Financial Inclusion, Trust, and Geography of Cryptocurrency

by

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This study examines whether a peer-to-peer payment system using cryptocurrencies serves as substitutes or complements for banks and money transfer operators in the cross-border payment market. I develop a conceptual framework and derive testable hypotheses to distinguish between these two possibilities. Using an exogenous shock in the bank-intermediated cross-border payment system, I employ a difference-in-differences design and find that, compared with the control group, cryptocurrency value received on blockchain is higher for treated countries after the shock. Moreover, the difference-in-differences in cryptocurrency received is more pronounced for countries with a higher share of unbanked population. Using a change specification that controls for time-invariant omitted variables, this study finds that on-chain value received increases as the share of banked population decreases. The cross-country variation in lack of trust in financial institutions partly explains the positive relation between the share of unbanked population and the geography of cryptocurrency. Overall, this study provides the first large-sample cross-country evidence that a peer-to-peer payment system using cryptocurrencies bypasses the conventional banking system and meets the demand that would otherwise be unmet by traditional financial intermediaries. The results highlight the potential of blockchain technology in enhancing financial inclusion.

Keywords: cryptocurrency; financial inclusion; cross-border payment; blockchain; trust in financial institutions; on-chain

JEL codes: F24; G15; G23; O33

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1. Introduction

Cryptocurrencies represented an overall market capitalization of about $1.5 trillion as of April 2023, with participation from both institutional and retail investors. Globally, the number of cryptocurrency users has increased from 5 million in 2016 to 101 million in the third quarter of 2020 (Blandin et al. 2020). Yet little is known about the user segments that cryptocurrencies serve. Does cryptocurrency meet the demand that would otherwise be unmet by banks and traditional financial intermediaries? Or do they compete with banks and traditional financial intermediaries for the same clientele? This issue is important for assessing the implications of cryptocurrency adoption and regulation. If cryptocurrencies are complements to banks, they enhance financial inclusion by expanding access for the population who are unbanked or underserved by the existing financial system. Accordingly, regulation should focus on how to potentially improve financial inclusion together with the existing financial system. If instead cryptocurrencies compete directly with banks and traditional financial institutions, cryptocurrency adoption is limited to users with banking access. Accordingly, regulation should focus on financial instability and fix specific issues rising on the cryptocurrency market.

Compared with a traditional payment system where a third-party payment company makes sure funds are sent and received properly and where banks of the sender and the receiver validate transactions, only the sender and the recipient participate in peer-to-peer payment system using cryptocurrencies. In theory, cryptocurrency could complement or substitute for the existing banking and financial system. On the one hand, a peer-to-peer (P2P) payment system using cryptocurrencies allows the unbanked population to bypass the conventional banking system. Bank accounts are *not necessary* for storing, sending, and receiving cryptocurrency in crypto wallets. On the other hand, existing banking customers could easily switch to using the blockchain-enabled cryptocurrency as substitutes for bank payments due to its convenience and lower costs.

The empirical challenge, however, is that the econometrician does not observe whether cryptocurrency users have banking access. For instance, cryptocurrency users may voluntarily choose a P2P payment system using cryptocurrencies over bank payment due to lower costs or greater convenience, or they may be forced to reply on cryptocurrency after being denied access to banking services. To address this empirical challenge, I developed a conceptual framework in which cryptocurrencies may operate as substitutes for bank payment or instead as complements. The conceptual framework considers a cross-border payment market in which bank-intermediated payment and cryptocurrency payment co-exist and the relation between banks and cryptocurrencies is defined by the clientele they serve in equilibrium. I derive testable hypotheses on how an exogenous shock to the bank-intermediated cross-border payment system affects both the *quantity* and the *geographic distribution* of cryptocurrency received on blockchain. The key identification assumption is that, if the bank-intermediated cross-border payment system experiences a negative shock in a particular country, more users from that country would be forced to use cryptocurrency for cross-border payments. Therefore, regardless of the user segment that cryptocurrency serves, destination countries that are the recipients of bank-enabled payments from this country in the pre-shock period are likely to receive more funds via cryptocurrency after the shock. However, depending on whether cryptocurrency complements or substitutes for bank-intermediated cross-border payments, the conceptual framework yields opposite predictions on the *geographical distribution* of the increase in cryptocurrency. If the user segments that cryptocurrencies serve are primarily individuals who *have* access to banking services, i.e., if cryptocurrency provides the banked population with a substitute product for cross-border payment, the conceptual framework will imply that the increase in cryptocurrency received on blockchain is more pronounced for destination countries with higher shares of *banked* population. However, if the user segments that cryptocurrencies serve are primarily individuals who do *not* have access to banking services, i.e., if cryptocurrency complements banks in terms of primary clientele, the conceptual framework will imply that the increase in cryptocurrency received on blockchain is concentrated in destination countries with higher shares of *unbanked* population.

Specifically, this study uses the removal of major banks in Russia and Belarus from SWIFT in the second quarter of 2022 as an exogenous shock to the bank-intermediated cross-border payment system to identify whether cryptocurrency and banks are substitutes or complements. Cross-border payment is a natural use case for cryptocurrency because a P2P payment system using cryptocurrency has the potential in mitigating the frictions in the bank-intermediated cross-border payment system, including high fees, unfavorable foreign exchange rates, and regulatory barriers such as registration requirements for each country. As more users in those two countries are forced to switch from bank payment to cryptocurrency for outward cross-border payments, destination countries are now more likely to receive cross-border payments via cryptocurrency after the shock. Accordingly, this paper classifies countries that were recipients of bank-intermediated cross-border payments from Russia and Belarus in the pre-shock period as the treatment group and the remaining countries as the control group. In terms of inference, an increase in cryptocurrency received on blockchain does not necessarily mean that users are more likely to use cryptocurrencies for payments because bank payments could increase as well. The shock itself presents a setting in which an increase in cryptocurrency inflows is more likely to be driven by a higher likelihood of using cryptocurrency instead of bank transfers rather than a higher demand for cross-border payments.

