



Monetary Authority
of Singapore



A Retail Central Bank Digital Currency: Economic Considerations in the Singapore Context

Economic Policy Group



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Executive Summary

The Monetary Authority of Singapore (MAS) has been engaging in projects on wholesale Central Bank Digital Currency (CBDC) solutions, which only involve the participation of financial institutions. A retail CBDC that makes central bank digital money directly and broadly available to members of the public would be a significant extension. This paper is a first assessment of the economic case for a retail CBDC in Singapore and its potential implications for financial stability and monetary policy.

The paper makes two main related inferences:

- First, a review of the literature and assessment of the current payment landscape do not suggest strong economic motivations for, nor intractable monetary and financial stability considerations against, a retail CBDC in Singapore.
- Second, emerging digital complementarities and global competitive forces could shape a future monetary arrangement that includes the possibility of a digital form of the Singapore dollar issued by MAS for general use.

Accordingly, MAS' strategic approach towards a retail CBDC for Singapore acknowledges the dynamic nature of the payment landscape, evolving public preferences and the potential of nascent technology solutions. While there is no need to issue a Singapore dollar retail CBDC at this point, it is prudent for MAS to embark on exploratory work to develop the technical and policy capabilities for its possible issuance in the future.

The global monetary and payment landscape appears to be on the cusp of far-reaching change. Today, central banks and commercial banks are at the core of the two-tier monetary system. As Singapore's central bank, MAS' liabilities serve as money to the general public (physical cash) and to commercial banks (digital reserves). Commercial banks, in turn, provide their liabilities as another form of money (deposits) to households and businesses. These deposits serve to facilitate electronic payments, which are ultimately settled on MAS' balance sheet. However, the ongoing digital revolution—characterised by the emergence of new financial and payment business models, and a new generation of general-purpose technologies that could potentially bypass central intermediaries—challenges this status quo. At the same time, large swathes of commercial activity are migrating online, and with this shift, the need for quick, seamless and low-cost digital payments has increased.

One implication of the digital revolution is that the relevance of cash as a means of payment is diminishing. Physical cash is already a small part of the stock of money in most advanced economies, including Singapore, but its disappearance from widespread use because of its incompatibility with the digital economy would still be perceived as an unprecedented shift in monetary arrangements.

A further implication is that the market structure of payments may undergo a fundamental change. Payments may no longer be the sole preserve of banks. As software and the internet pervade all aspects of commerce, a broad range of technology firms are integrating their digital services with payments. These new business models are unbundling payments from the traditional bank business model of lending and deposit taking, and producing new seamless and innovative experiences for households and merchants. However, the powerful network and scale effects in these data-driven business models pose

a risk. They may eventually lead to excessive market power, accentuated by the creation of closed-loop ecosystems that reduce contestability and increase fragmentation in payments and related digital services.

The ongoing digital acceleration globally is also uniquely marked by the emergence of new forms of digital money. These include CBDCs issued by other central banks and stablecoins from large firms, which seek to address needs unmet by the current bank-centric payment system. These monies are primarily designed for retail use and many have the potential to cross borders, riding on the strong network effects of existing vehicle currencies and global platforms. They could be made easily accessible to businesses and households in Singapore and be underpinned by convenient ecosystems and high efficiency in payments. In a small, open and highly digital economy, the Singapore dollar could be vulnerable to being displaced by a widely used foreign digital currency. Prudential regulations can be used to defend against such an outcome, but only up to a point. If domestic payment efficiency and innovation in the long term fail to keep pace with global digitalisation trends and standards, the attractiveness of other foreign money would eventually prevail.

An option that the central bank community has been considering in response to these developments is the issuance of a retail CBDC. As with many jurisdictions, the starting assumption for the assessment of a retail CBDC in Singapore is that it would be facilitated via a public-private partnership, much as how Singapore dollar cash is issued and distributed today. MAS would issue the digital Singapore dollar, while the private sector would handle distribution and customer-facing activities, including compliance and know-your-customer checks. A retail CBDC would have to be held in electronic wallets, which would primarily be provided by the private sector. But unlike existing forms of digital Singapore dollars available to members of the public, it would be a direct claim on the MAS.

A retail CBDC would preserve the relevance of generally-accessible central bank money as the economy digitalises. As a public digital payment alternative, it would help safeguard consumer and merchant interests as commerce moves further online. Physical cash plays a key role for in-person transactions today—individuals and firms can turn to cash issued by MAS as a means of payment if the cost, speed or other qualities of private sector payment solutions fall short of their needs. Cash is still a meaningful share of transactions in Singapore, which studies attribute in part to high transaction costs that merchants continue to incur when accepting digital payments. As more commercial activity occurs entirely virtually such that physical cash is no longer a practical payment option, a retail CBDC would allow a public payment instrument to continue its role in payments.

Regulation would also be a means of ensuring that electronic payments meets the desired minimum standards in end-user experience. For instance, MAS could stipulate the cost of electronic payments or the ways that transaction privacy should be protected. Interchange fee caps in other jurisdictions have set some precedent for such regulation. However, highly prescriptive regulations could constrain business models and stifle innovation, leaving consumers with fewer choices.

MAS' progressive implementation of FAST, PayNow and SGQR in collaboration with the industry over the past few years have been important steps in fostering greater interoperability and leaning against the build-up of "walled gardens" in payments. MAS has also significantly enhanced new entrants' access to core payment and banking infrastructures with the opening up of FAST and PayNow to eligible non-bank financial institutions, and the awarding of four new digital bank licenses in 2020.

A retail CBDC would go a step further by establishing a universally accepted digital medium of exchange in Singapore. Given the intrinsic characteristics of a digital Singapore dollar issued by MAS—safe, liquid, and widely accepted—it would reduce the need for new players in payments to build up their own e-money offering and a large merchant or customer base that accepts it. Instead, new entrants could integrate with the CBDC platform and offer new digital services around it. Start-ups and smaller firms would likely benefit most, given the high fixed costs associated with existing models of entry into electronic payments. There could also be greater innovation in “payment-adjacent” digital services as easier integration with the CBDC system would allow more firms to tap on payment data.

MAS assesses that a retail CBDC that is elastically supplied and universally accessible just like cash is today could impact credit creation and, more broadly, financial and monetary stability in Singapore. As a new form of money, there is significant uncertainty over the take-up of any retail CBDC. There is the possibility that economic agents will be attracted to a retail CBDC as a store of value and switch their holdings from bank deposits to it in large amounts. A significant outflow of retail deposits, which are a key source of low-cost stable funding for banks, would mean higher funding costs and liquidity risks for the banking system. Banks may choose to cut back on lending or raise lending rates to preserve their profit margins, which would result in tighter credit conditions in the economy if non-bank sources of financing are unable to step in to fill the gap. Alternatively, banks could absorb the rise in funding costs. However, lower profitability from banks’ core intermediation business could then make banks more vulnerable to shocks, reducing their ability to sustain credit flow and serve as anchors for the real economy during crises, as they have done in the past.

In the presence of an elastically supplied retail CBDC, systemic runs on the entire banking system are more likely to occur, and at greater speeds during times of financial stress. With the friction of converting bank deposits into risk-free central bank money (i.e. cash) greatly reduced, depositors are more likely to do so at the first signs of trouble.

Singapore could face more volatile capital flows especially if the retail CBDC was universally accessible. A retail CBDC could make the domestic currency more attractive to non-residents given its advantages over existing forms of Singapore dollar money—holding costs of a CBDC will be lower than of cash, while being similarly free of credit risks, and possibly more readily available as compared to bank deposits.

However, MAS’ preliminary assessment is that with appropriate regulatory safeguards, these macro-financial risks posed by a retail CBDC are likely manageable. Possible measures include financial disincentives or hard limits to prevent excessive CBDC holdings, as well as restrictions on the use of CBDC by non-residents. These risks could further be tempered by innovative design and technological solutions built into a digital Singapore dollar. Such safeguards would ensure that the retail CBDC serves primarily as a medium of exchange and not a major store of value.

Overall, MAS’ current view is that there is no pressing need for a retail CBDC in Singapore at this point in time. Demand for cash domestically remains some way from the “minimum threshold” where concerns of the negative implications from the lack of cash in circulation might arise. Retail payments are generally competitive, efficient and cheap, and innovation continues to flourish. Even as there remain pockets of frictions and high costs, there are other initiatives in the pipeline to address them. The fundamental soundness of the Singapore dollar and its dominance in the domestic economy will also be a bulwark against any rapid substitution towards the use of foreign currencies.

Nevertheless, MAS recognises the possibility that retail CBDCs may offer innovative solutions in the future. The gains from enabling greater innovation in payments and payment-adjacent digital services will grow as businesses continue to digitalise their operations. The case for a public payment alternative to protect end-user welfare in digital payments will naturally strengthen as more payments move entirely online, and could be underscored if the market structure of electronic payments grows more concentrated and rent-seeking behaviour begins to emerge, as has already occurred in some jurisdictions.

There is thus value for MAS to embark on the upstream technical work pertinent to the issuance of a retail CBDC. The development of a retail CBDC system and its ecosystem is likely to be an extended and complex undertaking. Structural trends reshaping domestic money and payments have long runways and could accelerate unexpectedly. MAS and the financial and technology industries should begin to build up the necessary expertise and capabilities to issue a CBDC.

MAS' exploration of CBDC technology, in partnership with the industry, has the potential to generate transferable know-how that could benefit payment innovation more broadly. Retail CBDCs have uniquely high requirements, of scalability, extensibility, and reliability. They are thus a useful "high-water mark" to spur innovations around this payment trilemma, which could have spillover benefits to payments even beyond CBDCs.

Several other important areas remain to be explored, including a retail CBDC's regulatory, legal and operational aspects. Depending on its design and technology, there are both risks as well as the potential for authorities to better combat money laundering, terrorism financing and tax evasion. There are also broader, non-economic considerations for a CBDC, such as the citizenry's desire for continued access to public money and payment privacy.

MAS notes that the adoption of next-generation payment technology and rails are in principle a distinct consideration from the issuance of a retail CBDC on it—while there are likely to be synergies from having public money on next-generation rails, the latest technology could yield significant benefits even when applied to private liabilities. As such, MAS will continue to study other emerging forms of digital money that may utilise such technology, such as privately-issued Singapore dollar-denominated stablecoins and synthetic CBDCs, on their own merits. MAS remains open to a range of possibilities for the future of money and payments, in parallel to the exploratory work on a retail CBDC.

Trusted money and efficient payments are core public goods. A high degree of public intervention in their provision is crucial in ensuring that payments are able to function smoothly and meet the evolving needs of society. MAS will continue to assess the role of public money in the growing sphere of digital payments, in conjunction with the regulatory, developmental and infrastructural initiatives already underway.

1 Introduction

The payment and broader financial landscape is evolving rapidly around the world, with these profound shifts confronting Singapore as well. As economic activity increasingly migrates online, the use of cash is declining while electronic payments, including across borders for retail transactions, are becoming the norm. At the same time, technology-driven non-bank companies are emerging to offer payment and financial services, while recent technological advances and innovations are making possible novel forms of digital money. These developments bring about important benefits, including by fulfilling previously unmet needs of consumers and merchants and addressing shortcomings in legacy systems. However, they come with their own set of challenges. At their core, they raise fundamental questions about the future of money.

Against this backdrop, MAS has been assessing the case for the issuance of a retail Central Bank Digital Currency (CBDC) in Singapore.¹ Today, resident households are already able to transact digitally in a fast, secure and seamless manner and MAS continues to lead initiatives to improve the efficiency and resilience of the existing electronic payment system. (Annex A provides an overview of Singapore’s digital payments journey to date.) Nonetheless, MAS recognises that there could be a complementary role for a retail CBDC—i.e. a digital Singapore dollar issued by MAS—to help meet the needs of the rapidly changing economy, and in the long run, ensure the public’s continued access to central bank-issued money and a public payment option in a digital world.

This paper focuses on the key economic considerations around the issuance of a retail CBDC in Singapore. It is not a comprehensive listing of all the potential benefits and risks of a retail CBDC, nor does it seek to pre-empt a specific CBDC infrastructure or operating model. The discussions in this paper should be viewed as part of MAS’ ongoing efforts to better understand the opportunities afforded by new digital forms of money.

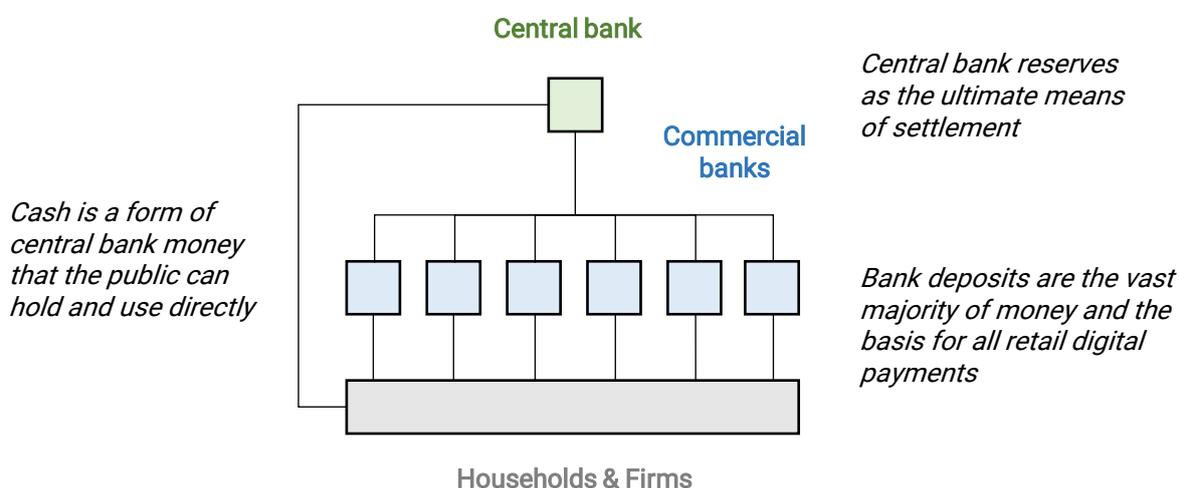
The rest of this paper proceeds as follows. The second chapter lays out key developments in the payment landscape that have ignited interest in a retail CBDC. Against this context, the third chapter discusses the potential benefits of a retail CBDC for Singapore. The fourth chapter highlights the risks to credit creation, financial stability and monetary policy if a cash-like CBDC is issued, as well as some safeguards that could mitigate these risks. The final chapter concludes and highlights areas that require further in-depth study.

¹ A retail CBDC is one that is accessible by members of the public, just like cash is today, whereas a wholesale CBDC is one whose access and use is restricted to financial institutions.

2 The Evolving Money and Payment Landscape

The foundational architecture of Singapore’s monetary system has remained broadly unchanged over the past five decades since the government began issuing its own currency in 1967. As Singapore’s central bank, MAS sits at the heart of this system (Figure 1). MAS issues central bank money, the most liquid form of Singapore dollars and the unit of account in Singapore, to the monetary system in two forms: first, (physical) Singapore dollar notes and coins that are for use by the general public, and second, (digital) reserves which are primarily for use by banks for the settlement of large-value Singapore dollar interbank transactions. In turn, the ability of commercial banks to settle with finality in central bank money allows them to be the primary issuers of Singapore dollar digital money to households and corporates, in the form of commercial bank deposits. Bank deposits today account for 92% of the money supply in Singapore and are the basis for all digital payments by households and firms.²

Figure 1 The Two-tier Monetary System



Source: MAS

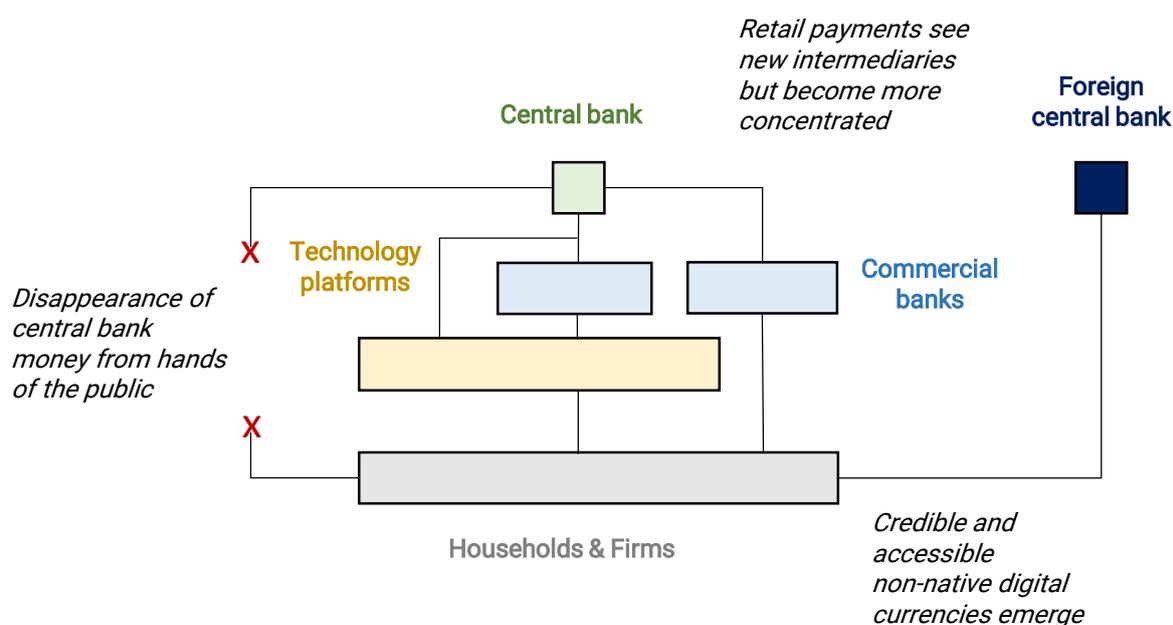
Financial innovations to date—from the creation of credit and debit cards and automated teller machines (ATMs) in the past, to the introduction of Apple Pay and electronic wallets (e-wallets) more recently—have largely represented easier, faster and more convenient ways for economic agents to interact with this core monetary architecture (BIS, 2020). Indeed, the same broad two-tier architecture of central banks and commercial banks as the foundations of the monetary system has persisted for centuries in older jurisdictions. However, growing preferences for more commercial and social activity online, technological change, and the rise of new, non-bank payment and financial services providers herald potentially fundamental shifts in how money and payments could work.

