the traditional securities context would be regarded as illegal market manipulation.¹³⁰ Unlike in TradFi, where transactions are generally handled by the intermediary in the order that they were received, in the blockchain context, blocks are updated on a competitive basis and transactions need not be processed in the order in which they were initiated. Rather, transactions are posted to a memory pool (or “mempool”), and miners can assemble a given block from these pending transactions in a manner that maximises their profits – also termed “miner extractable value” (MEV).¹³¹ Notably, miners can extract value by engaging in practices that resemble illegal market manipulation if executed in the traditional securities context, such as, front-running, “back-running” and “sandwich trading”.¹³² For instance, if there is a large pending transaction that will significantly affect market prices, a miner can engage in front-running by adding a transaction just prior to this large transaction, thus allowing the miner to profit from the price

127 Elliptic, “The State of Cross-Chain Crime 2023” (2023) at p 13 <<https://www.elliptic.co/resources/state-of-cross-chain-crime-2023>> (accessed 17 March 2025).

128 Elliptic, “The State of Cross-Chain Crime 2023” (2023) at p 13 <<https://www.elliptic.co/resources/state-of-cross-chain-crime-2023>> (accessed 17 March 2025).

129 Elliptic, “The State of Cross-Chain Crime 2023” (2023) at pp 13–20 <<https://www.elliptic.co/resources/state-of-cross-chain-crime-2023>> (accessed 17 March 2025).

130 Raphael Auer, Jon Frost & Jose María Vidal Pastor, “Miners as Intermediaries: Extractable Value and Market Manipulation in Crypto and DeFi” (16 June 2022) BIS Bulletin No 58 <<https://www.bis.org/publ/bisbull58.pdf>> (accessed 17 March 2025).

131 Raphael Auer, Jon Frost & Jose María Vidal Pastor, “Miners as Intermediaries: Extractable Value and Market Manipulation in Crypto and DeFi” (16 June 2022) BIS Bulletin No 58 at pp 1–2 <<https://www.bis.org/publ/bisbull58.pdf>> (accessed 17 March 2025); Campbell R Harvey, Ashwin Ramachandran & Joey Santoro, *DeFi and the Future of Finance* (Wiley, 2021) at p 31; Fabian Schär, “DeFi’s Promise and Pitfalls” [2022] *Finance & Development* 33 at 35.

132 Raphael Auer, Jon Frost & Jose María Vidal Pastor, “Miners as Intermediaries: Extractable Value and Market Manipulation in Crypto and DeFi” (16 June 2022) BIS Bulletin No 58 at p 3 <<https://www.bis.org/publ/bisbull58.pdf>> (accessed 17 March 2025).

change at other market participants' expense.¹³³ Another possible means of manipulating prices is through “flash loans”,¹³⁴ which are practically instantaneous loans that are repaid within the same transaction, with repayment being enforced by the smart contract.¹³⁵ Such practices exacerbate market integrity risks in the DeFi context.

39 Third, DeFi is also associated with technology and cyber risks.¹³⁶ These include developer malpractice¹³⁷ and cyberattacks of varying complexity, such as hacks and exploitation of smart contract coding vulnerabilities.¹³⁸ The use of smart contracts gives rise to what has been termed “smart contract risk”, which can take the form of errors in the code or vulnerability of the smart contract to economic exploitation.¹³⁹ Major smart contract attacks include the June 2016 attack on a smart contract designed by Slock.it to function as a decentralised venture capital fund, as well as the April 2020 attack on the Lendf.Me lending protocol.¹⁴⁰ In the second quarter of 2022, Immunefi estimated that \$670m was lost to smart contract breaches and hacks.¹⁴¹ Moreover, technology risk can be amplified due to the distinctive features of DeFi technologies. For example, decentralisation expands the number of attack vectors

133 Raphael Auer, Jon Frost & Jose María Vidal Pastor, “Miners as Intermediaries: Extractable Value and Market Manipulation in Crypto and DeFi” (16 June 2022) BIS Bulletin No 58 at p 3 <<https://www.bis.org/publ/bisbull58.pdf>> (accessed 17 March 2025).

134 “‘The Future of Money, Finance and the Internet’ – Speech by Mr Ravi Menon, Managing Director, Monetary Authority of Singapore, at Singapore FinTech Festival on 9 November 2021” *Monetary Authority of Singapore* (9 November 2021) <<https://www.mas.gov.sg/news/speeches/2021/the-future-of-money-finance-and-the-internet>> (accessed 17 March 2025).

135 Campbell R Harvey, Ashwin Ramachandran & Joey Santoro, *DeFi and the Future of Finance* (Wiley, 2021) at p 57.

136 See, eg, Monetary Authority of Singapore, “Proposed Regulatory Measures for Digital Payment Token Services” (October 2022) Consultation Paper P008 – 2022 at para 4.12 <<https://www.mas.gov.sg/-/media/mas/news-and-publications/consultation-papers/2022-proposed-regulatory-measures-for-dpt-services/consultation-paper-on-proposed-regulatory-measures-for-digital-payment-token-services-v3.pdf>> (accessed 25 April 2025).

137 Campbell R Harvey, Ashwin Ramachandran & Joey Santoro, *DeFi and the Future of Finance* (Wiley, 2021) at p 131.

138 Macroprudential Surveillance Department, Monetary Authority of Singapore, “Financial Stability Review” (November 2022) at p 100 <<https://www.mas.gov.sg/-/media/mas-media-library/publications/financial-stability-review/2022/financial-stability-review-2022.pdf>> (accessed 17 March 2025).

139 Campbell R Harvey, Ashwin Ramachandran & Joey Santoro, *DeFi and the Future of Finance* (Wiley, 2021) at p 131.

140 Campbell R Harvey, Ashwin Ramachandran & Joey Santoro, *DeFi and the Future of Finance* (Wiley, 2021) at pp 133–134.

141 Michael Casey, “‘DeFi’ and ‘TradFi’ Must Work Together” [2022] *Finance & Development* 24 at 26.

as compared with CeFi, in this sense amplifying potential technology risk.¹⁴² Where blockchain transactions are immutable, such immutability can greatly magnify the impact of smart contract programming errors.¹⁴³ Additionally, the composability of smart contracts, while lauded for improving interoperability, at the same time may also magnify the impact of disruptions: with increased interconnectedness across DeFi applications, a disruption in a single DeFi application may affect the functioning of multiple DeFi applications.¹⁴⁴ The nature of DeFi technologies, therefore, has the potential to augment technology and cyber risks.

