

CARF Working Paper

CARF-F-579

Design of a CBDC in a Highly Dollarized Emerging Market Economy: The Case of Cambodia

Kenichi Ueda
University of Tokyo

Chanthol Hay
National University of Battambang

February 1, 2024

CARF is presently supported by Nomura Holdings, Inc., Mitsubishi UFJ Financial Group, Inc., Sumitomo Mitsui Banking Corporation., The Norinchukin Bank, The University of Tokyo Edge Capital Partners Co., Ltd., Ernst & Young ShinNihon LLC, The Dai-ichi Life Insurance Company, Limited., and All Nippon Asset Management Co., Ltd.. This financial support enables us to issue CARF Working Papers.

CARF Working Papers can be downloaded without charge from:
<https://www.carf.e.u-tokyo.ac.jp/research/>

Working Papers are a series of manuscripts in their draft form. They are not intended for circulation or distribution except as indicated by the author. For that reason Working Papers may not be reproduced or distributed without the written consent of the author.

Design of a CBDC in a Highly Dollarized Emerging Market Economy: The Case of Cambodia

Kenichi Ueda¹
University of Tokyo

Chanthol Hay
National University of Battambang

Abstract

Cambodia is one of the two first countries that adopted a retail CBDC in October 2020. The design of the CBDC, called the Bakong, is a bit unique. We find a few design flaws that could potentially damage the central bank and then the Cambodian economy as a whole. We show some key statistics from our own survey in 2022 to clarify our arguments. The Bakong is offered in two currencies, the Khmer Riel (KHR) and the US dollar (USD), as Cambodia has been highly dollarized. We discuss theoretical predictions for the CBDC based on three kinds of substitutes: paper money, bank deposits, and foreign currencies. The third one is specific to the Bakong. Unlike a typical local currency CBDC, the USD Bakong may substitute for the KHR more. Moreover, it has been announced that the retail Bakong is legally not a liability of the central bank, but from the viewpoint of the underlying technology and economics, it is a central bank liability.

JEL codes: E42, F31

Keywords: Bakong, CBDC, dollarization, stable coin, deposit token

Accepted: 1 February 2024

¹ Correspondence: Kenichi Ueda, Graduate School of Economics, The University of Tokyo, 7-3-1 Hongo, Bunkyo-ku, Tokyo, Japan 113-0033. Email: uedak@e-u-tokyo.ac.jp

1. Introduction

Cambodia is one of the two first countries that adopted a retail central bank digital currency (CBDC) in October 2020. The design of the CBDC, called the Bakong, is a bit unique, which is understandable given the challenges faced by Cambodia's highly dollarized emerging market economy. However, we would like to point out a few design flaws that could potentially damage the central bank and then the Cambodian economy as a whole.

Besides a theoretical investigation, we also show a key statistic based on our own survey of the situation in Cambodia. To the best of our knowledge, few if any such empirical surveys existed at the time of our survey which was designed in late 2021 about a year after Cambodia introduced its CBDC, and conducted in mid-2022.²

2. Theoretical effects of a CBDC

The key function of "money" is as a medium of exchange. Between sellers and buyers, money is used as a means of payment. Hence, theoretically, a retail CBDC may substitute for existing money. In a typical emerging market economy, there are three kinds of money: paper money, bank deposits, and foreign currencies. Depending on how a retail CBDC substitutes for each of them, a retail CBDC could bring either benefits or costs to a country.

Many seem to start with a naïve view regarding a CBDC, namely, compared with paper money (M0), a retail CBDC is expected to lower the costs of issuing (or printing) for the authority once it is developed with some sunk costs. For citizens, a CBDC should also bring more convenience to carry around, though anonymity and privacy may be lost depending on legal protections. Overall, a retail CBDC could be beneficial from the viewpoint of substituting paper money.

Compared with bank deposits (M1), a retail CBDC in a pure form asks people to have transaction-purpose liquidity accounts with the central bank. This option of having a very safe central bank account should be quite attractive for a depositor who already has a liquidity account (for example, a checking account) with a private sector bank, in particular, during a period of financial turmoil.

² Due to COVID-19 pandemic, the implementation of our survey was delayed at least a half year.

However, this substitution with bank deposits would create problems in both the short and long run. In the short run, rapid money transfers from private sector banks to the central bank would create a massive banking crisis (Brunnermeier and Niepelt 2019; Keister and Sanches 2023). In the long run, a financial system without private sector banks implies, either an economy that would lack any bank loans or rely on loans from the central bank (or the government).³ If the former happens, it would result in lower growth with little financing for long-term investments (Diamond and Dybvig 1983). If the latter happens, the economy would resemble the economy of the the Soviet Union in communist times which was quite inefficient. This concern about a retail CBDC substituting for bank deposits seems to be a sufficient condition for preventing the introduction of a retail CBDC, at least a retail CBDC directly issued by the central bank.⁴ A more recent argument is to place the CBDC as a part of all decentralized finance (DeFi), which is a digital and distributed ledger-based finance system but is issued by a central bank (Aquilina et al. 2023).

The third type of substitution could happen against foreign currencies. This is especially important for a small open developing country. As a typical developing country still relies substantially on seigniorage for a part of its fiscal revenue (Khan et al. 2023), keeping its local currency is important for the welfare of its citizens. This monetary sovereignty issue seems indeed well recognized in many countries when Facebook tried to issue Libra, and especially in Asian countries when the Chinese government is experimenting with its retail CBDC and seemingly controls Alipay, which is a Chinese payments network, already set up in many Asian countries.⁵ If it is threatened by the competition from a foreign currency (or a crypto-currency), a country could benefit by issuing a retail CBDC to defend its monetary sovereignty and keep seigniorage.

³ Fernández-Villaverde et al. (2021) consider that the central bank can monopolize deposits and then let money lenders and investment funds take care of corporate finance, though we doubt if social welfare would be maximized in such a system. Chiu et al. (2019) argue in a country like Canada where a few big banks seem to enjoy oligopolistic rents, a CBDC could be a good competitor in the market to reduce such inefficiencies.

⁴ Stable coins backed by bank deposits, which are insured by the deposit insurance and (somewhat) by the lender of last resort function of the central bank, could be considered as an indirect retail CBDC as protected by the authorities. This indirect retail CBDC would preserve bank deposits.

⁵ Alipay is run under a private sector company, Alibaba. However, it has been said that a Chinese authority gained substantial control power on Alibaba in recent years.

3. The Cambodian Economy and Dollarization

Here, we would like to discuss Cambodia's struggle, and the resulting unique design of its CBDC, the Bakong.

Cambodia is growing like a typical East Asian developing country (Figure 1). While Bahama, the other country that adopted a retail CBDC around the same time, October 2020, uses the Bahamian dollar (called the Sand dollar in its CBDC form) that is pegged to the US dollar (that is, a sort of *de jure* dollarization), Cambodia does not make its local currency, the Khmer Riel, hard pegged to the US dollar (USD). Hence, Cambodia's case is classified as *de facto* dollarization. In such an environment, it is interesting to see the CBDC's effects on substitution between the local currency and the international hard currency. Also, while Bahama is a small island country relying on tourism, Cambodia is a more typical East Asian developing country, which has been rapidly growing since the 1990s by industrialization though the tourism sector seems also sizable (Figure 2).