Empirically, this study uses cryptocurrency value received on blockchain (weighted by gross domestic product [GDP] per capita) to capture the cross-country distribution of cryptocurrency (Chainalysis 2020, 2021, and 2022). Chainalysis uses the following three steps to estimate cryptocurrency value received on blockchain for a given period at the country level. The first step is to measure on-chain transactions occurring on each crypto service platform using transaction-by-transaction data on blockchain. As most crypto service platforms operate across many countries and serve the global market, the second step is to use web traffic tools, such as Similarweb, that provide the *geographical* distribution of web traffic for the service platform's URL address to allocate on-chain transactions of the platform to various countries. The last step is to aggregate transactions allocated to a given country across *all* service platforms and use the aggregated value as cryptocurrency value received on blockchain for the country. The share of the banked population is obtained from the Global Findex Database.

On a univariate basis, after the shock, cryptocurrency value received on blockchain for the treatment group increased by 0.19%, whereas on-chain cryptocurrency value for the control group decreased by 2.44%. I use a difference-in-difference design to examine whether the difference is statistically and economically significant after controlling for other economic and technological factors. In terms of extensive margin, cryptocurrency value received on blockchain (deflated by GDP per capita) is higher for the treatment group than the control group *after* the shock. Moreover, the difference-in-differences in cryptocurrency received on blockchain is more pronounced for countries with a higher (lower) share of unbanked (banked) population.

In terms of intensive margin, the potential effect of the exogenous shock is not equal across all treated countries because some destination countries receive more payments via banks from Russia and Belarus than others in the pre-shock period. The potential effect depends on the recipient country's reliance on the bank-intermediated cross-border payment system from Russia and Belarus. Remittance, a subset of cross-border payment that specifically refers to the transfer of *money* from one country to another, is economically substantial. Global remittances totaled $773 billion and outward remittances from Russia and Belarus totaled $17.5 billion in 2021. Empirically, this study uses a recipient country's share of remittances from Russia and Belarus in 2021 as a continuous measure to proxy for the *intensity* of the treatment effect and finds that cryptocurrency value received on blockchain after the shock is higher for countries that receive a higher share of remittances from Russia and Belarus in the pre-shock period. Moreover, holding constant a country's share of remittances, the difference-in-differences in cryptocurrency value received on blockchain is more pronounced for countries with higher shares of unbanked population.

To summarize, using an exogenous shock in the bank-intermediated cross-border payment system, this study identifies that cryptocurrency complements banks in terms of primary clientele it serves and enhances financial inclusion by providing access to the unbanked population in the cross-border payment market. Another scenario is that cryptocurrency payment and bank-intermediated payment system complement each other in that small value is transferred via cryptocurrency, whereas large value is transferred via banks (MTOs). This study also finds that the difference-in-differences in on-chain *retail* value received is more pronounced for countries with higher shares of unbanked population.

Conditional on identifying that cryptocurrency benefits the unbanked population more than banked population in response to a negative shock in the bank-intermediated cross-border payment system, this study extends the analysis from the use of cryptocurrency as a medium of exchange in the cross-border payment market to other use cases of cryptocurrency and derive a *general* bank-cryptocurrency relation and its comparative statistic. As the share of the banked (unbanked) population is not exogenous, this study uses a change specification to alleviate the concern for omitted correlated variables that are time invariant, which is equivalent to including country fixed effects. Using the change specification, this study finds that, after controlling for contemporaneous changes in economic and technological factors, on-chain cryptocurrency value received increases as the share of unbanked population increases. This indicates that cryptocurrency expands financial access to the unbanked population in a general sense. Furthermore, the bank-cryptocurrency relation in the change form is more pronounced in low-income and middle-income countries than high-income countries. The comparative statistic is consistent with the conjecture that remittance inflows are economically more important for low-and-middle-income countries.

Though the change specification alleviates the concern for time-invariant variables, it does not address omitted correlated variables that are time varying beyond the changes in the set of control variables. To further substantiate the cryptocurrency-bank relation, this study finds that lack of trust in banks and financial institutions partly explains the complementarity between banks and cryptocurrency. Conceptually, one might consider blockchain to be a technology-based control system that can remove the need for a trusted third-party financial institution. Parties on the blockchain trust the blockchain to do the things that a bank would do in a more conventional transaction: facilitate the transfer, ensure sender authenticity, and vouch for the validity of the currency exchanged. Using the percentage of respondents in a country or region that cite lack of trust in financial institutions as a barrier to financial account ownership, this study finds that cryptocurrency value received on blockchain increases as lack of trust in financial institutions increases. The positive association implies a substitution between blockchain-powered technology and trust in financial intermediaries in mitigating counter-party risk. However, such a substitution is less pertinent for crypto transactions that are not carried out on blockchain, such as buying and selling cryptocurrencies on centralized exchange platforms. As a placebo test, this study finds that the change in lack of trust in financial institutions *cannot* explain the change in the volume of off-chain cryptocurrency transactions. Accordingly, the share of banked population does *not* affect the geography of off-chain crypto transactions.

Taken together, this study provides the first large-sample cross-country evidence that users *without* banking access are the most likely to benefit from cryptocurrency in the cross-border payment market when the bank-intermediated cross-border payment system is interrupted. Cryptocurrency complements the banking system to the extent that cryptocurrencies enhance financial access to the unbanked population. This study differs from prior studies in several ways. First, much of the emerging literature focuses on the use case of cryptocurrency as *a vehicle for investment and speculation* (e.g., Makarov and Schoar, 2020; Liu and Tsyvinski, 2021). Other lines of research investigate the mining and verification mechanism of cryptocurrency (e.g., Easley, O'Hara, and Basu, 2019; Cong, He, and Li, 2020). This paper is among the first to focus on the use case of cryptocurrency as *a medium of exchange* and investigate the bank-cryptocurrency relation in the cross-border payment market. Overall, the evidence highlights the potential of blockchain-powered technology in enhancing financial inclusion in the cross-border payment market. Second, I develop a conceptual framework to study the effect of a negative shock to the bank-intermediated cross-border payment system. Under the framework, I explicitly address the issue of which user segments that cryptocurrencies serve and infer the bank-cryptocurrency relation from the *geographical* distribution of cryptocurrency value received on blockchain. Third, this study is the first to use *estimated* value transferred on blockchain to measure the cross-country distribution of cryptocurrency, which contrasts with various proxies used in prior studies for cryptocurrency adoption. For instance, Parino, Beiro, and Gauvin (2018) use the number of Bitcoin software client downloads and Google searches; Saiedi, Broström, and Ruiz (2020) use Bitcoin nodes; Liu and Tsyvinski (2021) use the number of wallet addresses; and Jalan et al. (2022) use the number of active receiving and sending addresses and market capitalization of cryptocurrencies.