40 This section has so far focused on ML/TF, market integrity and technology risks, in part because these risks may be distinctively amplified in the DeFi context, and in part because these risks are the focus of current and proposed regulation of digital payment token services in Singapore.¹⁴⁵ However, MAS, as well as international organisations such as the IMF, have also noted other types of risk associated with DeFi, including risks of consumer harm and liquidity risks.¹⁴⁶

41 Finally, this section closes with a brief discussion of potential financial stability concerns, which MAS has addressed, for instance, in

142 Campbell R Harvey, Ashwin Ramachandran & Joey Santoro, *DeFi and the Future of Finance* (Wiley, 2021) at p 131.

143 Fabian Schär, “DeFi’s Promise and Pitfalls” [2022] *Finance & Development* 33 at 35.

144 Macroprudential Surveillance Department, Monetary Authority of Singapore, “Financial Stability Review” (November 2022) at p 100 <<https://www.mas.gov.sg/-/media/mas-media-library/publications/financial-stability-review/2022/financial-stability-review-2022.pdf>> (accessed 17 March 2025).

145 See further Monetary Authority of Singapore, “Prevention of Money Laundering and Countering the Financing of Terrorism – Holders of Payment Services Licence (Digital Payment Token Service)” (2 April 2024) MAS Notice PSN02; Monetary Authority of Singapore, “Technology Risk Management Guidelines” (January 2021); Monetary Authority of Singapore, “Consultation Paper on Proposed Measures on Market Integrity in Digital Payment Token Services” (3 July 2023) P008 – July 2023 <<https://www.mas.gov.sg/-/media/mas/news-and-publications/consultation-papers/2023-consultation-paper-on-proposed-measures-on-market-integrity-in-dpt-services/consultation-paper-on-proposed-measures-on-market-integrity-in-dpt-services.pdf>> (accessed 17 March 2025).

146 Monetary Authority of Singapore, “Proposed Regulatory Measures for Digital Payment Token Services” (October 2022) Consultation Paper P008 – 2022 at para 4.12 <<https://www.mas.gov.sg/-/media/mas/news-and-publications/consultation-papers/2022-proposed-regulatory-measures-for-dpt-services/consultation-paper-on-proposed-regulatory-measures-for-digital-payment-token-services-v3.pdf>> (accessed 25 April 2025); “Cryptocurrencies and Decentralized Finance: Bank for International Settlements 21st Annual Conference – Tobias Adrian, IMF Financial Counsellor and Director of the Monetary and Capital Markets Department” *International Monetary Fund* (24 June 2022) <<https://www.imf.org/en/News/Articles/2022/06/24/sp083022-cryptocurrencies-and-decentralized-finance>> (accessed 17 March 2025).

a Special Feature in its 2022 Financial Stability Review.¹⁴⁷ In it, MAS considered that DeFi may have financial stability implications if it were to expand to the extent that it significantly increases the proportion of unregulated financial activity, results in the growth of shadow finance, displaces incumbent financial services providers, and/or changes the structure of the financial system.¹⁴⁸

42 In this regard, ultimately, it should be noted that the risk assessment is still dependent on the scale of the DeFi market. At present the DeFi market remains relatively small.¹⁴⁹ There is some potential for growth; for instance, asset tokenisation may increase the scale of DeFi by expanding the scope of assets with which DeFi applications may interact.¹⁵⁰ However, the scalability of DeFi technologies is still in question. Scalability, security and decentralisation are often represented as a trilemma; increasing the scalability of DeFi, therefore, may require trade-offs in the degree of security or decentralisation.¹⁵¹ As such, developments in the scalability of DeFi, together with its attendant trade-offs, may have implications for the regulatory approach. For example, to the extent increases in the scale of DeFi exacerbate risks, yet correspond with increased centralisation, it may be that new (or old) regulatory tools designed for regulation of centralised intermediaries may become available to mitigate these concerns. The scale and scalability of DeFi hence is an important part of the overall risk assessment.

43 Presently, it remains to be seen how DeFi will develop. Still, some of the regulatory issues associated with DeFi have already become apparent, and even at this relatively nascent stage of development, these issues merit considered scrutiny and continued observation.

147 Macroprudential Surveillance Department, Monetary Authority of Singapore, “Financial Stability Review” (November 2022) at pp 94–107 <<https://www.mas.gov.sg/-/media/mas-media-library/publications/financial-stability-review/2022/financial-stability-review-2022.pdf>> (accessed 17 March 2025).

148 Macroprudential Surveillance Department, Monetary Authority of Singapore, “Financial Stability Review” (November 2022) at pp 101, 103 and 106 <<https://www.mas.gov.sg/-/media/mas-media-library/publications/financial-stability-review/2022/financial-stability-review-2022.pdf>> (accessed 17 March 2025).

149 Monetary Authority of Singapore, “Proposed Regulatory Measures for Digital Payment Token Services” (October 2022) Consultation Paper P008 – 2022 at para 4.12 <<https://www.mas.gov.sg/-/media/mas/news-and-publications/consultation-papers/2022-proposed-regulatory-measures-for-dpt-services/consultation-paper-on-proposed-regulatory-measures-for-digital-payment-token-services-v3.pdf>> (accessed 25 April 2025).

150 Macroprudential Surveillance Department, Monetary Authority of Singapore, “Financial Stability Review” (November 2022) at p 103 <<https://www.mas.gov.sg/-/media/mas-media-library/publications/financial-stability-review/2022/financial-stability-review-2022.pdf>> (accessed 17 March 2025).

151 Fabian Schär, “DeFi’s Promise and Pitfalls” [2022] *Finance & Development* 33 at 35.

V. Regulating DeFi: trajectories for development?

44 In light of these regulatory issues, this Part discusses some potential directions for the future development of the regulation of DeFi. First and fundamentally, why regulate DeFi? Second, where regulation is justified, to what extent is it appropriate and feasible to apply and enforce existing laws and regulations? Third and relatedly, where new and/or alternative regulation is warranted, what forms could such regulation take (such as new forms of “embedded regulation”¹⁵² or “embedded supervision”¹⁵³)? Finally, what implications might DeFi have for the regulation of TradFi and CeFi?

