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E-Money and Monetary Policy Transmission

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E-Money and Monetary Policy Transmission

Prepared by Zixuan Huang, Amina Lahreche, Mika Saito, and Ursula Wiriadinata*

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ABSTRACT: E-money development has important yet theoretically ambiguous consequences for monetary policy transmission, because nonbank deposit-taking e-money issuers (EMIs) (e.g., mobile network operators) can either complement or substitute banks. Case studies of e-money regulations point to complementarity of EMIs with banks, implying that the development of e-money could deepen financial intermediation and strengthen monetary policy transmission. The issue is further explored with panel data, on both monthly (covering 21 countries) and annual (covering 47 countries) frequencies, over 2001 to 2019. We use a two-way fixed effect estimator to estimate the causal effects of e-money development on monetary policy transmission. We find that e-money development has accompanied stronger monetary policy transmission (measured by the responsiveness of interest rates to the policy rate), growth in bank deposits and credit, and efficiency gains in financial intermediation (measured by the lending-to-deposit rate spread). Evidence is more pronounced in countries where e-money development takes off in a context of limited financial inclusion. This paper highlights the potential benefits of e-money development in strengthening monetary policy transmission, especially in countries with limited financial inclusion.

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WORKING PAPERS

E-Money and Monetary Policy Transmission

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[1] The authors would like to thank the African Department's Research Advisory Group and Central Bank Digital Currency and Digital Payment Group for helpful comments. Helpful comments by Alexander Copestake and two anonymous referees are gratefully acknowledged.

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Glossary

CBDC: Central Bank Digital Currency

EMI: e-money issuer

FAS: Financial Access Survey

FI: Financial Inclusion

IFS: International Financial Statistics

MNO: mobile network operator

MPR: Monetary Policy Rate

PSB: Payment Service Banks

Executive Summary

The development of digital currencies is one of the most significant offspring of technological innovations in the financial sector. In many low-income and emerging market economies around the world, digital currencies—denominated in legal tender and exchanged through feature of smart phones—have gained widespread adoption. This development in turn has raised key questions for policy makers. What is the impact of "e-money" development on monetary policy transmission? What are the implications in designing other digital currencies such as central-bank digital currency (CBDC)?

The key question for central banks—whether the growth of e-money enhances or weakens monetary policy transmission—is an empirical question because nonbank deposit-taking e-money issuers (EMIs) can either complement or substitute banks. For example, typical EMIs such as mobile network operators (MNOs) can complement banks by bringing into the banking system previously unbanked depositors. The complementarity of EMIs with banks could lead to higher financial intermediation and stronger monetary policy transmission. EMIs can however also substitute banks by moving bank deposits away from banks to nonbank financial institutions. The substitutability of EMIs with banks could lead to financial disintermediation and weaker monetary policy transmission. E-money development therefore could have important, yet theoretically unclear consequences for monetary policy transmission.

Whether EMIs can complement or substitute banks would depend on e-money regulations. Typical features of e-money regulations found in Sub-Saharan Africa point to regulators' preference for EMIs to complement rather than substitute banks.

We then explore empirically the role of e-money on monetary policy transmission, using panel data covering 21 countries at a monthly frequency, and 47 countries at an annual frequency, for the period between 2001 and 2019.

We use a two-way fixed effect estimator with a single treatment to estimate causal effects of e-money development on monetary policy transmission. We find that e-money development has accompanied (i) stronger monetary policy transmission (measured by the responsiveness of interest rates to the policy rate), (ii) growth in bank deposits and credit, and (iii) competition among banks and efficiency gains in financial intermediation (measured by deposit-to-lending rate spreads). Evidence is more pronounced in countries where e-money development takes off in a context of limited financial inclusion. This paper highlights potential benefits of e-money development in strengthening monetary policy transmission, especially in countries with limited financial inclusion.

Introduction

The development of digital currencies is one of the most significant offspring of technological innovations in the financial sector.[1] In many low-income and emerging market economies around the world, digital currencies—denominated in legal tender and exchanged through features of smart phones—have gained widespread adoption. This development in turn has raised key questions to policy makers. What is the impact of "e-money" development on monetary policy transmission? What are the implications in designing other digital currencies such as central-bank digital currency (CBDC)?

The key question for central banks—whether the growth of e-money enhances or weakens monetary policy transmission—is an empirical question because nonbank deposit-taking e-money issuers (EMIs) can either complement or substitute banks. For example, typical EMIs such as mobile network operators (MNOs) can complement banks by bringing into the banking system previously unbanked depositors. The complementarity of EMIs with banks could lead to higher financial intermediation and stronger monetary policy transmission. EMIs can however also substitute banks by moving bank deposits away from banks to nonbank financial institutions. The substitutability of EMIs with banks could lead to financial disintermediation and weaker monetary policy transmission. The development of e-money therefore could have important, yet theoretically unclear, consequences for monetary policy transmission.

Whether EMIs can complement or substitute banks would depend on what EMIs are allowed to do (e.g., offer interest on savings or extend credit). We therefore first review e-money regulations across countries. In this paper, we present case studies of five countries at the frontline of e-money development in Sub-Saharan Africa—Ghana, Kenya, Nigeria, Tanzania, and Uganda. The e-money regulations of these countries share similar features: (i) money collected by EMIs must be maintained in a trust fund in banks; (ii)

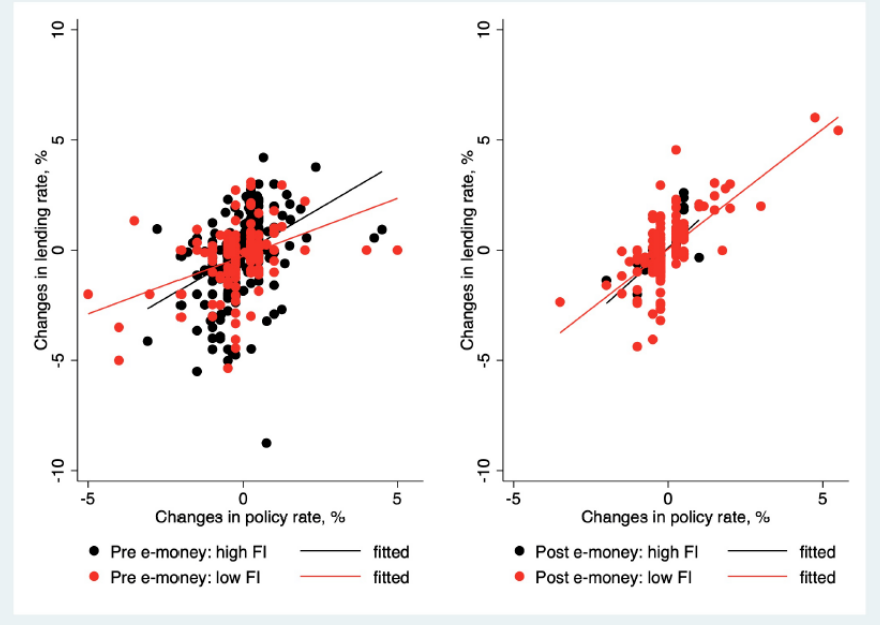
[1] Digital currencies, such as e-money, represents value digitally and is denominated in fiat currency (He and others, 2016).

EMIs are not allowed to extend credit but allowed to partner with banks to offer bank credit through features of smartphones; and (iii) most EMIs can offer interest on their customers' balances. Under these features of e-money regulations, EMIs are likely to complement rather than substitute banks. The complementarity of EMIs with banks point to stronger monetary policy transmission.