[Figures 1 and 2 around here]

The intrusion of the US dollar into Cambodia is quite large compared to any other South-East Asian country, or any other countries, which do not adopt the US dollar as the legal tender.⁶ This is perhaps due to prolonged political and civil unrest. The unrest may be traced back to the late 1960s and ended only in the late 1990s. It brought the United Nations and international non-profit organizations' activities coupled with the US dollars into the country.

By 2020, in Cambodia, about 80 % of bank deposits are contracted in US dollars (USD, Figure 3). Anecdotal evidence suggests that about a similar percentage of loans are also made in US dollars. By the way, salaries are also mostly paid in US dollars by relatively large firms and foreign firms, while salaries are paid in the local currency, the Khmer Riel (KHR), for government employees and small business workers (Hay 2020).

⁶ One of the authors of this paper, Hay, provides a thorough summary of Cambodia's *de facto* dollarization in his Ph.D. thesis (Hay 2020) that was written under the supervision of the other author, Ueda. The description and figures on dollarization are largely based on the data in this thesis.

[Figure 3 around here]

More importantly, in our survey of 359 shops in Phnom Penh in 2022, about 50-70 % of payments are made in US dollars. More specifically, about 38% of 359 shops answered that they have a price tag or menu. Among them, 15% show the price in USD only; 12% show the price both in USD and KHR; and 10% show KHR prices only. Roughly speaking, the sum of the first two indicates the dollarization of price tags ($27/38=70\%$). On the other hand, for our question on the pricing currency (with or without price tags), about 37% use USD; 11% use USD and KHR; and 51% use KHR only.

In an earlier survey conducted in Autumn 2020 in a similar manner (Hay 2020), the use of the local currency, Khmer Riel (KHR), was mostly concentrated in small transactions. In the survey of shops in Phnom Penh, the capital city, the prices quoted in KHR are for relatively cheap items (Figure 4). This is because USD paper money (larger than or equal to one dollar) is circulating in Cambodia but not USD coins. Still, there are many things that are sold under one US dollar. For those items, people need to use the Khmer Riel.⁷

[Figure 4 around here]

4. The Bakong: Key Facts

The National Bank of Cambodia (NBC) officially launched the CBDC, called the Bakong, on 28 October 2020. NBC began its CBDC project in 2016 with the inauguration of the Project Bakong, named after a temple of the ancient Khmer Empire.

When it was introduced, there were three official objectives of the Cambodian CBDC listed as follows: (1) promoting the use of Khmer Riel and reducing dollarization; (2) preventing the spread of COVID-19; and (3) promoting financial system efficiency, resilience, and inclusion. They were mentioned by Chea Serey who at the time was Director General of Central Banking at NBC, during the launching ceremony as follows: “I hope the official launch of Bakong

⁷ Note that there is at least one other reason on the supply side to use the Khmer Riel: the salaries of government employees are paid in Khmer Riel. In the private sector, foreign firms and big local firms pay salaries in US dollars, while small local firms pay in Khmer Riel (Hay 2020).

system today will help to promote social welfare and also prevent the spread of that disease through facilitating e-payment from person to person seamlessly without involving cash.”

Regarding the technology side, in 2017, the NBC selected Hyperledger Iroha, a blockchain platform that Soramitsu, a private company in Japan, would develop and maintain for its retail CBDC.⁸ The NBC and Soramitsu team collaborated for three years to implement the Project Bakong. The NBC launched the Bakong App in the end.

Cambodian citizens who have smartphones can download the Bakong App at home to store digital KHR and digital USD wallets if they have: (1) a national identity card; (2) a telephone number; and (3) a current selfie photo to put in the system. Users of this mobile app can make payments and transfer money from their e-wallets by scanning QR codes or tapping their phone numbers.

From the retail users’ point of view, Bakong App has 4 main functions, *Send*, *Receive*, *Deposit*, and *QR Pay*, in either KHR or USD.

- a) *Send* is used for transferring money to a receiver’s Bakong account, by using the receiver’s phone number.⁹
- b) *Receive* is used for receiving money from a sender. A receiver needs to show only his/her own QR code to the sender to make a transaction.
- c) *Deposit* is used for transferring money from a Bakong account to a bank deposit account if the bank partners with the Bakong App system.

⁸ Soramitsu is led by founder Kazumasa Miyazawa, who spent many years at Sony and developed a contactless payment system (FeliCa), now widely used in Japan (for example, SUICA) as well as worldwide (for example, Apple’s iPhone). However, Bakong is a QR code-based system, not a FeliCa-based system.

⁹ As of May 2023, the fee structure for sending money is as follows. No fee is charged for sending money from a Bakong account to another Bakong account. No fee is charged for money transfers less than or equal to \$US 50 from a major private sector ABA bank deposit account to a Bakong account. A fee of \$US 0.5 is charged if the money transfer is for a value between \$US 50 and \$US 500 from a major private sector ABA bank deposit account to a Bakong account. The fee varies by banks and increases with the amount of money to be transferred. If the amount of money to be transferred is \$US 700 from an ABA bank deposit account to a Bakong account, the fee is \$US 1.00. Between two commercial bank deposit accounts, for example sending money from ABA to Phnom Penh Commercial bank via the wholesale Bakong, a fee of \$US 0.50 is charged if the amount is less than \$US 500. This fee increases with the amount of money to be transferred. If the amount transferred from ABA to Phnom Penh Commercial bank is \$US 600 to be, the fee will be \$US 1.00.

- d) *QR Pay* is used for paying money to the receiver by QR code by scanning the receiver's QR code.

5. Bakong as a Wholesale CBDC and Money Transfers

The Bakong system was originally designed to upgrade a legacy interbank transfer system by replacing its relational database with the Iroha distributed ledger, which is resilient by design against hardware failures, tampering, and cyberattacks.¹⁰ In this sense, the Bakong is a wholesale CBDC, not only a retail CBDC. Note that a wholesale CBDC refers to a payments system used for interbank transfers. Traditional payment systems (of any countries) are known to be costly and to take substantial time to complete a transaction. However, if a blockchain-based technology is used, money transfers could be made rapidly and securely at little cost.¹¹ Hence, there may exist the wholesale-only users who transfers money from their conventional bank deposit accounts to others' conventional bank deposit accounts via the wholesale portion of the Bakong.

Of the four functions available to Bakong App users, functions (a), (b), and (c) are categorized as money transfers, which use the wholesale Bakong for a transfer between two commercial banks' deposit accounts. In this sense, the Bakong users, including the wholesale-only users, is considered to be quite many, even though they do not necessarily use the Bakong for retail payments. Indeed, the Bakong users reached to half the population by the time of our survey (*Nikkei Asia*, 4 January 2022).¹²

However, less is known about its actual usage related to payments at retail shops (that is, function (d)). Our analysis later in this paper is based on our own field survey which focuses on the actual use of the Bakong as a retail payments tool. Although functions (a) and (b), money

¹⁰ The Iroha distributed ledger was developed by Soramitsu and donated to the Hyperledger Project, which is a collection of open source blockchain applications.