A. Justifying DeFi regulation

45 Questions about *how* DeFi should be regulated are necessarily preceded by the more fundamental question: *why* regulate DeFi? In this regard, one important justification for regulating DeFi is based on a functional approach to regulation (as advocated by Aquilina *et al*): to the extent that DeFi performs the same financial functions as TradFi, the same economic rationales for regulation should apply.¹⁵⁴ As a corollary, where DeFi’s distinctive features give rise to risks that are different in type and/or degree from CeFi – or even mitigate or eliminate risks of CeFi – this difference in risk profiles may justify different regulatory treatment.¹⁵⁵

46 On the one hand, regulatory objectives – such as consumer protection, market integrity and financial stability – may be the same in both the TradFi and DeFi contexts.¹⁵⁶ Aquilina *et al* have identified and compared the economic functions of TradFi and DeFi (*eg*, transfer of economic resources, pooling of funds, clearing and settlement), the rationale for regulation of each function (*eg*, systematic externalities, information asymmetries), as well as mitigants (*eg*, TradFi prudential regulation, DeFi instantaneous clearing).¹⁵⁷ In some respects, the risks

152 Dirk A Zetsche, Douglas W Arner & Ross P Buckley, “Decentralized Finance” (2020) 6 *Journal of Financial Regulation* 172 at 174 and 201–203.

153 See Raphael Auer, “Embedded Supervision: How to Build Regulation into Decentralised Finance” (2019) BIS Working Papers No 811 <<https://www.bis.org/publ/work811.pdf>> (accessed 17 March 2025).

154 Matteo Aquilina, Jon Frost & Andreas Schrimpf, “Decentralized Finance (DeFi): A Functional Approach” (2024) 10(1) *Journal of Financial Regulation* 1.

155 Katrin Schuler, Ann Sofie Cloots & Fabian Schär, “On DeFi and On-Chain CeFi: How (Not) to Regulate Decentralized Finance” (2024) 10(2) *Journal of Financial Regulation* 213 at 239 and 241–242.

156 Matteo Aquilina, Jon Frost & Andreas Schrimpf, “Decentralized Finance (DeFi): A Functional Approach” (2024) 10(1) *Journal of Financial Regulation* 1 at 16.

157 Matteo Aquilina, Jon Frost & Andreas Schrimpf, “Decentralized Finance (DeFi): A Functional Approach” (2024) 10(1) *Journal of Financial Regulation* 1 at 14–16.

and issues that arise are similar, thus justifying regulation in the DeFi context as in the TradFi context.

47 On the other hand, in other respects, DeFi may have a different risk profile from CeFi, and this may justify different regulatory treatment.¹⁵⁸ Part IV above has discussed new risks posed by DeFi, as well as existing risks that are exacerbated in the DeFi context. It may even be the case that DeFi mitigates risks that are present in the CeFi context. For instance, DeFi may mitigate or even eliminate counterparty risk. This may be on account of “intra-transaction composability”, where a single transaction (eg, a swap) can involve actions across multiple smart contracts (eg, effecting the transfers of assets between the parties) – mitigating counterparty risk (eg, by ensuring that both transfers must take place in parallel).¹⁵⁹ Flash loans are an example of a type of DeFi transaction that purportedly eliminates counterparty risk, as if the loan is not repaid within the same transaction, the smart contract ensures reversion to the pre-transaction state.¹⁶⁰ To give another example, DeFi’s self-custodial nature may mitigate risk associated with “custodising” assets with a custodian.¹⁶¹ Where such counterparty and custody-related risks are not present in the DeFi context, this may justify the non-application of regulatory requirements directed at mitigating such risks. At the same time, however, new and/or distinct risks may arise, for instance, smart contract risk (such as in the example of flash loans) or self-custody-related risks (such as the risk of users losing their private keys). A distinct risk profile hence may call for different regulatory treatment.

48 Finally, even if DeFi regulation is justified from a functional perspective, ultimately, scale remains an important consideration (as discussed further at para 42). “Risk appropriate” and “impact sensitive” are two of the six tenets that guide MAS in the development of its regulatory framework.¹⁶² According to MAS’s preliminary analysis of the digital payment token sector in November 2023, the volume of DeFi

158 Katrin Schuler, Ann Sofie Cloots & Fabian Schär, “On DeFi and On-Chain CeFi: How (Not) to Regulate Decentralized Finance” (2024) 10(2) *Journal of Financial Regulation* 213 at 239 and 241–242.

159 Fabian Schär, “DeFi’s Promise and Pitfalls” [2022] *Finance & Development* 33 at 34; Katrin Schuler, Ann Sofie Cloots & Fabian Schär, “On DeFi and On-Chain CeFi: How (Not) to Regulate Decentralized Finance” (2024) 10(2) *Journal of Financial Regulation* 213 at 228.

160 Campbell R Harvey, Ashwin Ramachandran & Joey Santoro, *DeFi and the Future of Finance* (Wiley, 2021) at p 57.

161 Katrin Schuler, Ann Sofie Cloots & Fabian Schär, “On DeFi and On-Chain CeFi: How (Not) to Regulate Decentralized Finance” (2024) 10(2) *Journal of Financial Regulation* 213 at 241.

162 Monetary Authority of Singapore, “Tenets of Effective Regulation” (June 2010, revised in September 2015) at pp 1–3 <<https://www.mas.gov.sg/-/media/mas/>
(cont’d on the next page)

transactions was relatively low, comprising less than 1.7% of the total transaction volume.¹⁶³ As such, the scale and risks associated with DeFi may not presently justify a major new regulatory initiative, taking into account MAS's tenets of effective regulation. Conversely, a significant increase in the scale of DeFi may well justify such a regulatory initiative.

49 The above discussion on the justification for DeFi regulation notwithstanding, at present, most jurisdictions – including Singapore – do not have DeFi-specific regulation.¹⁶⁴ Rather, DeFi regulation tends to be regarded as an open question subject to further consideration.¹⁶⁵ As such, instead of making specific regulatory recommendations, paras 50–69 below consider the fundamental questions that underlie any such recommendations. It bears noting that there are indeed various potential policy responses to DeFi (such as those identified by the World Economic Forum in its policy-maker toolkit¹⁶⁶). These include, for instance: (a) forbearance or maintaining the status quo; (b) enforcement, in circumstances where DeFi is found to be non-compliant with existing regulations; (c) prohibitive measures banning certain DeFi activities; (d) issuing warnings to DeFi users; (e) issuing guidance regarding DeFi activities; (f) pruning regulatory requirements that are not required in the DeFi context; (g) providing the option to voluntarily opt in to be subject to regulation in exchange for certain protections; (h) introducing licences of limited scope that are subject to light-touch regulation; and (i) introducing new types of licences specifically for DeFi activities.¹⁶⁷ The following paragraphs may make reference to these where appropriate, but this article is not primarily concerned with recommending specific policy actions; rather, as mentioned above, it seeks to address the fundamental and conceptual issues that underlie specific regulatory choices.

news-and-publications/monographs-and-information-papers/tenets-of-effective-regulation.pdf> (accessed 17 March 2025).