In the first instance, the progressive obsolescence of physical cash as economic activity moves online could over time leave Singaporeans bereft of generally-accepted risk-free public money. In addition, the market structure of the banking and electronic payments industry

² Debit card and General Interbank Recurring Order (GIRO) transactions, for instance, involve a transfer of bank deposits from one account holder to another. Transfers utilising e-money, a relatively new form of money in the Singapore economy, are likewise ultimately settled by e-money issuers via bank deposits.

could change with the entry of technology and data-driven firms and business models, which could lead to increasing market concentration and lower contestability. Meanwhile, the emergence of credible non-native (i.e. non-Singapore dollar denominated) digital currencies issued by major central banks or global technology companies, potentially raises new challenges to Singapore’s monetary and financial stability. Figure 2 depicts a possible future architecture of money and payments in light of these developments.

Figure 2 A Possible Future of Money



Source: MAS

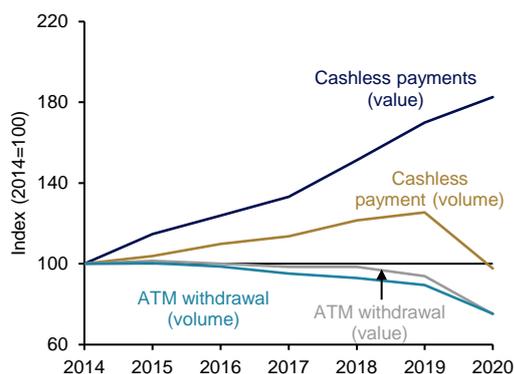
This chapter explores these three developments and their potential implications for MAS’ public policy imperatives of sound money and efficient payments. Not all of the implications are best addressed via a CBDC, or a CBDC alone; this chapter also incorporates relevant discussions of parallel policy responses that public authorities are considering and their limitations.

Decline of Cash as a Medium of Exchange

The relevance of cash as a means of payment in Singapore is diminishing. Singapore businesses and households have increasingly turned to cashless payment methods such as debit and credit cards and e-wallets, at points of sale. Now ubiquitous services such as ride-hailing, online shopping and food delivery seamlessly integrate electronic payments into their interfaces, creating better user experiences. Cash is generally incompatible with the digital economy. As households purchase more goods and services online over time, demand for cash as a means of payment will decline further. The total value and volume of cashless transactions³ in Singapore expanded by an average of 11.2% and 4.7% per annum over 2015–19 (Chart 1). In contrast, ATM withdrawals declined over the same period.

³ Cashless transactions include card and e-money payments as well as credit transfers and direct debits through GIRO and FAST. Payment by cheques have been excluded.

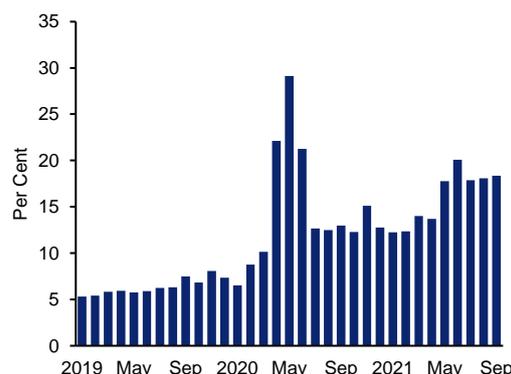
Chart 1 Cashless Payments and ATM Withdrawals



Source: MAS estimates

Note: The volume of cashless payments in 2020 was weighed down by a sharp reduction in public transport ridership.

Chart 2 Online Share of Total Retail and Food & Beverage Sales



Source: DOS

The COVID-19 pandemic has accelerated digitalisation and these shifts in user preferences in Singapore. The adoption of e-commerce and associated digital payment methods saw a discernible step up last year. For instance, DBS noted that 100,000 of its customers had started online spending for the first time in Q1 2020, and about 30% of them were above the age of 50 (Straits Times, 2020). In April and May 2020, when Singapore went into a “circuit breaker” phase to contain the spread of COVID-19, the share of total retail and food & beverage (F&B) sales conducted online rose to new highs (Chart 2). Notably, even after mobility restrictions were eased, online sales continued to account for over 12% of total retail and F&B revenue, double that in 2019. The adoption of electronic payments has risen in tandem. Total registrations by individuals and firms for the PayNow service increased by around 50% to 4.9 million in 2020 (MAS, 2021a), while the value of PayNow and PayNow Corporate transactions tripled during the year to \$38 billion (MAS, 2021c). In contrast, the use of cash for point-of-sales transactions fell to 26% in 2020, from 37% of in 2019 (Fidelity Information Services (FIS), 2020 and 2021).⁴

There are important benefits to Singapore reducing its relatively high reliance on cash. Digital instruments are more convenient, efficient and potentially greener than cash. Consumers and merchants need not make trips to bank branches or ATMs to deposit and withdraw cash. Businesses can save time and effort currently spent on counting cash and reconciling money in cash registers with items sold, as well as securing their money. The resultant savings can be substantial—the cost of processing cash in Singapore was estimated to be about \$2 billion a year, or 0.5% of GDP in 2015 (KPMG, 2016). As noted in MAS’ inaugural Sustainability Report (2021), currency operations, from printing to distribution, have a substantial carbon footprint. Rogoff (2016) also makes the point in the global context that cash can facilitate money laundering and terrorism financing due to its anonymity.

Hence, the government and MAS have been supportive of the shift towards electronic payments. This proved to be useful in 2020. For instance, individuals with PayNow accounts linked to their national identity number were able to receive financial support from the government up to two weeks earlier than those without, as the latter had to wait for physical cheques to be prepared and mailed. The government continues to introduce initiatives to

⁴ According to FIS estimates, cash accounted for only around 1% of online transactions in both 2019 and 2020.

encourage further adoption of electronic payment solutions. One example is the “Hawkers Go Digital” movement launched in June 2020 that sought to promote the use of the unified SGQR payments solution among stallholders in hawker centres and wet markets where cash continues to dominate transactions. As of August 2021, 11,600 stallholders in hawker centres, HDB coffee shops and JTC canteens were using electronic payments (MAS, 2021b).

MAS is committed to supplying Singapore dollar notes and coins for as long as it is demanded. However, as the use of electronic payments becomes ever more pervasive, there may come a time where demand for physical cash diminishes significantly. In the long run, public money may cease to be a generally-accepted medium of exchange in Singapore, even as its status as legal tender remains (Box A). As fewer consumers choose to use cash, businesses would find it more costly to accept it given the significant fixed costs associated with cash handling. Beyond a certain point, firms could stop accepting cash, which will further disincentivise customers from using it. Today, there are already some retail and food & beverage shops in Singapore that have gone fully cashless, such as Decathlon and The Coffee Bean & Tea Leaf (Straits Times, 2021). In Sweden, where cash in circulation as a percentage of GDP is among the lowest levels in the world, the Sveriges Riksbank is of the view that additional measures to protect physical cash acceptance can only hope to forestall, rather than avert, the disappearance of cash as the economy digitalises (Sveriges Riksbank, 2021).

Box A: Legal Tender vs the Acceptance of Cash

While cash issued by MAS is legal tender (i.e. recognised by law to be a valid means of payment), this does not mean that merchants in Singapore must accept it. If a vendor does not wish to accept cash as payment, they simply have to provide a written notice to customers prior to a transaction. The vendor may refuse to provide goods and services if the customer is not willing to accept the vendor’s terms of payment. As such, firms in Singapore could stop accepting cash once it becomes uneconomical to do so.

Authorities in some jurisdictions are taking steps to protect the relevance of cash. To address the decline in the acceptance of cash in China, the People’s Bank of China published a notice in December 2020 announcing its intention to investigate or punish firms and individuals that refuse to accept cash or adopt discriminatory measures against cash payments. In 2020, the Sveriges Riksbank also called for stronger legal protection for cash, to slow the decline of its use in Sweden.

Implications of the Obsolescence of Physical Cash

While physical cash is already a small part of the domestic money supply today, its disappearance from the hands of the public, if it occurs, could still mark an important shift in Singapore’s monetary arrangements.

First, the general public would no longer have direct access to a Singapore government-issued store of value and liquid means of payment. In its absence, households and businesses would have to rely entirely on privately issued money, which are subject to some degree of credit and liquidity risks. These risks, in the case of bank-issued deposits, are substantially mitigated by the government’s deposit insurance scheme, as well as MAS’ prudent regulation and supervision of the banking sector and credible liquidity backstops, but they cannot be completely eliminated.

In addition to MAS' safeguards for the value of private money outlined above, Singaporeans' trust in Singapore dollars, regardless of its form or issuer, is likely viscerally reinforced by their right to exchange their private money (i.e. claims on banks) into public money (i.e. claims on the state) whenever they wish, without restriction or loss of value.⁵ Money is, in the end, a social convention that can be very fragile under stress (Cunliffe, 2021). To this end, generally-accessible public money arguably has a role to play in anchoring the public's confidence in the soundness of all money in the economy. It is in this context that the erosion and potential elimination of a tangible tether between private and risk-free public money in Singapore should be seen.

Second, Singapore's retail payment system may be less resilient without a public payment backstop. Physical cash currently serves as a fall-back payment option to payment systems that are entirely dependent on the stability of the banks, the availability of the internet and a functional electrical grid. As acceptance falls, cash would become a less effective means of backup when the need arises, reducing the resilience of payments in Singapore.

On its own, the private sector may underestimate the need to improve resilience through maintaining extensive backups or developing offline digital payment modes. This may result in the under-provision of system robustness if there is no active intervention by public authorities (Sveriges Riksbank, 2018). However, the private market should not be expected to bear the full burden of safeguarding the social value of payments. Central banks, as public authorities, should share the responsibility of ensuring that the payment system has sufficient resilience, as it does today by maintaining the cash network (Armeliu et al., 2020).

Third, payments in Singapore could become less inclusive. Cash is a payment instrument that almost anyone is able to use. It does not require special devices or technical knowledge beyond the ability to recognise the notes and coins. Singapore's currency has been specially designed to take into account the needs of the wide spectrum of users, including the visually disabled. Setting aside handling and storage costs, consumers and merchants can pay using cash without transaction fees. In comparison, private providers of digital payments have commercial obligations and thus have less incentive to ensure that their offerings are as inclusive and accessible. The costs of maintaining cash withdrawal services, such as ATMs and branch networks, may also become increasingly prohibitive. Typically, a bank account is a pre-requisite for digital payments today, and Singapore residents who lack one could be excluded from digital payments.⁶

Fourth, the decline of cash would mean a lower level of privacy in legitimate economic transactions. As cash becomes increasingly less accepted, there would be fewer options for consumers and merchants to retain control over their transaction data. Cash has the capacity to ensure privacy because there are no centralised records of its holdings or transactions (Group of Central Banks, 2020). In contrast, electronic payments generate an extensive trail of data that is increasingly being collected and utilised by firms.

⁵ The perfect substitutability of different type of monies at their face value is key to the efficient functioning of the economy as it eliminates the need for economic agents to retain information about the creditworthiness of various means of payment, thereby reducing transaction costs.

⁶ It is estimated that less than 2% of adult Singaporeans are unbanked as at 2020 (MAS, 2020). This includes a minority that is unable to open a bank account because of risk factors such as placement on sanction lists.

New Business Models in Digital Payments and Retail Finance

While payments have historically been the preserve of commercial banks, a much wider range of firms are facilitating payments and bundling them with other digital services to better meet the needs of consumers and merchants today. FinTech firms, such as Square in the US, are combining payments with point-of-sale software, marketing and loyalty programs, and business checking and savings accounts, to provide merchants with an integrated suite of services. On the consumer-end, firms such as AfterPay in Australia, Atome and FavePay in Singapore are integrating e-commerce, digital payments and in some cases, new forms of financing to provide a more seamless way for consumers to discover merchants and shop online. At the same time, in Singapore and around the world, big technology (“BigTech”) firms providing social media (Meta⁷), chat (Tencent), internet search (Google), e-commerce (Alibaba, Sea), ride hailing and delivery (Grab) services are increasingly facilitating payments directly on their platforms, building off their large user bases and vibrant digital ecosystems.

The rise of non-banks facilitating digital payments and finance is likely a secular trend. The ability of payment facilitation to create high levels of engagement with customers, provide access to rich transaction data, and offer a high return on equity, makes it an attractive service for technology firms to incorporate into their offerings (McKinsey, 2019). In turn, payments have often served as a springboard upon which new entrants expand into a range of financial services. As these entrants gain access to the transactional balances and data that individuals and firms generate with banks today, they can subsequently leverage this information to offer savings, credit, insurance and wealth products (Carletti et al, 2020).

Such developments have the potential to improve the efficiency and vibrancy of payments and financial services globally. In the first instance, the wider array of choices for end-users can improve access to financial services and spur lower prices, which could be pertinent in Singapore’s market for payment services.⁸ At the same time, the low-cost structures, large global user bases, and complementary digital operations of new entrants could improve the price, speed and quality of cross-border payments.

Implications of a Changing Market Structure in Digital Payments

However, the shift from payments as a relatively standalone business to one that is increasingly offered as a complement to digital services—by both banks and new technology entrants alike—is likely to influence the industrial organisation of the payment sector.

Brunnermeier et al. (2019) suggests these developments could lead to an “inversion” of the industrial organisation of financial activities, with digital platforms instead of standalone bank applications serving as principal touchpoints through which end-users access banking and other related financial products. BigTech firms increasingly stand between banks and their depositors via e-wallets, while digital payments in apps are subject to fees which these firms control through their app stores. At the same time, commercial banks in Singapore and globally are launching their own digital ecosystems around core banking and payment platforms to meet consumer needs more holistically (Boston Consulting Group, 2021).

⁷ Facebook was rebranded as Meta in October 2021.

⁸ J.P. Morgan (2021) estimates that merchant discount rates (the cost per transaction borne by merchants to accept payments through banks) across a variety of transaction types, as well as payments income as a share of total revenue of banks, are highest in Singapore compared to ASEAN peers.

As a result, the payment market could become materially more concentrated in the future as naturally-occurring network effects in payments are reinforced by its bundling with digital services that enjoy economies of scale and scope (Box B). The BIS (2021) notes that the digital transformation of financial services could result in a “barbell” outcome composed of a few large providers, followed by a long tail of niche players. This is not incongruent with temporarily greater competition between present and future states of the world, which reflect competition “for the market” rather than “within the market” (Furman, 2019). There is thus no guarantee that sequential competition for the market, where new companies pose credible threats to the strong incumbent, would continue once large technology platforms become dominant.

Box B: Market Power in Payments

The market for electronic payments inherently has characteristics which cause it to tip towards monopoly-type structures. These include economies of scale arising from the provision of payment infrastructure and the network effects associated with having a large base of both users and vendors. In Singapore specifically, front-end retail payment services are currently dominated by a few large providers. Potential entrants face significant hurdles in challenging these incumbents due in part to high start-up costs, including from regulatory requirements, as well as banks’ competitive advantage from their control over the back-end payment infrastructure and ability to settle transactions with MAS directly.

A growing economic literature suggests that the entry of BigTech firms into payments poses even further risks of market concentration. This arises because BigTech firms appear particularly adept at making use of self-reinforcing Data analytics, Network effects, and user Activities (“DNA”) loops (BIS, 2019). In such loops, user data is used to improve services with natural network effects, such as internet search, social media and e-commerce. This in turn generates further user activity and data for analysis, growing the networks. Payment data is a uniquely rich source of insights (Botta et al., 2017), and can be used to bolster BigTech firms’ competitive advantage.^{1/} For instance, Meta’s push into payments through Facebook Pay and Whatsapp Pay could help it to collect transaction data for advertisement targeting, which is Meta’s core business. In contrast, while banks and traditional payment institutions have access to transaction data, they do not have the extensive auxiliary information that BigTech firms have collected from their platforms, nor possibly the ability to analyse and process data at the level of efficiency as BigTech firms (BIS, 2019).

^{1/} OECD (2015) notes that data exhibits increasing returns to scope—i.e. linking up data from different sources is a means to contextualising the information, and is thus a source of insights and value that is greater than the sum of the isolated parts. In turn, this can enhance consumer profiling.