Second, this study complements prior studies that examine whether fintech enhances financial access (e.g., Buchak et al. 2018; Fuster et al. 2019; Tang, 2019; Berg et al. 2020). Fuster et al. (2019) find *no* evidence that fintech lenders disproportionately target marginal borrowers with low access to finance in the U.S. mortgage market. Tang (2019) finds that peer-to-peer lending platforms largely substitute for banks in the consumer credit market. In contrast, Berg et al. (2020) find that, after the introduction of the digital footprint in an e-commerce company in Germany, customers with a good digital footprint and a low credit bureau score gain access to credit while customers with a medium credit bureau score and a poor digital footprint lose access to credit. This study is related to but distinct in two major aspects. First, prior studies typically use a fintech platform in a specific country as the setting and focus on the *distribution* of fintech-enabled financial access among players with differing *socioeconomic* statuses and *credit scores within* the country. In contrast, this study examines the geography of cryptocurrency and focuses on the distribution of blockchain-powered cryptocurrencies *across* countries with differing access to the *banking* system. Accordingly, this study sheds some light on the question of whether blockchain-powered cryptocurrency levels the playing field by examining whether countries with a higher share of unbanked population gain disproportionately more access to financial services through cryptocurrencies. Second, enhanced financial access typically relies on the financial intermediation of fintech platforms as documented in prior studies. This study differentiates on-chain crypto transactions that do not rely on financial intermediation from off-chain crypto transactions that rely on financial intermediation of crypto platforms and find that cross-country variations in shares of unbanked population explain the geography of cryptocurrency value received on blockchain, but *not* that of off-chain crypto transactions. The presence (absence) of financial intermediation implies that mechanisms underlying the effect of fintech platforms on financial inclusion are likely to differ from those of crypto transactions that are carried out on blockchain.

Third, this study contributes to the broad question of societal culture and economic outcomes. Prior studies have examined extensively the effect of *generalized* trust on economic outcomes (e.g., LaPorta et al. 1998; Stulz and Williamson 2003; Nahata, Hazarika, and Tandon 2014; Guiso, Sapienza, and Zingales 2008, 2009; Karolyi 2016). This study builds on the idea that blockchain removes the need for a trusted third-party and focuses on *trust in financial institutions* as the most relevant concept in the context of cryptocurrency adoption. Lack of trust in financial institutions discourages financial account ownership but increases the reliance on blockchain-powered control systems to mitigate counterparty risks, thereby increasing cryptocurrency value received on blockchain. The *negative* relation between *trust in financial institutions* and on-chain value received is opposite to the *positive* effect of *generalized trust* on participation in conventional financial markets (e.g., Guiso, Sapienza, and Zingales 2008, 2009; Karolyi 2016) and public interest in cryptocurrencies (e.g., Jalan et al. 2022). Lack of trust in financial institutions encouraging participation in nonconventional financial markets, however, is consistent with the negative association between the *level* of trust in banks and the adoption of Bitcoin infrastructure as documented in Saiedi, Broström, and Ruiz (2021), the rise of Bitcoin prices after institutional failures as documented in Tang, You, and Zhong (2023), and the increased probability of using FinTech with exposure to Wells Fargo scandal in the mortgage market as documented in Yang (2022).

2. Institutional background and conceptual framework

2.1. Institutional background on cross-border payments, remittances, and cryptocurrency

Cross-border payments are financial transactions where the sender and the recipient are based in different countries. They cover both wholesale and retail payments. Wholesale cross-border payments are typically between financial institutions, either to support its customers' activities or its own cross-border operating activities. Retail cross-border payments are typically among individuals and businesses and the key types include person-to-person, person-to-business, and business-to-business. Cross-border payments facilitate the expansion of global e-commerce, the rise of complex international supply chains, and remittances sent by migrant workers. Figure 1 depicts the flow chart of the existing cross-border payment process. The basic structure of the cross-border payment system consists of four main components: sender, recipient, payment service provider, and payment system. The sender is the person who initiates the transfer of funds to the recipient and the recipient is the person who receives the funds in another country. The payment service provider is the entity that facilitates the transfer of funds between the sender and the recipient, such as a bank, a money transfer operator (MTO), or a mobile money provider. The payment system is the network of institutions and mechanisms that enable the transfer of funds between the payment service providers in different countries, such as correspondent banking, card networks, or payment platforms. Compared with domestic payment, cross-border payment is associated with additional risks. First is the additional foreign exchange settlement risk. In the receiving country, a money transfer operator

(MTO) needs to buy the receiving currency from their correspondent bank and sell equivalent foreign currency. During this process, it is possible that the exchange rate goes in a detrimental direction and results in additional foreign exchange settlement risk. Second is the complicated regulatory environments. Each country issues a separate set of guidelines on issuing licenses for MTOs to send and receive money out of country, transaction processing, and settlement mechanisms. For instance, an MTO is required to register in each country in which it operates. Third is the risk of fraud, illicit activities, and money laundering. Financial institutions are expected to ensure due diligence of the cross-border transactions and stakeholders in terms of business models, KYC checks, anti-money laundering (AML), and combating the financing of terrorism (CTF). With strict regulations concerning AML/CFT, financial institutions tend to cut down on their number of MTO partnerships. All those factors make the bank-intermediated cross-border payment process more complex than that of domestic payment, and hence are more expensive. To summarize, high fees, foreign exchange settlement risk, and regulatory barriers are major frictions in the bank-intermediated cross-border payment system.