163 Monetary Authority of Singapore, “Virtual Assets Risk Assessment Report Singapore 2024” (2024) at para 5.3 <<https://www.mas.gov.sg/-/media/mas-media-library/publications/monographs-or-information-paper/amld/2024/virtual-assets-risk-assessment.pdf>> (accessed 17 March 2025).

164 World Economic Forum, “Decentralized Finance: (DeFi) Policy-Maker Toolkit” (2021) at p 21 <https://www3.weforum.org/docs/WEF_DeFi_Policy_Maker_Toolkit_2021.pdf> (accessed 17 March 2025).

165 Cambridge Centre for Alternative Finance and others, “2nd Global Cryptoasset Regulatory Landscape Study” (Cambridge Centre for Alternative Finance 2024) at pp 85–86 <<https://www.jbs.cam.ac.uk/wp-content/uploads/2024/10/2024-2nd-global-cryptoasset-regulatory-landscape-study.pdf>> (accessed 17 March 2025).

166 World Economic Forum, “Decentralized Finance: (DeFi) Policy-Maker Toolkit” (2021) at <https://www3.weforum.org/docs/WEF_DeFi_Policy_Maker_Toolkit_2021.pdf> (accessed 17 March 2025).

167 World Economic Forum, “Decentralized Finance: (DeFi) Policy-Maker Toolkit” (2021) at p 21 <https://www3.weforum.org/docs/WEF_DeFi_Policy_Maker_Toolkit_2021.pdf> (accessed 17 March 2025).

B. *Scope for application of traditional (intermediary-focused) regulation*

50 Having discussed the justification for regulating DeFi, this section now turns to addressing the question of how DeFi should be regulated. Before considering potential new forms of regulation (as will be discussed at paras 63–69 below), to what extent is it appropriate and feasible to apply and enforce – or even extend the applicability of – traditional, largely intermediary-focused laws and regulations?

51 In this regard, there are certain key considerations, drawing on the frameworks proposed by Schuler *et al* and Rettig *et al*.¹⁶⁸ In the first instance, despite the purportedly decentralised nature of the DeFi project, are there any identifiable points of centralisation?

(a) If the answer is yes (*ie*, there is at least one identifiable point or source of centralisation), to what extent is existing regulation applicable? Is it appropriate to expand the ambit of traditional intermediary-focused regulation – such as through the creation of new categories of DeFi-specific regulated activities?

(b) If the answer is no (*ie*, this is a genuine DeFi project), are there nevertheless any potential “regulatory hooks” – such as DeFi on- and off-ramps,¹⁶⁹ or even token issuers or smart contract developers?¹⁷⁰ Should new or alternative forms of regulation be considered (as will be discussed at paras 63–69 below)?

168 Katrin Schuler, Ann Sofie Cloots & Fabian Schär, “On DeFi and On-Chain CeFi: How (Not) to Regulate Decentralized Finance” (2024) 10(2) *Journal of Financial Regulation* 213; Rebecca Rettig, Michael Mosier & Katja Gilman, “Genuine DeFi as Critical Infrastructure: A Conceptual Framework for Combating Illicit Finance Activity in Decentralized Finance” (29 January 2024) at pp 29–43 <<https://papers.ssrn.com/abstract=4607332>> (accessed 17 March 2025).

169 These refer to points of entry into and exit from the DeFi ecosystem, where users exchange fiat currency for cryptoassets (“on-ramp”) or *vice versa* (“off-ramp”): see, eg, Monetary Authority of Singapore, “Project Orchid: Programmable Digital SGD” (2022) at p 31 <<https://www.mas.gov.sg/-/media/mas-media-library/development/fintech/project-orchid/mas-project-orchid-report.pdf>> (accessed 25 April 2025); Consultative Group of Directors of Financial Stability, “Financial Stability Risks from Cryptoassets in Emerging Market Economies” (2023) BIS Papers No 138 at p 41 <<https://www.bis.org/publ/bppdf/bispap138.pdf>> (accessed 25 April 2025).

170 Katrin Schuler, Ann Sofie Cloots & Fabian Schär, “On DeFi and On-Chain CeFi: How (Not) to Regulate Decentralized Finance” (2024) 10(2) *Journal of Financial Regulation* 213 at 239; HM Treasury, “Future Financial Services Regulatory Regime for Cryptoassets: Response to the Consultation and Call for Evidence” (October 2023) at paras 11.17–11.18 <https://assets.publishing.service.gov.uk/media/653bd1a180884d0013f71cca/Future_financial_services_regulatory_regime_for_cryptoassets_RESPONSE.pdf> (accessed 17 March 2025).

These considerations will be discussed in further detail below.

(1) *Identifying points of centralisation*

52 In determining the appropriate regulatory response, in the first instance, it is necessary to consider whether a DeFi project – despite its purportedly decentralised nature – nevertheless involves any identifiable points of centralisation. In seeking to apply existing laws and regulations to DeFi, one key challenge is that to the extent that DeFi involves true decentralisation, there may be no intermediary to whom legal and regulatory requirements can attach (as discussed at paras 23–28 above). This is perhaps the most fundamental way in which DeFi challenges existing regulatory paradigms. Yet, decentralisation may be a matter of degree – or may even be deceptive (as discussed at para 35 above). Rather than a strict dichotomy between centralisation and decentralisation, decentralisation has been described as a “spectrum”.¹⁷¹ When considering whether and how to regulate a given DeFi project, it is therefore important to ascertain whether there are any identifiable points of centralisation.