We then explore empirically the role of e-money on monetary policy transmission, using panel data covering 21 countries at a monthly frequency, and 47 countries at an annual frequency, for the period between 2001 and 2019. We examine whether the development of e-money: (i) increases or reduces banks' ability to create credit; (ii) increases or reduces the responsiveness of lending and deposit rates to the policy rate; and (iii) enhances or weakens competition among banks and in turn the efficiency of financial intermediation. Our main findings are as follows:

- All countries, irrespective of initial conditions, experience stronger monetary policy transmission with the development of e-money. This transmission, measured by the elasticity of the lending and deposit rates with respect to the policy rate, becomes higher with the introduction of e-money (Figure 1). Evidence is particularly pronounced in countries where e-money development takes off in a context of limited financial inclusion (e.g., low-income countries).
- E-money and the banking sector seems to develop in tandem, suggesting that complementarity is at play. Data also show that growth in e-money and growth in deposits and credit are more correlated in countries with limited initial levels of financial inclusion. There is also evidence that e-money development promotes financial inclusion itself.
- Lastly, bank lending-to-deposit rate spreads tend to decline with the development of e-money, suggesting that the development of e-money strengthens competition in the banking sector and supports efficiency gains in financial intermediation.

Figure 1: Relationship between Lending Rate Changes and Policy Rate Changes



Notes. This figure shows the relationship between changes in policy rate and changes in lending rate for low and high financial inclusion countries in pre- and post- e-money era. Policy rate change is measured as the change in policy rate from month $t-1$ to t. Lending rate change is measured as the change in lending rate from month $t-1$ to $t+6$. Data cover months from 2001 December to 2019 December, while periods when there was no policy rate change are excluded.

Literature Review

The impact of e-money on monetary policy transmission is an important empirical question. While the literature on e-money, financial inclusion, and economic growth is growing fast, relatively few studies have explored the relationship between the development of e-money and monetary policy transmission. Moreover, existing studies tend to focus on the impact of new forms of money on the financial systems of a single country or region. Our paper helps fill this gap by providing a quantitative analysis of the impact of the development of e-money on monetary policy transmission, using panel data covering up to 47 countries.

A large body of empirical literature has looked into the impact of e-money on financial inclusion and financial deepening. Aron (2018) reviews the empirical literature on the

economic impact of mobile money and concludes that the evidence—at least in studies conducted in East Africa and a few Asian countries—suggest that mobile money mitigates the asymmetric information in bank lending and fosters risk-sharing to the unbanked low-income households. Coulibaly (2020) examines the demographics of e-money users in the West African Economic and Monetary Union (WAEMU) countries and finds that e-money shapes saving and consumption behavior. Similarly, Ky and others (2017) find that e-money increases household's propensity to save in the case of Burkina Faso. Jack and Suri (2014) document that M-Pesa has facilitated risk-sharing and consumption smoothing in Kenya; households with access to e-money experience a smaller consumption shocks following a negative income shock. Mbiti and Weil (2014) find that M-Pesa in Kenya has increased the probability of households having access to banks. Anmad, Green and Jiang (2020) survey the literature and show that e-money has enhanced financial inclusion in Sub-Saharan African countries. Finally, Gosavi (2018) finds that e-money development in East Sub-Saharan Africa has also mitigated firm financing problems, as firms using mobile money are more likely to obtain bank credit. Gosh and others (2022), using India's FinTech lender's data, find that a larger use of cashless payments predicts a higher likelihood of loan approval, a lower interest rate, and a higher loan amount, especially for firms of higher credit quality. A more recent work by Brunnermeier and others (2023) investigate the tradeoff between competition and financial inclusion resulting from vertical integration between mobile network operators (MNOs) and mobile money companies that can be separated from MNOs and focus on payment exchange service. Using data from 129 mobile money operators operating in 42 African countries, they show that interoperability benefits mobile money operators; it also reduces mobile network towers and network coverage in rural and poor districts, lowering financial inclusion. These studies do, however, generally suggest that e-money development has promoted financial access and deepening.

More recently, a number of papers have provided a conceptual framework for the potential implications of Central Bank Digital Currency (CBCD). Das and others (2023) provide a conceptual analysis of the implications of CBDC for monetary policy. Cœuré

and Loh (2018) provide a conceptual framework for the potential effect of CBDC on payment services, monetary policy operation, and financial stability. Kahn and others (2022) analyze trends in currency-in-circulation and how it may impact central banks' seigniorage, monetary base, and the transactional velocity of digital money if money demand declines. Malloy and others (2022) discuss how CBDC could affect U.S. monetary policy implementation through the balance sheet of the Federal Reserve, commercial banks, and U.S. households. Chiu and others (2023) develop a micro-founded general equilibrium model of payments to study the impact of CBDC on bank intermediation ; they show that if banks have market power in the deposit market, a CBDC can enhance competition, raising the deposit rate, expanding intermediation, and increasing output. Burlon and others (forthcoming) have developed a quantitative DSGE model and examine the impact of CBDC issuance on bank intermediation and the economy; they estimate the optimal amount of CBDC that promotes a smoothing effect on lending while minimizing the disintermediation trade-off for the euro area. Recent advancement of theoretical work highlights that development of digital currencies, whether it is e-money or CBDC, could have important, yet theoretically complex, consequences for monetary policy transmission.

The findings in this paper contribute to the empirical literature focused on the impact of new forms of money on the financial system of a single country or a region. This paper shows that the relationships found in individual countries between the use of digital currency and financial access and deepening, and by extension monetary policy transmission, are also found in a broader set of countries.

Conceptual Framework

There are four main channels through which e-money growth can affect monetary policy transmission: credit, bank rates, asset prices, and the exchange rate. Each channel may enhance or reduce monetary policy transmission.

The development of e-money can *enhance* monetary policy transmission if EMIs can complement banks. There are four mechanisms through which this can happen. First, e-money can channel the currency in circulation outside the banking system into the banking system. This is possible when, for example, agents of MNOs deposit the banknotes and coins exchanged for airtime. These deposits in turn increase the pool of loanable deposits in the banking system, as long as they are not ring-fenced (for example through trust funds). As a result, the credit channel of monetary policy transmission would strengthen. Second, digitization and financial inclusion improve market efficiency and thus move savings from traditional instruments (e.g., currencies, gold, and real estate), which are less sensitive to monetary policy, into bank deposits. Digitization and financial inclusion therefore could bolster the asset price channel of monetary transmission. Third, higher competition in the banking sector to attract large wholesale depositors (e.g., MNOs) can lead to lower banks' excess reserves and thus strengthen the transmission of monetary policy to bank lending rate—the bank rate channel. Finally, safe and convenient e-money increases the appeal of domestic currency, which in turn could reduce demand for foreign currency deposits, strengthen local currency, and thus reduce currency risk premium—the exchange rate channel.

However, e-money growth can also *reduce* monetary policy transmission if EMIs substitute banks through various channels. First, e-money can reduce the supply of loans if deposits at banks are not loanable. For example, e-money prudential regulations may require EMIs to maintain a pool of liquid funds (e-float) equivalent to the aggregate balance of their clients' e-wallets (Shirono and others, 2021). Moreover, if e-money is deemed more trustworthy and safer than bank deposits, and in the extreme case, if there is no limit to the size of e-wallets, then bank deposits may shrink, leading to financial disintermediation and a weaker credit channel. Second, digitalization and financial deepening may shift savings from bank deposits towards other digital assets such as cryptocurrencies, which are less responsive to changes in the monetary policy at least in small economies whose asset allocation decisions do not affect global digital asset

prices.[2] This shift would reduce the asset price channel. Third, non-loanable e-money balances could lead to a credit crunch that shrinks bank lending to prime customers only—a category of customers whose credit demand tends to be less sensitive to monetary policy rate changes. For example, if EMIs could only invest client funds in government securities, in a context where government demand for credit is less sensitive to monetary policy rate changes than households' or firms', the bank rate channel would weaken. Finally, as monetary policy becomes less effective, the transmission to exchange rate could also weaken.

