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The People's Republic of China's digital Yuan: Its environment, design, and implications

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ADBI Discussion Paper Series

**THE PEOPLE'S REPUBLIC OF CHINA'S
DIGITAL YUAN: ITS ENVIRONMENT,
DESIGN, AND IMPLICATIONS**

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and Peter J. Morgan

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Dedicated to James G. McGann, PhD
Who taught us to do good and great things

James G. McGann, PhD, was the founder and director of the Think Tanks and Civil Societies Program at the University of Pennsylvania. An internationally renowned scholar and leader within the think tank community, Dr. McGann was an unrelenting advocate for institutional cooperation and a firm believer in the capacity for think tanks to deliver impactful social change.

For decades, Dr. McGann personally mentored hundreds of students. He championed his students and nurtured their academic, professional, and personal growth. Respected by all, beloved by many, Dr. McGann will be remembered for his fervent determination, boisterous presence, and deep compassion. Thank you, Jim.

Abstract

The People's Republic of China (PRC) has rapidly achieved a relatively high degree of financial inclusion (access of individuals to financial products and services) as a result of the development of various large-scale financial platforms using financial technology (fintech) to reduce the cost of providing financial services. Most notable are the two companies Ant Group and Tencent, which started in digital payments but have branched out into other bank-like services, such as investment products and loans. At the same time, the People's Bank of China (PBC) has been developing a central bank digital currency (CBDC), specifically the digital yuan. The digital yuan has a link to the legacy yuan in value terms but could act for retail digital transactions in a centralized payment system. This paper examines the likely contributions of the digital yuan to financial inclusion and financial stability in the PRC and includes the following:

- A description of the current state of digital payments in the PRC, including the role of non-banking platforms, such as Ant Group's Alipay and Tencent's WeChat Pay, as well as that of commercial banks.
- A description of the current state of digital finance in the PRC.
- A description of the current state of financial inclusion in the PRC.
- A description of the PBC's digital yuan project, including the modalities available to retail users (individuals and firms), the mechanisms (such as bank intermediaries) that can make the digital yuan available to such users, and the settlement processes.
- An analysis of the expected contribution of the PBC's digital yuan to financial stability, taking into account the possible effects of the introduction of the digital yuan on the assets and liabilities of commercial banks and on private borrowing behavior as well as the possible impacts on non-bank firms, such as Ant Group and Tencent.
- An analysis of the expected contribution of the PBC's digital yuan to financial inclusion, taking into account the expected value contributions of the digital yuan to retail users beyond what they obtain from the current system.

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1. INTRODUCTION

The PBC has made pioneering progress nationally toward implementing the world's first digital currency: the e-CNY (digital yuan). Many authors on this subject believe that digital currencies will have revolutionary effects on financial systems around the world. Some of these speculations are reasonable, while others exaggerate the potential impacts of digital currencies. This paper will examine the PRC's forthcoming digital currency, the e-CNY, and discuss which of its potential effects authors have overestimated and which may profoundly alter financial institutions and inclusion. Accordingly, we will first offer an overview of digital payments and finance in the PRC as well as the current state of financial inclusion. Second, we will describe the history of the PRC's e-CNY project, the digital currency's design, and its potential implications for a variety of subjects.

When contextualizing the financial landscape of the PRC, we shall study the Ant Group–Tencent duopoly in mobile payments and digital finance. As we shall see, these two companies have and will continue to play a critical role in the development and implementation of the e-CNY. Besides their importance to the e-CNY, both companies are continuing to make substantial progress toward the goal of expanding financial inclusion in the PRC. When providing an overview of the current state of financial inclusion in the PRC, we shall place special emphasis on understanding which groups the current status quo most excludes.

Our discussion of the e-CNY will begin with a brief history of the project's development. Following this, we will describe the design of the e-CNY using a modified taxonomy that Di Lucido (2020) developed, which will allow us to understand the unique characteristics of the e-CNY relative to other digital currency projects around the world. After establishing an understanding of the future implementation of the e-CNY, we shall discuss its potential effects on financial and monetary frameworks, financial oversight and crime prevention, RMB internationalization, and financial inclusion.

It is the opinion of the authors that the design of the e-CNY intended it to have a minimal impact on the structural conditions of financial and monetary frameworks. However, we can expect marginal changes in the form of eliminating paper currency printing costs, enabling "smart contracts," and offering new monetary policy tools, such as an expirable/restricted stimulus. We warn of the risks relating to cybersecurity and the expansion of the Ant Group–Tencent duopoly.

Similarly, we expect that the implementation of the e-CNY will have little to no direct effect on the RMB's internationalization. In short, RMB internationalization is a complex subject involving a multitude of factors. For the PRC, RMB internationalization is most dependent on the relaxation of capital controls and other domestic financial regulations that currently limit the RMB's use in international transactions and, by extension, its viability as an international currency.

We suggest that the most substantial impact of the e-CNY may be on financial oversight and crime prevention. This will result from the e-CNY's design, which maintains a record of all transactions at the People's Bank of China and allows the PBC to monitor, trace, block, and revert all transactions. This capacity has the potential to make financial crimes, such as illicit transactions, tax evasion, and (perhaps most importantly) money laundering, far easier to prevent and prosecute. We conclude by describing the e-CNY's potential impact on financial inclusion.

2. FINANCIAL LANDSCAPE IN THE PRC

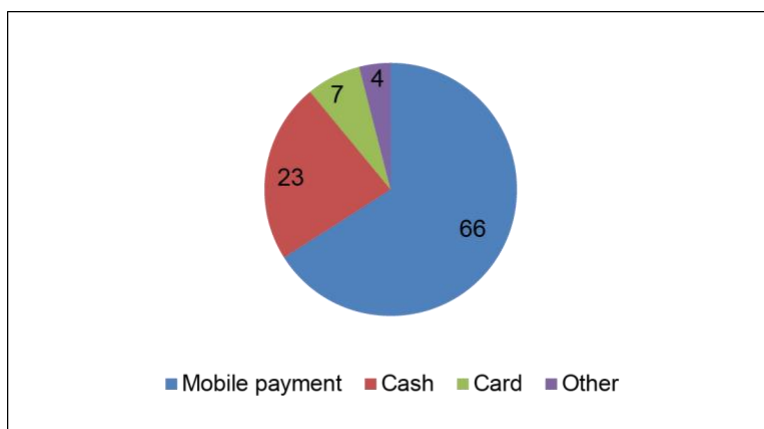
2.1 Digital Payments in the PRC

Intermediaries, such as bank accounts or mobile payment platforms, typically process payments between end-users. In this section, we first discuss digital payments through traditional platforms, then we move on to the mobile platforms of Alipay and WeChat Pay.

UnionPay, which the PBC State Council established in 2002, is by far the largest traditional payment system in the PRC (Asia Pacific n.d.). Functioning similarly to Western payment processors, such as Visa or Mastercard, UnionPay “formulates business protocols and technical standards for interbank bank card transactions. It operates the interbank bank card clearing system, and provides interbank bank card information exchange services” (Asian Banker 2015). According to *The Nilson Report*, UnionPay accounted for the second-highest number of purchase transactions on global general purpose card brands in 2020, with 151 billion transactions compared with the 188 billion of Visa (de Best 2021).

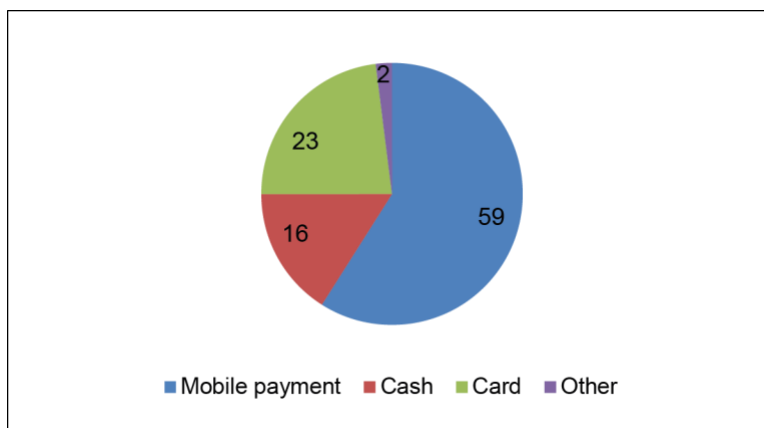
Although the PRC has a reliable payment system in UnionPay, third-party mobile payment platforms are extremely popular. A PBC survey in 2019 measured the number and value of transactions by payment type, and the results are as follows. With regard to the number of transactions, mobile payments accounted for 66%, beating cash and cards, which made up 23% and 7%, respectively. By value, mobile payments accounted for 59%, while cash and cards respectively made up 16% and 23% (see Figures 1 and 2). The same survey found that 46% of people had recently used no cash in any transaction (People’s Bank of China (PBC) 2021). “In 2019, with 851 million smartphone owners, 86% of the PRC’s population used mobile payments to make purchases ... According to data from the PBC, the amount of money that changed hands in the PRC via mobile payments grew from RMB 11.7 trillion (\$1.9 trillion) in 2013 to a staggering RMB 347.1 trillion (\$51.8 trillion) in 2019” (Center for Strategic & International Studies n.d.a) (see Figure 3).

Figure 1: Payment Type by Number of Transactions



Source: Data from the PBC (2021).