Remittance, a subset of cross-border payment, specifically refers to the transfer of *money* from one country to another. Migrant workers are a significant end user of the cross-border payment market and remittances are primarily money that immigrant workers transfer from the host country to their families in home countries. Remittances are economically substantial and a vital source of foreign income for many developing countries, sometimes surpassing foreign direct investment and overseas development assistance. According to the World Bank, global remittances sent to low-income and middle-income countries totaled $597 and $626 billion in 2021 and 2022, respectively. In 2021, India, Mexico, China, Philippines, and Egypt were the top recipients. In terms of the share of gross domestic product (GDP), the top five countries are Tonga (44.9%), Lebanon (37.8%), Samoa (33.7%), Tajikistan (32%), and Kyrgyz Republic (31.2%). Migrant workers and their families in their home countries are either underserved or excluded financially. Therefore, understanding how technology alters the way remittances were sent and received further our general understanding of financial inclusion.

In terms of instruments, digital payment far exceeded cash payment in the cross-border money transfer market largely because social distancing prompted a reduction of retail outlets in favor of account-to-account transfers (digital instrument).[1] In terms of channel for cross-border payment, while the MTO segment dominated the overall cross-border payment market, immigrant workers *mostly* use wire transfer services for remittances as bank-enabled services are considered the safest modes of fund transfer.[2] The largest MTOs are Western Union, MoneyGram, Intermex, and Ria. As shown in the flow chart, the traditional cross-border payment system usually involves various intermediaries like the sender bank, receiving bank, money transfer operators, foreign exchange, and payment system that charge high fees and take time to process the transactions. Globally, the average cost of sending $200 was 6% in 2022, which doubles the Sustainable Development Goal target of 3%. The excessive costs of bank-intermediated remittances impose disproportionately higher financial burdens on immigrant workers.

Cryptocurrencies, such as Bitcoin or Ethereum, enable value transfer directly between the sender and the receiver without the need for financial intermediaries. Blockchain helps remove intermediaries in the money transfer process and has the potential to reduce costs and increase transaction speeds than banks and credit card companies. Transactions take place in minutes, and fees on the blockchain are significantly lower. Accordingly, cryptocurrency provides a less costly but faster alternative to bank-intermediated cross-border payment system and has emerged as an important payment option. During the period from July 2019 to June 2020, crypto value transferred on blockchain reached $340 billion globally (Chainalysis 2020).

A unique feature of using cryptocurrency as a payment option is that bank accounts are *not* necessary for storing, sending, or receiving cryptocurrency in crypto wallets. According to Pew Research Center, 1.7 billion people are still unbanked globally. Services allow the unbanked population to buy Bitcoins. For instance, Local Bitcoins, one of the largest P2P crypto platforms, has over 1 million active users as of

[1] Alex Holmes, MoneyGram CEO, explained "Something like 70% of people over the age of 65 tried an online application for the first time during the coronavirus because they did not have an alternative. 35% of people are shifting to digital, the type of sources that they have not used before."

[2] See https://www.grandviewresearch.com/industry-analysis/digital-remittance-market

December 2021. Local Bitcoin offers several payment methods, such as cash and prepaid mobile phone cards, for buying Bitcoin with no bank account. On the platform, users post advertisements that state exchange rates and payment methods for buying or selling Bitcoin, and other users reply to these advertisements and make the payment using their specified payment method. Moreover, Bitcoin ATMs were used by users without bank accounts to convert between Bitcoin and local currency. Anecdotally, a Bitcoin ATM was installed in a small pizza place in Bishkek, Kyrgyzstan that transformed remittances.[3] According to Tradingbrower.com, while the share of unbanked population is 60% in Mexico, it ranks third in terms of the number of Bitcoin ATMs. In contrast, the unbanked accounts for less than 1% of the population in Sweden, but the country has no single Bitcoin ATM. Accordingly, cryptocurrency has the potential of enhancing financial inclusion because a P2P payment system using cryptocurrencies bypasses the traditional banking system and enables users to join the modern world of cross-border payments.

Another major advantage of cryptocurrency is its ease of use. Anyone with a smart phone and access to the Internet can send and receive Bitcoin. Therefore, families of migrant workers who live in less developed areas who may not have access to traditional banking services could easily switch to sending and receiving cross-border payment via cryptocurrency. For instance, the Lightning Network enables the creation of a peer-to-peer payment channel between two parties and allows users to send and receive on-chain Bitcoin faster and cheaper. The sender only needs the receiver's lightning address (usually accompanied with a QR code) via applications to send Bitcoin and the receiver, on the other hand, has the option to receive the payment in USD or Bitcoin.[4] With the rise of crypto offramps, users can easily exchange cryptocurrency for cash and manage financial risks easily by hedging against cryptocurrency

[3] https://www.kitco.com/news/2023-03-16/Crypto-and-Bitcoin-ATM-adoption-is-highest-in-countries-with-large-unbanked-populations.html

[4] On the Lightning Network, the payer must lock a certain amount of Bitcoin onto the network to create a payment channel. The recipient can invoice the amount to the payer and they can transfer funds to each other without informing the main blockchain. As transactions on the network do not need to be approved by all nodes, it speeds up transactions and increases efficiency. When the two parties finish transacting, they close the channel. All the channel's transactions are consolidated into one transaction, which is sent to the main Bitcoin blockchain to be recorded. According to 1ml.com, the average transaction cost is only $0.000000443 per dollar value transfer.

price volatility, making cryptocurrency a viable and practical payment option. Crypto offramps are the gateways provided by exchanges and payment processors that allow customers to convert crypto into fiat currency easily without the need for *technical* expertise. Once a user registers with an offramp service provider and go through the verification process, often through an app, she/he deposits cryptocurrency into the account provided by the offramp service and converts the deposited cryptocurrency into the desired fiat currency. Then the user can withdraw the converted fiat currency to a bank account or other desired destinations. For instance, Payouts.cash launched a crypto service where cryptocurrency sent is instantly converted to the receiver's local fiat currency and provides instant liquidity to recipients in African countries in under 3 minutes. To summarize, blockchain make cross-border payments *easier* and *cheaper*: Any person can send and receive payments from anywhere in the world with less worry about exchange rates or bank fees. For developing economies and people with friends or family living abroad, the ability to send and receive money cross-border instantaneously is transformative.