The key determinant would be whether EMIs would complement or substitute banks. The complementarity of EMIs with banks—irrespective of the transmission channels—could lead to higher financial intermediation and stronger monetary policy transmission. Conversely, the substitutability of EMIs with banks—irrespective of the transmission channels—could lead to financial disintermediation and weaker monetary policy transmission. E-money development therefore could have important, yet theoretically unclear, consequences for monetary policy transmission.

Whether EMIs can complement or substitute banks would depend on what EMIs are allowed to do (e.g., offer interest on savings or extend credit). We therefore first review e-money regulations across countries. In this paper, we present case studies of five countries at the frontline of e-money development in Sub-Saharan Africa—Ghana, Kenya, Nigeria, Tanzania, and Uganda.

Case Studies

In this section, we conduct case studies on five African countries where e-money has been growing rapidly: Ghana, Kenya, Nigeria, Tanzania, Uganda. We review and summarize regulatory aspects that are relevant to our question on the impact of e-money

[2] If cryptocurrencies are priced as a speculative bubble, or if demand for them co-moves with the financial cycle, then they could be highly responsive to monetary policy (Benigno and Rosa 2023; Che and others, 2023).

development on monetary policy transmission: (i) are EMIs required to maintain a pool of liquid funds equivalent to the aggregate balance of their clients' e-wallets? (ii) are EMIs allowed to lend e-money balances? and (iii) are EMIs required or allowed to pay interests on e-money balances?

Ghana

Under e-money regulations in Ghana, EMIs are required to keep the counterpart of e-money issued in trust funds held in commercial banks. These trust funds should either be in cash balances or other qualified liquid assets. EMIs are not allowed to make direct lending but can work with commercial banks to provide banking services, including lending. EMIs can also earn interest on e-money balances.

In Ghana, EMIs have to distribute a share of the interest income to e-money holders. The 2015 Guidelines for e-money Issuers set the minimum share of distributed interest income at 80 percent. Therefore, holding an e-money account in Ghana is very similar to holding an account in a commercial bank.

In 2015, the government began encouraging and allowing EMIs to work with commercial banks to provide banking services, including lending. This policy change stimulated rapid growth in the e-money industry, with the number of e-money accounts and transactions soaring (Bank of Ghana, 2022). In 2019, more e-money regulations were released under the Payment Systems and Services Act[3].

Kenya

E-money started in 2007 with the launch of M-Pesa by a leading cell phone company in Kenya, Safaricom Ltd. M-Pesa provides customers with deposit services, allowing customers to send and withdraw funds from their mobile phones. At the beginning, there

[3] Payment Systems and Services Act, 2019, Bank of Ghana.

was no regulation for e-money providers in the country. The government only enacted the National Payment System Regulations as the legal framework for this industry in 2014 [4].

EMIs have to establish a trust fund in banks to keep all the fundings received. These trust funds are treated equally with other bank accounts with respect to withdrawals, reserves requirements and other regulations (Ahmad and others, 2020; and Jack and Suri, 2011). Interest distribution is not allowed, and, as stated in the 2014 National Payment System, any income generated from placements of these trust funds shall be donated to a public charitable organization for the use for public charitable purposes. In practice, M-Pesa—the largest EMI in Kenya—established the M-Pesa Foundation for this specific purpose (Dias and Kerse 2021). In other words, e-money holders do not receive any interest on their e-money accounts.

Lending by EMIs is prohibited. However, EMIs can work with commercial banks and provide banking services including lending to customers. For example, M-Shwari, launched by Commercial Bank of Africa and Safaricom, offers M-Pesa users with loans and saving products. These loans and savings are underwritten under the balance sheet of Commercial Bank of Africa and thus under the bank's assets and liabilities. M-Pesa provides their customers with an instant access to loans and savings, allowing many M-Shwari customers to access otherwise unavailable formal credit and benefit from interest earning deposits. [5] The commercial bank gains access to a much larger customer base.

Nigeria

In 2022, the Central Bank of Nigeria issued MTN (the largest mobile network operator in Nigeria) the first license to operate mobile money services[6]. According to the Circular issued to Payment Service Banks (PSBs) in 2020[7], EMIs in Nigeria can apply to be a PSB

[4] Source: National Payment System Regulations 2014, Bank of Kenya.
[5] Source: https://www.vodafone.com/about-vodafone/what-we-do/consumer-products-and-services/m-pesa
[6] Source: https://www.connectingafrica.com/author.asp?section_id=761&doc_id=776736
[7] Circular to Payment Service Banks – Re: Guidelines for Licensing and Regulation Payment Service Banks (PSBs) in Nigeria 2020, Central Bank of Nigeria.

to carry out deposits and withdrawals services for households and small businesses, and issue debit card. However, PSBs are not allowed to make loans, including credit card, and unlike in other countries, they currently do not have the options to work together with banks to make loans. PSBs can earn interest on e-money balances and can distribute the interest income to their e-money holders. PSBs can invest in central bank securities, government T-bills, and other short-term government securities.

Tanzania

According to the National Payment systems Act, and similarly to in Kenya and Uganda, EMIs in Tanzania need to maintain the whole e-money balances in a trust fund in commercial banks.[8] EMIs are also not allowed to make loans directly but can cooperate with regulated financial institutions to provide loan services. For example, M-Pawa, a cooperation between Vodacom and Commercial Bank of Africa, allows e-money holders to save, earn interests, and access micro loans in Tanzania.

The e-money industry in Tanzania began in 2008. E-money operators earn interest from their e-money balances. They are not mandated but are allowed to distribute the interest to their e-money holders. In practice, EMIs do distribute interest to their customers since 2014 (Dias and Kerse, 2021; and McKay, 2016). Tigo Pesa and Airtel, two EMIs in Tanzania, distribute the interest in proportion to customers balances and transaction volumes (Dias and Kerse, 2021).

Uganda

According to the National Payment Systems Regulations published by Bank of Uganda, e-money providers are required to maintain the fundings received in trust funds held in commercial banks.[9] For example, in 2015, MTN Uganda partnered with 11 financial institutions in maintaining the trust funds (Macmillan and others, 2016).

[8] National Payments Systems Act 2015, Bank of Tanzania.
[9] Source: National Payment Systems Regulations 2020, Bank of Uganda.

As in Kenya, EMIs are not allowed to make loans but can engage in saving and credit products in partnership with banks. In August 2016, MTN Uganda launched micro-saving and microloan services, MoKash, in cooperation with Commercial Bank of Africa.[10] To use MoKash, customers can access saving and loan services through the mobile money platform. Transactions between MoKash and MTN e-money are free for both saving and loan services (Macmillan and others, 2016).

As for liquidity requirement, and similar to Kenya, e-money issuers need to keep 100 percent of e-money balances in liquid assets such as cash balances, treasury bills, and government bonds.

Unlike Kenya however, the interest earned on the trust fund should be distributed to customers at the end of every quarter.

Summary. Case studies allow to identify common e-money design (Text Table 1): (i) money collected by EMIs must be maintained in a trust fund in banks; (ii) EMIs are not allowed to make loans, but allowed to partner with banks; and (iii) most EMIs can offer interests on their customers' balances.

Text Table 1. Summary

	Start	Regulation / Oversight	Trust Fund		Interface with banking services
			required	interest earned	
Ghana	2009	2008; 2019	yes	yes	yes
Kenya	2007	2014	yes	no	yes
Nigeria	2022	2020	yes	yes	no
Tanzania	2008	2015	yes	yes	yes
Uganda	2009	2020	yes	Yes	yes

Sources: National sources; and IMF staff assessment.