53 How can such points of centralisation be identified? The idea of a “test of decentralisation” that has regard to both technical and governance aspects was highlighted in response to a DeFi discussion paper issued by the *Autorité des Marchés Financiers*.¹⁷² Such tests have emerged in the literature. Notably, Schuler *et al* have proposed a three-step framework for identifying sources of centralised control, which they describe as “centralization vectors”.¹⁷³ Under this framework, the first step is to determine the layer(s) on which the DeFi project is active – whether the settlement, asset, protocol, application or aggregation layer (as discussed at para 10 above). The second step is to ascertain whether there is any “endogenous” centralisation, that is, centralisation within the DeFi project itself. The third step is to ascertain whether there is any “inherited” centralisation, that is, centralisation that is derived

171 OECD, “Why Decentralised Finance (DeFi) Matters and the Policy Implications” (2022) at pp 20–22 <<https://doi.org/10.1787/109084ae-en>> (accessed 17 March 2025).

172 This refers to the French Financial Markets Authority. See *Autorité des Marchés Financiers*, “Decentralised Finance (DeFi), Trading, Protocols and Governance Issues: Overview, Observed Trends, and Regulatory Discussion Points – Summary of Responses to the AMF Discussion Paper” (2024) at p 7 <https://www.amf-france.org/sites/institutionnel/files/private/2024-07/2024_defi_synthese-papier-discussion-amf_veng.pdf> (accessed 17 March 2025).

173 Katrin Schuler, Ann Sofie Cloots & Fabian Schär, “On DeFi and On-Chain CeFi: How (Not) to Regulate Decentralized Finance” (2024) 10(2) *Journal of Financial Regulation* 213 at 220–221.

from external elements on which the DeFi project depends.¹⁷⁴ Given the hierarchical nature of the DeFi layers, Schuler *et al* argue that if there is endogenous centralisation within a given layer, this may give rise to inherited centralisation in the layer(s) and projects that depend or build on that (endogenously) centralised element.¹⁷⁵

54 Specifically, the authors explain how centralisation may occur on each layer, raising some of the following examples:

(a) at the settlement layer, potential issues include: (i) whether users' access to the network may be dependent on centralised services; (ii) whether the ability to verify transactions may be dependent on centralised inputs or computations (eg, data from centralised external and off-chain oracles¹⁷⁶); and (iii) whether the consensus protocol uses (or effectively uses) closed set(s) of consensus-relevant resources or nodes (eg, if only a few entities hold a significant proportion of the resources), thus giving rise to centralisation;

(b) at the asset and protocol layers, issues include: (i) whether the relevant smart contracts contain restricted functions; (ii) the criticality of any such restricted function (eg, one that restricts user participation may be regarded as more critical); and (iii) whether there is centralisation in the governance of the execution of such restricted functions (eg, if governance is account-based, by holders of "admin keys" who have centralised decision-making power); and

(c) at the application and aggregation layers, one potential issue is the extent to which access to and content of web-based applications may be controlled by their developers and/or operators, thus constituting a point of centralisation.¹⁷⁷

55 As it stands, the prevailing regulatory regime already recognises that ostensibly decentralised projects may in fact involve points of centralisation that can and should be regulated. For instance, several

174 Katrin Schuler, Ann Sofie Cloots & Fabian Schär, "On DeFi and On-Chain CeFi: How (Not) to Regulate Decentralized Finance" (2024) 10(2) *Journal of Financial Regulation* 213 at 221.

175 Katrin Schuler, Ann Sofie Cloots & Fabian Schär, "On DeFi and On-Chain CeFi: How (Not) to Regulate Decentralized Finance" (2024) 10(2) *Journal of Financial Regulation* 213 at 221.

176 Fabian Schär, "DeFi's Promise and Pitfalls" [2022] *Finance & Development* 33 at 35.

177 See, respectively, Katrin Schuler, Ann Sofie Cloots & Fabian Schär, "On DeFi and On-Chain CeFi: How (Not) to Regulate Decentralized Finance" (2024) 10(2) *Journal of Financial Regulation* 213 at 221–226, 226–237, 237–239, as well as the summary table at 240–241.

purported DeFi or DeFi-adjacent projects involve entities that are regulated by MAS in Singapore, such as DigiFT and the operator of InvestaX, IC SG (as discussed at para 16 above). However, taking into account that decentralisation is a spectrum, if we are seeking to increase regulatory clarity regarding the treatment of DeFi, then it may be appropriate, as an initial step, for regulators to articulate a framework and/or principles as to how centralisation should be assessed.¹⁷⁸ One example of such a general framework is that proposed by Schuler *et al*, discussed above.¹⁷⁹ Such principles may also be articulated in a jurisdiction-specific manner, building on or taking into account the existing local regulatory framework. For example, in the US context, Rettig *et al* have proposed a modification to the definition of “independent control” in existing US Financial Crimes Enforcement Network (FinCEN) guidance, to facilitate the identification of “on-chain CeFi”.¹⁸⁰ Whether through the use of a general framework or more specific guidance, once these points and sources of centralisation (if any) are identified, the next question is whether they are – or should be – regulated. DeFi projects with significant points of centralisation have been described as “on-chain CeFi”, while the term “genuine DeFi” has been used to describe independent and neutral infrastructure that lacks such centralisation.¹⁸¹ The former will be discussed at paras 56–59 below, while the latter will be discussed at paras 60–69 below.

(2) *Regulating “on-chain CeFi”*

56 If significant points of centralisation are identified within a purported DeFi project, one key question is whether existing intermediary-focused regulation applies or should be applied.

57 In the Singapore context specifically, many of the DeFi activities discussed above do not currently attract regulation. Notably, although the provision of digital payment token services is regulated under the PS Act

178 See, eg, Michael Casey, “DeFi’ and ‘TradFi’ Must Work Together” [2022] *Finance & Development* 24 at 26.

179 Katrin Schuler, Ann Sofie Cloots & Fabian Schär, “On DeFi and On-Chain CeFi: How (Not) to Regulate Decentralized Finance” (2024) 10(2) *Journal of Financial Regulation* 213 at 220–221.

180 Rebecca Rettig, Michael Mosier & Katja Gilman, “Genuine DeFi as Critical Infrastructure: A Conceptual Framework for Combating Illicit Finance Activity in Decentralized Finance” (29 January 2024) at pp 29–32 <<https://papers.ssrn.com/abstract=4607332>> (accessed 17 March 2025).

181 Katrin Schuler, Ann Sofie Cloots & Fabian Schär, “On DeFi and On-Chain CeFi: How (Not) to Regulate Decentralized Finance” (2024) 10(2) *Journal of Financial Regulation* 213 at 214–215; Rebecca Rettig, Michael Mosier & Katja Gilman, “Genuine DeFi as Critical Infrastructure: A Conceptual Framework for Combating Illicit Finance Activity in Decentralized Finance” (29 January 2024) at p 13 <<https://papers.ssrn.com/abstract=4607332>> (accessed 17 March 2025).