The potentially deleterious effects on consumer welfare from increased market concentration would be accentuated by the lack of a public alternative in digital payments. Historically, physical cash has functioned as an effective competitive constraint on electronic payment providers for in-person transactions. If consumers (or merchants) valued their privacy highly or the fees that providers of card and electronic payments levied for their services were too high, there was the option to use cash instead (Bergman, 2020). However, as cash becomes obsolete in the growing share of entirely-online transactions, and new payment service providers begin to use transaction data to provide better or bundled services, there is less competitive pressure to keep dominant payment service providers’ market power in check over time.

Consumer welfare in payment services may diminish over time in the absence of contestability. Dominant firms could begin charging unjustifiably high fees for payment services to both end users and merchants over the longer term (Armeliu et al., 2020).⁹ Digital monopolists could also engage in a range of undesirable rent-seeking behaviour, such as unethical consumer targeting. More broadly, even if firms did not charge an excessive mark-up, they would likely capture the bulk of the economic surplus generated from the aggregation of personal data (Acquisti et al., 2016). This occurs when individuals are unaware of the true value of their data and/or have insufficient bargaining power to get firms to compensate them for the use of it.¹⁰

It remains an area of active inquiry for policymakers globally on how best to realise the public gains from these new business models and players in payments, financial services, and indeed the broader digital economy. Regulation has a key role to play. Internationally, there is growing recognition that government action is needed to lean against developments in digital markets that could generate negative externalities.¹¹ However, it is unlikely to be a panacea. Setting aside practical difficulties that public authorities have faced in applying traditional anti-trust principles to new and rapidly changing markets¹², there is also the added complication that the dynamics in these digital markets (that tend to lead to “winner-takes-most” outcomes) may not be entirely undesirable. There may be trade-offs between market structure and innovation (Furman, 2019). For instance, as a firm’s market share grows, so does the share of data it captures, and in turn its ability to leverage more effectively on data-driven innovation. If regulation sought to promote competition but resulted in payment data and user activity being fragmented across multiple players, this could have the effect of limiting total economic value creation (Garratt and Lee, 2020). Depending on regulation alone to maximise consumer outcomes may be challenging given these inherent tensions.

In parallel, country authorities are leaning on public digital infrastructures to create the conditions for competition and innovation. In Singapore, the progressive implementation of FAST, PayNow and SGQR over the past few years has fostered interoperability in payments. With an already growing ecosystem of interoperable payment methods, new entrants should find it beneficial to “plug in” instead of going it alone. This is complemented by powers granted to MAS in the 2019 Payment Services Act to force important payment providers to make their systems interoperable if required. However, payment interoperability is not a guarantee against the build-up of market power, especially as payments become an integral part of broader digital platforms and ecosystems, which may remain as “walled gardens” if there are no active steps (e.g. regulations) taken to prevent them.

⁹ For example, WhatsApp charged merchants a 4% fee per transaction for its payment services in Brazil (Reuters, 2020). This paper recognises though, that it may be difficult to compare fees charged by current and emerging payment services providers on a like-for-like basis as payments are increasingly bundled with other value-added services, such as customer engagement platforms.

¹⁰ This is the case when consumer data is only valuable in aggregate, but not individually. Thus, only collective bargaining may allow consumers to demand for compensation by the firm. However, such arrangements typically do not exist (Garratt and Lee, 2020).

¹¹ For instance, in June 2021, the UK launched the Digital Markets Unit, a new regulatory body tasked at policing anticompetitive behaviour among the world’s largest technology companies. In July 2021, the US President also signed an Executive Order on Promoting Competition in the American Economy which takes action against anticompetitive behaviour by firms, including BigTechs. Meanwhile, the European Commission announced the Digital Markets Act in 2020 introducing rules for “gatekeepers” in the digital sector.

¹² In June 2021, the US District Court for the District of Columbia dismissed an anti-trust lawsuit brought by the Federal Trade Commission (FTC) against Meta, in part due to difficulties that the FTC faced in defining Meta’s share of what was recognised as “no ordinary or intuitive market” (US District Court, 2021).

Accordingly, policymakers globally are beginning to examine a state-issued digital medium of exchange as an additional way of securing consumer outcomes in digital payments, just as physical cash does for in-person payments today.

Emergence of Non-native Digital Currencies

Amid the milieu of cryptocurrency initiatives in recent years, a number of credible foreign digital currencies are emerging on the horizon. These currencies are largely targeted at retail use cases and include private sector-created stablecoins such as USDC and Diem, which are pegged to the US dollar, as well as CBDCs that some major jurisdictions are actively considering, or are already trialling, such as the digital euro, Bank of Japan's digital yen, and PBOC's e-CNY. These new digital currencies are likely to be more accessible internationally and convenient to use than existing forms of foreign currencies, as well as being embedded within innovative ecosystems. As they enter the market, firms could offer payment and other digital services in Singapore that use these international digital currencies instead of the Singapore dollar.

Foreign currencies are notably already an important medium of exchange for corporates in Singapore, especially for those that are engaged in international trade.¹³ In a survey conducted by MAS in 2019, 46% of the 184 domestic manufacturers who responded indicated that their sales were mostly invoiced in foreign currencies rather than the Singapore dollar. Some 14% of these manufacturers also paid for most of their business costs in foreign currencies. The foreign currency revenue generated by firms in Singapore likely induces demand for foreign currency borrowing, which further encourages firms to accumulate foreign currency for precautionary or store of value purposes.¹⁴

The significant use of foreign currency among local businesses reflects Singapore's inherently strong outward orientation and modest domestic market. Singapore's gross trade is over three times the value of its GDP—exceeded in the region only by Hong Kong which has chosen to peg its currency to the US dollar. The choice of some local firms to deal mainly in foreign currency likely arises because the utility of a currency as a medium of exchange depends on the size and reach of the network using it. The Singapore dollar is less useful for international trade and finance compared to global currencies like the US dollar. Indeed, research suggests that the US dollar is dominant in global trade and finance because of the large US economy, its deep financial markets and unparalleled network effects (Gourinchas, 2019).

While it remains a tail risk for now, a scenario where foreign currency use picks up significantly in Singapore, cannot be ruled out. Large global platforms utilising a foreign digital currency as the medium of exchange could offer cheaper, faster and more seamless transactions, thereby attracting merchants and consumers in Singapore to switch into it. Moreover, there are means by which BigTech companies could leverage their commercial or social media platforms and networks to actively scale adoption of their preferred non-

¹³ The reasons a domestic firm may choose to invoice or price their exports in foreign currency include hedging of import costs, which are priced in the producer's or dominant currency (i.e. the US dollar), and strategic complementarities, especially if international input-output linkages are strong (Mukhin, 2020). Apart from manufacturers, a wide range of Singapore's services sectors such as transport & storage, wholesale trade and parts of financial and professional services likely also transact extensively in foreign currencies.

¹⁴ Gopinath and Stein (2018) show that the extensive use of the US dollar in trade invoicing generates strong demand for US bank deposits for precautionary purposes, which drives down the cost of financing in US dollars, thereby incentivising firms to finance in US dollars. This in turn further encourages the use of US dollars in trade, in a self-reinforcing cycle that entrenches the dominance of US dollar in trade invoicing and finance.

Singapore dollar digital currency. For instance, these companies could make a particular digital currency the default payment option on their platform and offer financial incentives for its usage, such as discounts to consumers and lower transaction fees to merchants. The ecosystem that springs up around these new forms of money could also be more vibrant and innovative than the current bank-centric Singapore dollar electronic payment system.¹⁵

Singapore residents' inherently high share of imported consumption, already extensive use of global e-commerce platforms (implying transactions with vendors located abroad), and ample foreign currency liquidity (via banks and businesses) could be the confluence of factors that facilitates a rapid take up of an attractive foreign digital currency. Firms could choose to reduce their foreign exchange (FX) mismatches by paying their local workers partially or fully in foreign currency. Workers may accept the foreign currency because it can be used directly in a wide range of domestic and cross-border transactions. There are households in Singapore which already hold significant foreign currency-denominated investment portfolios. Meanwhile, firms could provide foreign currency loans leveraging off the voluminous transaction and auxiliary data they have on individuals and merchants. These loans could further incentivise the acceptance of foreign currency wages and revenue. Should this dynamic take root, there could be a significant shift away from the use of the Singapore dollar domestically.

Implications of a Shift Away from the Singapore Dollar

If the Singapore dollar ceased to be the predominant unit of account domestically (i.e. the currency in which most prices are quoted)¹⁶, the relevance of the Singapore dollar exchange rate in household and corporate decisions would weaken. In turn, MAS' monetary policy would be less effective in managing aggregate demand in the economy and influencing price formation. Moreover, the greater use of foreign currencies in Singapore would lead to stronger real and financial international spillovers from the global economy. MAS may be further constrained in its monetary autonomy as it attempts to mitigate these spillovers.

Nevertheless, Singaporeans' continued trust in the institutions backing the value of the domestic currency is a key factor that acts in favour of the Singapore dollar retaining its role as primary store of value. In addition, established habits could reinforce the use of the Singapore dollar as the unit of account domestically.¹⁷

Policymakers globally are increasingly recognising the risks that new forms of digital money could pose to the monetary and financial stability of smaller, open jurisdictions. There is an emerging view that some form of international coordination—whether to commit major economies to non-issuance (Cecchetti and Schoenholtz, 2021) or to allow authorities in recipient jurisdictions to impose restrictions on their residents' access to these forms of digital money (BIS et al., 2021)—may be necessary to mitigate the extent of negative spillovers. In addition, recipient jurisdictions, in the absence of international coordination, may

¹⁵ This is already being observed to some extent around stablecoins built on open crypto networks, where open access and a programmable ledger has allowed a rapid roll-out of new financial services integrated around these instruments (Schär, 2021).

¹⁶ In *extremis*, some studies (e.g. Brunnermeier et al., 2019) have suggested that open economies could be drawn into a broader foreign currency bloc or "digital currency area"—a network where payments and transactions are made digitally using a currency specific to the network.

¹⁷ This unbundling of the functions of money may be made possible through technology that enables frictionless switching between assets with different units of account. The absence of switching costs would reduce the need for users to coordinate on a single currency for transactions and as a store of value (Brunnermeier et al, 2019).

have to rely on unilateral policy levers, in the form of capital controls or other forms of regulation to limit adoption of foreign currencies domestically.

However, the pace at which international agreements can be struck, if at all, is uncertain. In Singapore, the use of capital controls or foreign exchange restrictions to prevent the displacement of the Singapore dollar by non-native digital currencies would not be contemplated, given the importance of current and capital account openness for economic and financial activity. It may be challenging for regulation and taxation alone to carry the full burden of stemming the adoption of foreign digital money instruments. Such measures may be inadequate if foreign currency denominated instruments truly offer an option that is desired by consumers and firms but unavailable in the domestic monetary system.

These concerns over the possible substitution into a non-native digital currency across all stages of the business cycle have been highlighted by the Sveriges Riksbank and the Bank of Canada—two central banks of relatively small, open and advanced economies with their own independent monetary policy. Similarly, the European Central Bank (ECB) has raised fears that stablecoins will “pose serious risks, both to...monetary sovereignty and financial stability” (Panetta, 2020). While most central banks view this risk as small for now, there is also recognition that the pace of change could quicken.

3 Assessing the Case for a Retail CBDC in Singapore

A retail CBDC is a digital payment instrument, denominated in the national unit of account, and a direct liability of the central bank which is usable by members of the public (BIS, 2020). In other words, it is akin to “digital cash”.

In Singapore, the case for issuing a retail CBDC largely rests on the benefits of keeping central bank money in the hands of the public and retaining a viable public option for payments as these migrate online. At the same time, additional benefits could arise as the retail CBDC serves as a platform for further innovation in Singapore dollar payments. The issuance of a Singapore dollar retail CBDC would allow MAS to holistically address the trio of challenges posed by the decline of cash, shifting structure of the payment industry, and the rise of credible non-native digital currencies, even as MAS’ core regulatory, supervisory and lender of last resort roles remain necessary and complementary.

To be clear, these three challenges, in the base case, are unlikely to pose a material threat to MAS’ public policy imperatives in the near term. The observed decline in cash as a medium of exchange in Singapore is occurring against a high base and the current amount of cash in circulation remains far from levels where acceptance problems could arise. Meanwhile, domestic retail payments are relatively competitive, efficient and cheap, and innovation continues to flourish. Although there are pockets of friction and high costs, there are ongoing initiatives to address them. MAS continues to watch developments in the payment industry closely as Singapore welcomes new entrants under the 2019 Payment Services Act and four successful digital bank applicants in 2020. The Singapore dollar is starting from an entrenched position for domestic use cases; the soundness of the domestic currency backed by the Singapore economy’s fundamentals, as well as its widespread use including for taxes and other transactions with the government, are meaningful forces that could keep residents from choosing a non-native unit of account over the domestic currency. Existing payment players in Singapore are also likely to respond strongly to any significant increase in the usage of non-native digital currencies or competition from their issuers’ ecosystem.

These challenges are trends with long runways but developments could unexpectedly accelerate. At the same time, technical and policy preparations for the issuance of a CBDC will likely take an extended period of time. While there is no urgent need for a retail CBDC in Singapore at this point, it would be prudent to ensure that MAS and industry have the ability to pivot to it as the payment and financial landscape continues to evolve in the future.

A Possible CBDC Model

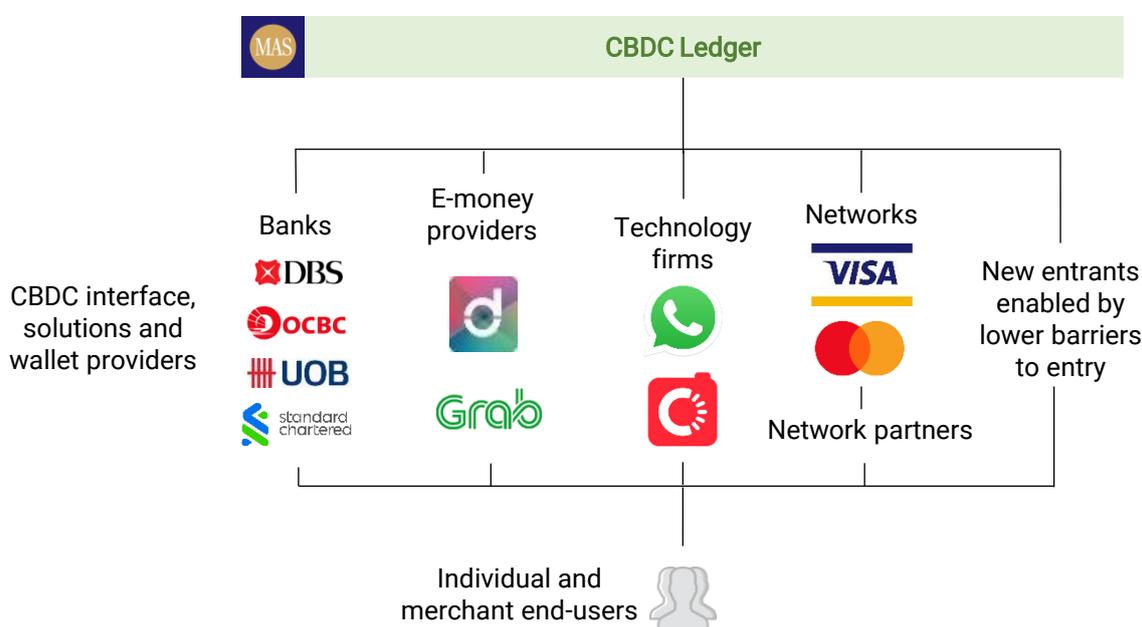
Unlike physical cash, which is simultaneously a store of value and medium of exchange in itself, digital money is first a store of value and can only be used for payments if there is a process in place to transfer balances (Fatás and Weder di Mauro, 2018). An analysis of (digital) money must thus be anchored on how its underlying payment mechanisms are structured (Borio, 2019).

In Singapore, as with many jurisdictions, the starting assumption is that the circulation of a retail CBDC would be facilitated via a public-private partnership, much as how physical cash is issued and distributed today. MAS would issue the digital Singapore dollar, while the private sector would handle distribution and customer-facing activities, including compliance and know-your-customer checks. Unlike physical cash, a retail CBDC would have to be held in e-wallets, which would primarily be provided by the private sector.

This partnership recognises the comparative advantage the private sector has in acquiring and serving end-users, as well as in innovating on the services that could be offered around a retail CBDC. Indeed, the digital nature of a retail CBDC may create more opportunities for the private sector to build service offerings around it than is currently possible with physical cash.

In the burgeoning CBDC literature, such public-private arrangements have been referred to as a “two-tier” (PBOC, 2021) or “hybrid” CBDC model (Auer and Bohme, 2020). One possible technical architecture, as articulated by the Bank of England (BOE, 2020), is a “platform model” (Figure 3) where the central bank operates a foundational retail CBDC ledger to which intermediaries connect as they integrate the CBDC into their digital offerings. Transactions using the CBDC would be recorded and settled with finality on the ledger.

Figure 3: Platform Model of a CBDC



Source: MAS

Note: Logos and companies displayed are for illustrative purposes only.

Such a retail CBDC architecture would be congruent with a number of underlying technologies, including both distributed ledger technology (DLT) or non-DLT solutions, account-based or token-based arrangements, as well as various privacy-protecting technical choices. The Global CBDC Challenge that MAS launched in June 2021 alongside international and industry partners represents the first step MAS is taking to understand the set of technological options available to best realise the potential benefits of a retail CBDC.¹⁸ The discussion below explicitly recognises that design features of the digital currency play a key role in these options.