¹¹ Evaluating a specific technology is beyond the scope of this paper and, as such, we cannot say this is always true.

¹² Recent figures do not show much difference. Most major financial institutions, namely 46 institutions, including commercial banks, specialized banks, microfinance institutions and payment service providers, have launched the Bakong payment system (*Khmer Time*, 20 March 2023). About 8.5 million accounts have been using Bakong e-wallets (*The Phnom Penh Post*, 22 February 2023). This is about half of the country's population, and is about the same estimate as in the *Nikkei Asia*'s report of 4 January 2022, a year earlier.

transfers between two Bakong accounts can be also considered as a retail CBDC, we would like to focus on a retail payment CBDC as a substitute for “money” as a medium of exchange.

By the way, many commercial banks in Cambodia had already introduced their own smartphone apps, which are similar to the Bakong App. People can use those private sector banks’ apps to pay at shops. Also, people can use those private sector banks’ apps to transfer money to other banks. For example, the ABA Bank has its own ABA App. People can use their smartphones to transfer money from the ABA Bank to another bank such as the Aceda Bank. In this case, the interbank transfer portion can be done through the wholesale part of the Bakong, if this is chosen by sender over the traditional interbank transfer system. They are the wholesale-only users.

6. The Bakong as a Retail CBDC and Deposit Token

The Bakong is not a pure form of a CBDC. Financial institutions are the direct participants of the wholesale Bakong, while retail users are required to be indirect participants by holding retail Bakong accounts with participant banks. Some participant banks may not choose to offer retail services and may join only the wholesale portion. Both wholesale and retail participants require permission to join the system (permissioned blockchain). As of August 2023, all 54 Cambodian banks are participants.

To start using the Bakong, a user transfers money from his/her bank deposit account to his/her Bakong account, which is offered by a bank. If a person uses the same bank for his/her deposit account and his/her Bakong account, then this transaction by one person would not change the bank’s liability to this person.

In economics, this Bakong account resembles just another (transaction-purpose) checking account at a bank under the same fractional reserve banking, which however seems technologically impossible. One of a few flaws appears here. A key difference of the Bakong from deposits is that, technologically, the value of “money” in one bank’s Bakong account has to be the same as in another bank’s Bakong account. This is so even if the bank goes bankrupt: the value of “money” in a Bakong account at the bankrupt bank cannot be lower than its face value, even the value of “money” in a deposit account at the bankrupt bank would be lower than its face value. Put simply, one “money” in a Bakong account is always one “money” in

any other Bakong account within the distributed ledger system based on the blockchain (in the same way as BitCoin).

This means that if a customer puts “money” in a retail Bakong account at a bank, immediately, a bank has to put the same amount of “money” in its wholesale Bakong account with the NBC.¹³ While the former appears on the liability side of the bank’s balance sheet, the latter should appear at the same time in the asset side of the bank’s balance sheet and should also appear in the liability side of the NBC’s balance sheet. Indeed, the NBC’s White Paper (NBC 2020; p.22), which is the technical summary of the Bakong, says: “End user’s balance at Bakong account is considered as cash equivalent, and it should be recorded in the participant’s Bakong settlement account at NBC. The balance is subject to an update at the end of each business day.”¹⁴ Put differently, the NBC guarantees the value of money in the Bakong account.¹⁵

Here, disintermediation occurs. The reserve requirements for deposit accounts are at 8% for KHR denominated accounts and 12.5% for USD denominated accounts. Banks use deposits, less reserves, to extend loans to firms and households (“fractional reserve banking”). However, technologically a 100 percent reserve is required for Bakong accounts, although the NBC does not call it a “reserve requirement.”

Let us illustrate this problem. If a customer transfers 10,000 Riel from his/her deposit account in a bank to his/her Bakong account in the same bank, the bank would reduce its reserves at the NBC by 800 Riel but immediately place 10,000 Riel with the NBC (Bakong settlement account). So, bank loans to the value of 9,200 KHR need to be reduced (assuming all the bank’s assets are loans except for reserves).

If it was a pure form of CBDC, retail users would have CBDC accounts directly with the central bank. On the other hand, if it is a deposit token (that is, a digital currency backed by bank deposits), then one bank’s deposit token could become lower than its face value if that bank

¹³ These details are informed via lengthy personal email discussions with an NBC staff member as well as during the online seminar at the NBC.

¹⁴ Here, a participant refers to a financial institution and an end user is a person that has a (retail) Bakong account with a participant (bank).

¹⁵ This was also confirmed during a seminar at the NBC.

went bankrupt, while another bank's deposit token could retain its face value. In this case, the token should carry a specific name depending on the issuing bank. A deposit token should have nothing to do with the central bank.

The Bakong is somewhere in between these two. It resembles a deposit token in that it seems to be just a liability of a private sector bank. But, the Bakong is not allowed to be so by its technology itself, and, as explained earlier, it becomes a liability of the NBC immediately and is guaranteed by the NBC explicitly.

Therefore, the retail Bakong should be called a retail CBDC from the viewpoint of the underlying technology and economics. Currently, people call it a quasi-CBDC or hybrid CBDC at best and the NBC does not admit it as its liability. On the other hand, e-CNY, a digital currency issued by the People's Bank of China (PBOC), adopts a similar two-tier system in which the PBOC issues e-CNY and retail banks distribute it through wallets set up by users.¹⁶ The e-CNY users then use the wallets to send, receive, deposit, and pay as is the case with the Bakong. Naturally, the PBOC admits e-CNY as its liability. Similarly, the NBC should admit the Bakong as its liability.

In any case, the two-tier system is a strong form of a narrow banking arrangement.¹⁷ This feature can be considered as beneficial if the Bakong is designed to resemble paper money (outside money) rather than bank deposits (inside money). By this design, the Bakong (at least the KHR Bakong) can escape from the possibility of traditional bank runs depicted in Diamond and Dybvig (1983). This benefit is the same one associated with narrow bank proposals but with obvious costs as it could cause the disintermediation described earlier.

An additional issue emerges in Cambodia as Cambodia does not have a deposit insurance scheme for bank deposits. In this case, strong guarantees for Bakong accounts could create

¹⁶ This similarity of e-CNY and the Bakong is pointed out by Yiping Huang, one of the designated discussant at the Asian Economic Policy Review conference, as well as Shang-Jin Wei on another occasion. Also see, for example, Deutsche Bank's description at <https://www.db.com/news/detail/20210714-digital-yuan-what-is-it-and-how-does-it-work> (accessed 3 February 2024)

¹⁷ Recall that, if for any reason (for example, theft by hackers into the bank's system), a narrow bank went bankrupt, then depositors would not receive the promised amount. However, if a person owns a retail Bakong in a wallet with a bank, he/she can always receive all of it as even theft by hackers is compensated by the NBC.

(even more) distortive higher demands for Bakong accounts. That is, disintermediation might occur even faster. The NBC has addressed at least partially these concerns of disintermediation. First, Bakong accounts do not offer positive interest rates, while bank deposit accounts offer them, possibly compensating for such a distortion. Also, the maximum transaction amount of the Bakong is set by each bank. This is because the retail Bakong is supposed to be used only for substituting paper money, not (large value) bank deposits. However, the maximum could reach even \$US 10,000 (for example, the Wooribank, as of January 2024), essentially surpassing most of the bank deposits of common people in Cambodia.