Relatedly, in addition to banks and traditional MTOs, online money transfer platforms have emerged as new players in the cross-border payment markets. Compared with banks that still dominate the space for large-value business transactions, online money transfer platforms are mostly focused on low-value transactions. However, it is important to point out that for the innovation for online money transfer platforms is primarily focused on the *front-end (the client-facing)* side, such as providing better branding, better customer services, and cheaper prices. The *back end* of online money transfer platforms still uses the legacy *banking* infrastructure such as clearing (NSCC), payment (ACH), and messaging (SWIFT) systems, which is in sharp contrast to cryptocurrency that relies on blockchain technology.

2.2. Conceptual framework for the bank-cryptocurrency relation

To guide the empirical investigation of the bank-cryptocurrency relation in serving various segments in the payment markets, I developed a simple conceptual framework in which cryptocurrency and the bank-enabled payment system coexist and compete. Each payment channel, either via bank/MTO or *via cryptocurrency*, offers a service menu that specifies payment instruments and costs. The market reaches an equilibrium when, given the menus offered by both channels, each user with or without access to banking services chooses the optimal instrument-cost combination offered to her. The relation between banks and cryptocurrency in the cross-border payment market is defined by the clientele they serve in equilibrium. Considering the share of the population that have access to banking services is γ, I let $\alpha(\gamma) \in [0,1]$ be the *fraction* of banked population who are served by cryptocurrency and 1- $\alpha(\gamma)$ be the *fraction* of banked population who are served by banks. For a given user with access to banking services, the two channels for cross-border payment are substitutes if $0 < \alpha(\gamma) < 1$; they are complements if $\alpha(\gamma)$ is either 0 or 1.

Eight banks in Russia, including Sberbank, the largest bank of Russia, and three banks in Belarus, were removed from Society for Worldwide Interbank Financial Communication (SWIFT) in March 2022.[5] SWIFT is a global financial messaging network that enables banks to securely exchange electronic messages and financial transactions, which is used by financial institutions in over 200 countries. Banks establish relationships with each other and use messages within the system to make payments. The messages ae secure and allow banks to process high volumes of transactions at high speed. SWIFT is the most influential infrastructure in financial services in terms of the volume and value of money that is being moved around the world. The removal of major banks in Russia and Belarus from SWIFT interrupts the bank (MTO)-enabled cross-border payment system.[6] Now consider the effect of the negative shock. Given that cryptocurrency serves the banked population as a substitute for bank-enabled cross-border payment, some users from Russia and Belarus, who previously use banks and MTOs for cross-border payment now switch to send money via cryptocurrency. The switching effect would imply, following the shock, more users from Russia and Belarus with banking access migrate to cryptocurrency for outward cross-border payment, and correspondingly, a greater fraction of users in destination countries that are the recipients of bank-enabled cross-border payments switch to *receive* cryptocurrency on blockchain. Let us say the fraction of banked population in destination countries that receive cryptocurrency *increases* by β.

[5] The other Russian banks removed from SWIFT were Bank Otkritie, Novikombank, Promsvyazbank, Rossiya Bank, Sovcombank, VEB, and VTB. SWIFT is a communication platform, not a financial payment system. Russia is ranked second in the world by the number of users of SWIFT.

However, a demand (income) effect could also be at work. Consider the negative effect of Russia-Ukraine war and trade embargo on the *demand* side of outward cross-border payment from Russia and Belarus. The decline in economic activities dampens employment and income of individuals, including migrant workers living in Russia and Belarus, and therefore, disposal income that is available for outward remittances, either via banks or cryptocurrency, declines. Accordingly, holding the fraction of individuals with banking access who use cryptocurrency for cross-border payment (α) constant before and after the shock, the income (demand) effect would predict that both the bank-enabled cross-border payment and cryptocurrency received from Russia and Belarus are lower.

Under the assumption that the market is in equilibrium before the shock and reaches a new equilibrium within a brief period after the shock, I derive the predictions about the effect of a negative shock to the bank-enabled cross-border payment system on the *quantity* and the *geographical distribution* of cryptocurrency value received on blockchain. Accordingly, I infer the *pre-shock bank*-cryptocurrency relation. To streamline the discussion, I first consider two polar cases—where banks and cryptocurrency are either perfect substitutes or perfect complements—and then discuss an intermediate case. Each case is characterized by γ (the share of banked population) and α (the fraction of banked population that cryptocurrencies serve).

First, let us consider the case that cryptocurrency operates as perfect substitutes for banks. In this case, cryptocurrency payments provide individuals with access to banking services with a substitute product and do not serve the "unbanked" population. That is, $0 < \alpha\ (\gamma) < 1$. Given that the share of the population with access to banking services is γ and that cryptocurrencies *solely* serve the segment of individuals with banking access, the share of the *total* population that cryptocurrencies serve is $\alpha^*\gamma$. An increase in cryptocurrency transaction volume does not necessarily mean that users are more likely to use cryptocurrencies for payments because the transaction volume of the existing bank payment system could increase as well. Accordingly, what matters is not the *absolute* volume of cryptocurrency value received on blockchain, but rather the *proportion* of payments via cryptocurrency. In terms of the geographical distribution, cryptocurrency value received on blockchain deflated by GDP per capita increases in the share of banked population (γ) and in the fraction of banked population who choose cryptocurrency (α). Let us say the fraction of users with banking access in destination countries that are recipients of cryptocurrencies from Russia and Belarus *increases* by β after the shock. Therefore, the fraction of banked population that receive cryptocurrency from Russia and Belarus is (α + β) and the fraction of the *total* population that cryptocurrency serves is (α +β) *γ after the shock. When cryptocurrencies primarily serve the population with banking access, as (α + β) is always positive, in terms of the geographical distribution, cryptocurrency received on blockchain (deflated by GDP per capita) increases in the share of banked population (γ).