Figure 2: Payment Type by Value

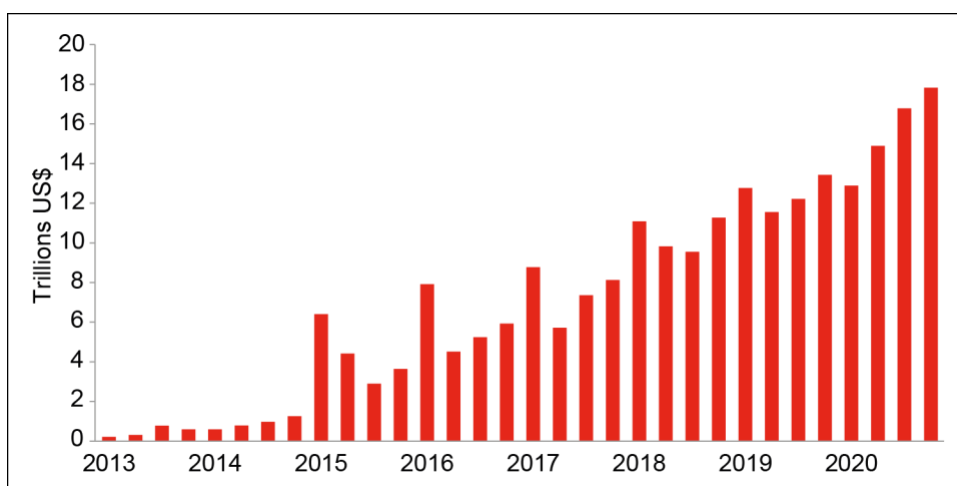


Source: Data from the PBC (2021).

Alipay remains the largest mobile payment platform in the PRC, with 55.6% of the sector’s market share as of Q2 2020 (Slotta 2021). It is the premier product of Ant Group, which is a subsidiary of the Alibaba Group. Users of Alipay can route transactions either between Alipay accounts or from Alipay accounts directly to recipients’ bank accounts.

Closely following Alipay, WeChat Pay holds 38.8% of the mobile payment market share (Slotta 2021). WeChat Pay is accessible through the PRC’s most popular messaging/social media app: WeChat. Tencent, which is one of the largest tech firms in the PRC, owns WeChat.

Figure 3: Value of Mobile Payments in the PRC



Source: CSIS (n.d.).

Together, Alipay and WeChat Pay handle a combined 94% of third-party mobile payments in the PRC (Jiang and Lucero 2021). There are reasons to believe that this duopoly poses serious risks to financial stability. One such risk is that any disruption to these companies’ digital payment infrastructure could cause short-term economic instability. Additionally, if there are large outflows from bank deposits to Alipay or WeChat Pay wallets, this could strain commercial banks’ liquidity, resulting in traditional credit shortages. Besides these practical issues, there is a concern that such extensive

access of these firms to citizens' transaction data gives them excessive power (Munroe and Fenton 2021). The PBC's forthcoming digital currency, the e-CNY, will centralize clearing mechanisms by delegating the PBC as the ultimate entity with the authority to monitor, trace, reverse, and block transactions. This will provide a backstop and reduce the autonomy of these two companies, hopefully also increasing financial stability, as the PBC will backlog any disruptions to these two companies' infrastructure resulting in compromised transactions (Jiang and Lucero 2021).

2.2 Digital Finance in the PRC

Digital finance means retail consumers' access to financial products and services—such as consumer credit, small- to medium-sized loans, and investment services—through digital platforms. They can use either computers or mobile devices to access such digital platforms. In addition to providing digital payment platforms, Ant Group and Tencent hold dominant positions in the PRC's digital finance sector. Due to both firms' near ubiquitous use, by offering financial services in addition to processing payments, they are capable of significantly expanding financial inclusion. However, it is important to note that both firms may substantially lose their footing in these forms of digital finance due to recent regulatory actions. For example, Ant Group Financial has received orders to release its Huabei and Jiebei services (which we will introduce next) into a separate app and corporate entity (Yu and McMorrow 2021).

Through the Alipay app, consumers were previously able to access consumer credit, small loans, and investment services (The Economist 2021). They could only use its consumer credit service, Huabei (花呗), which functions similarly to a credit card, for purchases on Alibaba platforms, such as Taobao (淘宝, the PRC's largest online retailer) and Ele.me (饿了么, a top food delivery platform). Huabei's consumer credit limit ranges from RMB500 to RMB50,000. A typical user's limit is around RMB10,000. Users' online purchasing history determines their credit limit, and users who have a history of making larger and more purchases receive higher limits.

Through the Alipay app, users can also access Jiebei (借呗), which offers small unsecured loans ranging from RMB1,000 to RMB300,000. All loans have a fixed daily interest rate of 0.045%. Users can borrow whenever they want and pay back their loan at any point within 12 months of issuance.

The Alipay app also hosts a "Fortune" feature, which offers various investment services. One such service is Alipay's own investment product, Yu'E Bao (余额宝, which translates as "leftover balance"). Yu'E Bao functions similarly to a checking account but offers far higher returns. In 2013, Yu'E Bao's annualized return was over 6%. Domestic savings accounts, by comparison, had annualized returns of less than 0.5% on average. Today, the rates remain nearly 4 percentage points higher than those of traditional bank accounts (Tin-yau 2017). Yu'E Bao also has a minimum deposit of only 1 yuan (Valentova 2015). These factors raised Yu'E Bao's assets under management to over 1.43 trillion yuan as of 2017, making it the PRC's largest money market. Its success came primarily from its ease of access, which brought a large segment of the PRC's previously unserved consumers into financial services (Tin-yau 2017).

The “Fortune” feature on Alipay also provides access to more traditional investment products. Overall, Alipay has consolidated an enormous number of financial services into one easy-to-use platform. Online payments, consumer credit, small loans, and investment services are all available through a single mobile application.

Tencent also offers numerous financial services. Through the WeChat Pay app, users can similarly access consumer credit services, small loans, and investment services. Its “Card Repay” service allows users to link multiple traditional credit cards to their WeChat account, and from there they may pay off their credit bills with their WeChat Pay balance with one click. WeChat will also notify users when their credit card payments are due.

WeChat Pay’s “Loans” feature allows users to take out small to medium-sized loans extremely quickly. Within 1 minute, users can receive a quote for their maximum loan. Within 3 minutes, the lender will deposit the loan in the user’s account. Users can pay back their loan at any time. Loans range from RMB500 to RMB200,000 and have a daily interest rate ranging between 0.02% and 0.05%.

Finally, WeChat Pay’s “Wealth” feature allows users to purchase various financial products that WeChat Pay’s wealth management arm or third-party firms have developed. One such product is WeChat’s own money market fund, LiCaitong, which it modeled on Alipay’s Yu’E Bao (GlobePay 2020).

The widespread use of Alipay and WeChat Pay, along with their ongoing expansion into financial services, makes both firms relevant to the goal of expanding financial inclusion in the PRC. However, both firms’ dominance in the digital payment space raises concerns that they may use their market power to raise transaction costs (Bank for International Settlements 2021). If both firms also expand their dominance into financial services, some worry that they could raise credit and investment fees as well.

2.3 Financial Inclusion in the PRC

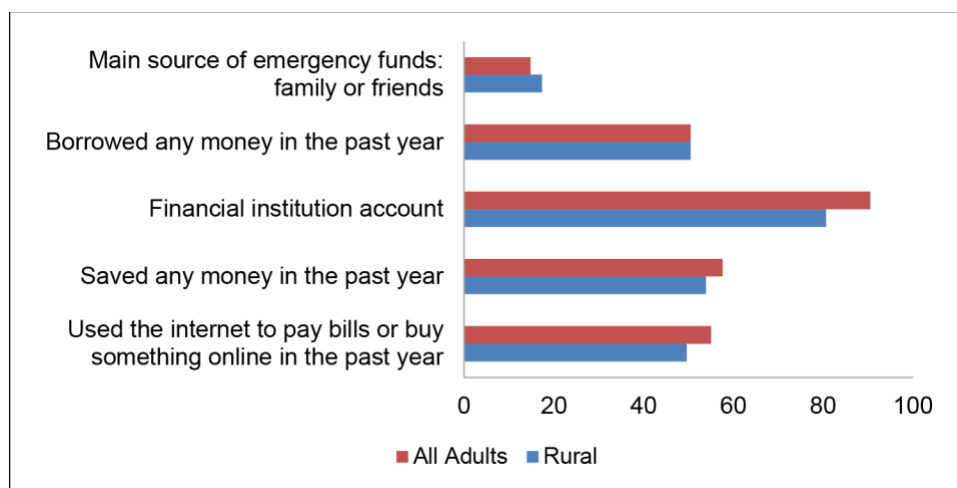
In 2017, more than 36% of respondents in the PRC stated that it would not be possible for them to come up with emergency funds (Demirgüç-Kunt et al. 2018). This example illustrates the importance of advancing financial inclusion, which the World Bank Institute defined as “individuals and businesses hav[ing] access to useful and affordable financial products and services that meet their needs—transactions, payments, savings, credit and insurance—delivered in a responsible and sustainable way,” in the PRC (World Bank n.d.). In this section, we will seek first to determine who currently lacks access to financial services and then attempt to explain why. We will reference data that the World Bank 2017 Global Findex Database published (Demirgüç-Kunt et al. 2018). For extensive tables containing the data that we will refer to throughout this section, please refer to the appendix.

We highlight six groups that we believe the current financial inclusion status quo excludes. In order of the severity of exclusion, they are rural communities, the uneducated, the impoverished, the unemployed, older generations, and women. It is important to note that many of these groups have significant intersections, so policy solutions targeting any of these groups are likely to affect others indirectly.

Rural communities consistently have the least access to financial services in the PRC. Around 200 million rural adults ($\approx 14.4\%$ of the PRC’s total adult population) were unbanked as of 2017 (Demirgüç-Kunt et al. 2018). At that time, 19.5% of unbanked respondents reported that they did not have a financial account because financial institutions were too far away, a problem that disproportionately affects rural communities (see Table 1). It is also important to note that being unbanked in the PRC

does not correlate with a lack of mobile phone ownership. In 2017, 82% of unbanked individuals in the PRC had a mobile phone. However, globally, only 25% of unbanked individuals had access to both a mobile phone and a stable internet connection—both of which are necessary to access Chinese digital payment platforms. Furthermore, in 2017, only 35% of rural respondents reported having used a mobile phone or the Internet to access an account. In sum, rural communities currently suffer from financial exclusion because of the significant distance between their communities and financial institutions, a lack of stable internet access, and compounding factors relating to education, wealth, and employment disparities, which we shall discuss next (Demirgüç-Kunt et al. 2018) (see Figure 4).