[10] Source: https://allafrica.com/stories/201608120543.html

These features of e-money regulation suggest e-money development would enhance monetary policy transmission. Specifically, e-money development is likely to enhance financial inclusion, channel currency into the banking sector, bolster banking sector credit creation, and increase competition in the banking sector. In the next section, we take this reading of regulations to panel data analyses and estimate causal effects of e-money development on monetary policy transmission.

Data

Data sources. Data on e-money are from the Financial Access Survey (FAS). The data are annual covering about 190 countries from 2004 to 2019. FAS provides data on the number of e-money registered accounts per one-thousand adults and the number of deposit accounts with commercial banks per one-thousand adults. Annual data on bank deposits, bank credits, government deposits, and bank credits to central government are from International Financial Statistics (IFS). Monthly data on deposit rate, lending rate, and policy rate are from IFS. Macro variables data are from the World Economic Outlook (WEO). The monthly interest rate data are from January 2001 to December 2019.

Summary statistics. The baseline sample covers 21 countries in the monthly data analysis and 47 countries in the annual data analysis over a 15-year period, from 2004 to 2019. The list of countries in each panel is shown in Table 1. We exclude the post-2020 period and 2008-09 in the baseline sample to avoid the effect of the COVID-19 crisis and the global financial crisis, respectively. Table 2 shows the mean and standard deviation of e-money intensity (see below for more detail), deposit growth, loan growth, and various interest rates.

Empirical Method

This section discusses the empirical strategy to examine the relationship of e-money development and monetary policy transmission.

The development of e-money is measured by "e-money intensity" (see below for more detail) while the strength of monetary policy transmission is measured by three variables: (i) the responsiveness of the bank lending and deposit rates to a change in the monetary policy rate (MPR), as stronger monetary policy transmission would typically be associated with more responsive lending and deposit rates; (ii) the spread between the lending and deposit rates, as stronger monetary policy transmission would typically be associated with stronger competition in the banking sector and lower costs of financial intermediation; and (iii) size of bank deposits and credits, as stronger monetary policy transmission would typically be associated with higher bank deposits and credit.

E-money Intensity

We create a measure of e-money adoption or penetration rate ("e-money intensity") defined as the ratio of the number of registered e-money accounts per 1,000 adults to the number of bank accounts per 1,000 adults. We use the number of bank accounts as the denominator to control for the large variation in financial sector development. We explored alternative measures, such as e-money intensity defined as simply the number of e-money accounts per 1,000 adults or using the number of bank accounts at the time when e-money was introduced as the denominator. Those alternative measures do not change our empirical findings in any significant manner.

The Elasticity of Bank Rates with respect to the Policy Rate

To examine the relationship between e-money development and the responsiveness of the bank lending rate to the monetary policy rate, we use a two-way fixed effect (TWFE)

estimator with a single treatment to estimate causal effects from panel data.[11] Specifically, we estimate the following empirical specification:

$$\Delta LendingRate_{it} = \alpha_i + \alpha_t + \beta_1 \Delta PolicyRate_{it} + \beta_{2L} D(emoneyL)_{it} \times \Delta PolicyRate_{it} + \beta_{2H} D(emoneyH)_{it} \times \Delta PolicyRate_{it} + D(emoneyL)_{it} + D(emoneyH)_{it} + \epsilon_{it}, \quad (1)$$

where $\Delta PolicyRate_{i,t}$ is a monthly change in policy rate of country *i* from period *t-1* to *t*; and $\Delta LendingRate_{i,t}$ is a change in bank lending rate from *t-1* to *t+6*.[12] Country fixed effects are used to control for time-invariant characteristics of countries. For example, some countries may consistently have more responsive lending rates due to higher competition of the banking sector than other countries. Country fixed effects help us control this unobserved heterogeneity that does not change over time for a given country. Time fixed effects control for variables that are fixed for each year but may change over time. For instance, if there is a common shock that applies to all countries in a year, time fixed effects can control for this common shock. In addition, standard errors are clustered at the country level, allowing for serial correlation and heteroskedasticity of error terms at the country level.

Two dummy variables are created for countries with different levels of e-money intensity. The role of these dummy variables is to distinguish the period before and after e-money was introduced in each country as well as the level of penetration of e-money in each country at each time.

- $D(emoneyL)_{it}$ is a dummy variable that equals to 1, if e-money has already been introduced and the e-money intensity at time t is less than 0.5;[13] and 0 otherwise.

[11] The e-money introduction is the only treatment in our analysis, thereby avoiding the complications associated with multiple treatment variables studied in de Chaisemartin and D' Haultfœuille (2023). This regression specification investigates how the introduction and level of e-money intensity influence the lending rate elasticity with respect to changes in monetary policy rate.

[12] A 6-month lag is allowed for the lending rate to respond to a change in the monetary policy rate. The choice of 6 month follows a common lag observed in the literature as testing for the appropriate lag length would require more degrees of freedom. Our results are not sensitive to the choice of the lag length.

[13] The cut off is set at 0.5 so that there is roughly an equal number of countries in two groups.

- $D(emoneyH)_{it}$ is a dummy variable that equals to 1, if e-money has already been introduced and the e-money intensity at time t reaches a level greater than 0.5; and 0 otherwise.

Our variables of interest are β_{2L} and β_{2H}, the coefficients on the interaction of $D(emoneyL)$ and $D(emoneyH)$ with monetary policy rate changes, respectively. The elasticity of bank lending rate with respect to the monetary policy rate is $\beta_1 + \beta_{2L}$ for countries with relatively low level of penetration of e-money and $\beta_1 + \beta_{2H}$ for countries with relatively high level of penetration of e-money. The difference between β_{2L} and β_{2H} would therefore capture the difference in the elasticity of bank lending rate with respect to the monetary policy rate between two groups of countries with different levels of e-money intensity.[14] *A positive difference between β_{2L} and β_{2H} means that e-money development is associated with higher responsiveness of bank lending rate with respect to a change in the monetary policy rate*.

To control for differences in the initial condition, we also estimate the baseline regression (1) in two separate samples; the total sample is split into a roughly equal size to maximize the degrees of freedom in each subsample and is split by the level of financial inclusion (FI) which is measured by the number of deposit account per 1,000 adults) prior to the introduction of e-money.

We also estimate the baseline regression (1) using the deposit rate instead of the lending rate.

The Lending-to-Deposit Rate Spread and the Deposit Rate

To assess the impact of e-money development on banking sector competition, we use the bank lending-to-deposit rate spread and the deposit rate as a proxy for the degree of banking sector competition. A more competitive banking sector is expected to exhibit a lower spread, as competition tends to increase deposit rates and reduce lending rate,

[14] Two groups of countries are different for different time periods as e-money intensity changes over time.

keeping everything else the same. E-money offers an alternative to banks, increasing the competition for household savings. If MNOs can make loans, e-money will also increase the competition among financial intermediaries for investment opportunities including lending to firms, reducing the lending rate.

To examine the relationship between e-money development on the interest spread we estimate the following specification using a TWFE estimator:

$$Spread_{it} = \alpha_i + \alpha_t + \beta_{2L} D(emoneyL)_{it} + \beta_{2H} D(emoneyH)_{it} + controls_{it} + \epsilon_{it}, \quad (2)$$

where $Spread_{it}$ is the difference in bank lending and deposit rates of country *i* in period *t*. $\alpha_i$and α_t represent country and time fixed effects. Control variables include the monetary policy rates, which are time varying and considered as an important determinant of bank rates. We are interested in β_{2L} and β_{2H}, which test whether the spread differs as a function of e-money intensity. *A negative coefficient suggests that e-money development is associated with a more competitive banking sector*.