Moreover, by allowing the sum of customers' Bakong as a bank's liability and the same amount of Bakong as a bank's assets, the bank's balance sheet may seem to be very liquid (on the asset side) and safe. This makes bank balance sheet information less transparent. For the remaining assets, banks could seek riskier investments as part of their liabilities are now insured strongly by the NBC. This moral hazard or risk-shifting problem is reminiscent of ones with deposit insurance (Kareken and Wallace 1978) and the too big to fail (TBTF) problem (Ueda and Weder di Mauro 2013; Chari and Kehoe 2016). However, the NBC has not taken any active measures to mitigate these risks.

7. The Bakong as a USD Stable Coin and Dollarization

As discussed earlier, the NBC guarantees the Bakong, that is, the value of money in Bakong accounts. This is easy to do so for the KHR Bakong since the NBC can issue KHR freely, but it is not easy for the USD Bakong. However, both the KHR Bakong and USD Bakong are offered to the people on the same terms. Bakong users are free to change KHR Bakong to USD Bakong and vice versa using the Bakong App. Also, users can freely transfer money in their Bakong wallet to their bank deposit accounts and vice versa. Depositors can withdraw paper money in either KHR or USD from their bank deposits.

In relation to the USD Bakong, the NBC seems as if it is issuing US dollars. Theoretically, the NBC is creating USD liquidity in the same way as a commercial bank in the US, receiving deposits of paper US dollars and giving depositors USD units in deposit accounts. Only a fraction of the US dollars received by a US commercial bank are deposited in the US Federal Reserve System as bank reserves ("fractional reserve banking"), and the USD deposit amounts, less bank reserves at the central bank, are considered to be created by the commercial bank

(“inside money”). The NBC appears to operate in the same way regarding the USD Bakong. The only difference seems to be that the NBC has foreign reserves (presumably mostly held in US treasury bonds) in its own hands, rather than bank reserves at the US Federal Reserve System.

Therefore, unlike the KHR Bakong, the USD Bakong is subject to the possibility of facing a traditional bank run like bank deposits (Diamond and Dybvig 1983) or facing a currency crisis like a fixed exchange rate regime (theoretically similar to a bank run as shown by Obstfeld (1996)). There are a few institutional setups that are known to contain bank runs: the lender of last resort and deposit insurance. However, obviously, the NBC is not a customer of the US Federal Reserve System, which plays the role of the lender of last resort, nor is the NBC a member of the US Federal Deposit Insurance Corporation (FDIC). This implies a USD Bakong is not likely to be as stable as US commercial bank deposits.

The question naturally arises whether people always trust the USD Bakong to keep par with the true USD (that is, USD paper money) with fractional foreign reserves. If they do not trust it, a typical currency crisis will occur. Note that each bank can limit the retail transactions so that huge withdrawals could be prevented at the bank level. But, given the two-tier system (a strong form of narrow banking system) of the Bakong, the problem lies not at each bank level but at the national level.

On the other hand, getting USD paper money in the hands of the NBC, as much as possible, may be regarded as a way of eliminating the de facto dollarization in Cambodia. This is indeed the objective of the NBC. The NBC openly says that it issues USD Bakong in order to eliminate dollarization.

However, this scenario would be considered a success especially if, at some point, the NBC actively stops the convertibility between the USD Bakong and USD paper money. We would call this case an “active” currency crisis case compared to the traditional passive currency crisis explained in the previous paragraph. In either case, as Krugman (1979) argues, people would start expecting the USD Bakong to lose its value, much earlier than the erosion of foreign reserves, and a crisis could occur.

Perhaps more importantly, assuming the USD Bakong is accepted widely by people, we can see one specific substitution effect of a retail CBDC, unique to the Bakong: the Bakong may eliminate the use of the local currency, Khmer Riel, even more. This perverse effect of the Bakong stems from the fact that the Bakong is issued in two currency units, KHR and USD. People can use USD Bakong even for smaller denominations than one dollar, for example, 25 cents. This eliminates the demand for the paper Riel that has complemented paper US dollars. We believe it important to note here that this specific substitution is opposite to the typical motivation of a small open country, and Cambodia's own motivation, to issue a retail CBDC to defend its local currency against the US dollar, or any foreign currencies and cryptocurrencies.

Either path for the USD Bakong, it vanishing in a currency crisis or it dominating the KHR, is not good for Cambodia. The best way is to stop issuing the USD Bakong. The second best option would be to change its name to the Cambodia dollar or something, so that, in a crisis, the NBC can devalue it against true USD. Doing so would prevent the exhaustion of Cambodia's foreign reserves.

8. Survey

8.1 Shop Survey

In March and April 2022, we conducted a survey of 359 shops in Phnom Penh. Interviewers on foot tried to surveyed as many shops as possible. As a result, this is not a random sample but is intended to include (almost) all the shops, though we do not have information on the shops that declined to be interviewed. The sample of shops were from traditional markets, modern markets, and along the streets. Some street vendors were also interviewed by our interviewers.¹⁸

The key results of our survey are as follows. Overall, about 20 % of shops do not accept any digital or electronic payments. However, 47% of shops accept digital payment in both USD & KHR, while 28% accept only USD.

¹⁸ Surveyors interviewed face-to-face and provided respondents with a pack of masks for preventing COVID-19. Surveyors also wore masks.

Among those that accept digital payments, only 0.3 % in Phnom Penh accept Bakong Pay, the smallest share among any of digital payment systems. On the other hand, ABA Pay is most widely accepted being accepted at about 80 % percent of shops and Acleda Pay is the second at about 40 % of shops.¹⁹ Credit card acceptance comes in third, at about 16 % of shops, while Alipay is at the penultimate at 0.8 % of shops.²⁰

The acceptance of the Bakong at retail shops for retail payment purposes is quite low. There is one clear practical reason. Each “Pay” service usually requires a different QR code to be displayed on the store’s counter but the store counter’s “real estate” is limited. For a typical traditional small shop, the counter is so small that it can show only a few QR codes. So, displaying the QR codes for ABA pay, Acleda pay, and Alipay could reach the constraint. On the other hand, a shop in a modern shopping mall could display more QR codes on its counter. Those modern shopping malls sell higher-priced goods compared to traditional markets or roadside shops, and thus may select naturally certain types of customers (for example, richer and more educated consumers).

Note that the NBC has likely recognized this constraint. After our survey in the spring 2022, a common QR code (KHQR) was introduced in the summer of 2022, that is, it was officially launched on 4 July 2022. So, the “real estate” limitation is likely to be reduced sooner or later. By the way, the same common QR code has now been introduced in Thailand, Laos, and Vietnam, seemingly igniting further international competition among digital currencies.

From our 2022 survey, other than the real estate limitation, we recognize that banks’ apps, especially ABA App and Acleda App, enjoy large shares. Theoretically, this result can be explained by network effects as these Apps were already available before the Bakong and were popular. Also, the private sector Apps may be more user-friendly and innovative. In general, it is always the case that a service should be provided by the private sector if that is possible without market distortions.