Figure 4: Rural vs. Total Financial Inclusion



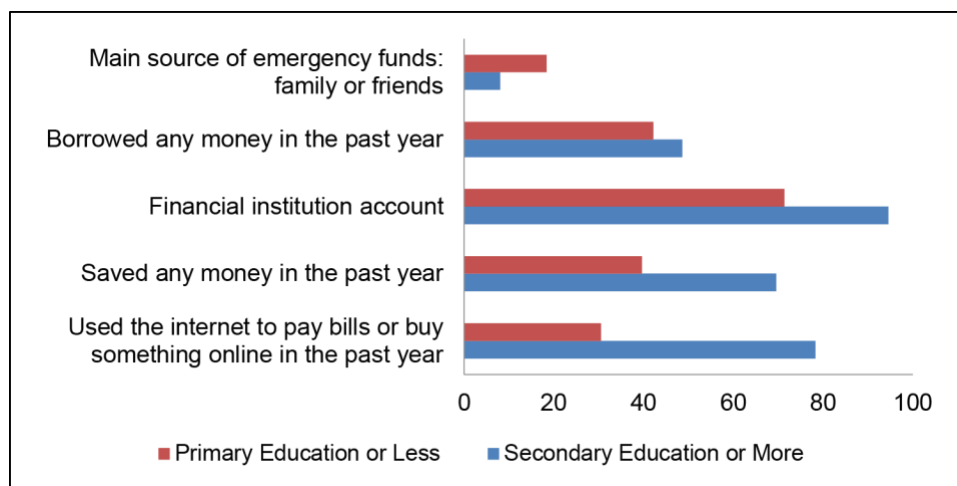
Source: Data from the World Bank 2017 Global Findex Survey (Demirgüç-Kunt et al. 2018).

The World Bank Findex data show that an individual’s education status is the greatest differentiating factor for a vast number of financial inclusion metrics. These disparities are most apparent in metrics that relate to financial technology. As just one example, 65% of respondents with a secondary education or more (whom we refer to henceforth as the educated sample) reported using a mobile phone or the Internet to access an account compared with just 24% of those with a primary education or less (whom we refer to henceforth as the less educated sample): a huge difference of 41 percentage points. There is also enormous inequality in terms of financial institution account ownership: 94% of educated sample respondents had a financial institution account, while only 71% of those from the less educated sample did, representing a difference of 23 percentage points. These disparities have concerning implications. For example, 69% of educated respondents reported saving money in the past year compared with 40% of the less educated, and 77% of educated respondents said that they could come up with emergency funds compared with only 45% of those with less education (see Figure 5).

Unsurprisingly, poorer individuals also have less access to financial products and services than wealthier individuals: 88% of the richest 60% had financial institution accounts compared with 79% of the poorer 40%. These disparities also apply to fintech use. As just one example, 75% of the wealthy sample had made digital payments in the previous year compared with only 40% of the poorer sample. While we expected many other metrics, which the appendix details, there is one more finding worthy of note. The poorer sample was 9 percentage points more likely to list family or friends as their main

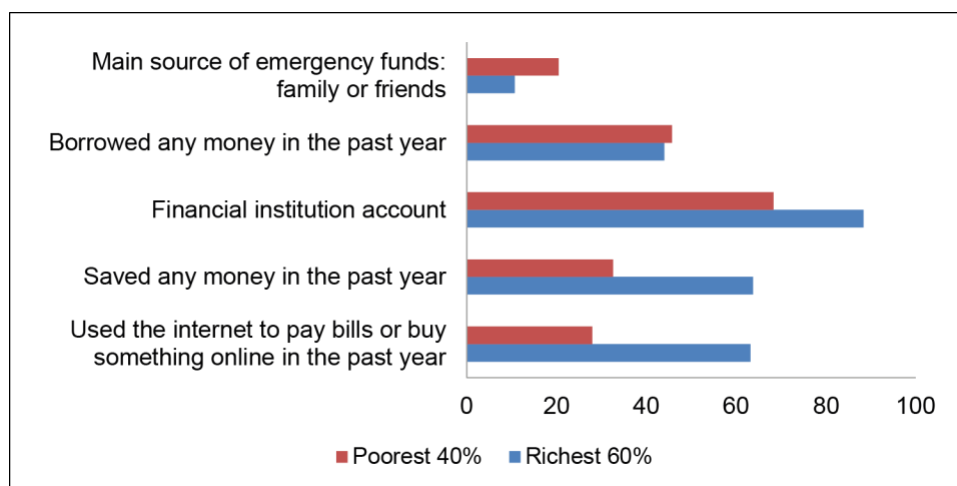
source of emergency funds and 16 percentage points more likely to have borrowed from family or friends in the past year. This is indicative that the poorest 40% of PRC citizens are likely to be credit constrained and would make use of financial services, such as consumer credit or small- to medium-sized loans, if they were more accessible (see Figure 6).

Figure 5: Education Level and Financial Inclusion (%)



Source: World Bank 2017 Global Findex (Demirgüç-Kunt et al. 2018).

Figure 6: Wealth Level and Financial Inclusion (%)



Source: Data from the World Bank 2017 Global Findex (Demirgüç-Kunt et al. 2018).

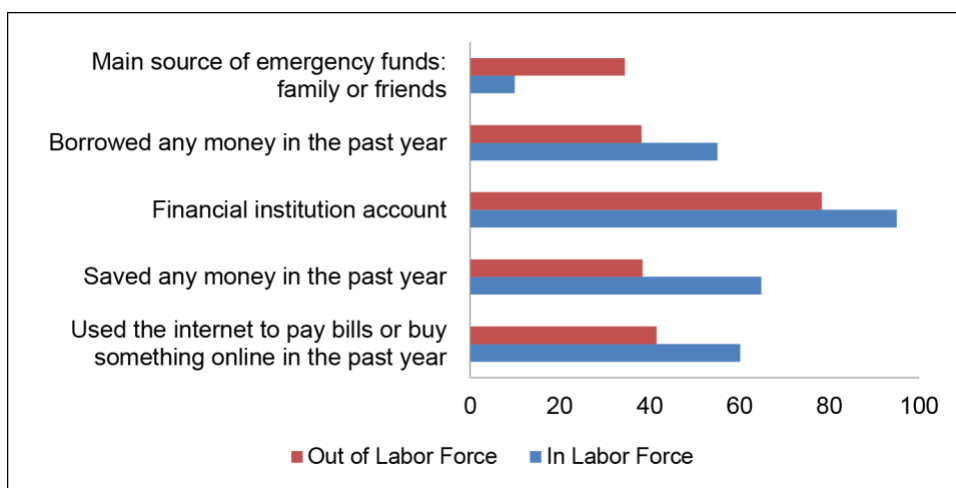
In 2017, 84% of those within the labor force had a financial institution account compared with 69% of those outside of it. The labor force metrics are very similar to those relating to wealth (see the appendix). Education, wealth, and labor force participation disparities are all likely to be complementary factors, which all relate to the most cited reason for individuals not having an account: 60% of respondents stated that they did not have an account because of insufficient funds (see Figure 7).

Age, on the other hand, significantly differed from our expectations. Surprisingly, 87% of respondents aged 15–24 had a financial institution account compared with 79% of those aged 25+. The younger demographic was also 13 percentage points more likely

to have saved for old age. Perhaps least surprising was that the rate of fintech adoption was much higher in the younger demographic. For example, 57% of the younger demographic used a mobile phone or the Internet to access an account compared with only 37% of the older demographic (see Figure 8).

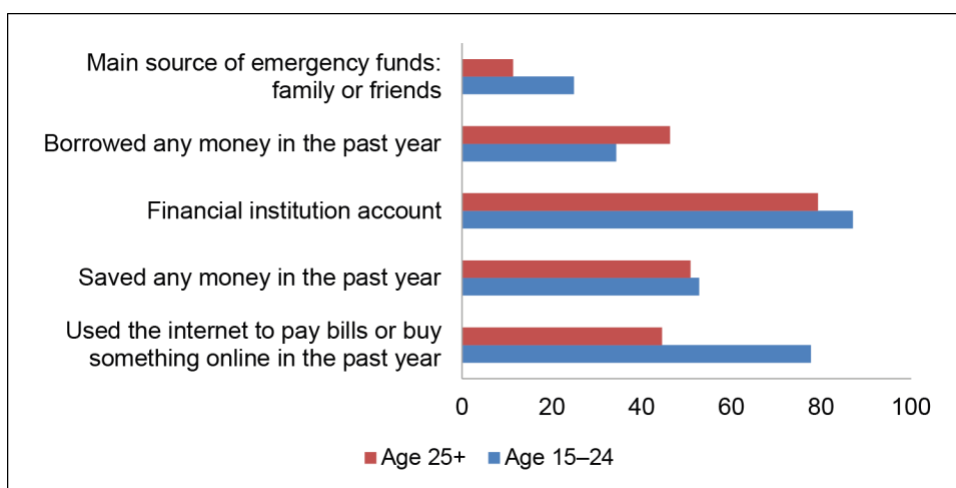
Finally, the PRC also faces a gender gap in account ownership. In 2017, 84% of men had a financial institution account while only 76% of women did. Men were also 5 percentage points more likely to have borrowed money and 10 percentage points more likely to have saved money in the past year. Women, on the other hand, were 5 percentage points more likely to state that they would not be able to come up with emergency funds. The conception that individuals (particularly women) do not need an account if someone in the family has an account are likely, at least in part, to drive these disparities, which 31% of respondents without an account cited as one of their reasons (Demirgüç-Kunt et al. 2018) (see Figure 9 and Table 1).

Figure 7: Labor Force Participation and Financial Inclusion (%)



Source: Data from the World Bank 2017 Global Findex (Demirgüç-Kunt et al. 2018).