To summarize, when the user segments that cryptocurrencies serve are primarily users with banking access in the pre-shock period, the predictions can therefore be summarized as follows. If banks and cryptocurrency are perfect substitutes in the cross-border payment market, the disruption to the bank-enabled cross-border payment system in Russia and Belarus entails (i) a lower bank-enabled outward cross-border payment from the two countries; (ii) if the switching effect dominates, a higher cryptocurrency value received on blockchain for recipient countries of bank-enabled cross-border payment from Russia and Belarus in the pre-shock period; (iii) if the switching effect dominates, in terms of geographical distribution, the higher cryptocurrency received on blockchain is concentrated in recipient countries with a higher share of banked population;[7] and (iv) if the income effect dominates, an overall decrease in cryptocurrency received on blockchain for recipient countries of bank-enabled cross-border payment from Russia and Belarus.

Second, let us consider the case that cryptocurrency operates as perfect complements for banks-enabled cross-border payment. In this case, banks serve users with bank accounts (the “banked” population), while cryptocurrency complements banks by serving users who do not have bank accounts (the “unbanked” population). That is, α (γ) = 0. Assume that the fraction of unbanked population that use cryptocurrency is π. Given that the share of the unbanked population is 1-γ and that cryptocurrency *solely* serve the segment

[7]The conceptual framework has implications on the effect of the shock on the quantity and the geographical distribution of cryptocurrency received by Russia and Belarus as well. However, in the pre-shock period, cross-border outflows dominated cross-border inflows in Russia and Belarus. For instance, in 2021, bank-enabled outward remittances were $17.5 billion, whereas bank-enabled inward remittances were $9.7 billion.

of individuals *without* banking access, the faction of the t*otal* population that cryptocurrencies serve in the cross-border payment market is (1- γ) *π in the pre-shock period. Therefore, after the shock, the fraction of cryptocurrency received on blockchain is (1- γ) *π + β*γ, which is equivalent to π + (β-π) * γ. Given that cryptocurrency primarily serves the unbanked population, it is reasonable to assume that the increase in the fraction of banked population that switch to cryptocurrency to receive cross-border payment from Russia and Belarus after the shock (β) is less than the fraction of unbanked population that uses cryptocurrency in the pre-shock period (π). If cryptocurrencies primarily serve the population without banking access, as (β-π) is negative, in terms of geographical distribution, cryptocurrency received on blockchain (deflated by GDP per capita) *decreases* in the share of banked population.

To summarize, when the user segments that cryptocurrencies serve are primarily users *without* banking access in the pre-shock period, the predictions can therefore be summarized as follows. If banks and cryptocurrency are perfect complements in the cross-border payment market, the disruption to the bank-enabled cross-border payment system in Russia and Belarus entails (i) a lower bank-enabled outward cross-border payment from the two countries; (ii) if the switching effect dominates, a higher cryptocurrency value received on blockchain for recipient countries of bank-enabled cross-border payment from the two countries in the pre-shock period; (iii) if the switching effect dominates, in terms of geographical distribution, the higher cryptocurrency received on blockchain is concentrated in recipient countries with a lower share of banked population; and (iv) if the income effect dominates, an overall decrease in cryptocurrency received on blockchain for recipient countries of bank-enabled cross-border payment from Russia and Belarus.

It is clear from comparing the predictions under these two polar cases that the effects of the shock on the quantity of *bank-enabled* cross-border payments from Russia and Belarus are the same. Regardless, recipient countries in the pre-shock period receive less bank-enabled cross-border payments from Russia and Belarus after the shock. However, the two cases have opposite effects on the *geographical distribution* of cryptocurrency received on blockchain. If the user segments that cryptocurrencies serve are primarily individuals that have access to banking services, cryptocurrency received is concentrated in treated countries with a higher share of banked population. However, if the user segments that cryptocurrencies serve are primarily individuals that do not have access to banking services, cryptocurrency received is concentrated in treated countries with a lower (higher) share of banked (unbanked) population. Those opposite predictions will allow me to distinguish between the two possible cryptocurrency-bank relations in the empirical analysis.

Moreover, this conceptual framework also can accommodate cases that are intermediate between the perfect substitutability and the perfect complementarity of banks and cryptocurrency. For instance, cryptocurrency may operate as substitutes for individuals with banking access while also catering to individuals who are unserved by banks. In this case, cryptocurrency serves a larger range of users than banks do. However, there will be no clear implications for the effect of the shock on the geographical distribution of cryptocurrency received in terms of its relationship with the share of banked population. The precise distribution depends on the relative extent of substitution and complementarity.

2.3. Blockchain technology, trust in financial institutions, and related literature

Blockchain is the technology that supports cryptocurrencies. Blockchain stores and transmits data in packages called "blocks" that are connected to each other in a digital "chain." Blockchain is a specific kind of distributed ledger technology, which replicates a distributed database that involves multiple nodes (computers and devices) and ensures that each node has an active copy. The double-spending problem (the possibility that an individual could duplicate the cryptocurrency and spend it simultaneously at two or more places) is prevented in Bitcoin by using the consensus mechanism known as Proof of Work (PoW). A decentralized network of "miners" not only secures the authenticity of the past transactions on blockchain but also detects and prevents double spending. Easley, O'Hara, and Basu (2019) and Cong, He, and Li (2020) study the mechanism and the incentives for Bitcoin mining. In practice, "miners" use hashes (long strings of numbers) to detect tampering, such as an attempt to double spend. Transactions that have been confirmed are posted publicly to a universal ledger system and maintained in perpetuity irreversibly. All recent transactions are written into blocks, which are then added to the ledger every few minutes. While users can navigate the blockchain for Bitcoin and review transactions for *quantity* only, the identities of the buyer and seller in any transaction are protected by high-level encryption. PoW makes it extremely difficult to change any aspect of the blockchain, as such a change would require remining all subsequent blocks. In summary, blockchain solves the double-spending problem through technology-based mechanisms and the distributed ledger effectively obviates the potential for some nodes to alter content, both of which ensure the independent verifiability of transactions and the pseudo-anonymity in the identities of counterparties.