We also explore the effect of e-money on the deposit rate. To do so, we change the dependent variable to the deposit rate:

$$DepositRate_{it} = \alpha_i + \alpha_t + \beta_{2L} D(emoneyL)_{it} + \beta_{2H} D(emoneyH)_{it} + controls_{it} + \epsilon_{it}. \quad (3)$$

A positive coefficient suggests that e-money development is associated with a more competition in the banking sector as it reveals that banks are competing for deposits.

To control for differences in the initial condition, we also estimate the baseline regression (2) in two separate samples which are split by the level of financial inclusion prior to the introduction of e-money.

Bank Deposits and Credit

To assess the impact of e-money development on the size of banking sector deposit and credit, we estimate the following specification using the Fixed-Effect (FE) estimator.

$$\Delta \log (y_{it}) = \alpha_i + \beta_1 \Delta \log (intensity_{it}) + \epsilon_{it}, \qquad (4)$$

Where $\Delta \log (y_{it})$ is either bank deposit growth or credit growth in country i and between year *t* and *t-1* and $\Delta \log (intensity_{it})$ is the growth of e-money intensity between year *t* and *t-1*. The growth rates are measured as log differences. α_i is the country fixed effect. Furthermore, standard errors are clustered at the country level. Our variable of interest is β_1. *A positive* β_1 *implies that e-money development is associated with the growth of bank deposits and credit.*

The FE estimator was considered appropriate here (as opposed to the TWFE estimator) as it was difficult to assume away the parallel trend assumption, a necessary condition for the TWEF estimator. It was evident that some countries have experienced declining trends in deposit or credit growth, while others have exhibited increasing trends. Compared with Ordinary Least Square (OLS) estimator, the FE estimator was preferred, as it can control for unobserved heterogeneity at the country level that remains constant over time. By incorporating country fixed effects, we eliminate time-invariant variations between countries, enabling us to examine the extent to which growth in e-money intensity is associated with changes in bank credit or deposit growth.

To control for differences in the initial condition, we also estimate the baseline regression (4) in two separate samples which are split by the level of financial inclusion prior to the introduction of e-money.

Moreover, to see whether the results are driven by public or private sectors, we estimate the same specifications with the dependent variable being public or private sectors balances.

Financial Inclusion

Lastly, to examine the relationship between e-money development and financial inclusion, we estimate the following regression specification:

$$FI_{it} = \alpha_i + \alpha_t + \beta\, D(emoney)_{it} + controls_{it} + \epsilon_{it}, \qquad (5)$$

where FI_{it} is the degree of financial inclusion of a country at year t measured as the share of banked population; $D(emoney)_{it}$ is a dummy variable that equals to 1, if e-money has been introduced and 0 otherwise; α_i is the country fixed effect; and α_t is time fixed effect. The control variables include the lagged log of the number of bank branches and ATMs. We are interested in the estimate on β. *A positive β means e-money development is associated with higher share of banked population.*

To control for differences in the initial condition, we also estimate the baseline regression (5) in two separate samples which are split by the level of financial inclusion prior to the introduction of e-money.

To examine the dynamic effect of e-money development, we also estimate the following specification:

$$FI_{it} = \alpha_i + \alpha_t + \beta_0 Post0_{it} + \beta_1 Post1_{it} + \beta_2 Post2_{it} + \beta_3 PostBeyond_{it} + controls_{it} + \epsilon_{it}, \quad (6)$$

where $Post0_{it}$ is a dummy variable equal to one if year *t* is the e-money inception, $Post1_{it}$ and $Post2_{it}$ are dummy variables equal one if year *t* is one year and two years after e-money inception, respectively, and $PostBeyond_{it}$ is a dummy variable equal to one for any period three years after the inception year.

Empirical Results

This section discusses the relationship between e-money development and monetary policy transmission and the potential underlying mechanisms as laid out in the conceptual framework section.

The Elasticity of Bank Rates with respect to the Policy Rate

Table 3 shows the estimate of equation (1) using the lending rate. The difference between β_{2L} and β_{2H} captures the difference in the elasticity of bank lending rate with respect to the monetary policy rate between two groups of countries with different levels of e-money intensity. *A positive difference between β_{2L} and β_{2H} means that e-money development is associated with higher responsiveness of bank lending rate with respect to a change in the monetary policy rate*. We observe a positive difference between β_{2L} *and* β_{2H} with statistical significance but only in the sample of countries with low initial financial inclusion. On average, in the subsample of countries where initial level of financial inclusion is low, e-money development is associated with an increase in the elasticity of the lending rate to the policy rate by 0.3.

Table 4 shows the estimate of equation (1) using the deposit rate. Here we observe a positive difference between β_{2L} *and* β_{2H} with statistical significance in the full sample as well as the subsample of countries with low initial financial inclusion. On average, in the full and subsample of countries, e-money development is associated with an increase in the elasticity of the deposit rate to the policy rate by about 0.4.

The Lending-to-Deposit Rate Spread and the Deposit Rate

Table 5 shows the estimate of equations (2) and (3), which show the impact of e-money development on the lending-to-deposit rate spread and the deposit rate, respectively. With regards to the spread, *a negative coefficient suggests that e-money development is associated with more competition in the banking sector*. With regards to the deposit rate,

a positive coefficient suggests that e-money development is associated with more competition in the banking sector. On average, in countries with high e-money intensity the deposit rate is 0.81 percentage point higher, and the spread is 0.84 percentage point lower. The results are statistically significant.

Comparing the results of the spread and deposit rates in the subsample of countries, columns (2) and (3), the effect on the deposit rate and spread is more pronounced in countries with low initial financial inclusion. The results are statistically insignificant for countries with higher initial level of financial inclusion. This is consistent with the idea that e-money development brings more competition among banks that used to face limited competition with limited level of financial inclusion.

Bank Deposits and Credit

Tables 6, 7, and 8 show the estimate of equation (4) using total bank credit, credit to the government and credit to the private sector, respectively. Tables 9, 10, and 11 show the estimate of equation (4) using total deposits, the government deposits, and the private-sector deposits, respectively. These results show that e-money development is significantly associated with growth in both credit and deposits.

Moreover, Tables 7 and 8 show that e-money development leads to a significant expansion to credit to the private sector. No evidence is found for credit to the government. Similarly, Tables 10 and 11 show that e-money development leads to an increase in private-sector deposits, but no evidence is found for the government deposits. This result is intuitive. E-money can channel more currency in circulation into the banking system, either indirectly through MMOs or directly through banks. Both mechanisms are associated with higher private-sector deposits and with higher credit when the deposits are loanable.

Financial Inclusion

Table 12 shows the estimate of equation (5). *A positive β means e-money development is associated with a higher share of banked population.* The estimate of β is positive and statistically significant in the full sample and in the subsample of countries with low initial financial inclusion. On average, e-money development is associated with a 4 percent increase in the share of banked population.

As for the dynamic effect, the coefficient is not statistically significant in the year of e-money inception, but it turns statistically significant and larger in magnitude from one-year post inception. This pattern suggests the effect of e-money on financial inclusion is gradual and can take a few years to fully materialize.

Policy Implications

The findings in this paper offer insight for policies surround the design and regulation of CBDC and e-money more broadly. First, e-money or CBDC should be accessible without the need for a bank account. This is crucial to allow e-money to improve access (financial inclusion). Second, e-money regulation should encourage a complementarity between e-money and banking sector growth. For instance, e-money balances should be channeled to banks and made available for loans. Enhanced credit registry would facilitate more efficient lending by banks. Third, EMIs should be encouraged to collaborate with banks to extend credit to the private sector (financial deepening). This can foster a mutually beneficial relationship between the two industries, promote broader financial access and deepening, while safeguarding financial sector stability. Safeguarding financial sector stability is an important consideration given that only banks are subject to regulation and supervision while MNOs or other EMIs are typically subject to oversight of the payment system only.