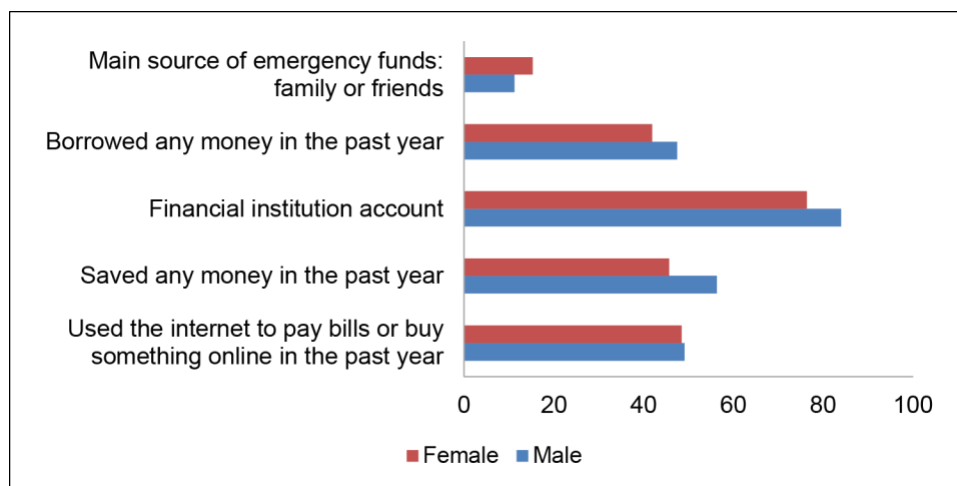
Figure 8: Age and Financial Inclusion (%)



Source: Data from the World Bank 2017 Global Findex (Demirgüç-Kunt et al. 2018).

As we can see, a lack of financial inclusion is a major issue in the PRC, disproportionately affecting some groups more than others. Rural communities are particularly lacking in financial inclusion. According to the China Internet Network Information Center, only 55.9% of people in the rural PRC used the Internet in December 2020 (Thomala 2021). The unequal access to internet and mobile technologies that rural communities face significantly limits the adoption of fintech and by extension the expansion of financial inclusion.

Figure 9: Gender and Financial Inclusion (%)



Source: World Bank 2017 Global Findex (Demirgüç-Kunt et al. 2018).

3. THE PBC’S E-CNY DIGITAL YUAN PROJECT

3.1 History of the e-CNY

According to the United States Federal Reserve, central bank digital currencies (CBDCs) are a digital form of a nation’s currency that uses an electronic record or digital token. CBDCs can either be wholesale, which only apply to inter-bank transactions, or retail, which individuals and firms can use as well (Board of Governors of the Federal Reserve System 2021a).

Table 1: Reasons for Not Having a Financial Account, Age 15+

Reasons for Not Having a Financial Account	%
No account because of insufficient funds	60.4
No account because someone in the family has an account	31.5
No account because financial institutions are too far away	19.5
No account because financial institutions are too expensive	12.6
No account because of a lack of necessary documentation	10.4
No account because of a lack of trust in financial institutions	7.8
No account because of no need for financial services ONLY	2.7
No account for religious reasons	2.4

Source: Data from the World Bank 2017 Global Findex (Demirgüç-Kunt et al. 2018).

The PBC has four main motivations for developing the e-CNY. First, the e-CNY aims to provide the public with a form of digital cash. Second, it intends to “support fair competition, efficiency and safety of retail payment services” (People’s Bank of China 2021). Third, the e-CNY will increase the efficiency of cross-border payments (State Council, People’s Republic of China n.d.). Fourth, it should have a positive impact on financial inclusion (People’s Bank of China 2021).

According to the PBC, the e-CNY is the digital version of the legacy yuan. Like the legacy yuan, it holds legal tender status (People’s Bank of China 2021). Yao Qian, former Vice Director-General of the PBC Technology Department, described the e-CNY as “a credit-based currency from a value dimension, an encrypted currency from a technical perspective, an algorithm-based currency when it comes to implementation, and a smart currency when it is applied in various scenarios” (Science China Press 2017).

The PRC’s research into central bank digital currencies (CBDCs) began in 2014 through the Digital Currency/Electronic Payment (DC/EP) project, which studied how it would issue and circulate a potential CBDC, how this CBDC would function both with domestic businesses and internationally, and what technologies would make up its infrastructure (Murphy and Yang 2020; People’s Bank of China 2021). In 2017, the PBC began to develop the e-CNY and established the Digital Currency Research Institute, with Yao Qian as its director (Jiang and Lucero 2021).

In 2018, Fan Yifei, deputy governor of the PBC, announced that it would centralize the e-CNY and adopt a two-tier distribution model. Its stated goal was to replace cash in circulation (Jiang and Lucero 2021). However, it is important to note that the PBC explicitly stated, “The PBC will issue e-CNY and physical RMB in parallel ... As long as there is demand for the physical RMB, the PBC will neither stop supplying it, nor replace it via administrative order” (People’s Bank of China 2021). In 2019, Mu Changchun, then deputy governor of the Payment and Settlement Department of the PBC, announced that commercial banks would need to hold the e-CNY at a 100% reserve ratio to prevent over-issuance following its first release. Mu also announced that the country would consider the e-CNY as unrestricted legal tender and that the e-CNY’s technological infrastructure would remain flexible such that it may adapt to new technologies and market needs (TuoniaoX 2019; Jiang and Lucero 2021). Yi Gang, the governor of the PBC, stated in 2019 that the e-CNY will replace a component of the PRC’s cash in circulation. However, this will not affect some areas of the nation’s money supply, such as bank deposits and private payment platforms.

In April 2020, the PBC began conducting pilot programs in Shenzhen, Suzhou, Chengdu, and Xiong’an. In November 2020, the pilot programs expanded to Shanghai, Hainan, Changsha, Xi’an, Qingdao, and Dalian. As of July 2021, pilots are ongoing across the Yangtze River Delta, the Pearl River Delta, the Beijing–Tianjin–Hebei region, and the PRC’s central, western, northeastern, and northwestern regions. China Daily has reported that “the pilot runs were designed to test the reliability of theories, the stability of systems, the usability of functions, the convenience of processes, the applicability of scenarios and the controllability of risk” (China Daily 2021; People’s Bank of China 2021). In Suzhou, civil servants installed a smartphone app that acted as a “digital wallet” prototype. This wallet received half the worker’s transport subsidy in the form of e-CNY, which they could then use directly for transactions at selected merchants or transfer directly into their bank account (Cheng 2020). In October 2020, the PBC gifted 10 million e-CNY (USD1.4 million) to 50,000 Shenzhen residents, who could spend it at over 3,300 businesses. After a week, they had spent 8.8 million e-CNY (USD1.3 million) in over 62,000 transactions. Again, a smartphone app processed these transactions. As of 30 June 2021, people had opened more than

20.87 million personal wallets and over 3.51 million corporate wallets. Over 70.75 million transactions have used the e-CNY, with a total value of more than RMB34.5 billion (China Daily 2021; People's Bank of China 2021).

In February 2021, MYBank (owned by Ant Group) and WeBank (owned by Tencent) announced that they would both begin participating in e-CNY trials and eventually work with the PBC and other (primarily state-owned) banks to distribute the e-CNY nationally. Soon after these announcements, Mybank's and WeBank's services became available through the PBC's digital yuan app (CNBC 2021). The PBC has since stated that it had studied dual offline payments on mobile devices and smartphone-free hardware wallets (China Daily 2021; People's Bank of China 2021). These announcements further underscore the importance of Ant Group and Tencent in the PRC's digital finance ecosystem as well as the continued willingness of those firms and the PBC to cooperate. In 2022, the e-CNY will undergo testing at the Beijing Winter Olympics, and many tests have already taken place in anticipation of the games. Such tests included unmanned vending carts, automatic vending machines, unattended supermarkets, and wearable clothing/accessories with payment functions. The PBC has stated that it has "no preset timetable for the final launch" (China Daily 2021; Jiang and Lucero 2021; People's Bank of China 2021). Based on the rapid acceleration of mobile payment use in the PRC, Chinese consumers are likely to adopt the e-CNY rapidly.

3.2 e-CNY Design

In terms of its readiness for national implementation, the PRC's e-CNY is one of the most developed CBDCs in the world. This section will give a brief taxonomy of CBDCs more generally to contextualize the design choices of the PBC. For a more detailed description of other nations' CBDCs, see Di Lucido (2020).

Di Lucido defined five design parameters of CBDCs as follows:

- **Access:** Whether there are restrictions on who may hold the CBDC or whether it is universal.
- **Anonymity:** Whether the CBDC gives the user total anonymity or quasi-anonymity or whether it is fully traceable. A quasi-anonymous CBDC allows anonymity relative to some but not all parties, such as transaction partners, intermediaries, or central banks.
- **Intermediation:** Direct systems allow the central bank to provide end-users with payment services. Synthetic systems have intermediaries to provide end-user services, but the CBDC has the backing of central bank reserves and the central bank handles wholesale payments between intermediaries. Hybrid systems give the end-users a direct claim on the central bank, but intermediaries provide the payment services.
- **Settlement:** Whether a centralized or a decentralized infrastructure records and settles transactions.
- **Remuneration:** Whether the CBDC is remunerative, that is, interest bearing, non-remunerative, or subject to tiered remuneration, such as interest based on the size of the holding.

We add the following categories:

- Validation: Whether the transaction processing takes place through the validity of a token, such as cash, or the validity of an account, such as a traditional bank or digital payment account.