¹⁸ The Global CBDC Challenge was launched to catalyse development of a set of technologies to enable issuance of a retail CBDC. In particular, it recognised the potential for innovative technological solutions to overcome specific trade-offs in payments and secure welfare gains for society. The hackathon put forth 12 problem statements, crafted around central tensions that policymakers globally are likely to face in building a CBDC system, for participants to address. More details can be found at <https://www.mas.gov.sg/news/media-releases/2021/mas-partners-imf-world-bank-and-others-to-launch-global-challenge-for-retail-cbdc-solutions>.

Confidence and Trust in the Monetary System

By “modernising” cash, a retail CBDC would ensure that Singaporeans can continue to access and use public money, even as digitalisation encroaches on the utility of physical cash over time. Issued by the central bank and backed by the government, generally-accessible public money is arguably a part of the social contract between the state and members of the public (BIS, 2021).

Fundamentally, Singaporeans may wish to retain the ability to hold or have recourse to a Singapore dollar asset whose value is always stable and sure. Indeed, in Singapore, households and businesses increasingly appear to be holding Singapore dollar cash as a store of value rather than using it as a medium of exchange. While payments went more cashless at the height of the COVID-19 pandemic last year, currency in active circulation rose to a high of 11.5% of nominal GDP. This demand for cash likely reflects the public’s implicit understanding that central bank money is free of credit and liquidity risks.

At the same time, a Singapore dollar CBDC is an additional lever for MAS, besides financial regulation and liquidity safety nets, to underpin the general public’s confidence in the Singapore dollar as the pace of change in money and its forms accelerates. The BIS (2021) describes CBDCs as providing: “...a tangible link between the general public and the central bank in the same way that cash does, as a salient marker of the trust in sound money itself.” By preserving Singaporeans’ ability to redeem private money against risk-free state-issued money at par and on demand, a retail CBDC would help to reinforce the perception and reality of the uniformity of all Singapore dollars in the economy. While there exist a number of parallel ways through which MAS can anchor the fungibility of Singapore dollars in the economy as physical cash disappears, these fall short of generally-accessible public money on several dimensions (Box C).

Further, generally-accessible central bank money could be a parsimonious way for MAS to maintain the safety of, and the public’s trust in, privately-issued Singapore dollars. By serving as a riskless “outside option” to private money for households and firms, its presence disciplines private issuers, pushing them to ensure their assets and liabilities are well managed.

The role of a widely available Singapore dollar-denominated risk-free asset in anchoring trust is possibly even more pertinent with the rise of new forms of digital monies. Digital currencies issued by foreign central banks, or stablecoins fully backed by foreign safe assets (particularly central bank reserves¹⁹), could be seen as substantively safer than bank money in Singapore during crises, while being potentially more easily available through digital channels than foreign bank accounts are today. In the absence of similarly safe and accessible forms of digital money in Singapore, a shock to the Singapore financial system could result in a run not just on the domestic banking system, but on the Singapore dollar itself, as households and corporates rapidly switch out into safe foreign money holdings.²⁰

¹⁹ A number of central banks, such as the BOE and ECB, are considering allowing a wider variety of private firms, including issuers of stablecoins, to directly back their liabilities with central bank reserves.

²⁰ A parallel can be drawn with the Singapore government’s decision to guarantee all deposits of individuals and non-bank customers of banks licensed in Singapore in 2008, in response to similar announcements by other jurisdictions in the region. This ensured that Singapore residents would not switch out of the domestic financial system in a time of heightened uncertainty. Such considerations could also apply as foreign CBDCs proliferate.

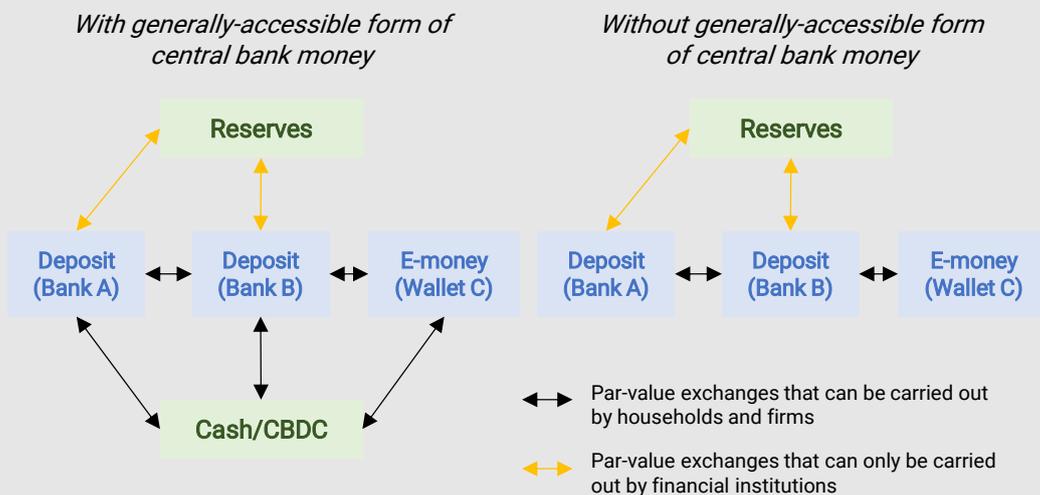
Box C: Parallel Anchors for the Uniformity of Money

The uniformity of money is the phenomenon whereby all money in the same unit of account are perceived to be “one and the same” regardless of their issuer, and thus can be used interchangeably for payments, without being subject to discounting or other frictions (Engert and Fung, 2020). For instance, in Singapore, \$10 of e-money in one’s Grab wallet is seen to have the same value as \$10 in deposits with DBS, \$10 in deposits with UOB and a \$10 bill. Note that \$10 of e-money in a Grab wallet is a liability of Grab, while \$10 of deposit in a DBS or UOB bank account is a liability of the respective banks. Only the \$10 bill is issued by, and a liability of, MAS.

In normal times, central bank reserves are typically sufficient to ensure the uniformity of money by serving as the monetary anchor. However, whether central bank reserves would suffice in periods of severe financial stress would depend on the general public’s appreciation of (1) the deposit insurance scheme, (2) the central bank’s lender of last resort function and (3) the availability of payment alternatives that are instantaneous. Given imperfect information and bounded rationality, there is the risk that the general public does not understand how reserves, which are out of their reach, ensures the convertibility of one form of money to another at par (Armelius, Clausen and Hendry, 2020). In turn, the emergence of doubts about the creditworthiness of a particular issuer could quickly cause its money to be exchanged at a discount with other forms of money that are denominated in the same unit of account, fragmenting the homogeneity of the currency.

The introduction of a generally-accessible CBDC reinstates clear channels of convertibility that would otherwise be lost with the disappearance of cash, thereby helping to reinforce the perception that all money in the domestic currency are at par (Figure D1).

Figure D1 Convertibility at Par of Singapore Dollar-denominated Monies



Source: MAS

Regulation, supervision and the deposit insurance scheme could be enhanced to make up for the absence of a generally-accessible central bank money. However, the extent of augmentation required, its attendant costs and overall effectiveness remains an open question. Regulations take time to enact and update. There is the risk that regulations will fall behind developments in technology and business models amid a rapidly changing payment landscape, allowing firms to circumvent safeguards (Armelius et al., 2020). Information asymmetry also means that some gaps in supervision may be present despite the regulator’s best efforts. Iyer and Puri (2012) find that deposit insurance is only partially

effective in preventing a run on banks—even depositors with balances under the insurance thresholds have tended to run, although they are less likely to do so than those with balances above the limit. Above all, there are likely to be serious moral hazard issues if the central bank were to guarantee, implicitly or otherwise, the safety of all private money.

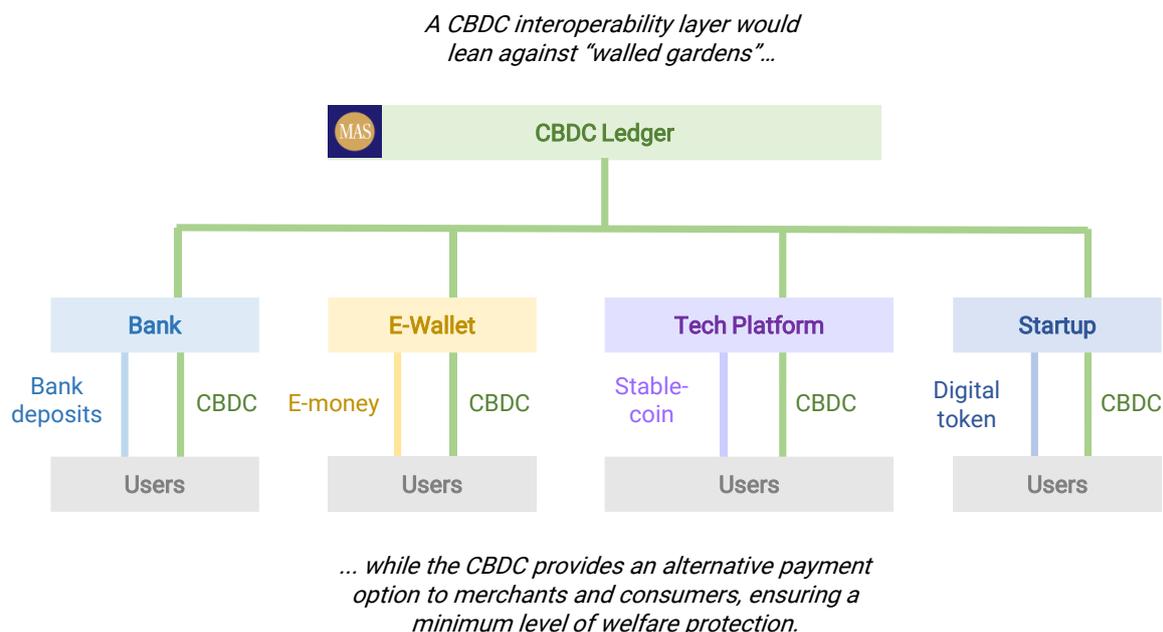
Protecting Public Interests in Retail Payments

A retail CBDC, as a public digital payment option, could act as a valuable competitive check on naturally-arising monopoly power in electronic payments that is already evident to a degree today. As BIS (2021) notes, the cost of conventional digital payments remains high and still exceeds that of cash for small retail transactions, despite decades of technological progress that has driven marginal information processing costs to near-zero. This persistent wedge between prices and marginal costs, as is typical in the presence of market power, could lead electronic payments to be under-supplied relative to what would be societally optimal in the economy.²¹ Such considerations could grow increasingly pertinent in a future payment landscape markedly more concentrated than what is currently observed. Shin and Cœuré (2021) argue that the appropriate counterfactual for evaluating a CBDC is not only the banking and payment sector as it stands, but also where it may headed if new entrants and business models result in the eventual domination of payments by one or two large firms.

In such a scenario, a Singapore dollar CBDC (in conjunction with legal protections to ensure widespread acceptance) could overcome the powerful network effects that closed-loop private digital monies would enjoy, and restore the balance of competitive pressures in the payment market. An open and widely-used CBDC network would be a useful complement to the broader arsenal of regulatory and technical measures that authorities are exploring today to shape digital finance and prevent the emergence of such systems in the first place. Concurrently, a viable public option, by establishing a (higher) base level of standards—e.g. for speed and cost—in digital payments, would secure end-user outcomes while motivating private money providers to compete more aggressively in technology innovation (Duffie, 2021). In this way, a CBDC would play a dual role in the payment landscape: as a back-end infrastructure leaning against the formation of “walled gardens” in the first instance, but also as a government-issued digital payment medium that ensures a minimum level of end-user welfare regardless of the evolution of the landscape (Figure 4).

²¹ For instance, KPMG (2016) and Channel News Asia (2018) noted that high per-transaction costs, as well as prohibitive fees charged by payment providers to set up electronic payments acceptance for merchants, are one of the primary obstacles to small businesses’ adoption of digital payments in Singapore.

Figure 4: CBDC as a Lever to Address Rising Market Power in Payments



Source: MAS

At the same time, a parallel set of payment rails would serve as an important backup in the event of a failure in private networks. Coupled with MAS’ enhanced supervision of payment systems deemed critical to the financial system²², this increase in the variety of payment networks would strengthen the resilience of the payment system by reducing concentration risks and ensuring that there is always a dependable way of making transactions. If structured as a parallel system, with minimal reliance on existing infrastructure, a retail CBDC could lead to fewer single points of failure for electronic payments (De Nederlandsche Bank, 2020). The retail CBDC could be designed with offline functionality, which will further enhance its availability and usability if telecommunication networks are down.²³

As with cash today, a CBDC would be a lever for MAS to maintain inclusive access to money and payments. MAS would retain significant control over the design of a CBDC, which would allow the development of payment solutions that take into account the wide variety of needs, particularly of disadvantaged groups such as low-income individuals or people with disabilities. For instance, offline functionality for the CBDC would give greater access to digital payments to individuals without subscriptions to mobile data networks. MAS could also ensure that the retail CBDC is offered at no cost to use, like cash, and compatible with

²² Under the Payment Services Act, a payment system is designated as a systemically important payment system (SIPS) or system-wide important payment system (SWIPS), would entail closer supervision by MAS to safeguard the safety and efficiency of the financial system.

²³ That said, there are limits to the extent to which a digital Singapore dollar could improve the resilience of the domestic payment system. If the retail CBDC is provided through intermediaries like banks (the way cash is), its infrastructure might not be fully independent of other electronic payment systems. Disruptions to intermediaries’ electronic systems could mean that users would not have access to the digital Singapore dollar as well. Further, an offline digital Singapore dollar would likely need to be pre-funded. This means that in the event of a crisis, users without sufficient holdings of digital Singapore dollar would still not be able to make payments. These are similar to the shortcomings of cash—cash payments are ultimately constrained by the stock of notes and coins consumers have on hand. To obtain additional cash, consumers would need to withdraw it from bank branches or ATMs, and the ability to do so is likely to be compromised when the electricity or telecommunications networks are down.

cheap, easy-to-use hardware, to avoid reliance on the latest smartphones or a high level of technical literacy.²⁴

MAS could seek to design the CBDC in a way that better enables users to control their transaction data and preserve their privacy, even as the CBDC would not, in all likelihood, be as anonymous as cash. Notably, as a public institution, MAS is not driven to collect and utilise transaction data or personal information for profit motives. MAS could thus offer a CBDC payment system that confers a higher degree of privacy to consumers by default compared to existing modes of electronic payment, while ensuring protections against illicit money flows.²⁵ MAS' access to personal transaction data could be further limited and secured by legal provisions. The retail CBDC system would form part of the "stack" of foundational digital infrastructure in Singapore, cutting across payments, identity and data storage and governance mechanisms, that would be necessary to protect the privacy and welfare of individuals more holistically.²⁶

Globally, the growing appreciation of privacy and control over one's transaction data as basic consumer rights is likely to be a key driver of demand for a CBDC. Png and Tan (2020) show that concern over privacy is one of the determinants of cash usage in retail transactions across countries. Bech and Garratt (2017) and others have argued that the main benefit of a CBDC is that it could bring some level of anonymity to electronic payments. To this end, a well-designed CBDC would give users the ability to retain control over whom can access their transaction data and how it can be used, thus offering significantly stronger consumer protection than current payment methods (Lee, 2015).

The provision of a privacy-preserving retail CBDC would also increase consumers' share of the economic surpluses created by the data economy. Garratt and Lee (2020) argue that a retail CBDC would in effect help consumers to "monetise" their privacy. In the presence of the CBDC, firms would have stronger incentives to offer discounts or other benefits to consumers on an ongoing basis to entice them to pay using their proprietary electronic payment modes. This would allow such intermediaries to better obtain transaction data, given that these are valuable sources of competitive advantage. To date, firms have captured most of the value generated from transaction data because consumers have little alternative to control the sharing of their personal digital transactions. A CBDC would provide a credible "bargaining tool" and may help facilitate an environment where consumers are better compensated for the use of their data.²⁷

Overall, money and payments are core public goods with positive externalities to their smooth functioning. Together with basic rights to autonomy and privacy, these call for some degree of direct public intervention. While regulation alone could probably be used to achieve

²⁴ The ECB (2020), for instance, highlights that a CBDC could be made compatible with and accessed via dedicated physical devices such as smart cards. Nevertheless, in a CBDC model that depends on intermediaries for distribution and customer services, regulation may be necessary to ensure such access.

²⁵ An example of this is the PBOC (2021)'s concept of "managed anonymity". There is anonymity for small value payments but traceability for high value transfers. The PBOC also has the ability to impose differential tiers of data access for CBDC transactions for various participants in the CBDC system.

²⁶ It should be noted that a CBDC cannot adequately protect consumer privacy alone. Without privacy-preserving identity solutions and proper governance of data storage and usage, even if consumers were to use a CBDC to pay for services on a digital platform, their actions and purchase information would still be observable and attributable to them by the platform operator.

²⁷ In equilibrium, firms would continue to collect proprietary data, which they can then use to provide superior products and maximise economy-wide innovation.

broad public policy objectives, government ownership and provision of critical infrastructure and related services would be a parsimonious alternative to an extensive regulatory machinery (Armeliu et al., 2020). The existence of a digital public payment option helps to safeguard important public policy interests that the private sector may not be sufficiently incentivised to achieve, such as resilience, inclusivity and privacy. In other jurisdictions, recent efforts to improve governance structures for retail payment systems point to the need to look beyond regulation in ensuring retail payments remain fit-for-purpose.²⁸ A two-pronged approach of regulation and the provision of a public payment option by MAS could thus be optimal.