(as discussed at paras 18–28 above), an activity is expressly excluded from the ambit of this statute if it is a service provided by a technical service provider that (a) supports the provision of any digital payment token service and (b) does not enter into the possession of money under that digital payment token service.¹⁸² In this regard, MAS has also expressly clarified that it generally does not seek to regulate persons that are only engaged in software application development or technical activities that fall within the foregoing exclusions, including mining or the functioning of validator nodes.¹⁸³ Hence, even if centralisation is identified at the settlement layer – for instance, due to concentration of mining or validator capacity, or because the consensus protocol uses closed sets of consensus-relevant resources or nodes – such may be outside the scope of present regulation. Likewise, even if centralisation is identified at the application layer on account of developer control, such dApp developers presently are generally outside of the regulatory ambit.

58 If existing regulation does not apply, the question then is whether the regulatory perimeter should be expanded to encompass such points of centralisation. This may require the creation of new categories of regulated activities (eg, in relation to the validation of transactions, to potentially address centralisation at the settlement layer; or in relation to the governance of smart contracts, to potentially address centralisation at the protocol layer). In the UK, for instance, HM Treasury, in its consultation on its future financial regulatory regime for cryptoassets, has contemplated regulating validation and governance activities.¹⁸⁴ The introduction of new regulated activities hence may bring certain points of centralisation within the regulatory scope.

59 Nevertheless, even absent such changes, the value of a framework for assessing centralisation remains. It allows for greater transparency as to the true degree of centralisation within a purported DeFi project,

182 Payment Services Act 2019 (2020 Rev Ed) First Schedule, Pt 2, at para 2(h); see also Financial Services and Markets Act 2022 (Act 18 of 2022) First Schedule, Pt 2, at para 1(a), which provides for a similar exclusion in relation to digital token services (although this provision has not yet come into effect as of the date of writing).

183 Monetary Authority of Singapore, “Response to Feedback Received on the New Omnibus Act for the Financial Sector” (February 2022) at para 3.26 <<https://www.mas.gov.sg/-/media/mas/news-and-publications/consultation-papers/2020-july-consultation-on-fsma/response-to-feedback-received-on-the-new-omnibus-act-for-the-financial-sector.pdf>> (accessed 17 March 2025).

184 HM Treasury, “Future Financial Services Regulatory Regime for Cryptoassets: Consultation and Call for Evidence” (2023) at p 28 <https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1133404/TR_Privacy_edits_Future_financial_services_regulatory_regime_for_cryptoassets_vP.pdf> (accessed 17 March 2025).

addressing the “decentralization theatre” concern¹⁸⁵ (discussed at para 35 above). It also facilitates the identification of regulatory concerns that may arise from such centralisation. For instance, even if points of centralisation at the settlement layer are outside the regulatory ambit, to the extent that such centralisation poses issues and is “inherited” by a DeFi project residing in a different layer, it may potentially be addressed at that subsequent layer. Moreover, if a determination is made that the regulatory perimeter should be expanded, then the identification of points of centralisation also allows for these to be assessed for suitability as potential regulatory hooks for what is in effect a form of traditional intermediary-focused regulation.

(3) *Regulating “genuine DeFi”*

60 The above section has considered the scenario where significant points of centralisation are identified within a purported DeFi project. What about the converse scenario, where the project is determined to be genuine DeFi, that is, consisting of independent and neutral infrastructure that lacks such centralisation?

61 Even with genuine DeFi, it is possible to assess whether there are nevertheless any potential regulatory hooks. One clear example is DeFi on- and off-ramps, particularly fiat-to-crypto exchanges.¹⁸⁶ In Singapore, such exchanges generally would already be regulated as digital payment token service providers under the PS Act.¹⁸⁷ However, regulation of DeFi on- and off-ramps addresses risks only at the entry and exit points to the DeFi system (for instance, addressing ML/TF risks through customer due diligence measures applicable to those who exchange fiat currency for digital payment tokens at a regulated exchange that serves as a DeFi on-ramp). It does not target risks that arise *within* the DeFi system. This may include ML/TF risks that arise *within* the DeFi system, as well as technology, market integrity and consumer protection risks. To address such risks, additional and supplementary regulation, therefore, may be required. Other examples of potential regulatory hooks – albeit more distant from the current regulatory perimeter – may even include token

185 Fabian Schär, “DeFi’s Promise and Pitfalls” [2022] *Finance & Development* 33 at 35.

186 Katrin Schuler, Ann Sofie Cloots & Fabian Schär, “On DeFi and On-Chain CeFi: How (Not) to Regulate Decentralized Finance” (2024) 10(2) *Journal of Financial Regulation* 213 at 239; HM Treasury, “Future Financial Services Regulatory Regime for Cryptoassets: Response to the Consultation and Call for Evidence” (October 2023) at para 11.17 <https://assets.publishing.service.gov.uk/media/653bd1a180884d0013f71cca/Future_financial_services_regulatory_regime_for_cryptoassets_RESPONSE.pdf> (accessed 17 March 2025).

187 Payment Services Act 2019 (2020 Rev Ed) ss 2(1) and 5; First Schedule, Pts 1–3.

issuers or smart contract developers.¹⁸⁸ However, some have expressed scepticism about targeting such regulatory hooks, questioning, *eg*, the fundamental appropriateness of applying CeFi solutions to DeFi, as well as the practicality of enforcement.¹⁸⁹

62 Given these limitations and objections, where genuine DeFi is concerned, should new or alternative forms of regulation be considered (rather than – or in addition to – traditional intermediary-focused regulation)? This question is the focus of the next section.

C. *Scope for introduction of new or alternative forms of regulation*

63 Departing now from the paradigm of intermediary-focused regulation, where new and/or alternative regulation is warranted, what forms could such regulation take and what regulatory tools are available?

(1) *“Embedded” regulation or “compliance by design”*

64 The technological architecture of DeFi potentially allows for new forms of regulation and oversight, such as “embedded regulation” (as argued by Zetzsche *et al*)¹⁹⁰ and “embedded supervision” (as argued by Auer)¹⁹¹ – where regulation may potentially be integrated into DeFi itself through “compliance by design”.¹⁹²

65 Auer has proposed the concept of “embedded supervision”: rather than a traditional approach of requiring reporting, collection and

188 HM Treasury, “Future Financial Services Regulatory Regime for Cryptoassets: Response to the Consultation and Call for Evidence” (October 2023) at paras 11.17–11.18 <https://assets.publishing.service.gov.uk/media/653bd1a180884d0013f71cca/Future_financial_services_regulatory_regime_for_cryptoassets_RESPONSE.pdf> (accessed 17 March 2025).