The PRC's e-CNY fits into this taxonomy as follows, noting that our categorization differs from Di Lucindo's in that, while Di Lucindo described the e-CNY as fully traceable, we define it as quasi-anonymous:

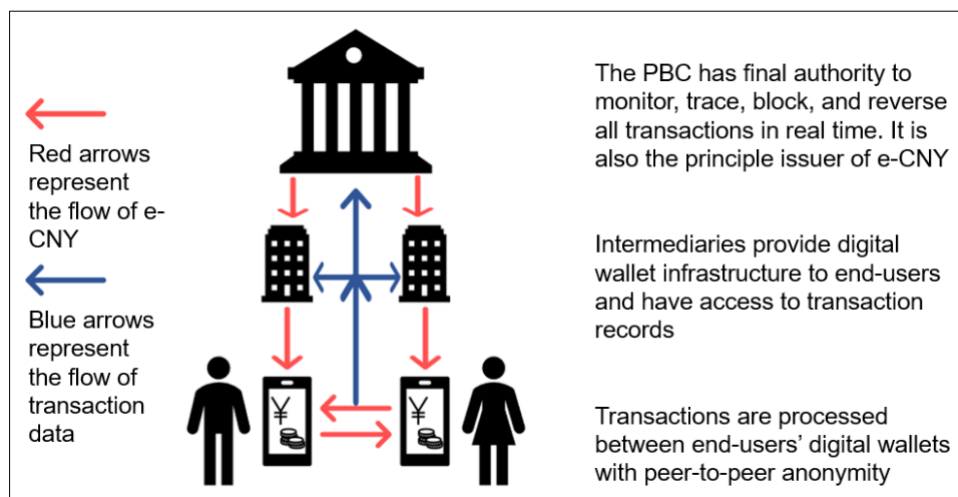
- Universal access: As of now, there is no indication that any restrictions will limit who may hold the e-CNY.
- Quasi-anonymous: While the e-CNY is fully traceable for intermediaries and the PBC, peer-to-peer (P2P) transactions are anonymous because transaction partners need to validate only the exchanged tokens rather than the accounts of their counterparts. It is also notable that the PBC has made a public commitment to data privacy: "e-CNY follows the principle of 'anonymity for small value and traceable for high value,' and attaches great importance to protecting personal information and privacy ... The e-CNY system collects less transaction information than traditional electronic payment and does not provide information to third parties or other government agencies unless stipulated otherwise in laws and regulations. Internally, the PBC sets up a firewall for e-CNY-related information, and strictly implements information security and privacy protocols, such as designating special personnel to manage information, separating e-CNY from other businesses, applying a tiered authorization system, putting in place checks and balances, and conducting internal audits. Any arbitrary information requests or use are prohibited" (People's Bank of China 2021).
- Hybrid intermediation: Intermediaries are responsible for issuing the e-CNY and maintaining end-users' digital wallets. Although the e-CNY functions as a direct claim on the PBC, end-users will primarily interact with intermediaries. However, as of now, intermediaries must hold 100% reserves at the PBC and the PBC is responsible for the final clearing of transactions. The PBC described this system as a "two-tier operation whereby the PBC is responsible for issuance and disposal, inter-institution connection and wallet ecosystem management ... Other commercial banks and institutions, under the PBC's centralized management, give full play to their creativity, and collectively provide services for e-CNY circulation. Specifically, under the quota management of the PBC, the authorized operators open different types of digital wallets for customers based on the strength of customer personal information identification, and provide e-CNY exchange services. In the meantime, to enable secure and effective operation, authorized operators and related commercial institutions jointly provide e-CNY circulation services and retail management, including innovation on payment product design, system development, scenario expansion, marketing, business processing as well as operation and maintenance ... On top of that, since the public is used to accessing financial services via commercial banks, the two-tier system can increase the public acceptance of e-CNY" (People's Bank of China 2021).
- Centralized settlement: The e-CNY operates on "centralized-permissioned Distributed Ledger Technology (DLT)," which the PBC maintains and which creates a record of and clears all transactions. The Bank of International Settlements described systems of this kind of technology as borrowing concepts from decentralized cryptocurrencies but allowing only a network of

vetted or allowed validators to provide validation (Bank for International Settlements (BIS) 2021). This means that the government has full access to transaction data and can cancel or revert transactions when it deems this to be appropriate.

- Non-remunerative: The e-CNY is non-interest bearing.
- Token validation: Transactions take place by exchanging tokens across “digital wallets.” However, it is important to note that, although transactions process tokens, digital wallets themselves have a link to an account that the PBC can identify (People’s Bank of China 2021).

As stated previously, the e-CNY will adopt a two-tier distribution system. From the top tier, the PBC will issue and redeem the e-CNY to commercial banks and other authorized entities, such as Ant Group and Tencent. From the second tier, these authorized entities will distribute the e-CNY to the general public (see Figure 10). One major difference between the e-CNY and more traditional currencies is that the PBC retains the sole authority to clear transactions, whereas, for more traditional fiat currencies, that role is the responsibility of “second-tier” entities. “This model avoids disintermediating the financial system by leaving user interactions to commercial banks or other entities, and it also reduces the responsibilities and risk exposure of the central bank” (Jiang and Lucero 2021).

Figure 10: e-CNY Transaction Flow Chart



Source: Authors.

The PBC has also released a large amount of details pertaining to digital wallets. First, different wallets have different associated “strengths,” which set per-transaction and daily limits on transaction values as well as a maximum balance. Customers may open wallets with the highest restrictions anonymously and then upgrade them later, once they have provided proper identification (People’s Bank of China 2021). Second, users can customize wallets to have functions specific to their needs. Third, digital wallets seem to have three key dimensions:

- Personal/corporate. Individuals can open personal wallets, and their personal information determines the wallets’ strength. Institutions can open corporate wallets (People’s Bank of China 2021).

- Software/hardware. Customers access software wallets through mobile payment apps, software development kits (SDKs), and application programming interfaces (APIs). They access hardware wallets through IC cards, mobile phones, wearable objects, and Internet of Things devices (People's Bank of China 2021).
- Parent/sub-wallets. It is possible to divide wallets into a main (parent) wallet and several sub-wallets. From there, sub-wallets can be subject to payment caps, payment conditions, personal privacy protection, and other functions. Corporate wallets in particular can make use of sub-wallets to pool and distribute funds (People's Bank of China 2021).

While private firms in the PRC may currently refuse to accept AliPay or WeChat Pay, because the country considers the e-CNY as legal tender, all private entities in the PRC have a legal obligation to accept it as payment. Transactions can occur between two e-CNY wallets using phones as a hardware intermediary. It is not necessary for these wallets to have an association with a bank account to make a transaction, and transactions can occur offline if the two phones are physically close to one another, whereas existing digital payment systems require an online connection. This creates “partial anonymity” wherein transactions take place between two wallets instead of passing through an online banking system. The exact details of how the PBC will receive offline transactions remain unclear. However, the PBC has stated that it will have access to all transaction data, so it will still be able to deactivate wallets and reverse transactions (Jiang and Lucero 2021).

Yao Qian described the framework that the PBC is adopting for the e-CNY as “One Coin, Two Repositories, Three Centers”. “One Coin” refers to the e-CNY currency itself, which is a token-based system. “Two Repositories” refers to the two-tiered structure—the PBC issues the e-CNY to authorized entities, which then distribute it to digital wallets. “Three Centers” refers to the data centers within the PBC that will perform the authentication, registration, and big data analysis. The authentication center performs authentication and management, and issues certificates of user identities. The registration center deals with issuance, transfer, and withdrawal of the e-CNY as well as the publication of registration information through distributed ledgers. The big data analysis center is responsible for the risk management of the entire system, know your customer (KYC), anti-money laundering (AML), and other risk control work (Jiang and Lucero 2021).

4. IMPLICATIONS

4.1 Implications for Financial and Monetary Policy

According to the PBC's 2020 Financial Stability Report, “The PBC has closely studied possible impacts of the DC/EP on the macroeconomy, monetary policy, financial growth and financial stability, to prevent any potential shocks to the existing monetary and financial systems and the transmission of monetary policy” (Financial Stability Analysis Group (FSAG) of the People's Bank of China 2021). This means that many of the most transformative design choices of CBDCs have faced restrictions to maintain financial stability. For example, the e-CNY is non-interest bearing by design, and its distribution takes place via a two-tier system, so the risk of disintermediating existing financial institutions is low. According to the same PBC report, “CBDCs bearing interests could affect monetary policy transmission [and may affect financial intermediation of banks], while the effects are minimal for non-interest bearing ones”

(FSAG of the People's Bank of China 2021). Furthermore, the choice to design the e-CNY as non-interest bearing means that the PBC cannot implement negative interest rates or other transformative monetary policy tools.

While the e-CNY's design aims not to disintermediate intermediaries, it will provide the PBC with the resources necessary to backstop intermediaries in the case of major disruptions. Specifically, it provides the PBC with the balances of intermediaries' clients, which would allow it to maintain the payment system in the case of any disruptions or failures (Bank for International Settlements 2021). This added element of financial security is beneficial for the financial system as a whole.

While the Financial Stability Analysis Group of the PBC has stated that "The full rollout of the DC/EP will provide a common digital monetary instrument across all major payment systems in the PRC for the first time, achieving interoperability between Alipay and WeChatPay and also between those systems and the bank-intermediated payment system" (Arner, Buckley, Zetsche, and Didenko 2020), the potential benefits of this are marginal at best. Under the current payment system, users can transfer funds from digital payment systems such as AliPay to other AliPay accounts or other bank accounts, and the same is true for WeChat Pay. The only interoperability that the e-CNY would enable is transactions between WeChat Pay and AliPay, since both platforms would be managing e-CNY digital wallets. However, the benefits of this are minute since it is already easy to deposit transfers between one digital platform and a bank account into another digital platform. Additionally, according to a survey that Rakuten Insight conducted in February 2020, 95.5% of respondents reported using WeChat Pay and 93.9% of respondents reported using AliPay (Ma 2020). This indicates that a large number of users already have both services, so interoperability would not be a major advantage.

That said, one way in which the e-CNY could substantially add value is by lowering the costs of printing paper money. Although the China Banknote Printing and Minting Corporation does not disclose its production costs, the Federal Reserve's 2021 currency operating budget was \$1,095.8 million (Board of Governors of the Federal Reserve 2021b; Jiang and Lucero 2021). By replacing physical cash, the e-CNY would free up 0.5% of the PRC's GDP (Center for Strategic & International Studies, China Power Project n.d.a). The PBC itself noted that the usage of cash is declining as well as expensive: "Every element in the cash cycle consumes much human, physical and financial resource. Such elements include banknote design, minting and printing, transportation, deposit and withdrawal, identification, processing, reflow, destruction, counterfeit prevention and etc." However, it is important to remember that the PBC has explicitly stated that it will continue to issue e-CNY and cash in parallel so long as there is a demand for physical cash (People's Bank of China 2021).

Another benefit is that e-CNY digital wallets will allow for the execution of "smart contracts": contracts that execute themselves digitally on the fulfillment of the terms of an agreement, without the need for human intervention (China Daily 2021; Jiang and Lucero 2021). The BIS 2021 Annual Economic Report described such agreements as: "An additional benefit of settlement in wholesale CBDCs is to allow for new forms of the conditionality of payments, requiring that a payment only settles on condition of delivery of another payment or delivery of an asset" (BIS 2021).