Concluding Remarks

This paper examines whether the growth of e-money enhances or weakens monetary policy transmission. EMIs can either complement or substitute banks and the former can increase financial intermediation and strengthen monetary policy transmission but not the latter. The impact of e-money development on monetary policy transmission is therefore an empirical question.

Our main findings are as follows. First, all countries, irrespective of initial conditions, experience stronger monetary policy transmission with the development of e-money. This transmission, measured by the elasticity of the lending and deposit rates with respect to the policy rate, increases with e-money intensity; the evidence is particularly pronounced in countries where e-money development takes off in a context of limited financial inclusion. Second, e-money and the banking sector seem to develop in tandem, suggesting the complementarity is at play. Data also show that growth in e-money and growth in deposits and credit are more correlated in countries with limited initial levels of financial inclusion. There is also evidence that e-money development promotes financial inclusion. Lastly, bank lending-deposit spreads tend to decline with the development of e-money, suggesting more competition among banks with an increase in e-money intensity.

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Table 1. Countries Included in Empirical Analysis

Panel A: Annual data

Afghanistan, Islamic Rep. of	Jordan	Philippines
Albania	Kenya	Rwanda
Armenia, Rep. of	Lesotho, Kingdom of	Samoa
Botswana	Liberia	Seychelles
Cambodia	Madagascar, Rep. of	Solomon Islands
Cameroon	Malaysia	South Africa
Chad	Maldives	Tanzania
Congo, Rep. of	Mauritania, Islamic Rep. of	Thailand
Egypt, Arab Rep. of	Mauritius	Tonga
Eswatini, Kingdom of	Mexico	Uganda
Fiji, Rep. of	Mongolia	Zambia
Ghana	Mozambique, Rep. of	
Guinea	Myanmar	
Guyana	Namibia	
Haiti	Pakistan	
Honduras	Panama	
Indonesia	Papua New Guinea	
Jamaica	Paraguay	

Panel B: Monthly data

Albania	Mauritius
Armenia, Rep. of	Mexico
Egypt, Arab Rep. of	Mongolia
Fiji, Rep. of	Papua New Guinea
Gambia, The	Paraguay
Guyana	Philippines
Honduras	Rwanda
Indonesia	South Africa
Jamaica	Thailand
Jordan	
Kenya	
Malaysia	

Notes. Panel A exhibits 47 countries included in the country-year analysis. Panel B shows the list of countries included in country-month analysis. Due to limited availability of monthly data, there are fewer countries in Panel B than in Panel A.

Table 2. Summary Statistics

Panel A: Annual data

	All countries		Low financial inclusion		High financial inclusion	
	Mean	SD	Mean	SD	Mean	SD
E-money intensity	1.14	1.59	0.26	0.28	1.81	1.89
Deposit growth (percent)	11.8	9.2	10.0	6.4	13.4	10.6
Loan growth (percent)	12.9	9.2	10.3	6.7	15.4	10.3
Number of observations	247		98		123	
Number of countries	47		21		22	

Panel B: Monthly data

	All countries		Low financial inclusion		High financial inclusion	
	Mean	SD	Mean	SD	Mean	SD
Deposit rate (percent)	5.7	4.0	5.2	3.6	7.3	4.1
Lending rate (percent)	12.8	6.2	11.4	5.3	15.8	7.1
Policy rate (percent)	6.7	4.6	5.8	3.5	8.4	5.9
Number of observations	3,281		1,744		1,163	
Number of countries	21		11		8	

Notes. Panel A and B show the summary statistics of data on yearly and monthly basis, respectively. In panel A, deposit and loan growth rates are at annual basis, and only countries with available data on e-money intensity are included. In both panels, the numbers of countries with high and low financial inclusion do not sum to the number of all countries, because the proxy for the classification of the financial inclusion level is not available for some countries.

Table 3. E-Money and Elasticity of Lending Rate

	Changes in Lending Rate		
	(1) All	(2) Low financial inclusion	(3) High financial inclusion
Changes in Policy Rate	0.86***	0.89***	0.65*
	(0.16)	(0.05)	(0.35)
High E-money Intensity	-0.03	0.03	-0.18
	(0.19)	(0.34)	(0.30)
Low E-money Intensity	0.11	0.25	-0.1
	(0.12)	(0.20)	(0.15)
High E-money Intensity x Changes in Policy Rate	0.26	0.28**	-0.05
	(0.16)	(0.10)	(0.38)
Low E-money Intensity x Changes in Policy Rate	-0.03	-0.02	0.13
	(0.24)	(0.26)	(0.35)
Constant	-0.14**	-0.17	-0.05
	(0.05)	(0.13)	(0.06)
Observations	2,903	1,102	1,441
Country FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
R-squared	0.17	0.36	0.22

Notes. This table estimates the effect of e-money on elasticity of lending rates. The data on policy rates and lending rates, from International Financial Statistics Database, are at the country-month level and cover December 2001 to December 2019. In column (1), the sample consists of all countries where monthly data on bank rates and policy rates are available. In column (2), the sample consists of countries with low initial financial inclusion prior to the emergence of e-money. In column (3), the sample consists of countries with high initial financial inclusion prior to the emergence of e-money. Changes in Policy Rate are defined as the difference in policy rates between two months. Changes in Lending Rate are the lending rate in six months minus the lending rate one month ago. The variable "High E-money Intensity" is an indicator variable equal to 1, if e-money intensity is larger than 0.5, where e-money intensity is defined as the number of e-money registered accounts per 1,000 adults over the number of deposit accounts with commercial banks per 1,000 adults. The variable "Low E-money Intensity" is an indicator variable equal to 1, if e-money intensity is smaller than 0.5 but larger than 0. Country and time fixed effects are included and shown in the table. Standard errors are clustered by country and shown in the parentheses. *, **, and *** indicates significance at 0.1, 0.05 and 0.01 levels, respectively.

Table 4. E-Money and Elasticity of Deposit Rate

	Changes in Deposit Rate		
	(1) All	(2) Low financial inclusion	(3) High financial inclusion
Changes in Policy Rate	0.94***	0.93***	0.94**
	(0.12)	(0.10)	(0.34)
High E-money Intensity	0.31	0.47	0.08
	(0.28)	(0.38)	(0.37)
Low E-money Intensity	0.30*	0.43*	-0.02
	(0.17)	(0.20)	(0.22)
High E-money Intensity x Changes in Policy Rate	0.39***	0.42***	-0.44
	(0.12)	(0.07)	(0.36)
Low E-money Intensity x Changes in Policy Rate	0.21	0.24	-0.15
	(0.24)	(0.22)	(0.42)
Constant	-0.19**	-0.27	-0.06
	(0.08)	(0.14)	(0.08)
Observations	2,977	1,102	1,523
Country FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
R-squared	0.2	0.3	0.26

Notes. This table estimates the effect of e-money on elasticity of deposit rates. The data on deposit rates and policy rates, from International Financial Statistics Database, are at the country-month level and cover December 2001 to December 2019. In column (1), the sample consists of all countries where monthly data on bank rates and policy rates are available. In column (2), the sample consists of countries with low initial financial inclusion prior to the emergence of e-money. In column (3), the sample consists of countries with high initial financial inclusion prior to the emergence of e-money. Changes in Policy Rate are defined as the difference in policy rate between two months. Changes in Deposit Rate are the deposits rate in six months[i] minus the deposit rate one month ago. The variable "High E-money Intensity" is an indicator variable equal to 1, if e-money intensity is larger than 0.5, where e-money intensity is defined as the number or e-money registered accounts per 1,000 adults over the number of deposit accounts with commercial banks per 1,000 adults. The variable "Low e-money intensity" is an indicator variable equal to 1, if e-money intensity is smaller than 0.5 but larger than 0. Country and time fixed effects are included and shown in the table. Standard errors are clustered by country and shown in the parentheses. *, **, and *** indicate significance at 0.1, 0.05 and 0.01 levels, respectively.