Creating a Platform for Future Payment Innovation

Safeguarding the public's access to central bank money and maintaining provision of a public payment option arguably already provide sufficient grounds for a retail CBDC to be issued. That said, contingent on the decision to issue a CBDC, there are further benefits that could be realised by the design of a new payment system from scratch, unencumbered by legacy design architectures and technology.

A Singapore dollar retail CBDC presents an opportunity to construct a brand-new payment architecture from the ground up to support the next leg of payment innovation. This could increase the diversity of firms that are innovating on retail payments and related services, and enable programmable money to support a digital economy. Payments are part of foundational digital infrastructure and laying the appropriate technological foundations and governance structures for it are important enablers for further private sector innovation.

Enabling Greater Diversity in Retail Payment Innovators

A retail CBDC platform has the potential to allow a significantly broader and more diverse set of firms to participate in providing retail payments and other auxiliary services than the current infrastructure is set up for. Central banks globally recognise that democratising access to payment infrastructure can spur competition and financial innovation by offering a more level playing field for new intermediaries, who are otherwise likely to run into excessive entry barriers. Accordingly, in recent years, MAS and other central banks have extended direct access to critical infrastructure, such as Faster Payment Systems (FPS) and Real-time Gross Settlement Systems (RTGS), to non-bank financial institutions (NBFIs). However, one constraint these initiatives are likely to face is that existing payment infrastructures are not optimised for a large number of participants, as they were built at a time when large banks were the only providers of payment services.²⁹

In Singapore, banks remain the primary participants of MEPS+, MAS' real-time gross settlement system, and have exclusive access to MAS' reserves, the ultimate means of settlement even with the opening up of direct access to FAST and PayNow to major non-bank

²⁸ In the UK, the formation of the New Payment Systems Operator in 2017, later renamed as Pay.UK, is an illustrative example. It acquired three payment systems in the UK to consolidate their governance and operations in a single entity. This recognised that the governance of existing payment systems, e.g. with member-bank appointed directors with potential conflicts of interest, could at times lead strategic initiatives to be postponed or not pursued. Pay.UK's governance structure seeks to ensure that the development of UK retail payment systems reflect the views of a significantly wider stakeholder community (PSODG, 2017).

²⁹ For instance, while the BOE has opened up access to their RTGS system to non-bank payment services providers since 2018, barriers such as capacity constraints of the legacy architecture have limited BOE's ability to onboard more players. The BOE has embarked on a major RTGS renewal project and one of the objectives is to facilitate greater access by speeding up onboarding times and reducing the operational overheads of RTGS membership (BOE, 2017).

payment institutions. Disruptions to the MEPS+ system can pose a significant risk to financial stability. Thus, MAS imposes high security and compliance requirements for its access. These, together with other requirements such as a SWIFT membership³⁰, make it very costly for any firm to become a direct participant in MEPS+. Existing non-banks in Singapore thus have little interest to join MEPS+ even as it leaves them dependent on banks for settlement of their outstanding obligations from FAST clearing. As a wholesale payment system, MEPS+ was not meant to support retail payments, which are smaller value but significantly higher volume transactions relative to wholesale transfers.

Thus, a retail CBDC platform that exists in parallel with MEPS+ could be an avenue through which MAS offers settlement in central bank money at lower cost to a broader group of firms, without potentially compromising the resilience of MEPS+. In particular, the retail CBDC could serve as a platform through which MAS introduces new governance structures and safeguards in place of existing requirements that non-banks have found prohibitive to meet. In turn, with equal access to critical back-end infrastructure, new payment entrants would no longer be reliant on the back-end functionality provided by commercial banks. This would help create a more level playing field in payments, and act as a further spur to diversity and innovation in payments and related services.

A retail CBDC would establish a standardised digital medium of exchange that firms can integrate around. This could lower barriers to entry to front-end payment services more effectively than adjustments to the access policy for FAST. Given the intrinsic characteristics of a digital Singapore dollar—safe, liquid and widely accepted—it would reduce the need for an entrant to build up its own proprietary e-money offering and a large merchant or customer base to accept that payment instrument. Barriers to entry could be further lowered via right-sized regulatory requirements, reducing regulatory costs, given that CBDC intermediaries would not be creating private money (unlike banks) and hence pose less credit and liquidity risks. Start-ups and smaller firms would likely benefit most, given the high fixed costs of previous models of payment entry.

In addition, there are likely to be synergies in the issuance of a retail CBDC with Singapore’s Smart Nation journey. Digital payments are a critical enabler of more efficient business processes and a gateway to broader digitalisation. These “payment-adjacent” services include accounting and inventory management, as well as the tracking of customer transactions for loyalty, advertising and marketing programmes. Indeed, McKinsey (2021) estimates that outlays on these processes make up almost half of SME business spend. Improving the ease of entry into payment services is likely to not only benefit competition in payments, but also spur greater innovation and productivity gains in other services that have close integration with payments data.

Programmable Money

In addition, a retail CBDC could unlock the possibilities of programmable money. The universal acceptance of a digital currency issued by MAS, coupled with a well-designed set of smart contracts, could enable new business and operating models. These programs would allow the conditional movement of the retail CBDC by third parties, and be a key building block for payment innovation. For instance, it could allow the issuance of ‘digital vouchers’ that can only be used to pay certain merchants, with controls to determine whether payments are

³⁰ SWIFT, the Society for Worldwide Interbank Financial Telecommunication, is the largest provider of secure financial messaging services globally. Members of SWIFT use its international network to relay information, such as money transfer instructions, to other financial institutions so as to effect cross-border transactions.

allowed based on merchant identifiers. This could thus serve as the underlying infrastructure through which the government disburses a variety of highly targeted or in-kind fiscal support (e.g. grocery vouchers for low-income families or time-limited tourism vouchers) to Singaporeans in a timely, safe and cost-efficient manner.

In early discussions with MAS, industry players also highlighted a number of business solutions they could offer around a programmable CBDC. These include more seamless machine-to-machine transaction³¹ solutions for smart device manufacturers, as well as the creation of financial products (e.g. retail digital bonds) that leverage on the CBDC infrastructure for more efficient conditional and scheduled payouts to retail investors.

Expanding the Payment Possibility Frontier

In designing a retail CBDC system, central banks would inevitably come up against trade-offs between their desired features. Allen et al. (2020) and MAS (2021b) described some of the tensions between the objectives discussed above—such as privacy, programmability and expanded access. For instance, the growing desire for data privacy would need to be balanced against the surveillance of digital transactions needed for law enforcement. The extensibility³² of a CBDC platform, such as through enabling smart contracts, could come at the cost of additional system complexity and raise operational and cyber risks. Security for critical infrastructure such as payment systems has also been historically safeguarded through limitations on the number of participants with direct access (Narula, 2021).

At the same time, in implementing a CBDC, central banks have an opportunity to exploit advances in new technologies to ease these trade-offs. For example, Ali and Narula (2020) suggest that advances in cryptographic primitives like zero-knowledge proofs can be used to protect transaction privacy while preserving the ability of third parties to audit transactions. Improvements in safe programming languages, such as the use of custom resource types and formal verification, can help prevent developer errors while preserving expressiveness (Blackshear et al., 2019). Public permissionless blockchains like Ethereum have piloted paradigmatically more open access to financial infrastructure, even as there remain significant challenges to overcome if these are to be adopted more broadly.

While still nascent and unproven for large-scale use, the list of new technological solutions to trade-offs is growing. Further research is needed to ascertain if they are able to support the scale of transaction volumes and security demands of a CBDC, but a next generation of payment rail that successfully expands the “payment possibility frontier” would be a source of welfare gains. Given the uniquely rigorous demands of a retail CBDC infrastructure, MAS’ efforts to catalyse fundamental research into retail CBDC technologies would be helpful in advancing progress in these payment technologies.

Preserving the Singapore Dollar’s Relevance Amid Emerging Forms of Non-native Money

The threat of widespread adoption of a non-native digital currency in Singapore suggests that there is a need to carefully consider ways in which the relevance of the Singapore dollar

³¹ Machine-to-machine transactions are payments that occur autonomously between two connected devices, such as autonomous vehicles, smart home appliances and factory equipment with minimal human intervention.

³² An extensible CBDC system would be one that does not constrain the range of services that can be provided in the future, as there will be emerging payments needs, and innovative use cases for CBDC, that currently cannot be foreseen (BOE, 2021a).

can be secured. An increasing number of central banks are contemplating the issuance of their own retail CBDC as a strategic or defensive response. While the international use of currencies is largely determined by economic and financial fundamentals, the relative efficiency and vibrancy of a country's payment system could make a difference by influencing economic agents' choice of payment modes, and consequently, the underlying currency used in a transaction. Thus, one way to buttress the use of the local currency is to ensure that the domestic payment system is on par in terms of efficiency, costs and functionalities with that of any non-native digital currencies.

Indeed, one of the factors underlying the ECB's interest in a digital euro is the explicit recognition that a domestic payment system at the technological frontier may be necessary to maintain the euro's relevance, especially if other major central banks were to issue their own CBDCs (ECB, 2020). Meanwhile, the Bank of Canada has indicated that one of the conditions under which they would be prepared to introduce a retail CBDC is if a private cryptocurrency or stablecoin makes substantial inroads as a means of payment in the Canadian economy (Lane, 2020).

MAS is of the view that a fit-for-purpose digital payment system, potentially enabled by a retail CBDC, could complement other payment initiatives in ensuring that Singapore dollar payments are as trusted, frictionless and innovative as possible.³³ Given the domestic economy's openness, however, a purely domestic-oriented Singapore dollar retail CBDC would probably not be a sufficient bulwark against emerging non-native digital currencies. Notably, a major competitive advantage of global stablecoins or international CBDCs would be their ability to facilitate highly efficient cross-border payments. Singapore's retail CBDC settlement system would therefore need to be interoperable with that of other countries in a way that better allows for seamless cross-currency transactions.

While the economic implications of allowing the use of a Singapore dollar CBDC internationally are not yet fully understood and need to be studied further, MAS' ongoing explorations of distributed ledgers and wholesale CBDC, will inform on its use in cross-border or multi-currency environments. For instance, in Phase 5 of Project Ubin, which concluded in 2020, MAS developed a prototype multi-currency wholesale settlement network. Building on this, MAS is partnering the Reserve Bank of Australia, Bank Negara Malaysia and South African Reserve Bank with the BIS Innovation Hub in Singapore to test the use of CBDCs for international settlement ("Project Dunbar").

³³ At the same time, it should be acknowledged that there are alternative solutions which MAS can rely on, such as regulatory ringfencing of domestic transactions. Regulatory clarity for stablecoins (BOE, 2021b) as well as how banks can participate in their supporting services (US Office of the Comptroller of the Currency, 2020) can facilitate the issuance and use of new forms of the Singapore dollar on emerging payment infrastructure. MAS could also build new infrastructure that private sector firms can issue their monies on.

4 Implications for Monetary and Financial Stability

A retail CBDC needs to be seamlessly integrated into the existing payment networks if it is to play the roles envisioned in the preceding chapter. Familiarity with its use, and widespread acceptance by consumers and merchants alike, are necessary conditions for it to serve as a viable public payment option, as well as a platform for supporting innovative payment services. However, excessive demand for the CBDC may have implications for Singapore's monetary and financial stability. The first part of this chapter highlights the potential macroeconomic and macro-financial risks that could arise from the issuance of a digital Singapore dollar. Having identified the risks, the paper considers the design safeguards that could be adopted to minimise them.

Frictionless Transactions

A CBDC which is a liability of MAS would be as safe as cash, but transactions now digitalised, would be seamless and instant without the frictions and costs associated with obtaining, handling and storing physical notes and coins.

If a CBDC is elastically supplied—available on demand and on an unlimited basis against Singapore dollar deposits from banks just as cash is today—households and firms could convert as much deposits as they want into central bank money at a touch of the button, without the hassle of having to make a trip to ATMs or bank branches. Likewise, if a Singapore dollar CBDC is universally accessible³⁴ with no restrictions on access just as cash enjoys today, non-residents would be able to swap into digital Singapore dollars issued by MAS instantly and in large volumes without much difficulty. The high costs of storing and securing physical cash naturally discourages large holdings of public money today. However, this deterrence would disappear with the introduction of a digital currency, given that the incremental cost of storing Singapore dollars in CBDC form would be negligible compared to that for physical cash.

In addition, the introduction of CBDC opens up the possibility that cash could bear interest. An interest-bearing CBDC would be similar to saving instruments such as bonds as a store of value, while being comparable to transactional bank deposits as an instantaneous medium of exchange. The higher the remuneration on the CBDC relative to other instruments, the more attractive it would be relative to all other existing payment and saving instruments today.

³⁴ That is, all economic agents can easily obtain the CBDC. One enabler of this is the free cross-border movement of capital in and out of Singapore. Since 1978, all exchange controls in Singapore have been abolished, with the current policy only limiting lending of Singapore dollars to non-resident financial institutions for the purpose of speculation on the Singapore dollar (MAS Notice 757). In addition, the *de facto* accessibility of the Singapore dollar is also influenced by other factors, including the presence of deep and liquid Singapore dollar foreign exchange markets.

Table 1 A Comparison of Safe Retail Payment and Saving Instruments

	Risk-free	Universally Accessible	Elastically Supplied	Medium of Exchange	Digitally Native	Interest bearing
Physical Cash	x	x	x	x		
Bank Deposits	^		*	x	x	x
Singapore Saving Bonds/ Government Securities	x	x			x	x
“Frictionless” Retail CBDC	x	x	x	x	x	x

* Deposits can technically be considered to be elastically supplied, albeit to a lesser extent than cash. The aggregate supply of deposits in the economy are determined in large part by banks’ credit creation, with the latter constrained by MAS’ monetary policy stance and regulations (e.g. capital and liquidity requirements).

^ At least up to the amount covered by deposit insurance.

A retail CBDC that has all the properties in Table 1 is likely to run counter to the principles laid out in Group of Central Banks (2020) on CBDC issuance—that it should in the first instance “do no harm” and be designed for “co-existence” with other forms of money in the economy. Such a retail CBDC could come to be preferred to all existing forms of money and safe assets available to the general public today; it is the only form of money that checks all the boxes.³⁵ This could in turn expand the reach and use of public money in unprecedented ways, including at the expense of existing forms of money. For one, a retail CBDC could unduly hasten the disappearance of cash. It could also cause economic agents to shift their funds away from bank deposits in a significant way. Non-residents might find a Singapore dollar CBDC highly appealing, driving them to increase their holdings of Singapore dollars substantially. These developments could negatively impact credit creation by banks, weaken financial stability and complicate the formulation and implementation of monetary policy.

Credit Creation and Financial Stability

Credit Creation

The impact of introducing a retail CBDC on the banking system in normal times would depend on the CBDC’s attractiveness relative to bank deposits as both a medium of exchange and store of value.

As a publicly-provided digital means of payment, a retail CBDC is a close substitute for bank deposits held for transactional purposes, particularly in its ability to meet online payment needs. Thus, the successful introduction and adoption of a digital Singapore dollar will inevitably entail some degree of substitution from bank deposits into CBDC, with households and firms dividing their transactional balances between bank deposits and the CBDC. The magnitude of the shift for transaction reasons would depend on the CBDC’s attributes, including accessibility and functionalities. For instance, a universally accessible CBDC which enables payments that are cheaper, faster, more privacy preserving and usable in a wide range of transactions (including for cross-border transactions) could induce a

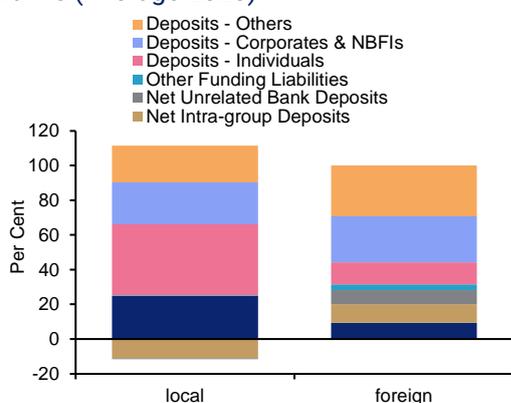
³⁵ A factor that could influence end-user preferences towards a CBDC vis-à-vis existing forms of money not discussed in Table 1 is the willingness of private payment service providers to integrate a CBDC into a wide array of payment flows. This is not a given, but it is likely that a CBDC will be designed to allow a broader range of firms to integrate it into their services than is possible with other forms of digital money today.

significant number of end-users to switch transactional balances into it, compared to one that is more restricted.³⁶

Given that most deposits are held for saving purposes, the attractiveness of a retail CBDC as a store of value would be another key determinant of the extent to which bank deposits would flow into CBDC. The demand for a retail CBDC as a store of value would in turn largely depend on its remuneration for holders compared to the (risk-adjusted) rate of return on deposits (BIS, 2018). The lower the interest rate on the retail CBDC relative to bank deposits, the less desirable it would be. A non-interest yielding CBDC similar to cash should, in most states of the world, limit the extent to which positive interest rate bearing deposits are displaced. That said, the opportunity cost of holding an unremunerated asset would evolve with the interest rate cycle and risk sentiment. In the current low interest rate and uncertain environment, there are likely to be some consumers and firms who prefer to hold a non-interest yielding CBDC (as well as cash) that is risk-free instead of bank deposits.