The e-CNY may also provide the PBC with a new monetary policy tool in the form of issuing stimulus currency that either expires or applies only to purchases of certain goods and services. This could give greater strength and flexibility to the PBC's monetary policy tools. However, given the PBC's decision to make the e-CNY non-remunerative and its general prioritization of financial stability over innovative

forms of financial and monetary policy, there is reason to believe that it will choose not to utilize such potentially disruptive tools.

The potential risks of the e-CNY include that, if it further consolidates and expands the Ant Group–Tencent duopoly as a result of its increased reliance on mobile payment systems, it could result in an increased drain of funds from the traditional commercial banking sector. Additionally, it may be a challenge to reform regulations to accommodate the new technological and structural changes that the e-CNY will produce. Finally, design failures in the e-CNY could create unexpected information security risks (Allen et al. 2020). For example, advances in quantum computing pose serious decryption risks for the critical payment infrastructure (Denning 2019).

4.2 Implications for Financial Oversight and Crime Prevention

The most important effect that the e-CNY will have for commerce in the PRC relates to the PBC's oversight and control of financial transactions. If the e-CNY were to replace cash in the PRC, then the PBC would have the capability to monitor, trace, block, and revert transactions that were previously invisible. Such a capacity would make financial crimes, such as money laundering, tax evasion, financing terrorism, and the purchasing of illicit goods, far easier to identify and prosecute.

These illegal transactions are major issues for the PRC. For example, Yu argued that capital flight is a popular means for financial criminals to avoid prosecution and prevent the repatriation of embezzled or stolen assets. Additionally, Yu insisted that "Legal or not, capital flight drains government coffers and can even trigger financial or currency crises" (Yu 2021). The increased surveillance capacity of the e-CNY could significantly hamper capital flight.

Tax evasion also remains one of the most pressing challenges draining the central government's coffers. Due to widespread tax evasion, only 8% of the PRC's total tax revenue came from personal income tax in 2017. By contrast, personal income tax made up (on average) 24% of OECD nations' total tax revenue. Officials within the Finance Ministry have estimated that only 28 million people (2% of the population) paid income taxes in 2017 out of the 187 million people who should have done so (The Economist 2018). This issue alone provides a compelling reason to innovate to prevent tax evasion. The e-CNY's increased surveillance capacity is likely to be an effective means of curtailing tax evasion.

The e-CNY could also aid the central government in fighting local corruption. Within the current framework, to issue subsidies or benefits to local populations, the central government must operate through several layers of middlemen, all of whom could potentially embezzle a portion of the subsidy. The e-CNY would provide the central government with a clear record of transactions, which would make identifying theft far easier.

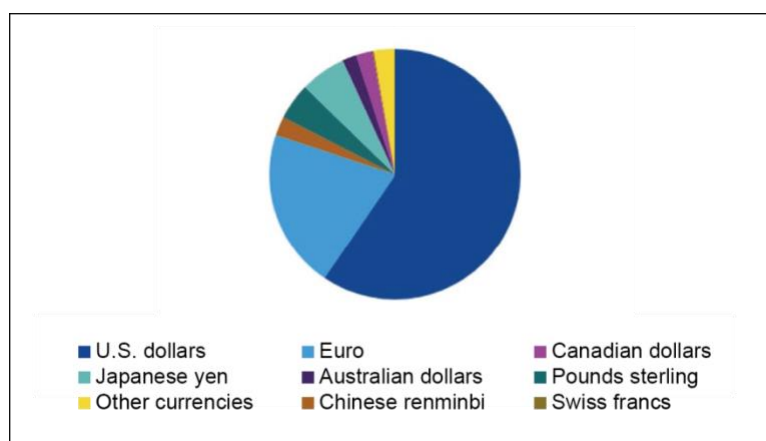
While this has caused some alarm among data privacy activists, the PBC has stated that "The design of China's digital RMB can realize 'controllable anonymous' payment at the current stage. It means, if transactions are not very frequent or the amount is not large, the monetary authorities do not need to intervene to verify or examine the transactions, said Li [Lihui, former president of Bank of China and head of the blockchain research working group at the National Internet Finance Association of China]" (China Daily 2021).

4.3 Implications for RMB Internationalization

RMB internationalization is another long-term goal of the PRC, and there has been speculation that the e-CNY will be another contributing factor to that goal’s realization. However, the e-CNY is likely to have a minimal impact on RMB internationalization. The internationalization of a currency is dependent on a multitude of factors, such as Forex trading, Forex reserves, and the share of cross-border payments and capital flows. The PRC has made substantial progress with respect to some of these metrics already: the RMB reserves are now the fifth largest in the International Monetary Fund’s Currency Composition of Official Foreign Exchange Reserves (COFER) at 2.45%, and the market share of the RMB in Forex trading is 4.3% (International Monetary Fund 2021). That said, the RMB still falls behind many smaller nations in terms of its international use.

In 2019, only \$285 billion worth of RMB traded daily on Forex markets compared with \$5.8 trillion USD. This difference is totally disproportionate to the PRC’s role in the global economy. Since 2001, despite the PRC’s trade in goods increasing by a factor of 9, making it the world’s largest single trader, the use of the RMB in Forex trades has only expanded from nearly 0% to 4.3% of all trades. It remains the eighth most traded currency, falling behind the Japanese yen, British pound, and Australian dollar, all of which have total trade values that range from less than a third to nearly a tenth of the Chinese total trade value (Center for Strategic and International Studies, China Power Project n.d.b).

Figure 11: Allocation of Global Forex Reserves by Currency for 2021Q1



Source: IMF (2021).

The RMB’s use in Forex reserves is even more disproportionate than its use in trading. The RMB only makes up 2% of the global Forex reserves compared with the euro’s 20% and the US dollar’s 60% (Figure 11). In regard to international payments, “according to the Society for Worldwide Interbank Financial Telecommunication (SWIFT), the world’s largest international electronic payment system, the renminbi was only used in about 1.9 percent of all international payments in July 2020. By comparison, the US dollar and the euro were used in 38.8 percent and 36.5 percent of transactions, respectively” (Center for Strategic and International Studies, China Power Project n.d.a). In 2019, only \$285 billion worth of RMB traded daily on Forex markets compared with \$5.8 trillion USD (Figure 12).

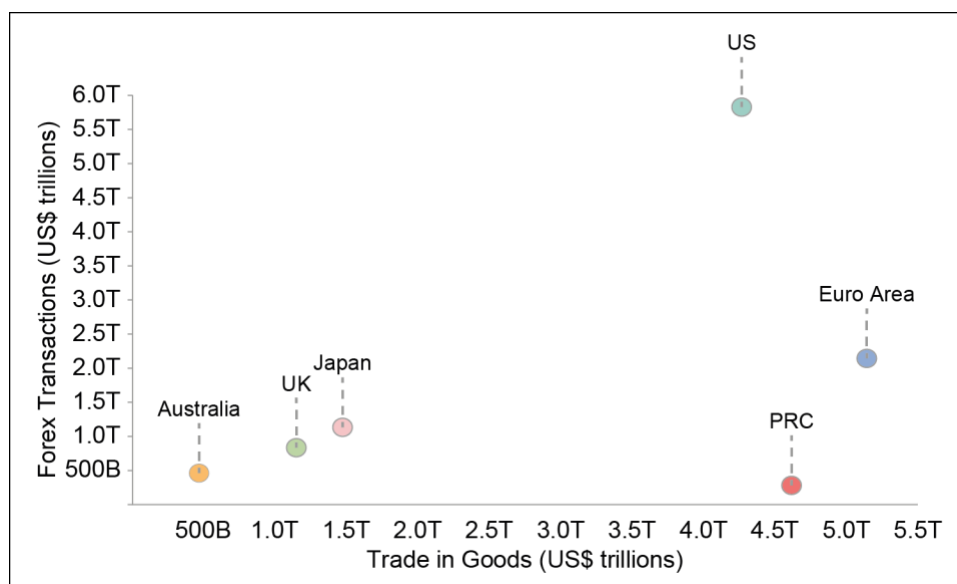
RMB internationalization is a priority for the PRC for numerous reasons. The PRC would receive many benefits from successfully internationalizing its currency, such as lowering international borrowing costs, reducing exchange rate risks, and decreasing the dominance of the dollar and other internationalized currencies in the global economy. The PRC and various other nations, including those in the European Union, have argued that the US dollar has “exorbitant privilege,” which poses a risk to global economic stability and allows the US to exert disproportionate influence over other nations through unilateral sanctions and other methods (Center for Strategic and International Studies, China Power Project n.d.b).

A joint book project of the Asian Development Bank Institute and the Brookings Institution Press argued “that the international community—especially the Asia region—has an interest in a smooth and successful internationalization of the Renminbi.” Among other reasons, the book’s authors insisted that the 2008 global financial crisis is evidence that overreliance on the dollar poses a risk to international economic stability. However, the authors also recognized that, unless the PRC implements more market liberalization and less restrictive capital controls, it is unlikely that the renminbi’s internationalization will be successful (Eichengreen and Kawai 2015).

By far the most compelling reason to believe that the development of the e-CNY will not dramatically affect the RMB’s internationalization is that senior officials from the PBC have explicitly stated that its design did not intend this. “Zhou Xiaochuan, former governor of the PBC, said in his keynote speech at the Tsinghua PBCSF Global Finance Forum in Beijing that the intention of designing the PRC’s central bank digital currency was never to replace the US dollar’s dominant position as the world’s reserve currency as well as the preferred mode for payments” (China Daily 2021).