¹⁹ ABA Bank is a Canadian bank operating in Cambodia, while Acleda Bank is a domestic bank.

²⁰ Alipay is provided by Ant Financial, a Chinese firm, a part of the Alibaba group. We also include Apple Pay provided by Apple, an American firm, and Pay Pay provided by Softbank, a Japanese firm, as both are supposed to be active in Cambodia. However, no shops in our sample replied that they accept these two payment tools.

The other possibility is the trust of foreign banks. Although Aceda Bank is a local bank, ABA Bank is a Canadian bank's subsidiary. In this sense, people could see (hidden) guarantees by the parent company which could be trusted more than the central bank. Note that major international credit rating agencies have been considering both kinds of (hidden) guarantees when they rate banks.

Also, the major banks such as ABA Bank and Aceda Bank have incentives to stick to their own Apps (to get fees), and use the Bakong only for interbank transactions (Miyazawa 2024). Accordingly, in reality, the retail Bakong is offered only via lesser-known banks and is not used so much (see below). Therefore, disintermediation is not happening. Instead, currently Cambodia's digital payment system is essentially a combination of the wholesale Bakong and retail e-payments (without digital token) backed by deposits at each bank.

8.2 Individual Survey

In summer 2022, we conducted an online survey (though with some face-to-face interviews) for individuals, solicited through SNS services, mainly Facebook.²¹ This survey includes many questions including questions related to the use of the Bakong App and other digital or electronic payments systems, as well as the characteristics of the respondent. The total sample size is 827.

By design, this survey does not rely on random sampling. Those who are surveyed need to have access to the internet and are most likely to own smartphones. Those surveyed also need to understand what digital payments and the Bakong are. They need to connect to major SNS services. Those requirements are, perhaps, easy for people living in advanced countries, but might not be so easy for people in Cambodia.²²

Individuals in the survey were asked 46 questions. Not all questions got many answers, especially the detailed ones. For this paper, we utilize the responses to about a dozen questions

²¹ The survey questions for individuals as well as for shops are jointly written by two authors, Ueda and Hay. The survey was managed by Hay and employed interviewers who were mostly students at the National University of Battambang. Due to the COVID-19 pandemic, these interviews were delayed compared to our original research plan.

²² Besides the restrictions due to the COVID19 pandemic, this was also one of reasons that we did not design our survey to be based on random sampling.

which got a sufficient number of responses. Table 1 shows the definition of those variables, and Table 2 shows a key statistical summary of those variables.

[Tables 1 and 2 around here]

Notably, more than 1/2 of our respondents have as college degree (*Education* in Table 2).²³ However, only about 10 % of the Cambodian population have college degrees according to the World Bank database.²⁴ This implies that our sample is quite skewed towards highly educated people, and thus our results are likely to be biased towards greater acceptance of any digital payment systems compared to the population average. At the same time, if we selected our sample randomly, a sizable portion of respondents might not have access to financial services as well as the internet, and also have difficulties in understanding our questions regarding the use of digital payments and transfers.

Some other variables in Table 2 show the characteristics of respondents. Due to our survey design, most respondents, about 80 %, live in the capital city, *Phnom Penh*, an urban area. Others can be regarded as living in a rural area. The variables *Male/Female* and *Age* are self-explanatory. *Working* (about 70 %) includes full-time students with paid jobs and excludes retired people. Again, the online questionnaires are disseminated originally from the university, so full-time students (that is, unemployed if they do not have paid jobs) are likely to be overrepresented. *Public servants* are about 10 %, excluding those who work for NPOs. Note again that workers at (mostly international) NPOs and large companies are usually paid in US dollars, while public servants are paid in Khmer Riel, naturally preferring retail payments in Khmer Riel.

Retail Payments

Table 2 shows that those who prefer to pay digitally (*Digital Preference*) are about 30 %, while those who have ever experienced paying in digitally (*Digital Experience*) are about 60 % of

²³ Hereafter *capitalized and italicized* words are used for the variables we discuss below.

²⁴ Using data.worldbank.org (accessed 25 May 2023), we look at the variable named “Educational attainment, at least completed short-cycle tertiary, population 25+, male (%) (cumulative) – Cambodia,” which is available for 2014 (8.5 %) and 2015 (9.4 %), which originally comes from UNESCO’s Institute for Statistics. According to data.worldbank.org (accessed 25 May 2023), the tertiary school enrollment in 2021 was about 13 %.

our sample. Overall, 20 % of our sample have used the *Bakong* for retail payments. Again, this is likely to overestimate the use of the *Bakong* in retail payments.²⁵

When using any payment tool (including paper money), about 60 % of respondents in our sample are more likely to use the US dollar (*USD user* in Table 2) compared to Khmer Riel is. This seems consistent with our shop survey, which reveals that about 40 % of shops show price tags only in USD, about 30 % in KHR, and about 30 % in both USD and KHR.

Most importantly, the *Bakong_USD* variable captures USD users but only when using the Bakong. Bakong USD users are about 2/3 ($=0.134/0.197$) of Bakong users. This is a bit higher than the general USD users (60 %) described earlier. This seems consistent with one of the key hypotheses, that is, a perverse substitution effect of the KHR over the USD via the Bakong.

Money Transfers

Our survey also includes questions about money transfers, similar to those about retail payments. The retail money transfer function may be more utilized because it is closer to the wholesale function of the Bakong, which is undoubtedly successful as was explained earlier.

Indeed, the descriptive statistics (Table 2) show about 25 % of our sample use the Bakong for retail money transfers (*MTBakong*), greater than 20 % for retail payments. As such, the retail payment function may be utilized with some delay by those who become accustomed to using the Bakong directly for money transfers.

Moreover, the *MTBakong_USD* variable captures USD users conditional on using the Bakong for transfers. Bakong USD transfer users are about 3/4 ($=0.186/0.245$) of Bakong transfer users. This is a bit higher than the Bakong USD payment users (2/3) described earlier. Since transfers can be done via an electronic format, even before the Bakong, a perverse substitution effect of the KHR over the USD is nothing to do with this result. This requires further research, for

²⁵ The survey of shops covers many small shops, but the Bakong is more likely to be accepted in modern shopping malls where richer and urban people shop. Note that, still this may be a small number, and is perhaps consistent with the low acceptance rate of e-CNY in China, where the competitors like Alipay and WeChat pay are dominant (in the sense of network effects) and convenient—this comment was made by Yiping Huang at the Asian Economic Policy Review Conference.

example, if a remittance to a rural area is a key demand for transfers, this high percentage of the USD may imply a rapid dollarization in rural areas.

Further Empirical Study

In a companion paper (Ueda and Hay 2023), we investigate the substitution effects of the retail payment Bakong using a logit analysis of data from our individual survey. We have three hypotheses, two of which are common to all the retail CBDCs, and one which is unique to Cambodia's Bakong.

- H1: A retail CBDC substitutes for M0, paper money.
- H2: A retail CBDC substitutes for M1, bank deposits (or more broadly private sector payment tools like debit cards and QR code-based payments)
- H3: The Bakong substitutes US dollars for Khmer Riel.