Table 5. E-Money and Bank Competition

	Spread		
	(1) All	(2) Low financial inclusion	(3) High financial inclusion
High E-money Intensity	-0.84***	-0.71*	-0.48
	(0.24)	(0.37)	(0.32)
Low E-money Intensity	-0.04	0.22	0.06
	(0.33)	(0.42)	(0.36)
Policy Rate	-0.50***	-0.54***	-0.44***
	(0.08)	(0.07)	(0.08)
Constant	1.55	0.02	0.31
	(1.01)	(3.31)	(1.25)
Observations	2,987	1,081	1,584
No. of countries	21	8	11
Country FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes
R-squared	0.92	0.92	0.94
	Deposit Rate		
	(1) All	(2) Low financial inclusion	(3) High financial inclusion
High E-money Intensity	0.81***	0.78**	0.39
	(0.26)	(0.33)	(0.33)
Low E-money Intensity	-0.09	-0.23	-0.14
	(0.29)	(0.35)	(0.33)
Policy Rate	0.56***	0.64***	0.47***
	(0.07)	(0.07)	(0.07)
Constant	-0.6	0.51	-0.15
	(0.93)	(2.98)	(1.25)
Observations	2,987	1,081	1,584
No. of countries	21	8	11
Country FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Controls	Yes	Yes	Yes
R-squared	0.93	0.93	0.93

Notes. This table estimates the effect of e-money development on deposit rates and spreads between lending and deposit rates. The data, from International Financial Statistics Database, are at the country-month level and cover December 2001 to December 2019. In column (1), the sample consists of all countries. In column (2), the sample consists of countries with low initial financial inclusion prior to the emergence of e-money. In column (3), the sample consists of countries with high initial financial inclusion prior to the emergence of e-money. The variable "High E-money Intensity" is an indicator variable equal to 1, if e-money intensity is larger than 0.5. The variable "Low E-money Intensity" is an indicator variable equal to 1, if e-money intensity is smaller than 0.5 but larger than 0. The numbers of countries

with high and low initial financial inclusion do not sum to the number of all countries, because the proxy for the classification of the financial inclusion level is not available for some countries. Control variables include lagged lending rate and the number of banks to control for the loan demand. Standard errors are clustered by country and shown in the parentheses. *, **, and *** indicate significance at 0.1, 0.05 and 0.01 levels, respectively.

Table 6. Bank Credit and E-Money Intensity

	Growth of Bank Credit					
	All		Low financial inclusion		High financial inclusion	
	(1)	(2)	(3)	(4)	(5)	(6)
Growth of e-money intensity	0.04***	0.03***	0.05***	0.04**	0.01	0.02
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)
Constant	0.12***	0.12***	0.14***	0.14***	0.10***	0.10***
	(0.01)	0.00	(0.02)	0.00	(0.01)	(0.01)
Observations	247	247	123	123	98	98
No. of countries	47	47	21	21	22	22
Country FE	No	Yes	No	Yes	No	Yes
R-squared	0.040	0.049	0.074	0.069	0.004	0.013

Notes. This table estimates the effect of e-money development on growth of bank credits after e-money was introduced. The regression specification is $\Delta credit_{it} = \alpha_i + \beta \Delta intensity_{it} + \epsilon_{it}$. The data are from International Financial Statistics Database, at the country-year level and covers 2004 to 2019 to avoid COVID19 periods. Growth of bank credits is defined as $credit_{it}/credit_{it\text{-}1} - 1$. E-money intensity is computed as the number or e-money registered accounts per 1,000 adults over the number of deposit accounts with commercial banks per 1,000 adults. The growth of e-money intensity is defined as $intensity_{it}/intensity_{it\text{-}1} - 1$. In columns (1) and (2), the sample consists of all countries. In columns (3) and (4), the sample consists of countries with low financial inclusion prior to the emergence of e-money. In columns (5) and (6), the sample consists of countries with high initial financial inclusion prior to the emergence of e-money. Fixed effects are denoted in each column. Standard errors are clustered by country, shown in the parentheses. *, **, and *** indicate significance at the 0.1, 0.05 and 0.01 levels, respectively.

Table 7. Credit to Government and E-Money Intensity

	Growth of Credit to Government					
	All		Low financial inclusion		High financial inclusion	
	(1)	(2)	(3)	(4)	(5)	(6)
Growth of e-money intensity	-0.02	-0.03	-0.04	-0.05	-0.01	-0.01
	(0.06)	(0.06)	(0.10)	(0.10)	(0.03)	(0.03)
Constant	0.17***	0.17***	0.23***	0.23***	0.10***	0.10***
	(0.03)	(0.02)	(0.06)	(0.03)	(0.02)	(0.01)
Observations	247	247	123	123	98	98
No. of countries	47	47	21	21	22	22
Country FE	No	Yes	No	Yes	No	Yes
R-squared	0.002	0.002	0.003	0.004	0.002	0.000

Notes. This table estimates the effect of e-money development on growth of bank credits to the government after e-money was introduced. The regression specification is $\Delta governmentcredit_{it} = \alpha_i + \beta \Delta intensity_{it} + \epsilon_{it}$. The data are from International Financial Statistics Database, at the country-year level and covers 2004 to 2019 to avoid COVID19 periods. Growth of credits to the government is defined as $governmentcredit_{it}/governmentcredit_{it\text{-}1} - 1$. E-money intensity is computed as the number or e-money registered accounts per 1,000 adults over the number of deposit accounts with commercial banks per 1,000 adults. The growth of e-money intensity is defined as $intensity_{it} / intensity_{it\text{-}1} - 1$. In columns (1) and (2), the sample consists of all countries. In columns (3) and (4), the sample consists of countries with low initial financial inclusion prior to the emergence of e-money. In columns (5) and (6), the sample consists of countries with high financial inclusion prior to the emergence of e-money. Growth of bank credit to the government and of e-money intensity is the annual growth of bank credits to the government and of e-money intensity at the country level respectively. Fixed effects are denoted in each column. Standard errors are clustered by country, shown in the parentheses. *, **, and *** indicate significance at the 0.1, 0.05 and 0.01 levels, respectively.

Table 8. Credit to the Private Sector and E-Money Intensity

	Growth of Credit to the Private Sector					
	All		Low financial inclusion		High financial inclusion	
	(1)	(2)	(3)	(4)	(5)	(6)
Growth of e-money intensity	0.04**	0.04**	0.05**	0.04*	0.01	0.02
	(0.02)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)
Constant	0.12***	0.12***	0.13***	0.13***	0.10***	0.10***
	(0.01)	0.00	(0.02)	(0.01)	(0.01)	(0.01)
Observations	247	247	123	123	98	98
No. of countries	47	47	21	21	22	22
Country FE	No	Yes	No	Yes	No	Yes
R-squared	0.036	0.040	0.057	0.047	0.008	0.022

Notes. This table estimates the effect of e-money development on growth of bank credit to the private sector after e-money was introduced. The regression specification is $\Delta privatecredit_{it} = \alpha_i + \beta \Delta intensity_{it} + \epsilon_{it}$. The data are from International Financial Statistics Database, at the country-year level and covers 2004 to 2019 to avoid COVID19 periods. Growth of credits to the private sector is defined as $privatecredit_{it}/privatecredit_{it\text{-}1} - 1$. E-money intensity is computed as the number or e-money registered accounts per 1,000 adults over the number of deposit accounts with commercial banks per 1,000 adults. The growth of e-money intensity is defined as $intensity_{it}/intensity_{it\text{-}1} - 1$. In columns (1) and (2), the sample consists of all countries. In columns (3) and (4), the sample consists of countries with low financial inclusion prior to the emergence of e-money. In columns (5) and (6), the sample consists of countries with high initial financial inclusion prior to the emergence of e-money. Growth of bank credits to the private sector and of e-money intensity is the annual growth of bank credits to the private sector and of e-money intensity at the country level respectively. Fixed effects are denoted in each column. Standard errors are clustered by country, shown in the parentheses. *, **, and *** indicate significance at the 0.1, 0.05 and 0.01 levels, respectively.