While some have argued that the e-CNY would make it easier for the PRC and other nations to avoid US and other international sanctions, international clearing structures rather than the design of underlying currencies influence international transactions and trade more heavily. Currently, most cross-border transactions’ processing takes place through the dollar-dominated SWIFT system. The PRC established its own alternative system, the Cross-border Interbank Payment System (CIPS), in 2015. Since its release, the CIPS has achieved moderate success by processing transactions between the PRC and the Belt & Road Initiative (BRI) nations. In 2018, it processed RMB26 trillion worth of payments (IMF 2021). If the CIPS’s adoption as a major international payment system is successful, it would be a major advancement toward the goal of disintermediating the United States in international transactions. It is feasible that the PRC may spur the adoption of the CIPS by implementing the e-CNY, for example by helping other nations to develop their own CBDCs, which are interoperable with the e-CNY, providing foreign aid in the form of e-CNY, or insisting on the use of the e-CNY in BRI projects. However, PBC officials have not announced these additional policies and they are not intrinsic implications of e-CNY development.

Although there are reasons to be skeptical, one potential benefit of the e-CNY for RMB internationalization is, according to the PBC, that “Wholesale CBDCs have advantages in improving large-value payment settlements, increasing efficiency and safety of cross-border payments and lowering costs, and could be used to facilitate international trade and financial transactions” (F.S.A.G. of the People’s Bank of China 2021).

Figure 12: Forex Transactions by National Trade in Goods

Source: Center for Strategic and International Studies, China Power Project (n.d.b).

The Bank for International Settlements (BIS), in its 2021 Annual Economic Report, also set out a framework that utilizes CBDCs for the purpose of improving cross-border payments. According to the BIS, multi-CBDC (mCBDC) arrangements, which join up CBDCs across borders and that feature a jointly operated payment system hosting multiple CBDCs, offer the greatest potential for improving cross-border payments. Preliminary mCBDC research projects are already underway, such as the “mCBDC Bridge” project of the BIS Innovation Hub and its partner central banks in the PRC; Hong Kong, China; Thailand; and the United Arab Emirates (BIS 2021). If the PRC is able to develop such an mCBDC network, it could substantially change the current international payment system and raise the e-CNY to international prominence.

However, there are also reasons to believe that the increased control that the PBC would have over capital flows in e-CNY may actually disincentivize the international use of the e-CNY rather than encouraging it. For instance, if the PBC has the capacity to issue expirable e-CNY and block/revert transactions, foreign parties will need sufficient assurance that the e-CNY which they receive would be a stable store of value and means of exchange.

Besides issues relating to CBDCs, by far the greatest limitation on RMB internationalization stems from Beijing’s tight capital controls, which inhibit the free movement of the RMB and thus make it less attractive as an international currency (Center for Strategic and International Studies, China Power Project n.d.b). The Chinn–Ito Index documents the PRC’s restrictive capital controls, quantifying and ranking nations’ “capital account openness,” and it ranked the PRC 105th, tied with 60 other nations, in 2018. By contrast, the nations with the most internationalized currencies—Australia, Japan, the United Kingdom, the United States, and 14 of the 19 nations that use the euro—all tied for first place (Chinn and Ito 2006).

While loosening capital controls would enable RMB internationalization, such policies also come with significant costs, the largest of which is the risk of capital flight, which has long been one of the PRC’s greatest financial challenges.

4.4 Implications for Financial Inclusion

Advancing financial inclusion through digital finance has been a long-term goal of the PBC, rightfully so given that nearly 20% of Chinese adults did not have a financial institution account in 2017 (Center for Strategic and International Studies, China Power Project n.d.a). In 2018, Deputy Governor Chen Yulu spoke at the Conference on Innovative Development of Digital Financial Inclusion and announced, “Focused on inclusive growth, poverty alleviation and country development, efforts have been made to establish a model of ‘One Platform Four Systems’ in pursuit of three goals, i.e. every village having access to digital financial inclusion services, every household having access to financial inclusion loans, and every individual having access to digital financial inclusion services” (People’s Bank of China 2018). While there is significant speculation that the e-CNY could increase financial inclusion, there are many reasons to be skeptical.

Some researchers have argued that the e-CNY will increase financial inclusion by accelerating the development of digital payments and finance, which would increase financial accessibility for anyone with a smartphone and stable internet access. However, given that 86% of smartphone users in the PRC already use mobile payment platforms, it is unclear how a shift to the e-CNY will accelerate the adoption of digital fintech unless a mandatory shift away from the legacy RMB accompanies it (there has been no indication that the country will quickly remove the legacy RMB from circulation if and when it distributes the e-CNY nationally).

The PRC’s rural population is most in need of expanded financial inclusion; however, much of this population does not have a bank account or stable internet access. It is unclear how the e-CNY will address these issues. Institutional and legal changes may prove to be more effective at expanding financial inclusion than other measures.

Nevertheless, there are ways in which the PRC’s e-CNY could advance financial inclusion. The PBC claimed that “An e-CNY system will make financial services more accessible, providing fiat money for a large population in various scenarios. Those without bank accounts can enjoy basic financial services provided via e-CNY wallet, and foreign residents temporarily travelling in the PRC can open an e-CNY wallet to meet daily payment needs without opening a domestic bank account” (People’s Bank of China 2021). Furthermore, if it is not necessary to link the e-CNY to a bank account, then it may imply that digital payment platforms such as AliPay and WeChat Pay may no longer need a connection to traditional bank accounts. This would enable these two platforms truly to expand access for unbanked individuals, and both platforms already boast an impressive range of additional financial services, such as consumer credit, small loans, and investment services. It is also worth noting that fully decoupling digital payment providers from the traditional banking sector poses significant potential financial stability risks by draining capital from traditional banks and further consolidating the Ant Group–Tencent duopoly (The Economist 2021). The e-CNY could also increase financial inclusion by allowing the PBC to issue subsidies directly to citizens rather than having to pass through intermediary channels. It could also provide the PBC with more real-time economic data, which would allow it to target poverty alleviation programs and government loan issuance more precisely.

5. CONCLUSION

The development of the e-CNY has spurred much speculation, both within the PRC and internationally. The purpose of this report is to provide a holistic description of the currency and its potential implications, with a particular emphasis on financial inclusion. Our primary conclusions are as follows.

With regard to the financial landscape of the PRC, AliPay and WeChat Pay provide valuable access to mobile payments, consumer credit, small- to medium-sized loans, and investment services/products, thus increasing financial inclusion. This is most important for rural residents, who constitute the group facing the most financial exclusion. Increasing access to stable internet services, enabling them to adopt accessible fintech, would best increase financial inclusion in the PRC.

There are several noteworthy components of the e-CNY's design. First, the e-CNY operates under a system of "controllable anonymity." This means that transactions between peers are anonymous and, according to the PBC, the e-CNY offers "anonymity for small value and traceable for high value" (People's Bank of China 2021) transactions. In other words, while the PBC retains the authority to monitor, block, and reverse transactions, such actions require explicit approval on a case-by-case basis. Second, the e-CNY adopts a two-tier intermediated system through which the PBC issues the e-CNY to commercial banks and similar institutions, which then provide circulation services and retail management (People's Bank of China 2021). Third, the e-CNY is stored in digital wallets, which themselves may have different characteristics. Each wallet may be personal/corporate, software/hardware, or a parent/sub-wallet.

As stated previously, the e-CNY will effect major changes with respect to some policy areas and have little impact on others. By far the greatest impact that the e-CNY will have is on preventing and prosecuting financial crimes, such as money laundering, tax evasion, and the purchasing of illicit goods and services. The e-CNY can also prevent corruption when issuing government benefits to local populations. The unprecedented access that the PBC will have over transactions in e-CNY will accomplish this.

By contrast, the e-CNY will have little to no impact on financial and monetary policy or RMB internationalization. However, the development of multi-CBDCs, which join up CBDCs across borders and feature a jointly operated payment system hosting multiple CBDCs, could spur RMB internationalization (BIS 2021). Finally, the e-CNY could enable financial inclusion by providing the PBC with the ability to issue subsidies directly as well as offering more extensive economic data, which could help to target poverty alleviation programs better. However, by far the best way of increasing financial inclusion remains providing universal internet access.

APPENDIX: FINANCIAL INCLUSION TABLES

Table A1: Financial Inclusion Indicators: Total and Rural

Metric	All Adults	Rural	Rural Diff
Made digital payments in the past year	60.87	56.30	4.57
Made or received digital payments in the past year	67.94	63.96	3.98
Received digital payments in the past year	36.21	33.16	3.05
Used a mobile phone or the internet to access an account	39.81	35.10	4.71
Used the internet to buy something online in the past year	45.28	41.00	4.27
Used the internet to pay bills in the past year	39.55	34.44	5.11
Used the internet to pay bills or buy something online in the past year	48.79	43.97	4.82
Financial institution Account	80.23	71.48	8.75
No account and no withdrawal from an account in the past year	12.03	13.10	-1.07
Borrowed any money in the past year	44.71	44.74	-0.03
Outstanding housing loan	12.41	11.72	0.70
Borrowed for education or school fees	4.92	5.73	-0.81
Borrowed for health or medical purposes	6.39	7.29	-0.89
Borrowed from a financial institution or used a credit card	22.71	19.74	2.97
Borrowed from a financial institution	8.61	8.88	-0.27
Borrowed from family or friends	28.33	31.30	-2.97
Borrowed to start, operate, or expand a farm or business	5.02	5.39	-0.38
Saved any money in the past year	51.06	47.78	3.28
Saved at a financial institution	34.78	31.99	2.79
Saved for old age	21.56	20.23	1.33
Saved to start, operate, or expand a farm or business	15.59	15.22	0.37
Coming up with emergency funds: not possible	36.72	41.31	-4.59
Main source of emergency funds: family or friends	13.08	15.38	-2.30
Main source of emergency funds: money from working	45.38	42.82	2.57
Main source of emergency funds: savings	38.97	38.97	0.00
Received a public sector pension in the past year	6.85	7.78	-0.93
Received government payments in the past year	17.22	18.75	-1.54
Received government transfers in the past year	12.23	13.63	-1.40
Received public sector wages in the past year	3.68	3.49	0.19

Source: Data from the World Bank 2017 Global Findex (Demirgüç-Kunt et al. 2018).