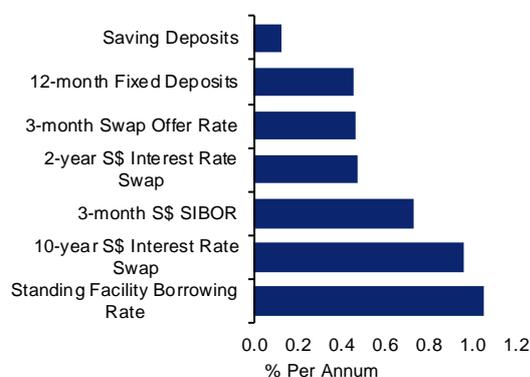
As economic agents switch out of bank deposits into the CBDC, banks' funding positions would be negatively impacted. In Singapore, retail deposits are currently a key source of low-cost stable funding for local banks (Chart 3 and 4). An outflow of retail deposits to CBDC would reduce banks' holdings of MAS reserves, akin to the situation when depositors swap their deposits for cash from banks today (Figure 5, top half). The concurrent decline in retail deposits and reserves in turn leaves banks with a lower volume of stable funding on the liability side of their balance sheet and a more illiquid portfolio on the asset side, which increases their funding risks and causes the Net Stable Funding Ratio (NSFR)³⁷ requirement to become more binding (Juks, 2018).

Chart 3 Funding Structure of Local and Foreign Banks (Average 2020)



Source: MAS estimates

Chart 4 Interest Rates across Funding Types (Average 2020)



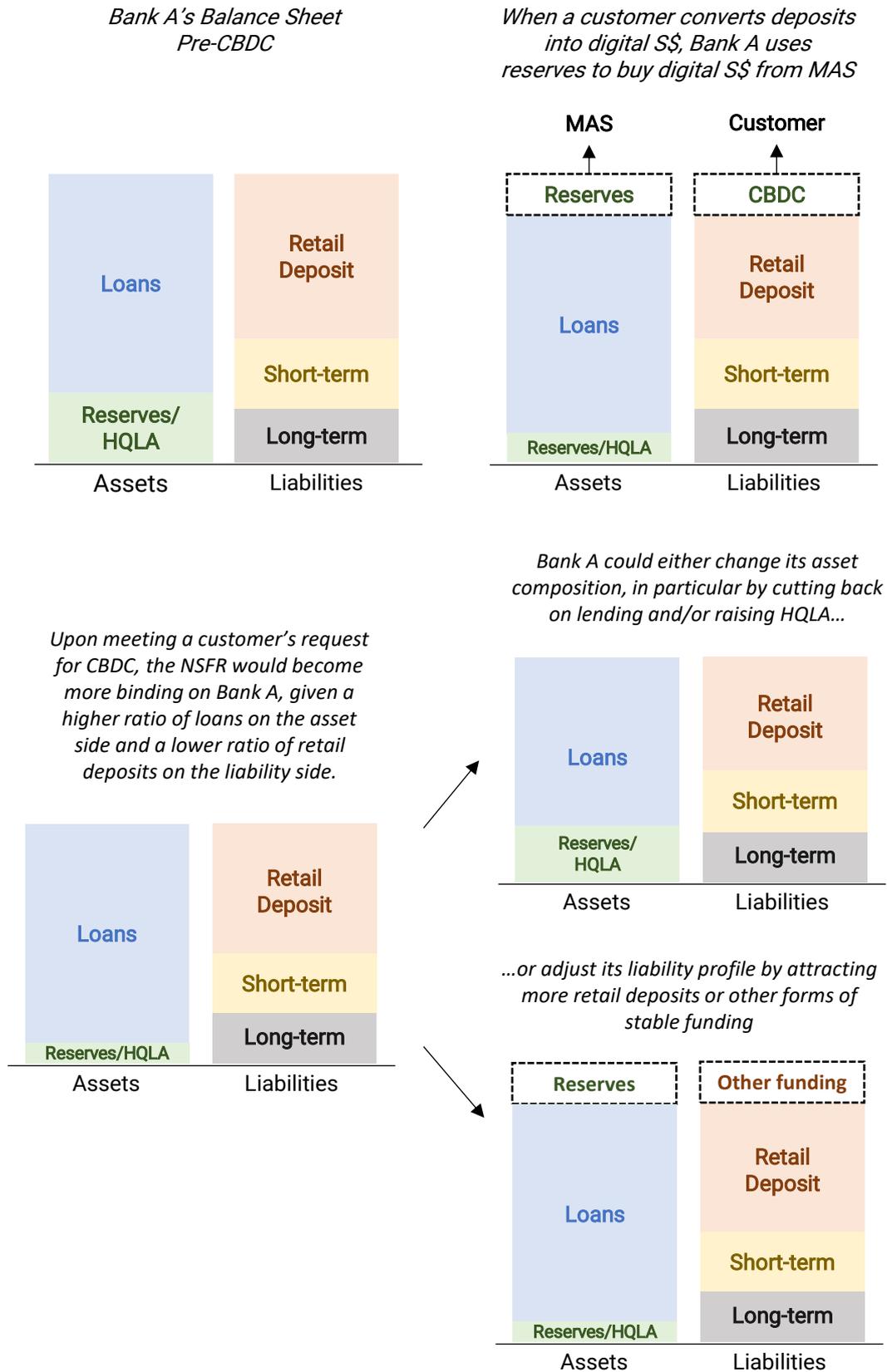
Source: ABS Benchmarks Administration Co Pte Ltd, ICE Benchmark Administration Ltd, Bloomberg and MAS estimates

Note: IRS stands for interest rate swap.

³⁶ That said, the experience with e-money suggests that the amount of transactional bank deposits that could be displaced by the CBDC is likely to be small relative to the total amount of deposit balances in the system.

³⁷ The NSFR is a regulatory requirement imposed by MAS on domestic systematically important banks (D-SIBS) and internationally active banks in Singapore. (See MAS Notice 652 for more details.) It ensures that banks maintain a stable funding profile in relation to the composition of their assets and off-balance sheet activities, so as to reduce the likelihood that disruptions to a bank's regular sources of funding will erode its liquidity position in a way that would increase the risk of its failure and potentially lead to broader systemic stresses (BIS, 2014).

Figure 5 Stylised Representation of a Bank's Balance Sheet and Changes in Funding



Source: MAS
 Note: HQLA stands for high quality liquid assets.

To restore its funding stability following a permanent outflow of retail deposits to CBDC, a bank could choose to (i) reduce the amount of lending to the economy and/or (ii) pay a higher cost of financing (Figure 5, bottom half). In the case of (ii), a bank could offer a higher interest rate to retain its retail deposits or raise other sources of stable funding, such as through the issuance of bonds. As wholesale funding of longer maturities that are at least as stable as retail deposits are typically more expensive, all adjustments on the liability side are likely to increase the bank's cost of funding. In response, the bank could raise lending rates to maintain profitability, which would result in a lower level of loans in the economy *ceteris paribus* (BIS, 2018).

Nevertheless, it is possible that banks continue to readily supply credit to the economy in similar quantities and costs following the introduction of a retail CBDC but at lower profitability, as banks absorb part or all of the increase in funding cost. The price of bank loans comprises not only funding costs, but also credit spreads, capital costs, bank profit margins and other components. Thus, an increase in funding costs may not be passed through in its entirety to the price of loans if other components adjust. There are limits to how much a bank can raise its lending rates before its loans become uncompetitive relative to those offered by others that are less dependent on retail deposits to begin with, as well as other forms of market and non-bank financing (Juks, 2018).

A number of theoretical studies (e.g. Chiu et al., 2019) suggest that when banks have monopolistic power in offering deposits, competition from a CBDC would only reduce rents, with limited negative impact on lending. The studies highlighted the possibility that banks could have used their market power to keep deposit rates below what would have prevailed in a competitive market, thereby earning supernormal profits on their deposit taking activities. At the same time, the profitability of their lending activities is determined by policy or market rates, which may not change with the rise in deposits rates (Andolfatto, 2021).³⁸

In principle, the impact of any pullback in bank lending on broader financial conditions and real economic activity can also be mitigated by an expansion of non-bank financing, both by capital markets and non-bank technology players. A greater diversity of financing sources within the economy would be a positive development (Carney, 2021). Some of these new players utilise alternative data and new technology-driven methods, such as artificial intelligence and machine learning, to overcome information asymmetries relating to the provision of credit more effectively than traditional lenders. Indeed, Frost et al. (2019) note that operators of digital platforms that use activity data from their ecosystems to perform credit risk assessments can predict loss rates of small businesses more accurately and lower the cost of credit intermediation. In addition, cost savings in credit provision can arise from a number of sources, including more efficient or lower risk loan collection and lower costs of borrower acquisition, some of which may be more available to credit providers that operate adjacent digital services.³⁹

A growing role for alternative financing sources could be helpful in complementing bank-based credit, such as for fast-growing technology businesses that are emerging in the digital economy where the relative paucity of physical assets and greater uncertainty has led to a

³⁸ Policy or market rates represent the opportunity costs of lending to the real sector rather than investing in market securities or wholesale lending.

³⁹ For instance, a payroll provider can potentially collect payments on loans before income is transferred to a borrower's bank account, in what is known as pre-income servicing. This lowers the cost and risk of loan payment collections, contributing to overall lower costs in credit provision.

smaller role for bank financing (Dell’Ariccia et al, 2021). That said, MAS is mindful that the rise of new lenders could complicate regulations given their differences in terms of funding, technology and business models.

Financial Stability Risks

The foremost financial stability risk of a retail CBDC is that it increases the likelihood of systemic bank runs during periods of financial stress when confidence in the banking system is lower. In recent decades, individuals and firms have typically run from a troubled bank by transferring their deposits to sounder banks within the domestic banking system, or by purchasing safe assets such as government bonds (electronically) using their deposits (Juks, 2018). Central bank money, i.e. cash, has been the least significant instrument that deposits have shifted to during a bank run, reflecting cash’s inconvenient physical nature. Meanwhile, price adjustments on traditional safe assets such as government bonds act as a natural limiting factor on the extent to which depositors could run to them. Given their fixed supply (in the short term), existing owners of safe assets would need to be adequately compensated for exchanging their safe assets for risky bank deposits. If no counterparty is willing to take on bank credit risks, there might be no seller of these traditional safe assets in systemic risk-off environment.

An elastically supplied digital Singapore dollar issued by MAS could lower the hurdle of running from all banks in the system. Once central bank money is readily available, depositors may see no need to settle for the second-best alternative in a bank run—deposits with another bank—especially if the potential spillovers from a distressed bank to other banks are unclear. Hence, even creditworthy banks could face greater withdrawals when a distressed bank experiences a run (BIS, 2018). In turn, money could shift out of banks into digital cash at unprecedented speed and scale in times of stress, subjecting banks to liquidity strains that exceeds the buffers provided for by existing regulatory safeguards (such as the Liquidity Coverage Ratio⁴⁰). Limited coverage by deposit insurance and an absence of caps on CBDC holdings or the amount that can be transferred into CBDC wallets would further exacerbate run risks.

A retail CBDC could raise financial stability risks if it reduces banks’ resilience. In particular, Singapore’s financial system has historically relied on a strong core of local banks to act as anchors, including to sustain the flow of credit during abnormal periods and acquiring distressed financial institutions whose failure could otherwise have a systemic impact (Shanmugaratnam, 2012). As highlighted in the preceding section, the presence of a CBDC could potentially lower the profitability of banks’ core credit intermediation business by raising their funding costs. Lower profitability could in turn make banks more vulnerable to shocks, as they are less able to build up capital through retained earnings. Various studies have noted that weaker banks may be less able or willing to play a stabilising role during economic downturns, and may be incentivised to engage in riskier forms of lending in normal periods to restore profitability (e.g. BIS, 2018). Similarly, a reduced role in deposit-taking and

⁴⁰ The Liquidity Coverage Ratio (LCR) aims to improve the short-term resilience of a bank’s liquidity risk profile by requiring banks to hold enough high-quality liquid assets to cover projected outflows over a 30-day stress scenario (BIS, 2013). The insurance provided by the existing LCR requirements could potentially be inadequate in the presence of a retail CBDC, especially in the absence of caps on CBDC holdings, as the rate of deposit outflows during crises could be higher than the current estimates (Juks, 2020). Should global regulators tighten LCR requirements to reflect the increased runnability of bank deposits into central bank money, banks would be required to hold a higher amount of HQLA. This could in turn raise banks’ funding costs and/or reduce bank lending. That said, the LCR is generally not a binding constraint for domestic systemically important banks in Singapore at present.

payments could impair banks' risk assessment capacity as they would have less information about clients, resulting in a riskier balance sheet (ECB, 2020).

However, the materiality of a CBDC's impact on banks' competitiveness and overall profitability is unclear at this juncture, with bank responses, new opportunities from a CBDC's introduction, as well as the CBDC's overall design still to be taken into account holistically. Singapore's banks are likely to remain highly competitive given existing customer relationships and the trust that they have built up over time. A survey by BIS (2021) shows that consumers in Singapore trust traditional financial institutions with their data more than FinTechs and other non-financial services companies. Moreover, banks could seek to retain deposits via non-price factors, by bundling more financial services such as financial advice and wealth management with their deposit accounts that CBDC intermediaries may not offer (Mancini-Griffoli et al., 2018). Banks in Singapore have made significant strides in expanding their franchises in these directions in recent years.⁴¹

Banks in Singapore could prove increasingly adept at leveraging technology and data to improve products and retain deposits, thus keeping funding costs contained. Indeed, the BIS (2019) argues that the barriers to the global banking industry becoming more like technology-driven firms to-date appear to be largely regulatory and technological—banks have historically been required to separate banking and commercial activity, while legacy IT systems constrain their agility. To this end, MAS has fine-tuned regulations to broaden banks' ability to provide a fuller suite of services to their customers. For instance, regulatory requirements were streamlined in 2017 to make it easier for banks to conduct or invest in permissible non-financial businesses that are related or complementary to their core financial businesses. Banks were also allowed to engage in the operation of digital marketplaces for consumer goods or services, as well as the online sale of such goods or services. Local banks have concurrently made significant progress in building up the infrastructure (such as cloud computing) and human capital needed to provide their customers with high-quality digital experiences and payment solutions.

As discussed earlier, banks and industry players have raised a number of possible services they could offer around a CBDC, in addition to basic wallet functionality. Any introduction of a CBDC in Singapore would provide time for industry to adjust and integrate it into their business models. MAS has further options to offset the risks posed by the issuance of retail CBDC to financial stability, as an additional buffer to such a transition period and safeguards in the CBDC design. Box D discusses some of these options and their implications.

⁴¹ For instance, wealth management has grown at a double-digit pace in recent years, and accounted for between 30–60% of Singapore banks' fee and commission income in FY2020 (Business Times, 2021).

Box D: Additional Options to Mitigate Financial Stability Risks of a CBDC and their Implications

Central banks could enhance their lender of last resort (LOLR) function to be able to meet banks' higher liquidity needs during periods of financial turmoil. The volume of liquidity available in practice is constrained by the amount of eligible collateral banks hold and the central bank's willingness to take on financial risks (Juks, 2018). Thus, with a CBDC, Bindseil (2020b) notes that central banks may have to broaden the collateral framework or reduce the haircut applied to assets to adequately backstop the banking sector during crises, given potentially larger and faster outflows.

The collateral framework could be pre-emptively widened outside of stress periods given the perpetual availability of a CBDC. In providing greater assurance of access to the liquidity backstop, it could help to contain any liquidity strains before they pose a challenge, and forestall banks from choosing an overly conservative liability structure if they foresee increased systemic run risks. A conservative liability structure would be more expensive to fund and would require greater adjustment on the part of the bank with regards to loan rates and quantity (Bindseil, 2020b).

Though unrelated to CBDC issuance, MAS has already taken steps in these directions with the launch of its SGD Term Facility in September 2020, which provides banks with a channel to borrow SGD funds from MAS at longer tenors and with more forms of collateral, including allowing domestic systematically important banks (D-SIBs) to pledge eligible residential property loans as collateral. The introduction of this facility was predicated on the need to provide banks with greater certainty of access to central bank liquidity amid heightened liquidity risks arising from the COVID-19 crisis, and thereby ensure stable SGD liquidity conditions and the resilience of the banking system.

That said, standard LOLR measures may not be adequate in an extreme stress scenario. Once a systemic bank run begins, MAS might have to commit to passing the funds received from depositors in the form of CBDC back to banks in order to mitigate the overall impact on banks' deposit base. Brunnermeier and Niepelt (2019) show that if central banks were to pass on the CBDC deposits they received from the real sector to commercial banks, it would reinforce the credibility of private banks and reduce the risk of runs. However, there would be significant drawbacks to MAS being a large depositor with banks. For one, the unsecured nature of the lending would be a departure from how central banks usually provide a liquidity backstop and expose MAS to credit and liquidity risks. The fact that MAS chooses which banks to receive deposits also impinges on the market allocation process, while potentially raising moral hazard risks.

In extremis, the introduction of a retail CBDC could lead to a greater role for MAS in the allocation of credit in the economy. This would occur if the digital Singapore dollar makes significant inroads into bank deposits, forcing banks to rely more on central bank credit to fund their lending activities. In the event that the exceptional measures above are needed, MAS' balance sheet would grow and the centralisation of credit would become a key concern. By intermediating a larger share of savings from the economy via CBDC issuance and credit provision to banks, MAS' policy choices (e.g. what qualifies as eligible assets under its collateral framework) would have a large impact on asset prices and yields across the economy. This would, in turn, reduce the role of the market in price setting which could lead to allocative inefficiencies, an outcome that has been flagged in several studies, (e.g. Bindseil, 2020a and BIS, 2018).