189 Michael Casey, “DeFi and ‘TradFi’ Must Work Together” [2022] *Finance & Development* 24 at 26; HM Treasury, “Future Financial Services Regulatory Regime for Cryptoassets: Response to the Consultation and Call for Evidence” (October 2023) at para 11.18 <https://assets.publishing.service.gov.uk/media/653bd1a180884d0013f71cca/Future_financial_services_regulatory_regime_for_cryptoassets_RESPONSE.pdf> (accessed 17 March 2025).

190 Dirk A Zetzsche, Douglas W Arner & Ross P Buckley, “Decentralized Finance” (2020) 6 *Journal of Financial Regulation* 172 at 174 and 201–203.

191 Raphael Auer, “Embedded Supervision: How to Build Regulation into Decentralised Finance” (2019) BIS Working Papers No 811 <<https://www.bis.org/publ/work811.pdf>> (accessed 17 March 2025).

192 BIS Innovation Hub, “Project Mandala: Streamlining Cross-Border Transaction Compliance” (2024) at pp 3–5, 8, 13, 15 and 51 <<https://www.bis.org/publ/othp87.pdf>> (accessed 17 March 2025).

verification of data, “embedded supervision” would entail automatic compliance monitoring by reading the market’s ledger.¹⁹³ This leverages the technological nature of DeFi to introduce a new form of compliance monitoring. Building on this concept of “embedded supervision”, Zetzsche *et al* have argued for a similarly more “visionary” approach, which they describe as “embedded regulation” – where regulatory requirements and key regulatory objectives are “embedded technically into DeFi systems”.¹⁹⁴ For instance, the DeFi system may be designed such that input of certain data (such as proof that ML/TF checks have been passed) is a condition for processing a given transaction. The system could also be designed in such a way that certain types of conduct (such as certain conduct that undermines market integrity) simply cannot occur.¹⁹⁵ One (albeit imperfect) analogy might be to an ignition interlock device or in-car breathalyser, where the driver’s breath alcohol concentration must be tested and verified to be within a legal range before a car’s engine can be started. Likewise, the concept here is to “embed” regulation such that compliance with the relevant regulatory requirement is a pre-requisite for performance of a given financial function within the DeFi system.

66 MAS itself has expressly referred to a similar – albeit somewhat broader and more design-focused – concept of “compliance by design”.¹⁹⁶ The concept and technical feasibility of “compliance by design” was recently demonstrated in Project Mandala, an experimental collaborative project between the BIS Innovation Hub and the central banks of Australia, Korea, Malaysia and Singapore.¹⁹⁷ The project encoded jurisdiction-specific regulatory requirements (such as sanctions screening and capital flow management requirements) into a protocol, which could be used for selected large-value cross-border transactions.¹⁹⁸ The Project Mandala

193 Raphael Auer, “Embedded Supervision: How to Build Regulation into Decentralised Finance” (2019) BIS Working Papers No 811 at p 3 <<https://www.bis.org/publ/work811.pdf>> (accessed 17 March 2025).

194 Dirk A Zetzsche, Douglas W Arner & Ross P Buckley, “Decentralized Finance” (2020) 6 *Journal of Financial Regulation* 172 at 174 and 201.

195 Dirk A Zetzsche, Douglas W Arner & Ross P Buckley, “Decentralized Finance” (2020) 6 *Journal of Financial Regulation* 172 at 202; Fabian Schär, “DeFi’s Promise and Pitfalls” [2022] *Finance & Development* 33.

196 “BIS and Central Bank Partners to Explore Protocols for Embedding Policy and Regulatory Compliance in Cross-border Transactions” *Monetary Authority of Singapore* (5 October 2023) <<https://www.mas.gov.sg/news/media-releases/2023/bis-and-central-bank-partners-to-explore-protocols-for-embedding-policy-and-regulatory-compliance>> (accessed 25 April 2025).

197 BIS Innovation Hub, “Project Mandala: Streamlining Cross-Border Transaction Compliance” (2024) at pp 4–5 <<https://www.bis.org/publ/othp87.pdf>> (accessed 17 March 2025).

198 BIS Innovation Hub, “Project Mandala: Streamlining Cross-Border Transaction Compliance” (2024) at pp 4 and 8 <<https://www.bis.org/publ/othp87.pdf>> (accessed 17 March 2025).

architecture automatically generated cryptographic proofs of compliance, which could be attached to a digital settlement asset (eg, wholesale central bank digital currency), to ensure that funds would only be released upon compliance with the relevant regulatory requirements.¹⁹⁹ Although Project Mandala was a CeFi project, it nevertheless demonstrated how regulation can be “embedded” into the design of a system – a concept that could potentially also be implemented in the DeFi context.

67 In the DeFi context, however, what would incentivise such “compliance by design” or “embedded regulation”? One possibility may be to introduce a form of voluntary certification, that is, introducing standards as to compliance with key regulatory requirements, and providing the option for a DeFi project to voluntarily opt-in to be certified for compliance with these standards, in exchange for certain regulatory protections or privileges – one of which may be user trust.

68 In any case, there are significant challenges associated with an “embedded regulation” approach. One key challenge is that it may be difficult to “embed” regulation *ex post*, particularly in already existing and well-established DeFi protocols. Ideally, regulation would be “embedded” *ex ante*, but practically, there may be limited consideration of regulatory concerns at the initial stages of development. Another challenge, given the cross-border nature of DeFi, is that it may be impracticable to embed the entire range of applicable jurisdiction-specific requirements. Zetzsche *et al* have suggested a model for cross-border regulatory collaboration,²⁰⁰ while Project Mandala demonstrated how compliance with several jurisdiction-specific regulatory requirements can be incorporated into the system design in the context of cross-border transactions.²⁰¹ Nevertheless, challenges remain. Even so, however, “embedded regulation” and “compliance by design” are promising potential new forms of regulation that are possible due to the technological architecture of DeFi.

(2) *Self-regulatory solutions*

69 Moreover, it also briefly bears noting that self-regulatory solutions are another possible alternative way of regulating DeFi. Casey

199 BIS Innovation Hub, “Project Mandala: Streamlining Cross-Border Transaction Compliance” (2024) at p 4 <<https://www.bis.org/publ/othp87.pdf>> (accessed 17 March 2025).