Table A2: Financial Inclusion Indicators: By Level of Education

Metric	Sec Education/+	Prim Education/-	Education Diff
Made digital payments in the past year	85.97	45.35	40.62
Made or received digital payments in the past year	88.73	55.13	33.61
Received digital payments in the past year	51.16	27.10	24.06
Used a mobile phone or the internet to access an account	65.39	23.92	41.47
Used the internet to buy something online in the past year	75.31	26.67	48.63
Used the internet to pay bills in the past year	68.29	21.74	46.55
Used the internet to pay bills or buy something online in the past year	78.34	30.50	47.84
Financial institution Account	94.61	71.38	23.23
No account and no withdrawal from an account in the past year	7.42	14.79	-7.37
Borrowed any money in the past year	48.62	42.19	6.42
Outstanding housing loan	15.37	10.62	4.75
Borrowed for education or school fees	4.11	5.40	-1.29
Borrowed for health or medical purposes	3.65	8.09	-4.44
Borrowed from a financial institution or used a credit card	36.36	14.17	22.19
Borrowed from a financial institution	10.37	7.54	2.83
Borrowed from family or friends	20.65	33.10	-12.46
Borrowed to start, operate, or expand a farm or business	5.14	5.02	0.12
Saved any money in the past year	69.55	39.66	29.89
Saved at a financial institution	50.99	24.81	26.19
Saved for old age	27.79	17.65	10.14
Saved to start, operate, or expand a farm or business	23.13	10.94	12.19
Coming up with emergency funds: not possible	17.54	48.64	-31.11
Main source of emergency funds: family or friends	8.08	18.38	-10.30
Main source of emergency funds: money from working	52.25	38.09	14.16
Main source of emergency funds: savings	38.29	39.74	-1.45
Received a public sector pension in the past year	6.44	7.16	-0.72
Received government payments in the past year	16.04	18.05	-2.02
Received government transfers in the past year	8.97	14.33	-5.37
Received public sector wages in the past year	6.56	1.91	4.66

Source: Data from the World Bank 2017 Global Findex (Demirgüç-Kunt et al. 2018). "Sec. Education/+" is short for "secondary education or greater". "Prim. Education/-" is short for "primary education or less."

Table A3: Financial Inclusion Indicators: By Level of Wealth

Metric	Richest 60%	Poorest 40%	Wealth Diff
Made digital payments in the past year	75.06	40.30	34.75
Made or received digital payments in the past year	79.57	51.07	28.50
Received digital payments in the past year	43.72	25.32	18.40
Used a mobile phone or the internet to access an account	53.61	19.79	33.82
Used the internet to buy something online in the past year	58.97	25.42	33.55
Used the internet to pay bills in the past year	52.52	20.73	31.79
Used the internet to pay bills or buy something online in the past year	63.17	27.93	35.25
Financial institution Account	88.42	68.35	20.07
No account and no withdrawal from an account in the past year	9.08	16.31	-7.23
Borrowed any money in the past year	44.00	45.74	-1.74
Outstanding housing loan	14.34	9.62	4.71
Borrowed for education or school fees	3.09	7.75	-4.66
Borrowed for health or medical purposes	3.88	10.04	-6.15
Borrowed from a financial institution or used a credit card	29.88	12.31	17.57
Borrowed from a financial institution	9.88	6.77	3.11
Borrowed from family or friends	21.64	38.04	-16.40
Borrowed to start, operate, or expand a farm or business	5.32	4.67	0.65
Saved any money in the past year	63.79	32.61	31.18
Saved at a financial institution	46.41	17.93	28.48
Saved for old age	26.34	14.62	11.72
Saved to start, operate, or expand a farm or business	20.34	8.69	11.65
Coming up with emergency funds: not possible	21.26	59.15	-37.89
Main source of emergency funds: family or friends	10.71	20.45	-9.74
Main source of emergency funds: money from working	49.35	33.08	16.27
Main source of emergency funds: savings	38.28	41.09	-2.81
Received a public sector pension in the past year	5.89	8.26	-2.37
Received government payments in the past year	14.83	20.68	-5.86
Received government transfers in the past year	9.54	16.13	-6.59
Received public sector wages in the past year	4.44	2.57	1.87

Source: Data from the World Bank 2017 Global Findex (Demirgüç-Kunt et al. 2018).

Table A4: Financial Inclusion Indicators: By Labor Force Status

Metric	In Labor Force	Out Labor Force	Labor Diff
Made digital payments in the past year	66.38	46.31	20.07
Made or received digital payments in the past year	73.45	53.37	20.08
Received digital payments in the past year	42.35	19.99	22.36
Used a mobile phone or the internet to access an account	45.49	24.78	20.71
Used the internet to buy something online in the past year	49.53	34.05	15.47
Used the internet to pay bills in the past year	43.83	28.23	15.60
Used the internet to pay bills or buy something online in the past year	53.32	36.80	16.53
Financial institution Account	84.29	69.49	14.80
No account and no withdrawal from an account in the past year	11.16	14.34	-3.18
Borrowed any money in the past year	48.82	33.84	14.99
Outstanding housing loan	15.01	5.55	9.47
Borrowed for education or school fees	5.82	2.04	3.78
Borrowed for health or medical purposes	6.58	5.91	0.67
Borrowed from a financial institution or used a credit card	26.96	11.48	15.47
Borrowed from a financial institution	10.35	4.00	6.35
Borrowed from family or friends	29.47	25.31	4.16
Borrowed to start, operate, or expand a farm or business	6.53	1.15	5.38
Saved any money in the past year	57.51	34.00	23.51
Saved at a financial institution	39.79	21.54	18.25
Saved for old age	23.94	15.28	8.66
Saved to start, operate, or expand a farm or business	18.74	7.25	11.49
Coming up with emergency funds: not possible	31.35	50.92	-19.57
Main source of emergency funds: family or friends	8.80	30.57	-21.77
Main source of emergency funds: money from working	50.98	22.52	28.46
Main source of emergency funds: savings	37.80	43.75	-5.95
Received a public sector pension in the past year	7.22	5.89	1.32
Received government payments in the past year	17.89	15.43	2.46
Received government transfers in the past year	11.80	13.36	-1.56
Received public sector wages in the past year	4.78	0.77	4.01

Source: Data from the World Bank 2017 Global Findex (Demirgüç-Kunt et al. 2018).

Table A5: Financial Inclusion Indicators: By Age Group

Metric	Age 15-24	Age 25+	Age Diff
Made digital payments in the past year	80.18	58.00	22.19
Made or received digital payments in the past year	81.43	65.95	15.47
Received digital payments in the past year	33.15	36.69	-3.54
Used a mobile phone or the internet to access an account	57.56	37.16	20.39
Used the internet to buy something online in the past year	74.21	40.97	33.24
Used the internet to pay bills in the past year	63.74	35.98	27.76
Used the internet to pay bills or buy something online in the past year	77.67	44.48	33.19
Financial institution Account	87.02	79.26	7.75
No account and no withdrawal from an account in the past year	10.28	12.26	-1.98
Borrowed any money in the past year	34.29	46.28	-11.99
Outstanding housing loan	2.79	13.85	-11.06
Borrowed for education or school fees	6.70	4.62	2.08
Borrowed for health or medical purposes	2.32	7.01	-4.69
Borrowed from a financial institution or used a credit card	18.85	23.27	-4.42
Borrowed from a financial institution	4.98	9.17	-4.19
Borrowed from family or friends	19.88	29.63	-9.75
Borrowed to start, operate, or expand a farm or business	3.77	5.25	-1.49
Saved any money in the past year	52.78	50.85	1.94
Saved at a financial institution	35.34	34.71	0.63
Saved for old age	23.32	9.92	13.40
Saved to start, operate, or expand a farm or business	15.83	15.56	0.28
Coming up with emergency funds: not possible	35.59	36.84	-1.25
Main source of emergency funds: family or friends	24.88	11.34	13.54
Main source of emergency funds: money from working	39.21	46.31	-7.10
Main source of emergency funds: savings	33.48	39.80	-6.31
Received a public sector pension in the past year	4.53	7.19	-2.66
Received government payments in the past year	12.94	17.87	-4.92
Received government transfers in the past year	8.61	12.78	-4.16
Received public sector wages in the past year	3.49	3.69	-0.20

Source: Data from the World Bank 2017 Global Findex (Demirgüç-Kunt et al. 2018).

Table A6: Financial Inclusion Indicators: By Gender

Metric	Male	Female	Gender Diff
Made digital payments in the past year	63.56	58.10	5.46
Made or received digital payments in the past year	71.66	64.08	7.58
Received digital payments in the past year	40.42	31.87	8.55
Used a mobile phone or the internet to access an account	40.72	38.86	1.86
Used the internet to buy something online in the past year	43.86	46.75	-2.89
Used the internet to pay bills in the past year	41.66	37.36	4.30
Used the internet to pay bills or buy something online in the past year	49.09	48.47	0.62
Financial institution Account	83.97	76.36	7.60
No account and no withdrawal from an account in the past year	12.04	12.02	0.03
Borrowed any money in the past year	47.46	41.87	5.59
Outstanding housing loan	14.00	10.77	3.23
Borrowed for education or school fees	5.32	4.50	0.82
Borrowed for health or medical purposes	7.12	5.65	1.47
Borrowed from a financial institution or used a credit card	25.59	19.73	5.86
Borrowed from a financial institution	10.50	6.65	3.84
Borrowed from family or friends	28.77	27.87	0.90
Borrowed to start, operate, or expand a farm or business	6.35	3.71	2.64
Saved any money in the past year	56.28	45.66	10.62
Saved at a financial institution	38.97	30.45	8.51
Saved for old age	24.66	18.35	6.31
Saved to start, operate, or expand a farm or business	18.40	12.67	5.73
Coming up with emergency funds: not possible	34.22	39.31	-5.08
Main source of emergency funds: family or friends	11.21	15.28	-4.07
Main source of emergency funds: money from working	47.72	42.64	5.08
Main source of emergency funds: savings	38.46	39.56	-1.10
Received a public sector pension in the past year	7.57	6.12	1.45
Received government payments in the past year	19.83	14.52	5.31
Received government transfers in the past year	13.64	10.78	2.86
Received public sector wages in the past year	4.90	2.42	2.48

Source: Data from the World Bank 2017 Global Findex (Demirgüç-Kunt et al. 2018).

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