Table 9. Deposits and E-Money Intensity

	Growth of Deposits					
	All		Low financial inclusion		High financial inclusion	
	(1)	(2)	(3)	(4)	(5)	(6)
Growth of e-money intensity	0.03**	0.03***	0.05***	0.05***	-0.01	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Constant	0.11***	0.11***	0.12***	0.12***	0.10***	0.10***
	(0.01)	0.00	(0.02)	0.00	(0.01)	0.00
Observations	247	247	123	123	98	98
No. of countries	47	47	21	21	22	22
Country FE	No	Yes	No	Yes	No	Yes
R-squared	0.026	0.043	0.068	0.095	0.004	0.000

Notes. This table estimates the effect of e-money development on growth of deposits after e-money was introduced. The regression specification is $\Delta deposits_{it} = \alpha_i + \beta \Delta intensity_{it} + \epsilon_{it}$. The data are from International Financial Statistics Database, at the country-year level and covers 2004 to 2019 to avoid COVID19 periods. Deposits growth is defined as $deposits_{it}/deposits_{it\text{-}1} - 1$. E-money intensity is computed as the number or e-money registered accounts per 1,000 adults over the number of deposit accounts with commercial banks per 1,000 adults. The growth of e-money intensity is defined as $intensity_{it}/intensity_{it\text{-}1} - 1$. In columns (1) and (2), the sample consists of all countries. In columns (3) and (4), the sample consists of countries with low initial financial inclusion prior to the emergence of e-money. In columns (5) and (6), the sample consists of countries with high initial financial inclusion prior to the emergence of e-money. Fixed effects are denoted in each column. Standard errors are clustered by country, shown in the parentheses. *, **, and *** indicate significance at the 0.1, 0.05 and 0.01 levels, respectively.

Table 10. Government Deposits and E-Money Intensity

	Growth of Government Deposits					
	All		Low financial inclusion		High financial inclusion	
	(1)	(2)	(3)	(4)	(5)	(6)
Growth of e-money intensity	0.48	1.35	0.98	2.40	-0.02	0.00
	(0.60)	(1.43)	(1.30)	(2.62)	(0.04)	(0.04)
Constant	1.40	1.13**	2.70	2.26**	0.14***	0.13***
	(1.24)	(0.45)	(2.51)	(0.81)	(0.03)	(0.01)
Observations	247	247	123	123	98	98
No. of countries	47	47	21	21	22	22
Country FE	No	Yes	No	Yes	No	Yes
R-squared	0.000	0.001	0.000	0.002	0.002	0.000

Notes. This table estimates the effect of e-money development on growth of government deposits after e-money was introduced. The regression specification is $\Delta governmnetDeposits_{it} = \alpha_i + \beta \Delta intensity_{it} + \epsilon_{it}$. The data are from International Financial Statistics Database, at the country-year level and covers 2004 to 2019 to avoid COVID19 periods. The growth of government deposits is defined as $governmnetDeposits_{it}/governmentDeposits_{it\text{-}1} - 1$. E-money intensity is computed as the number or e-money registered accounts per 1,000 adults over the number of deposit accounts with commercial banks per 1,000 adults. The growth of e-money intensity is defined as $intensity_{it}$ / $intensity_{it\text{-}1} - 1$. In columns (1) and (2), the sample consists of all countries. In columns (3) and (4), the sample consists of countries with low financial inclusion prior to the emergence of e-money. In columns (5) and (6), the sample consists of countries with high financial inclusion prior to the emergence of e-money. Fixed effects are denoted in each column. Standard errors are clustered by country, shown in the parentheses. *, **, and *** indicate significance at the 0.1, 0.05 and 0.01 levels, respectively.

Table 11. Private-Sector Deposits and E-Money Intensity

	Growth of Private-Sector Deposits					
	All		Low financial inclusion		High financial inclusion	
	(1)	(2)	(3)	(4)	(5)	(6)
Growth of e-money intensity	0.03*	0.03**	0.05**	0.05***	-0.01	0.00
	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)
Constant	0.11***	0.11***	0.12***	0.12***	0.10***	0.10***
	(0.01)	0.00	(0.02)	0.00	(0.01)	0.00
Observations	247	247	123	123	98	98
No. of countries	47	47	21	21	22	22
Country FE	No	Yes	No	Yes	No	Yes
R-squared	0.021	0.034	0.054	0.076	0.003	0.000

Notes. This table estimates the effect of e-money development on growth of private-sector deposits after e-money was introduced. The regression specification is $\Delta \text{private}Deposits_{it} = \alpha_i + \beta \Delta intensity_{it} + \epsilon_{it}$. The data are from International Financial Statistics Database, at the country-year level and covers 2004 to 2019 to avoid COVID19 periods. The growth of private-sector deposits is defined as $\text{private}Deposits_{it}/\text{private}Deposits_{it\text{-}1} - 1$. E-money intensity is computed as the number or e-money registered accounts per 1,000 adults over the number of deposit accounts with commercial banks per 1,000 adults. The growth of e-money intensity is defined as $intensity_{it} / \ intensity_{it\text{-}1} - 1$. In columns (1) and (2), the sample consists of all countries. In columns (3) and (4), the sample consists of countries with low initial financial inclusion prior to the emergence of e-money. In columns (5) and (6), the sample consists of countries with high initial financial inclusion prior to the emergence of e-money. Fixed effects are denoted in each column. Standard errors are clustered by country, shown in the parentheses. *, **, and *** indicate significance at the 0.1, 0.05 and 0.01 levels, respectively.

Table 12. E-Money Emergence and Financial Inclusion

	Share of Depositors					
	All		Low financial inclusion		High financial inclusion	
	(1)	(2)	(3)	(4)	(5)	(6)
Post	4.04**		4.44**		8.94	
	(1.89)		(2.03)		(9.66)	
Post0		1.66		3.55**		1.55
		(1.65)		(1.69)		(6.98)
Post1		3.30*		4.98**		2.93
		(1.73)		(1.97)		(6.80)
Post2		5.61**		7.68**		6.91
		(2.68)		(2.90)		(8.39)
PostBeyond		7.37**		7.28**		21.23
		(3.30)		(3.09)		(18.94)
Observations	339	339	221	221	73	73
No. of countries	32	32	20	20	9	9
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.44	0.44	0.53	0.54	0.65	0.71

Notes. This table estimates the relationship between the introduction of e-money and share of depositors. The dependent variable is share of depositors, calculated as the number of depositors in 1,000 adults divided by 10. Columns (1) and (2) consist of the sample of all countries. Columns (3) and (4) consist of the sample of countries with low initial financial inclusion, and columns (5) and (6) consist of the sample of countries with high initial financial inclusion. $Post$ is a dummy variable which equals 1, if year t is after the inception year and zero otherwise. $Post0$ equals 1, if the year is the inception year. Similarly, $Post1$ and $Post2$ are 1, if the year is one or two years after the inception, respectively. $PostBeyond$ is 1, if the year is at least three years after the introduction of e-money. Fixed effects and control variables are denoted in each column. Control variables include lagged number of ATMs and lagged number of bank branched. Standard errors are clustered by country, shown in the parentheses. *, **, and *** indicate significance at the 0.1, 0.05 and 0.01 levels, respectively.

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