200 Dirk A Zetzsche, Douglas W Arner & Ross P Buckley, “Decentralized Finance” (2020) 6 *Journal of Financial Regulation* 172 at 202.

201 BIS Innovation Hub, “Project Mandala: Streamlining Cross-Border Transaction Compliance” (2024) at pp 3–5, 8, 13, 15 and 51 <<https://www.bis.org/publ/othp87.pdf>> (accessed 17 March 2025).

has suggested that regulators could work with the industry to develop such solutions that leverage on the technology and decentralised nature of DeFi.²⁰² Specific examples raised include “bug bounty” programmes that offer rewards to those who discover and report a vulnerability to the dApp developer, periodic software audits and stress tests of collateral models.²⁰³ These are some new and/or alternative regulatory possibilities that can be explored and potentially implemented even for “genuine DeFi”.

D. Implications for TradFi regulation

70 Finally and crucially, albeit briefly, what implications may DeFi have for TradFi regulation? To the extent that individuals are turning to DeFi as a result of exclusion from and disillusionment with the TradFi system, the rise of DeFi is in this sense an indictment of TradFi and its present failures. This concern dates to origins of the cryptocurrencies that preceded DeFi. The invention of Bitcoin in 2008²⁰⁴ – sometimes described as the “Big Bang” of the Internet of money²⁰⁵ – coincided with the global financial crisis, a nadir of systemic trust.²⁰⁶ Some 15 years on, these issues persist. MAS has noted this concern “[e]ven in an economy like Singapore where ... its financial system is stable and trusted”.²⁰⁷ In this regard, MAS has noted that a key mitigant of shadow finance is an inclusive financial system, observing that increased financial inclusion in the regulated TradFi sphere should reduce the likelihood of its displacement by unregulated DeFi.²⁰⁸ Apart from raising the question of how DeFi should be regulated, the rise of DeFi hence also raises the question of whether TradFi and TradFi regulation ought to change. DeFi hence has implications beyond its own sphere, raising the question of whether TradFi regulation ought to further prioritise objectives that

202 Michael Casey, “DeFi’ and ‘TradFi’ Must Work Together” [2022] *Finance & Development* 24 at 26.

203 Michael Casey, “DeFi’ and ‘TradFi’ Must Work Together” [2022] *Finance & Development* 24 at 26.

204 Satoshi Nakamoto, “Bitcoin: A Peer-to-Peer Electronic Cash System” <<https://bitcoin.org/bitcoin.pdf>> (accessed 17 March 2025).

205 Brian Kelly, *The Bitcoin Big Bang: How Alternative Currencies Are About to Change the World* (John Wiley & Sons, 2014).

206 Felix Roth, “The Effect of the Financial Crisis on Systemic Trust” in Felix Roth, *Public Support for the Euro* (Springer, 2022).

207 Macroprudential Surveillance Department, Monetary Authority of Singapore, “Financial Stability Review” (November 2022) at p 106 <<https://www.mas.gov.sg/-/media/mas-media-library/publications/financial-stability-review/2022/financial-stability-review-2022.pdf>> (accessed 17 March 2025).

208 Macroprudential Surveillance Department, Monetary Authority of Singapore, “Financial Stability Review” (November 2022) at pp 104 and 106 <<https://www.mas.gov.sg/-/media/mas-media-library/publications/financial-stability-review/2022/financial-stability-review-2022.pdf>> (accessed 17 March 2025).

TradFi may have neglected or overlooked, such as those of financial inclusion and trust in the financial system.

VI. Conclusion

71 This article has focused on the issue of the regulation of DeFi, particularly within the context of Singapore. It has provided an overview of DeFi, assessed the current regulatory landscape in Singapore, examined key regulatory issues and policy considerations, and discussed some potential directions for the future development of DeFi regulation. It assessed the justification for DeFi regulation, the scope for applicability of traditional intermediary-based regulation of points of centralisation in the DeFi context, the scope for introduction of new forms of DeFi regulation (such as “embedded regulation” and “compliance by design”), as well as DeFi’s broad implications for TradFi regulation. In doing so, this article hopes to contribute to ongoing conversations on the regulation of DeFi, which remains an open question and is currently still regarded as a future target of regulation in many jurisdictions.²⁰⁹

72 Moreover, the development of DeFi regulation is contingent on many broader questions and trends that lie beyond the regulatory sphere. In the international dimension, one key question is the progress of international standard-setting and co-ordination.²¹⁰ In the technological dimension, questions include that of the extent of continuing technological innovation and industry adoption. In the socio-economic dimension, there are troubling issues of financial exclusion, disillusionment and disenfranchisement that may be driving movement towards DeFi.

73 At this point in time, DeFi is still very much a nascent and emergent phenomenon. It is the object of many superlatives. Much has been made of its risks and rewards, its “promise and pitfalls,”²¹¹ and DeFi has been both hyped and reviled. Yet, as Sir Niall Ferguson memorably put it: “Financial markets are like the mirror of mankind, revealing ... the

209 Cambridge Centre for Alternative Finance and others, “2nd Global Cryptoasset Regulatory Landscape Study” (Cambridge Centre for Alternative Finance 2024) at pp 85–86 <<https://www.jbs.cam.ac.uk/wp-content/uploads/2024/10/2024-2nd-global-cryptoasset-regulatory-landscape-study.pdf>> (accessed 17 March 2025).

210 Macroprudential Surveillance Department, Monetary Authority of Singapore, “Financial Stability Review” (November 2022) at p 461 <<https://www.mas.gov.sg/-/media/mas-media-library/publications/financial-stability-review/2022/financial-stability-review-2022.pdf>> (accessed 17 March 2025).

211 Fabian Schär, “DeFi’s Promise and Pitfalls” [2022] *Finance & Development* 33.

way we value ourselves and the resources of the world around us. It is not the fault of the mirror, if it reflects our blemishes as well as our beauty.²¹²

74 In the final analysis, DeFi is no different. Regulation, however, has a crucial role in shaping this mirror and overseeing us who gaze so intently into it. Even in the heady rush towards ever greater heights of innovation, the hope is that regulation will push DeFi to reflect not our worst impulses, but our better angels.

212 Niall Ferguson, *The Ascent of Money: A Financial History of the World* (Penguin Books, 2009) at p 332.