We find evidence supporting all the hypotheses in our logit analyses. Note that those predictions, especially H1 and H2, are consistent with the key theoretical papers described already as well as with many policy-oriented documents and academic reviews when the discussions became popular in 2018 to 2020 (for example, Adrian and Griffoli 2021; Agur et al. 2022; Allen et al. 2020; Auer and Boehme 2020; BIS 2018a, 2018b; Boar, Holden and Wadsworth 2020; Griffoli et al. 2018; Townsend 2020; Yanagawa and Yamaoka 2019) and these discussions still continue (for example, Khan et al. 2022; Aquilina et al. 2023; Prasad 2021; Ueda 2022). As for hypothesis H3, again, it is specific to Cambodia.

9. Conclusion

The Bakong is quite successfully used in wholesale interbank transfers in Cambodia. It is thus not surprising that the Bakong could also be used in retail transfers and, though less so, retail payments. However, there are a few concerns.

First, our survey shows disintermediation is not happening as the retail Bakong is not accepted much among banks, shops, and consumers. If the demand continues to be low like this for a few more years, the NBC should stop offering the retail Bakong. This may be indeed the best solution, according to the economics principle that the government should not provide services that the private sector can provide. Indeed, the private sector usually has more incentive to innovate products and produce at lower costs than the government.

Second, on the other hand, if usage of the retail Bakong picks up, especially if it reaches widely into the unbanked population, the NBC should improve the institutional setup of the Bakong. It seems fine to have a two-tier system for the retail Bakong. However, the NBC has been emphasizing that the Bakong is not a liability of the NBC, which is not true from the viewpoint of the underlying technology and economics. The fact that any retail Bakong account is a 100 % liability of the NBC has not been well explained to the public. This should be more transparent. In addition, such strong backing by the NBC could create a possible distortive demand for retail Bakong accounts against bank deposit accounts. A possible remedy would be to introduce deposit insurance for bank deposit accounts. Also, in any case, with such public guarantees, a strengthening of bank regulation and supervision would be necessary.

Third, given the high dollarization in Cambodia, the Bakong is issued not only in the local currency KHR but also in USD. In this case, a currency crisis due to a lack of sufficient foreign reserves could happen, not just in the exchange rate market but also in the domestic USD Bakong market (Bakong USDs against true USDs). Here, some remedies should be warranted, including radical ones, for example, stopping the issuance of the USD Bakong (even the wholesale one) or creating a different name for the USD in Bakong accounts (such as the Cambodia Dollar) to enable the mitigation of a potential crisis by devaluation, for example. This would be a typical currency board arrangement, which usually has its own currency name, not the USD.

Note that a private sector bank can provide a USD deposit account, but a central bank should not do so. A collapse of a private sector bank could cause a banking crisis, which however could be managed with known policy tools. On the other hand, the collapse of the central bank would create devastating instability of the whole economy for a prolonged period.

Acknowledgment

The views expressed in this paper are those of the authors and should not be attributed to any institutions that the authors have been or are affiliated with. The research in this paper is conducted as a part of the Digital Economy Project, led by Kenichi Ueda at the University of Tokyo, and funded by donations from the Silicon Valley Fund as a part of the University Blockchain Research Initiative (UBRI). We also acknowledge financial support from the Center for Advanced Research in Finance (CARF) at the University of Tokyo. We appreciate

the research assistance provided by Liliya Repa. We benefitted from comments at the 38th Asian Economic Policy Conference held at the Japan Center for Economic Research (JCER), the 4th UTokyo Digital Currency and Finance Workshop at CARF, and an (online) seminar at the National Bank of Cambodia. In particular, discussions with Naomi Takeda, Yiping Huang, Kazumasa Miyazawa, Yasushi Nakayama, Noriyuki Yanagawa, and Toshitaka Sekine were helpful at those occasions. We would also like to thank Piti Disyatat and Andreas Scrimpf for their insightful comments on an earlier version of the companion paper.

References

Adrian T. & Griffoli T.M. (2021). The rise of digital money. *Annual Review of Financial Economics*, **13**, 57-77.

Agur I., Ari A. & Dell’Ariccia G. (2022). Designing central bank digital currencies. *Journal of Monetary Economics*, **125**, 62-79..

Allen, S., Grimmelmann J. Juels A. & Prasad E. (2020). Design choices for central bank digital currency. 23 July. Brookings Institution. Accessed 31 October 2023. Available from URL: <https://www.brookings.edu/articles/design-choices-for-central-bank-digital-currency/>

Aquilina M., Frost J. & Schrimpf A. (2023). Decentralized finance (DeFi): A functional approach. CEPR Discussion Paper no. DP17810, Centre for Economic Policy Research (CEPR).

Auer R. & Boehme R. (2020). The technology of retail central bank digital currency. *BIS Quarterly Review*, March, 85-100.

Bank for International Settlements (BIS) (2018a). Central bank digital currencies. Report by Committee on Payments and Market Infrastructures and Markets Committee. Accessed 1 February 2024. Available from URL: <https://www.bis.org/cpmi/publ/d174.pdf>

Bank for International Settlements (BIS) (2018b). Proceeding with caution: A survey on central bank digital currency.,” *BIS Papers* no. 101, Bank for International Settlements.

Boar C., Holden H. & Wadsworth A. (2020). Impending arrival: A sequel to the survey on central bank digital currency. *BIS Papers*, No. 107, Bank for International Settlements.

Brunnermeier M.K. & Niepelt D. (2019). On the equivalence of private and public money. *Journal of Monetary Economics*, **106**, 27-41.

Chari V.V. & Kehoe P. (2016). Bailouts, time inconsistency, and optimal regulation: A macroeconomic view. *American Economic Review*, **106**, 2458–2493.

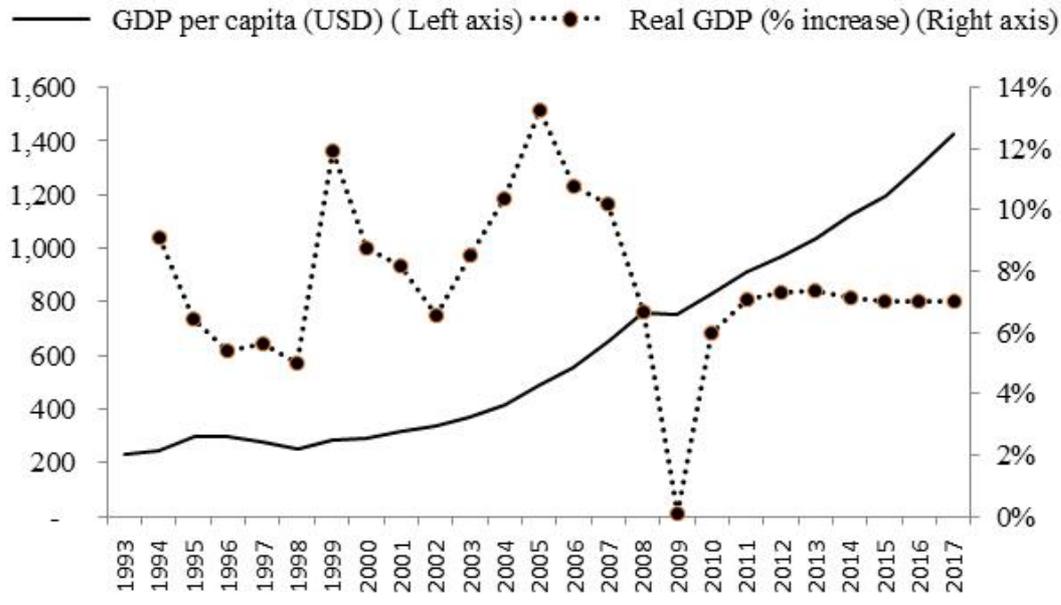
Chiu J., Jiang J.H., Davoodalhosseini S.M. & Zhu Y. (2019). Central bank digital currency and banking. Society for Economic Dynamics Meeting Papers no. 862.