Monetary Policy and Macroeconomic Stability

Monetary Policy Instrument

The issuance of a globally accessible Singapore dollar CBDC could have implications for the robustness of MAS' monetary policy instrument—the Singapore dollar nominal effective exchange rate (S\$NEER). These effects can be assessed through the following three criteria: (1) measurability, (2) controllability and (3) predictability (Mishkin, 2009).

The first criterion that the monetary policy instrument be measurable refers to the requirement that it can be readily observed, and signals the policy stance with as little delay as possible. The Singapore dollar exchange rate reflects the (external) price of the Singapore dollar vis-à-vis foreign currencies. The issuance of a retail CBDC, irrespective of how widely it is circulated, should in principle not affect the measurability of the exchange rate. It is likely that the Singapore dollar exchange rate will continue to be largely determined in existing foreign exchange markets. Even if a parallel CBDC-based FX market was developed, for instance with the establishment of an international multi-currency CBDC platform⁴², its exchange rates should be closely linked to those in existing FX markets given the fungibility of CBDCs with bank deposits. Furthermore, retail transactions are much smaller in size than wholesale transactions and thus unlikely to move prices in the FX market. There is the small risk that exchange rates could diverge across instruments during times of extreme financial stress. This is unlikely to occur in normal periods.

The second criterion requires that the monetary policy instrument be controllable, in that the central bank retains effective leverage over the operational target of monetary policy. Given its exchange rate-centred monetary policy framework, MAS has had a history of not encouraging the use of the Singapore dollar outside Singapore for activities unrelated to the domestic real economy, particularly for speculative purposes (Ong, 2003).⁴³ If foreigners are granted unfettered access to MAS' digital currency as they have for physical banknotes currently, it would be a *de facto* further 'liberalisation' of the Singapore dollar. As noted earlier, a retail CBDC could be more attractive than existing forms of money, including those denominated in other currencies. In turn, its introduction might increase the use of the Singapore dollar by financial market participants for international settlement and by non-residents as a safe asset and means of retail payment. In addition, more convenient access and seamless convertibility to the domestic currency via a CBDC could lower the transaction costs for taking speculative positions in the currency, including among less-informed investors that are more susceptible to herd effects (IMF, 2020).

If the Singapore dollar becomes a (digital) currency of choice in transactions that were not previously denominated or settled in it, or it gains a larger share in global portfolios, external demand for the Singapore dollar could increasingly be driven by factors unrelated to Singapore's domestic economic conditions. Moreover, a CBDC is fundamentally different from Singapore dollar bank deposits. Its equivalence to high-powered MAS reserves suggests that a retail CBDC could theoretically 'super-charge' the uncovered interest rate parity (UIP) condition. Ferrari et al. (2020) show that capital flows and the exchange rate are likely to

⁴² See MAS Project Ubin Phase 4 and 5 reports, as well as Auer, Haene and Holden (2021).

⁴³ To this end, MAS currently imposes limits on the lending of Singapore dollar to non-resident financial institutions for speculation in the Singapore dollar currency market (see MAS Notice 757.) This policy does not constitute a form of capital or exchange control. Since 1978, all exchange controls in Singapore have been abolished, and both residents and non-residents are free to remit Singapore dollar funds into and out of the country. They are also free to purchase or sell Singapore dollar in the FX market.

respond more significantly to shocks in the presence of a CBDC—foreign investors rebalance much more into a CBDC than they would otherwise into bonds in the same currency because the CBDC provides payment services in addition to being a store of value. Against larger and more volatile capital flows, potentially of a pro-cyclical nature, MAS could find it more difficult to manage the exchange rate and keep it at a level consistent with domestic price stability. Larger and more frequent FX intervention operations may be necessary. The controllability of the exchange rate would essentially be weaker.

The extent to which controllability is eroded would depend on the increase in the use of the Singapore dollar as an invoicing vehicle⁴⁴ and safe haven (or speculative) currency following the introduction of a retail CBDC. Today, there is already a significant pool of Singapore dollar offshore; the 2019 BIS Triennial Statistics suggests that about half of Singapore dollar FX turnover is traded outside Singapore. The incremental impact of a retail CBDC can likely be managed through proper design of the digital Singapore dollar. (See discussion below.) Moreover, some loss in controllability of the monetary policy instrument might be an acceptable trade-off if a digital Singapore dollar is able to prevent to some extent non-native digital currencies from making inroads into domestic retail transactions. The ability to monitor aggregate CBDC flows in real-time could also aid in MAS' foreign exchange intervention response to capital flows arising from its introduction.

The third criterion refers to the existence of a stable relationship between the monetary policy instrument and the goal of monetary policy, which in Singapore's case, is the relationship between S\$NEER and inflation. With a retail CBDC, the exchange rate determined by MAS could theoretically be transmitted more directly and promptly to businesses and households. The ease of arbitrage between the CBDC and wholesale markets, and lower bid-ask spreads for retail FX transactions in a CBDC market (e.g. due to a larger number of competing FX service providers and less frictions) could imply that exchange rates facing households and businesses would adjust more quickly to levels determined by MAS' intervention operations in the wholesale markets, which could have a direct bearing on a broad range of household and corporate decisions. In turn, the empirical relationship between the exchange rate and output (the "I-S curve") and inflation (the Phillips Curve) may need to be re-established, even as the predictability criterion is not fundamentally violated. The ensuing uncertainty also suggests that there will be a greater risk of policy missteps between the time when the retail CBDC is introduced to the time when the relationships between the S\$NEER, output and inflation settle at a new equilibrium.

Monetary Aggregates and Real Economic Impact

The macroeconomic impact of introducing a retail CBDC can be assessed through the lens of monetary aggregates, its relationship with economic activity and the potential effects of raising the supply capacity of the economy through improved productivity.

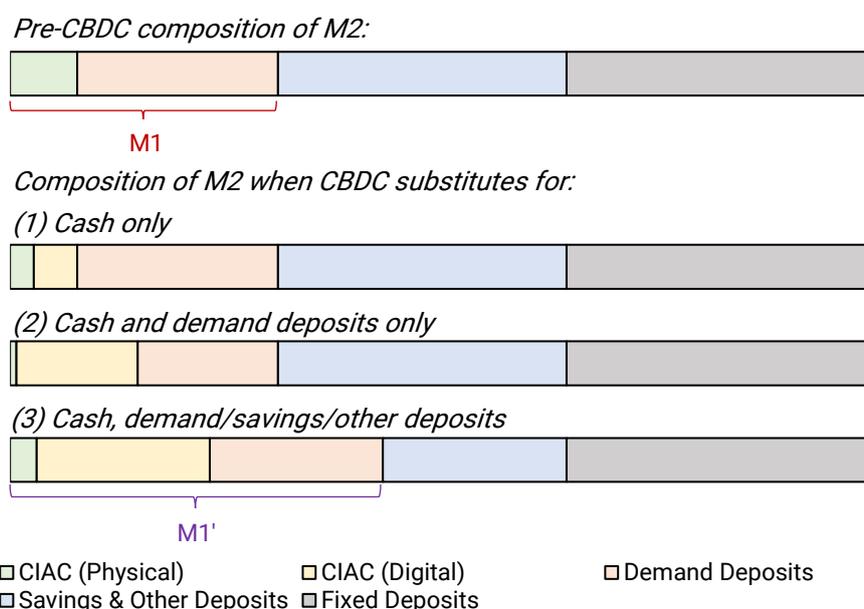
As new forms of money emerge, there will be a need for the international central banking community to review and update the definitions and taxonomy for monetary aggregates. In the interim, one solution is to accord the retail CBDC the same statistical treatment as banknotes and coins in the current framework for the compilation of money supply statistics. This is the approach taken in the subsequent discussion: the definition of Currency in Active

⁴⁴ A vehicle currency is a medium of exchange across currencies. It is usually used to bridge transactions between illiquid currency pairs. For instance, instead of exchanging Singapore dollar for Polish zloty directly, FIs and firms usually exchange the Singapore dollar for US dollar (the vehicle currency) first and then the US dollar for the Polish zloty. The US dollar is the most prominent vehicle currency today.

Circulation (CIAC) is simply broadened to include both physical and digital forms of central bank money that are in the hands of the money-holding sectors in the economy. This would then carry through to narrow money (M1) and the broader monetary aggregates (M2 and M3) as CIAC is a component of all these measures.

There is significant uncertainty over the take-up of the retail CBDC. Nonetheless, the introduction of a digital Singapore dollar could change the composition of broad money⁴⁵ in the economy. Figure 6 below illustrates the different configurations of broad money that could emerge with the introduction of a retail CBDC. The third scenario—where the shares of cash and various deposits shrink with the addition of a retail CBDC, and M1 plays a larger role—is the most plausible outcome, even though much would depend on the design of the digital Singapore dollar. A retail CBDC could displace bank deposits to some extent, while also substituting for physical cash, albeit not completely. There will likely be continued demand for cash in the near to medium term given that a retail CBDC is unlikely to be able to fully replicate the features of cash, particularly its degree of anonymity.

Figure 6 Stylised Diagram on the Composition of Broad Money, Pre- and Post-CBDC



Source: MAS

The shift from the use of cash and less technologically advanced payments such as cheques to the CBDC could have the effect of increasing the velocity of money (as less money is demanded in equilibrium). One reason why individuals and firms hold cash and bank deposits is their usefulness in facilitating transactions. A digital Singapore dollar could reduce the size of liquidity buffers that economic agents maintain to ensure that transactional needs can always be met. For instance, the replacement of cash by a retail CBDC would eliminate the need for change (money) at points of sale and hence floats in cash registers, while speedier receipt of incoming payments, such as those facilitated by the use of smart contracts, would diminish the need for excess deposits or cash to bridge two transactions.

⁴⁵ Here, we refer to M2, as it is generally the most useful measure of the purchasing power of the money-holding sector in Singapore. M2 has a more comprehensive coverage of financial instruments that are used as a medium of exchange compared to M1. In particular, the difference between M1 and M2 has diminished over time because of the increased transferability of deposits between a current or savings account. Meanwhile, the difference between M2 and M3, which is net deposits with finance companies, is relatively small (1.8% of M3).

However, any increase in the velocity of money due to the introduction of a retail CBDC is likely to be small—the use of cash and cheques for payments is already in decline and a growing proportion of retail payments are processed in real-time.⁴⁶ A rise in the velocity of money or its volatility is also not expected to have significant macroeconomic implications, given its unstable link to output and inflation.

The impact of CBDC issuance on overall money supply growth is somewhat ambiguous. From the money creation perspective, a retail CBDC could affect money supply in the economy through its effects on bank credit creation. Bank lending is a primary source of money creation: when a bank makes a loan, it simultaneously generates a matching deposit in the borrower's bank account, which adds to money supply (McLeay et al., 2014). The introduction of a digital Singapore dollar could result in reduced bank lending in the economy (as discussed above) and thus a lower rate of money supply growth. There is, however, the possibility that bank credit is unchanged as well, with banks continuing to supply credit, albeit at thinner margins. In a theoretical model, Barrdear and Kumhof (2019) show that real interest rates in the economy fall when CBDC is issued against government bonds.⁴⁷ An increase in the total quantity of money or a fall in interest rates is therefore also possible.

The real effects of introducing a highly efficient, low cost public digital payment system is likely to be positive in the long run. The supply side of the economy would benefit directly from the introduction of a new, state-of-the-art payment system, as well as the competitive pressure it exerts on the existing market for payment services. The cost of payment services could thus decline. At the same time, the CBDC's introduction could also spur broader innovation and digitalisation in other aspects of economic activity.

It is important to appreciate that the aggregate amount of money in the Singapore economy is ultimately influenced by MAS' monetary policy stance, and this would not change with the introduction of a retail CBDC. In prescribing a path for the exchange rate, MAS effectively sets the relative price of all Singapore dollar-denominated money—including the CBDC—to other foreign currencies over time. This external price of the Singapore dollar affects the level of domestic economic activity and the demand for credit.⁴⁸ Thus, while MAS allows the quantity of money supply to be determined endogenously by the needs of the economy, it will adjust the (external) price of the Singapore dollar to ensure that the medium-term price stability objective of monetary policy is met.

Overall, challenges arising from changes in payment technology are not new phenomena. Central banks have always had to adapt monetary policy to financial innovations throughout history.

⁴⁶ The effect of the introduction of a payment instrument with a higher velocity on the aggregate velocity of money in the economy also tends to be outweighed by the effects of other macroeconomic factors (e.g. the interest rate level, expectations of inflations and income growth, scarring effects of crises).

⁴⁷ This occurs if a CBDC is issued via the central bank's purchase of an equivalent amount of government bonds. The extent of the decline is determined by the elasticity of the real interest rate with respect to changes in the government debt-to-GDP ratio.

⁴⁸ A change in MAS' exchange rate policy stance could also affect Singapore dollar interest rates, all else equal. For instance, an easing of monetary policy, achieved through (unsterilised) foreign exchange interventions to purchase foreign currency leads to an expansion of Singapore dollar liquidity. *Ceteris paribus*, this expansion of Singapore dollar liquidity in the banking system should lead to a fall in Singapore dollar interest rates.

Safeguards in the Singapore Dollar Retail CBDC Design

The discussions above highlight that a CBDC which is elastically supplied and universally accessible poses risks to bank disintermediation and monetary policy implementation whereas physical cash does not. This suggests that some form of “friction” needs to be introduced into the CBDC design in order to mitigate these risks. This section considers levers in the CBDC which would enable MAS to exert some degree of control over the volume of retail CBDC in circulation. The key design features elaborated in the following segments focus on some form of access restrictions and an (relatively) unattractive remuneration rate, which are largely similar to those currently being considered by other central banks.

Access

To mitigate the risks of weaker controllability over the monetary policy instrument and bank disintermediation, two types of access restrictions should be considered: (i) on holdings of the digital Singapore dollar by non-residents and (ii) on domestic use cases.

First, CBDC access and holdings could, in the first instance, be restricted only to domestic residents.⁴⁹ Limited and time-bound access to the Singapore dollar CBDC can be offered to tourists and other short-term visitors to Singapore. This could potentially be enforced by tying the use of the retail CBDC to geographical location, an approach considered by the PBOC for its e-CNY (Auer, Cornelli and Frost, 2020) or by implementing an account-based system tied to national digital identities (BIS, 2021).

Indeed, in light of the risks of cross-border usage of retail CBDCs, most jurisdictions are taking a cautious approach on this front: a survey by the BIS (Auer et al., 2021) found that only four central banks out of 50 respondents envisage permitting the use of their CBDC by non-residents beyond their borders at this point in time.⁵⁰ Likewise, MAS’ assessment is that a retail CBDC need not have cross-border use cases in the initial phase of issuance, even as further research and experimentation on cross-border CBDC mechanisms are continuing on a parallel track. As noted by Carstens (2021), restricting non-residents’ access is a way for countries to reduce the risks of volatile capital flows.⁵¹ Ultimately, international cooperation, including coordination on CBDC design such as wallet parameters, will likely be needed to ensure that CBDCs can be used across borders with minimal risks to countries’ monetary policy and financial stability (BIS et al., 2021).

⁴⁹ Residents refer to those whose usual place of residence is Singapore, and would include citizens, permanent residents and holders of work and dependent passes. An exception could be made for Singapore citizens who reside abroad.

⁵⁰ This is even as slightly over a quarter of the 50 central bank respondents would allow the use of their CBDC by visitors within their borders.

⁵¹ Restrictions on non-residents’ access are also seen as a way to reduce the risk of currency substitution in recipient countries (Carstens, 2021). Adrian and Mancini-Griffoli (2021) noted that IMF member countries have raised questions about the technical feasibility and policy desirability of limiting foreign digital currency transactions and holdings. They are of the view that it may be possible to put in place basic parameters for wallets and networks to limit currency substitution, but these must be coordinated at the global level to avoid regulatory arbitrage.

Second, limits on the holdings of the CBDC (“stock caps”) and the amount one can spend in CBDC over a given period of time (“flow caps”) can be considered to mitigate the risks of disintermediation (BOE, 2020).⁵² This would be functionally similar to the caps that are in place for personal e-money wallets in Singapore under the Payment Services Act. While the caps would inhibit the use of the CBDC for transactions beyond the limit, it may not be necessary for the CBDC to be able to meet all the transactional needs of resident households and corporates. In particular, large enterprises are likely well served by using commercial bank money for high-value business-to-business transactions, as payment inefficiencies and frictions for them are already low.

A hard stock cap is one way of giving MAS control over the maximum quantity of CBDC circulating within the economy, since no single individual or firm can hold CBDC above their respective limits at any point in time.⁵³ Constraining the aggregate quantity of retail CBDC will keep monetary and financial stability risks manageable and ensure that any unintended negative impact which surfaces is contained. For instance, discouraging the use of the digital Singapore dollar for large-value corporate transactions reduces the magnitude of potential deposit outflows from banks. A flow cap would also guard against a rapid leakage of bank deposits into the domestic retail CBDC, particularly during crises. Together, such caps would reduce any increased “runnability” of corporate deposits, and limit the maximum outflow of deposits, thus better securing banks’ deposit base and the cost and supply of credit in the economy (BIS, 2021).