Lack of trust in financial institutions could partly explain the bank-cryptocurrency relation. Counterparty risk, the risk that a potential trading partner will act opportunistically, is an ever-present threat to every economic exchange and every financial contract. Trust is inversely related with the subjective assessment of counterparty risk and is a *multidimensional* (generalized, relational, and institutional) prerequisite for economic exchanges (Dupont and Karpoff 2020). Prior studies have extensively examined the role of *generalized* trust on economic outcomes. For instance, prior studies find that *generalized trust* enhances participation in *conventional* financial markets (e.g., Guiso, Sapienza, and Zingales 2008, 2009; Karolyi 2016). In the context of cryptocurrency, Jalan et al. (2022) use the World Value Survey trust measure and find a positive association between *generalized* trust and public interest in cryptocurrencies. Tang, You, and Zhong (2023) document an increase in Bitcoin prices after *institutional* failures.

A *decentralized* network minimizes the trust we need in other players. As a means of payment, cryptocurrencies, starting from the Bitcoin experiment, represent the possibility of utilizing blockchain as an alternative *technology-based mechanism* for overcoming the threat of opportunistic counterparties in economic exchanges. The pseudonymous founder of Bitcoin, Satoshi Nakamoto, wrote extensively in the white paper, *Bitcoin: A Peer-to-Peer Electronic Cash System*: "We have proposed a system for electronic transaction without relying on trust. What is needed is an electronic payment system based on cryptographic proof instead of trust, allowing any two willing parties to transact directly with each other without the need for a trusted third party. This is the first time we are trying a decentralized, *non-trust-based* system." (Nakamoto 2008). In a conventional online payment system, users trust a third-party payment company to make sure funds are sent and received properly; banks, credit card companies, and payment processors validate the transactions and minimize the risk of double spending. In contrast, in the P2P payment using cryptocurrency, there is no third-party intermediary—just the sender and the recipient. Parties trust the blockchain to do the things that a bank would do in a more conventional transaction: facilitate the transfer, ensure sender authenticity, and vouch for the validity of the currency exchanged.

Conceptually, one might consider blockchain to be a technology-based control system that can remove the need for a trusted third-party financial institution. Nakamoto commented that "the root problem with conventional currency" is the need to trust central banks not to debase the currency and to trust banks to hold our money and transfer it electronically and not to let thieves drain our accounts (Nakamoto 2009). Accordingly, this study focuses on trust in a *specific* type of institution, financial institutions, as the most relevant concept in the geography of cryptocurrency. The substitution between trust in financial institutions and blockchain-powered control system implies that, when banks and third-party payment companies become less trustworthy, market participants rely more on blockchain-powered control systems to mitigate counterparty risks, thus increasing the use of cryptocurrency. As trust in banks as measured by Life in Transition Survey has no time-series variation, Saiedi, Broström, and Ruiz (2021) use a *level* specification and find a negative association between trust in banks and the adoption of Bitcoin infrastructure.[8]

Although blockchain-based control systems could substitute for trust in financial institutions, blockchain does not *eliminate* the need for trust because blockchain does not solve human problems. Even if the computer codes that provide the foundation for blockchain-powered control systems work perfectly, blockchains are designed, implemented, and used by humans. Crypto markets are fraught with fraudulent and illegal activities, such as money laundering and terrorist financing (Amiram, Jorgensen, and Rabetti 2022), price manipulation (Griffin and Shams 2020), illicit activities (Foley, Karlsen, and Putniņš 2019), and fake volume (Amiram, Lyandres, and Rabetti 2021). Furthermore, some individuals do not interact with each other directly on the blockchain, but instead interact through platforms or wallets or other intermediaries that help them buy, sell, and hold cryptocurrencies.[9] Those transactions are off chain in

[8] On a related note, Yang (2002) document that an increased exposure to Wells Fargo scandal is associated with an increased probability of using FinTech in the mortgage market.

[9] A bank account is generally needed to transfer money *into* a centralized crypto exchange, from which a person can then transfer their cryptocurrency to a crypto wallet. As banks do not exchange cryptocurrencies, such as Bitcoin, for U.S. dollars directly, the most common method for withdrawing cryptocurrencies into a bank account is for users to transfer cryptocurrencies to a centralized exchange and then trade their cryptocurrencies for a stablecoin on that

nature. In fact, a new set of financial intermediaries has been created for those off-chain transactions, and users are trusting (1) that markets are not being manipulated, (2) that wallets will generate secure keys, and (3) that trading platforms are using best security and governance practices (e.g., Bratspies 2018). Accordingly, the substitution between trust in financial intermediaries and blockchain-powered control systems is less pertinent for crypto transactions that are not carried out on blockchain.

3. Data, sample, and research design

3.1. The country-level cryptocurrency value received on blockchain

This study uses cryptocurrency value received on blockchain as the primary measure to capture the geography of cryptocurrency. Chainalysis estimated the value based on the transaction-by-transaction data on blockchain. Therefore, the measure emphasizes grassroots cryptocurrency adoption *beyond* the pure trading volume of cryptocurrencies on centralized exchange platforms and captures cryptocurrency payments by *all* market participants. To estimate the on-chain cryptocurrency value received for each country, Chainalysis follows a three-step procedure. First, using blockchain data, Chainalysis estimates the *on-chain* value received by a cryptocurrency service platform during a pre-specified period. Because many crypto service platforms operate in multiple countries, as the second step, Chainalysis uses web traffic tools, such as Similarweb, that provide the *geographical* distribution of web traffic for the platform's URL address to *allocate* the cryptocurrency value received on blockchain to various countries. For instance, Stellar, a cryptocurrency payment service platform, received a total of $100 million deposits from users on blokchain in June 2022. Based on web traffic analytics on Similarweb, the United States accounts for 39% of web traffic on Stellar.org, Netherlands accounts for 6% of web traffic, and Vietnam accounts for 5%. Accordingly, Chainalysis estimates that the on-chain values received by US, Netherlands, and Vietnam on the crypto service platform is $39 million (39% of $100 million), $6 million (6% of $100 million), and $5

exchange. Stablecoin can then be converted into a local fiat currency to use to transfer to a bank account. For example, a person can exchange Bitcoin for USDT (a dominant stablecoin), then convert USDT into U.S. dollars, and lastly, withdraw U.S. dollars to their bank account.

million (5% of $100 million), respectively. As the last step, Chainalysis aggregates cryptocurrency value received on blockchain across over 2,000 service platforms and uses the *aggregated* value received on blockchain as the *on-chain value received* for each country. The types of crypto service platforms covered by Chainalysis include cryptocurrency wallets, crypto payment platforms, crypto exchanges, merchant services, cryptocurrency ATMs, and gambling and gaming service platform that together control hundreds of millions of addresses and account for over $1 trillion value transferred. As the dominant cryptocurrency, Bitcoin, is still dominated by large and concentrated players (e.g., Makarov and Schoar 2021), another metric is the *on-chain retail value received* where a retail transaction is defined as a transaction under $10,000 worth of cryptocurrency. The on-chain retail value received captures cryptocurrency payments of *nonprofessional, individual* cryptocurrency users.