- Diamond D.W. & Dybvig P.H. (1983). Bank runs, deposit insurance, and liquidity. *Journal of Political Economy*, **91** (3), 401-419.
- Fernández-Villaverde J., Sanches D., Schilling L.M. & Uhlig H. (2021). Central bank digital currency: Central banking for all? *Review of Economic Dynamics*, **41**, 2021, 225-242.
- Griffoli T.M., Peria M.S.M., Agur I., Ari A., Kiff J., Popescu A. & Rochon C. (2018). Casting light on central bank digital currencies. IMF Staff Discussion Note no. 18/08, International Monetary Fund (IMF).
- Hay C. (2020). *Essays on the Macroeconomic Effects of Dollarization on Cambodian Economy*. Unpublished Ph.D. dissertation, Graduate School of Public Policy, The University of Tokyo.
- Kahn C., Singh M. & Alwazir J. (2022). Digital money and central bank operations. IMF Working Paper no. WP22/85, International Monetary Fund (IMF).
- Kareken J.H. & Wallace N. (1978). Deposit insurance and bank regulation: A partial-equilibrium exposition. *Journal of Business*, **51** (3), 413–438.
- Keister T. & Sanches D.R. (2023). Should central banks issue digital currency? *Review of Economic Studies*, **90** (1), 404–431..
- Krugman P. (1979). A model of balance of payments crises. *Journal of Money, Credit, and Banking*, **11**, 311-325
- Miyazawa K. (2024). Ajia taiheiyo chiiki ni okeru chuo ginko dejitaru tsuka no tenkai (Central bank digital currency developments in the Asian-Pacific region). *Keizai Seminar*, February-March issue, 7-15 (in Japanese).
- National Bank of Cambodia (NBC) (2020). *Project Bakong: Next Generation Payment System*. Accessed 1 February 2024. Available from URL: https://bakong.nbc.gov.kh/download/NBC_BAKONG_White_Paper.pdf
- Obstfeld M. (1996). Models of currency crises with self-fulfilling features. *European Economic Review*, **40**, 1037-1047.
- Prasad E.S. (2021). *The Future of Money: How the Digital Revolution Is Transforming Currencies and Finance*. Cambridge: Harvard University Press.
- Townsend R.M. (2020). *Distributed Ledgers: Design and Regulation of Financial Infrastructure and Payment Systems*. Cambridge: MIT Press.
- Ueda K. (2022). *Kinyu Shisutemu no Keizaigaku (The Economics of the Financial System)*. Tokyo: Nihon-Hyronsha (in Japanese).
- Ueda K. & Hay C. (2023). Empirical evaluation of CBDC in Cambodia. Paper presented at the NBER EASE conference in June 2023.

Ueda K. & Weder di Mauro B. (2013). Quantifying structural subsidy values for systemically important financial institutions. *Journal of Banking and Finance*, **37**, 3830-3842.

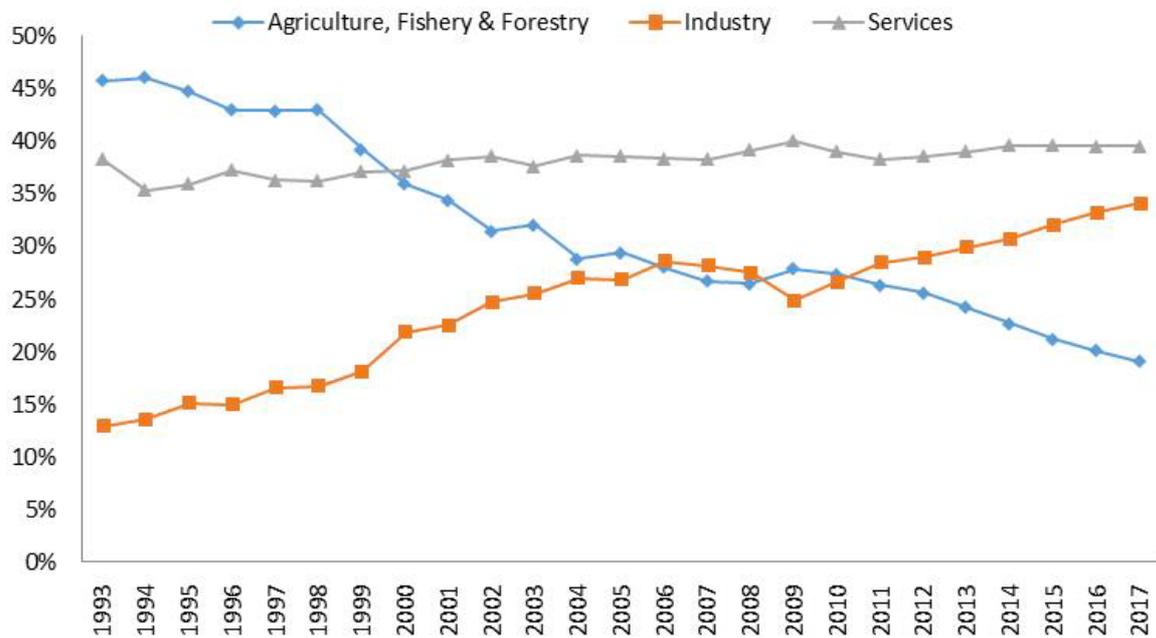
Yanagawa N. & Yamaoka H. (2019). Digital innovation, data revolution and central bank digital currency. BOJ Working Paper no. 19-E-2, Bank of Japan.