To prevent incoming payments from failing when limits are reached, one option is for CBDC wallets to be accompanied by a “waterfall account”, a designated deposit account into which the excess amount of CBDC holdings above the cap will be automatically transferred (Bindseil, 2020a). Also known as the “overflow approach”, this mechanism has the added benefit of limiting the disintermediation of banks, because most depositors would not be able to completely eliminate the need for ordinary bank accounts.

The considerations of the cap thresholds are beyond the scope of this paper. However, these limits should be calibrated to allow the retail CBDC to meet the regular payment needs of households and SMEs, while safeguarding the banking sector from excessive and abrupt substitution of the CBDC for bank deposits. The quantum of any stock and flow caps and its structure could be reviewed periodically, as MAS gains a better understanding of the demand for CBDC and its determinants over time. As nominal output in the economy grows, the caps could become increasingly binding over time if they are not adjusted to keep up with the value of transactions.

Remuneration

Interest payable on CBDC balances could be set at 0% in line with the *de facto* rate of remuneration on banknotes and MAS reserves. In normal circumstances, this ensures that the digital Singapore dollar is less attractive as a store of value compared to bank deposits

⁵² There are concerns that hard caps on CBDC holdings could lead to the emergence of a “dual currency system” whereby a Singapore dollar CBDC is more valuable than other forms of Singapore dollar-denominated money. For the uniformity of money to be broken in this way, there must exist a secondary market in which the CBDC is traded and individuals are able to circumvent the stipulated individual limits.

⁵³ This assumes that all users will be identified (at least during onboarding) and there is a technological solution that allows for the consolidation of the amount of CBDCs held by an individual or a firm across different wallets based on their unique identifier (e.g. National Registration Identity Card (NRIC) number or Unique Entity Number (UEN)) so that these limits can be enforced.

which are interest-bearing. Economic agents would then likely maintain only a small float of retail CBDC for making payments, negating some of the risks associated with excessive deposit outflow.

However, the design of the CBDC may need to incorporate the possibility for MAS to adjust the (effective) interest rate on the CBDC. In the current global interest rate environment, the flexibility to impose negative interest rates either outright or through a levy on holdings is of considerable value for central banks as argued by the BOE (2020). A negative domestic interest rate environment in Singapore cannot be ruled out. In the years since the Global Financial Crisis, domestic interest rates, particularly implied Singapore dollar rates such as the Swap Offer Rate, have fallen below zero from time to time, reflecting a global interest rate environment that has been hovering around the zero lower bound. In a world with widespread negative rates, a zero-return safe asset could be immensely attractive. If a Singapore dollar CBDC were to be remunerated at 0% and there were no foreign access restrictions, MAS could struggle to offset capital inflows and implement our exchange rate-centred monetary policy in the presence of a persistently positive interest rate differential. Accordingly, MAS might need to adjust administered rates on central bank money to avoid disrupting interbank borrowing and lending markets. This potentially includes charging interest on excess reserves that banks hold with MAS, and reinforcing this with an imposition of the same negative rates on the digital Singapore dollar.⁵⁴

Quantitative caps on CBDC holdings, if implemented, would mean that financial disincentives, including negative remuneration, are unlikely to be needed. Nevertheless, to enable greater flexibility, the CBDC's design should also allow policymakers to impose a tiered remuneration system through a combination of price mechanism and quantity limits to control the volume of retail CBDC demanded. Such a tiered system could be particularly useful if the stock and flow caps needed to be lifted or access widened to non-residents, although its implementation is likely to be more complex.

Following Bindseil (2020a), a tiered system could be one where holdings of CBDC below a certain threshold are assigned to Tier 1, while all remaining balances above the threshold would be in Tier 2. CBDC balances would yield no returns in Tier 1, but would be subjected to a negative interest rate in Tier 2 if needed. The interest rates on Tier 2 are adjustable, allowing MAS to use it as a lever to manage the total volume of CBDC in circulation. The difference between Tier 1 and Tier 2 interest rates could be calibrated over time depending on assessments of the appropriate level of demand for the CBDC.

The primary advantage of such an approach is that it could disincentivise the use of the CBDC as a large-scale store of value without discouraging its use as a means of payment.⁵⁵ In particular, it essentially assigns the payment function of money to Tier 1 CBDC, while the store of value function would be assigned to Tier 2. This could allow MAS to provide non-residents with access to Singapore dollar CBDC to facilitate retail payments, and yet

⁵⁴ In line with the experience in most economies who have imposed negative interest rates, households and small businesses need not necessarily face negative rates because they can easily convert their bank deposits to cash. Banks are more likely to pass on negative rates to large corporates, who would be more willing to stomach negative returns on their deposits and CBDC holdings given the cost of handling, storing and insuring cash. The marginal rate has been estimated in most advanced economies to be around -1 to -2% p.a., thus setting the "effective" lower bound on monetary policy.

⁵⁵ Notably, advanced economy central banks have had ample experience with tiered remuneration systems, including over periods of negative interest rates. Bindseil (2020a) argues that this experience could be readily applied to CBDC which would address the structural and cyclical bank disintermediation issues without exposing households using CBDC for payment purposes to (perceived) financial repression.

discourage Singapore dollar CBDC holdings as a store of value abroad. Foreigners who do not reside in Singapore could be assigned a zero Tier 1 allowance, such that all their holdings of the digital Singapore dollar would be remunerated at the Tier 2 (negative) interest rate, making it an unattractive investment asset. Moreover, a tiered remuneration system could ensure that there is a minimum level of CBDC that all Singaporeans can hold without facing negative interest rates, should this be needed.

Overall, a CBDC's digital nature opens up more possibilities to control its aggregate volume, price and whom it can be held by than is available with physical cash today. However, the limitations and restrictions introduced to manage risks may ultimately come at some cost to the ability of the retail CBDC to meet the public policy goals described in Chapter 3. Apart from narrowing its use cases to domestic and small-value transactions in the first instance, these safeguards could introduce frictions to the user experience that may make a retail CBDC possibly less attractive than other forms of digital money, thereby weakening its acceptance. Policymakers will need to navigate and calibrate the design of the CBDC to maximise its usefulness even as risks are kept contained. The design features set out in this sub-section are a starting point for discussion. Further exploration of retail CBDC architecture and technology may yet yield additional opportunities for policymakers to mitigate risks while preserving the benefits of a retail CBDC.

5 Concluding Remarks and Next Steps

The world is coming to a crossroads in the evolution of money and payments. Like many central banks around the world today, MAS is considering how best to respond to the emergence of new forms of money delivered by potentially dominant payment service providers, alongside the decline in the use of cash.

This paper surveys the landscape and explores one of the options available to MAS—the issuance of a Singapore dollar retail CBDC in partnership with the private sector to serve as a public digital payment option.

MAS' view is that a well-designed retail CBDC could have unique value propositions in the future economy. A retail CBDC will preserve the benefits of generally-accessible public money even as cash becomes obsolete and ensure that there is a publicly-provided payment option in Singapore as digitalisation intensifies. This would protect the public's interest in digital payments and reinforce trust in the Singapore monetary system. Concurrently, the issuance of a retail CBDC presents an opportunity for MAS and the industry to keep pace with advances in payment technology and leverage welfare-enhancing technical improvements.

While the introduction of a retail CBDC poses risks to credit creation, financial stability and monetary policy, the incorporation of appropriate safeguards in the CBDC would help mitigate these. A CBDC can be designed to minimise its store-of-value function, even as its adoption as a medium of exchange merely offsets some of the decline in the use of physical cash in day-to-day transactions.

Constraints on a CBDC, however, may chip away at its full potential. Nevertheless, innovations in payments technology and design are rapidly growing and may allow the benefits of a retail CBDC to be better harnessed while mitigating its risks more securely. It is likely only in experimenting with actual designs, proofs of concepts and pilot tests, alongside consultations, that the benefits and risks of a retail CBDC will be more fully understood. MAS has not yet decided on issuing a retail CBDC. Further in-depth analyses on the implications of a retail CBDC for MAS' regulatory frameworks, operational and legal considerations and its impact on the financial sector among others, still need to be undertaken in parallel.

MAS' decision to proceed with further technological and policy explorations of a retail CBDC should not be taken as a commitment to its issuance. There are broader considerations for CBDC issuance, such as whether the public expects direct access to central bank money as part of the social contract in Singapore. At the same time, while there is general consensus that money and payments are public goods whose provision should not be left entirely to the private sector, the appropriate "division of labour" between the public and private sector ultimately also involves some normative judgement.

MAS remains open to a broad spectrum of possible policy options, including other modalities of public-private partnerships. The development of next-generation payment rails to reap the benefit of welfare-improving advances in payment technology and governance principles can in principle be done independently of the issuance of a new MAS liability. Another alternative would be to support the growth of Singapore dollar-denominated stablecoins, including by allowing issuers to back their tokens fully using central bank reserves. (See Annex B for a brief discussion of such instruments, which have been termed in some parts of the literature as "synthetic CBDCs"). In these cases, MAS would play a more indirect back-end role in the provision of money and payments to households and firms in

Singapore. Each of these options comes with its own balance of costs and benefits, and would need to be evaluated in parallel with the work on CBDCs. Notably, they are not necessarily mutually exclusive—there is the possibility that the co-existence of various new forms of monies, with each serving different needs, emerges as the optimal outcome.

Singapore's Digital Payments Journey

Singapore's electronic payments journey began as early as 1986 with the introduction of General Interbank Recurring Order (GIRO). The intervening 35 years saw the addition of a variety of payment modes, major upgrades to the underlying electronic payments infrastructure and enhancements to regulatory, supervision and licensing frameworks. These efforts have made it possible for households and firms in Singapore to pay in a convenient, safe and instant manner. Against this backdrop, MAS continues to innovate and push ahead with new initiatives to further advance domestic and cross-border payments.

Recent improvements to Singapore's payment infrastructures

A major milestone in the last decade was the introduction of the Fast And Secure Transfers (FAST) system in 2014. FAST was among the first of its kind in the world. It enabled direct real-time transfers from one bank account to another, across different banks, at any time of the day.

In 2017, the PayNow central addressing system was developed as an overlay service to FAST. With PayNow, consumers only need to know the recipient's mobile or National Registration Identity Card (NRIC) number to transfer funds, and not bank account details, significantly simplifying the process. PayNow Corporate was launched in 2018 to extend this service to businesses and government agencies, enabling them to receive funds instantaneously via Unique Entity Numbers.

The Singapore Quick Response (SGQR) code was created in 2018 to address the confusion caused by the proliferation of QR codes from different banks and payment providers displayed at merchants' cashiers. With SGQR, merchants only need to display a single, standardised QR code for all the different types of payments they are accepting.

Recognising that NBFIs were becoming a more integral part of payments with the popularity of e-wallets, MAS granted eligible NBFIs the right to connect directly to FAST and PayNow from February 2021. This direct connection allowed users to transfer funds between their bank accounts and e-wallets, as well as between e-wallets provided by the different companies, in real time.

Looking beyond domestic payments, MAS has also been working to make cross-border payments more seamless and efficient. India's Rupay and Singapore's NETS were connected in 2019 to make merchant payments interoperable.

In April 2021, the linkage between Singapore's PayNow and Thailand's PromptPay real-time retail payment systems went live. The first of its kind globally, this link-up supports seamless, real-time transfers between the two countries using just a mobile number. The service is affordably priced, and fees are transparently displayed to senders prior to confirming their transfer. Building on this experience, MAS is working closely with the BIS Innovation Hub Centre in Singapore on Project Nexus, which will allow countries to link real-time national payment systems with minimal adaptations. There are also plans to connect Singapore's PayNow with India's Unified Payments Interface and Malaysia's DuitNow real-time payment systems in 2022.

Enhancements to regulatory regime

A new Payment Services Act (PS Act) came into force in January 2020 to consolidate the licensing, regulation, and supervision of all relevant segments of the payment ecosystem in Singapore. The risk-based regulatory regime seeks to promote a progressive payments sector while ensuring that risks continue to be well-managed.

The PS Act regulates seven types of payment services⁵⁶ for four key risks—money laundering and terrorism financing, user protection, interoperability and technology risks. Requirements are calibrated based on the specific risks of each payment service as well as the scale of the activities. The modular regulatory regime also provides MAS the flexibility to respond quickly to the fast-changing payments landscape and preserves stability while facilitating the innovation and growth of electronic payments in Singapore. In addition, the PS Act continues to regulate significant payment systems, to ensure the stability and market efficiency of the financial system.

Advancing technological frontiers

Over 2016–20, MAS led the industry to explore the use of blockchain technology and a wholesale CBDC to clear and settle payments and securities more efficiently. Project Ubin demonstrated that multi-currency payment and settlement across borders built on such technology could be done in real time, and at lower risks and costs compared to prevailing mechanisms.

Following the conclusion of Project Ubin, MAS has partnered the BIS Innovation Hub Centre in Singapore on Project Dunbar, together with the Reserve Bank of Australia, Bank Negara Malaysia and South African Reserve Bank, to explore multilateral linkages of countries' CBDC-based retail payment systems and multi-currency settlement platforms with one another. The project explores functional and technical designs, operating models and governance structures, with a vision of faster, cheaper and secured cross-border payments.

In June 2021, MAS announced the launch of a global challenge for retail CBDC solutions. Conducted in partnership with the International Monetary Fund, World Bank and others, the challenge sought innovative solutions to address problem statements in three areas— instruments, distribution and infrastructure. Three winners will be selected during the 2021 edition of the Singapore FinTech Festival, and 15 finalists will be fast-tracked in their applications for grant funding of up to S\$200,000, under the MAS Financial Sector Technology and Innovation (FSTI) Proof-of-Concept Scheme. The solutions of the finalists as well as key insights from the other submissions will be featured in a post-event report.

⁵⁶ The seven types of payment services are account issuance, domestic money transfers, cross-border money transfers, merchant acquisition, e-money issuance, digital payment token dealing and exchanges, and money changing.

Synthetic CBDCs

“Synthetic CBDCs” are digital money issued by private intermediaries who hold 100% reserves at the central bank as backing for the digital money (Adrian and Mancini-Griffoli, 2019). Despite its name, a synthetic CBDC is by definition not a CBDC as it is ultimately a liability of its issuer and not a direct claim on the central bank. Synthetic CBDC arrangements are instead a type of narrow (or full-reserve) bank.

Synthetic CBDCs have attracted attention as one possible means by which central banks could respond to the evolving payment and financial landscape. In allowing new issuers of digital money to back their liabilities fully using risk-free central bank reserves, it would remove liquidity and market risks from the asset side of the issuers’ balance sheet and help reinforce the safety of new forms of private money (BOE, 2021b). This would in turn help secure the domestic currency as the predominant domestic unit of account.

Further, if supplemented by (i) legal structures that ensure that reserves can only be used to pay holders of the synthetic CBDC in the event of the issuer’s bankruptcy and (ii) a mechanism, supervisory or otherwise, that prevents the total value of synthetic CBDC in circulation from exceeding the amount of reserves held with the central bank, a synthetic CBDC could arguably be as safe as a CBDC. This would meet the public’s demand for safe money, as cash disappears from use.

Proponents of synthetic CBDCs also argue that in issuing a retail CBDC “by proxy”, it could preserve a larger role for the private sector, and hence the benefits of private sector innovation than most retail CBDC models. In particular, the private sector would retain their ability to issue their own proprietary liabilities, and have further scope to develop their own underlying payment systems and arrangements for transfers. This freedom for firms to compete in all aspects of payment provision, from the instrument to the platform, would in turn potentially contribute to greater dynamism and innovation in payments, compared to when firms are building on top of a standard digital currency issued by the central bank with a given technology (Adrian, 2020).

However, a payment system based on synthetic CBDCs would inherently have higher barriers to entry than one centred on retail CBDCs, as it continues to keep the creation of digital payment instruments solely in the domain of private firms that can afford the high regulatory and technical costs of doing so. The degree of interoperability is likely to be lower in a synthetic CBDC model as well, given the proliferation of proprietary instruments and technology. Interoperability would only be assured if all the different operators and synthetic CBDC issuers are brought onto a common platform and there is perfect fungibility between their various digital currencies (Duffie, 2020). In turn, the risks of the emergence of “walled gardens”, where end-users are served in a closed proprietary network, are higher in a synthetic CBDC model compared to a retail CBDC model in the long run.

The Group of Central Banks (2020) noted that synthetic CBDCs are likely to be less liquid than CBDCs as their issuers would not be able to create additional liabilities at short notice. Moreover, synthetic CBDCs would pose just as much competition and risks as retail CBDCs to conventional bank deposits which are only fractionally backed. Thus, synthetic CBDC could

end up eroding banks' deposit bases in the same way as a retail CBDC, with similar implications for credit creation, financial stability and monetary policy.

Depending on the aims of the central bank, the basis on which synthetic CBDC proposals are evaluated would differ. As a regulatory model for stablecoins, the merits of a synthetic CBDC would have to be weighed against other forms of backing, e.g. high-quality liquid assets or bank deposits. As a model for the public provision of payments, the relative extent to which a synthetic CBDC supports the central bank's public policy objectives would be key.

Central banks' decisions to facilitate synthetic CBDCs and issue retail CBDCs are by no means mutually exclusive. Both synthetic CBDCs and retail CBDCs may have a role to play in the future monetary landscape.

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