Figure 1 Cambodia's GDP per capita and real GDP growth rate



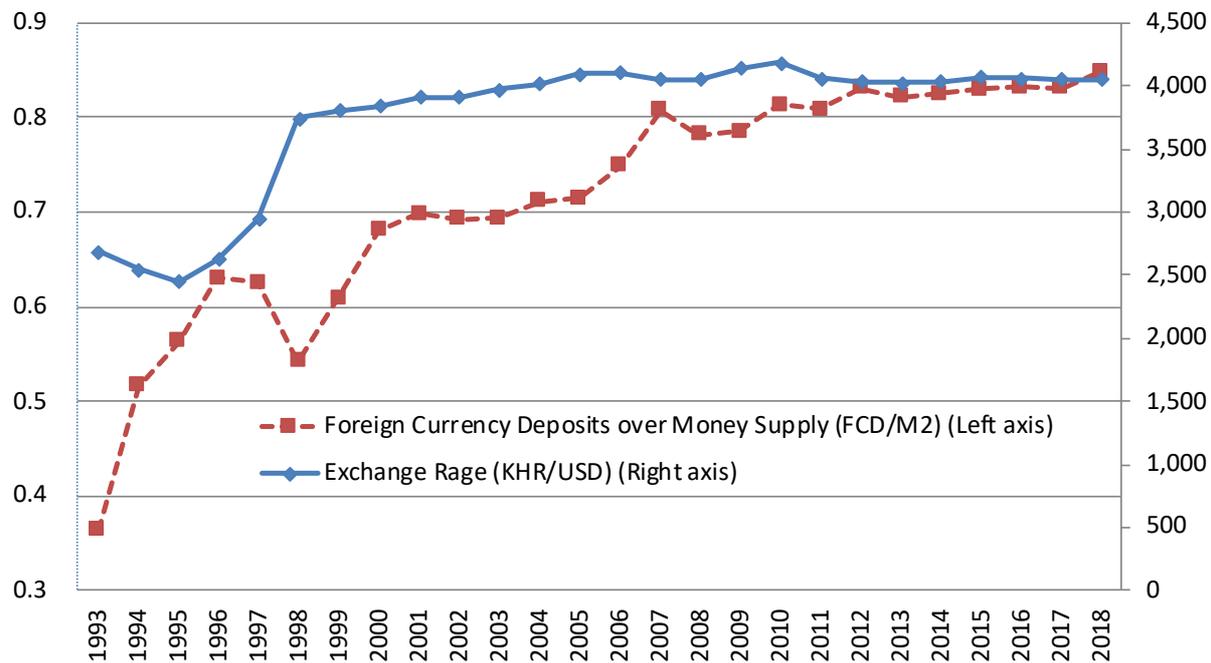
Source: Ministry of Economy and Finance, Cambodia

Figure 2 Industry Shares in GDP



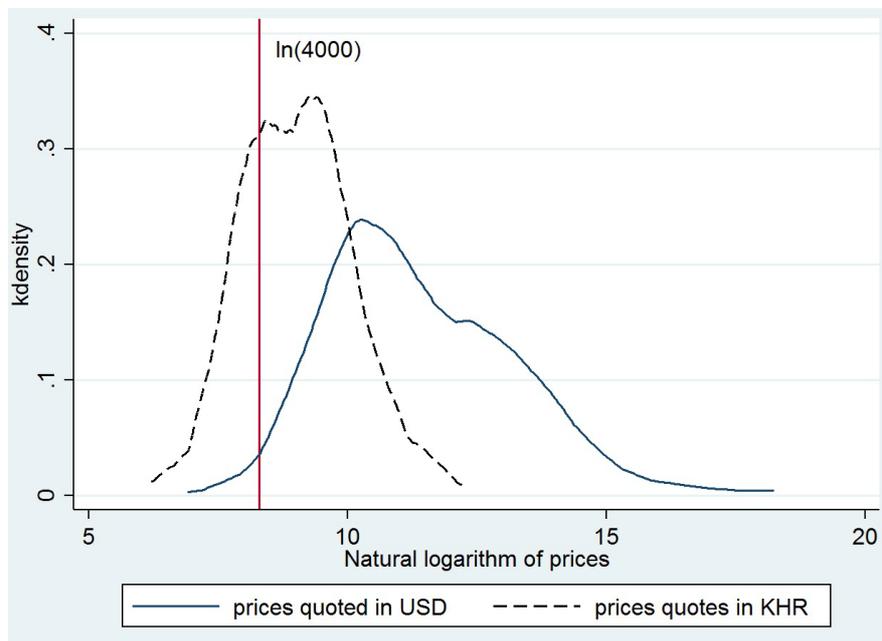
Source: Ministry of Economy and Finance, Cambodia

Figure 3. Dollarization and exchange rate



Source: The National Bank of Cambodia

Figure 4. Prices quoted in USD and KHR in shops in Phnom Penh



Source: Hay (2020).

Note: The vertical line shows 4000 KHR, which is about one USD.

Table 1 Definition of Variables

Name	Definition
<i>USD user</i>	<i>Dummy, defined "1", USD or Equally convenient; "0" Khmer Riel.</i>
<i>Digital Preference</i>	<i>Dummy, defined "1" if respondent prefer digital payment; "0" for cash or indifference.</i>
<i>Digital Experience</i>	<i>Dummy, defined "1" if purchasing goods and services, ever used digital payment; "0" otherwise.</i>
<i>Bakong</i>	<i>Dummy, defined "1" Bakong users any response for questions on currency preference; "0" otherwise.</i>
<i>Bakong USD user</i>	<i>Dummy, defined "1", Bakong users who prefer USD; "0" otherwise.</i>
<i>MTBakong</i>	<i>Dummy, defined "1" Bakong uses any response for questions on currency preference in money transfers; "0" otherwise.</i>
<i>MTBakongUSD</i>	<i>Dummy, defined "1" Bakong users for money transfer in USD; "0" otherwise.</i>
<i>Phnom Penh</i>	<i>Dummy, defined "1", if respondent identifies a place he/she stays as a "Phnom Penh" (used as a proxy for urban area identification); "0" - "Not in Phnom Penh" (rural).</i>
<i>Male/Female</i>	<i>Dummy, defined "1" for male and "0" for female.</i>
<i>Age</i>	<i>Actual value variable defines age of respondent. It ranges between 16-72.</i>
<i>Working</i>	<i>Dummy, defined "1", for all categories of respondents who has paid job, including: Paid employee or worker, Employer or Manager, Self-employed or business owner, Full time student with paid job, Farmer; "0" for all other categories.</i>
<i>Public Servant</i>	<i>Dummy, defined "1", Public Institutions; "0" otherwise.</i>
<i>Education</i>	<i>Dummy, defined "1", if respondent hold PhD, master or Bachelor Degree; "0" otherwise.</i>

Source: Survey on dollarization and digitalization in payments in Cambodia

Table 2 Statistical Summary of Variables

	Obs	Mean	Std. dev.	Min	Max
<i>USD user</i>	826	0.613	0.487	0	1
<i>Digital Preferences</i>	817	0.297	0.457	0	1
<i>Digital Experience</i>	813	0.592	0.492	0	1
<i>Bakong</i>	827	0.197	0.398	0	1
<i>Bakong USD user</i>	827	0.134	0.341	0	1
<i>MTBakong</i>	827	0.245	0.431	0	1
<i>MTBakongUSD</i>	827	0.186	0.390	0	1
<i>Phnom Penh</i>	827	0.819	0.386	0	1
<i>Male/Female</i>	826	0.414	0.493	0	1
<i>Age</i>	822	31.082	11.761	16	72
<i>Working</i>	825	0.728	0.445	0	1
<i>Public Servant</i>	827	0.104	0.305	0	1
<i>Education</i>	821	0.553	0.497	0	1

Source: Prepared by the authors, based on a survey on dollarization and digitalization in payments in Cambodia.