It is important to acknowledge some important features of cryptocurrency value received *on blockchain* estimated by Chainalysis. First, the on-chain cryptocurrency value received excludes conversions from fiat currencies to cryptocurrencies because those conversions are handled by the internal system between centralized exchanges and banks that an investor uses. Such conversions are not on blockchain. Second, the on-chain cryptocurrency value received does *not* track transactions between addresses *inside* a centralized exchange platform. Centralized services take custody of funds, and transactions between addresses inside a centralized exchange platform are contained only in the service provider's order books, which are *not* recorded on public blockchain and to which Chainalysis does not have access. Third, one caveat of the estimate is that, if a user uses mixers or VPN services, web traffic tools are not able to correctly identify the URL address and/or the user's location. To summarize, the estimated cryptocurrency value received on blockchain captures the use case of cryptocurrency as *a medium of exchange* rather than as a vehicle for investment or speculation.

Chainalysis publishes an annual index that is based on cryptocurrency value received on blockchain scaled by the country's PPP per capita. The index measures each country's purchase power-adjusted on-chain cryptocurrency value received. The first report covers the period from July 2019 to June 2020 and the last report covers the period from July 2021 to June 2022. For instance, as reported in panel B of table

2, during the period from July 2020 to June 2021, China, India, US, Vietnam, Brazil, Ukraine, Thailand, Russia, Turkey, Philippines, Pakistan, UK, South Korea, Argentina, and Nigeria are in the *top* decile of purchase-power-adjusted on-chain value received. However, the shares of banked population are as low as 16%, 30%, and 45% for Pakistan, Vietnam, and Nigeria, respectively. As reported in panel C of table 2, while both Luxembourg and Iceland are in the *bottom* decile of purchase-power-adjusted on-chain value received, virtually all adults have at least one bank account in the two countries.[10]

3.2. Difference-in-differences design in response to an exogenous shock

In this section, this paper uses a difference-in-differences design to investigate whether cryptocurrencies and banks are substitutes or complements for cross-border payments. Specifically, this study uses the removal of major banks in Russia and Belarus from SWIFT as a shock to the bank-intermediated cross-border payment system. In response to the shock, some users from Russia and Belarus, who previously use banks and MTOs for cross-border payment now switch to *send* money via cryptocurrency, and consequently, a greater fraction of users in destination countries switch to *receive* cryptocurrency after the shock. As the World Bank data only captures remittances sent through formal channels, such as banks, money transfer operators, and post offices, I use the cross-border bilateral transfer estimated by the World Bank to classify countries that receive at least 0.1% of bank remittances originated from Russia and Belarus in 2021 as treated countries. Given that outward bank-enabled remittances from Russia and Belarus totaled $17.5 *billion*, of which $ 16.4 billion were from Russia, the threshold implies that each treated country received at least $17.5 *million* remittances from Russia and Belarus in 2021. The treated countries include Armenia, Azerbaijan, Belarus, China, Czech, Estonia, France, Georgia, Germany, Hungary, Israel, Kazakhstan, Kyrgyzstan, Latvia, Lithuania, Moldova, Mongolia, Poland, Russia, Tajikistan, Ukraine, and Uzbekistan. The remaining countries are classified as the control group. I also

[10] Chainalysis also ranks countries according to each of the three metrics, on-chain value received, on-chain retail value received, and P2P exchange trade volume, and takes the geometric mean of each country's ranking in each of the subcomponents, and then normalizes that final number on a scale of 0 to 1 to compile the crypto adoption index.

remove Russia, Belarus, and Ukraine from the analysis to eliminate other confounding factors. I use the following specification to identify the bank-cryptocurrency relation in the cross-border payment market:

$$ONCHAINVALUEit = \alpha + \beta 1 * TREATED(OUTFLOWSHARE)it + \beta 2 * POSTit + \boldsymbol{\beta 3} * \boldsymbol{TREATED(SHAREOUTFLOW)it} * \boldsymbol{POSTit} + \beta 4 * BANKEDSHARE + \beta 5 * TREATED(SHAREOUTFLOW)it * BANKEDSHAREit + \boldsymbol{\beta 6 POSTit} * \boldsymbol{TREATED(SHAREOUTFLOW)}it * \boldsymbol{BANKEDSHAREit} + \beta 7 * INTERNETit + \beta 8 * MOBILEPHONEit + \beta 9 * GDPpercapitait + \beta 10 * INFLATIONit + \beta 11 * FOREXit + \beta 12 * POP + \beta 13 * CAPITALCONTROLit + \beta 14 * MOBILEMONEYit + \beta 15 * AMLSCOREit + \varepsilon \quad Equation\ (1)$$

where *i* denotes countries and *t* indexes time. *TREATED* is a dummy variable set to 1 for countries that receive at least 0.1% of bank-enabled outward remittances from Russia and Belarus during 2021, and 0 otherwise. *OUTFLOWSHARE* is a continuous variable, which is measured as the destination country's share of cross-border payments sent from Russia and Belarus in the pre-shock period. *POST* is a dummy variable set to 1 for periods after March 2022 and 0 otherwise. The dependent variable is the normalized index of on-chain cryptocurrency value received scaled by the GDP per capita in country *i* at time *t* (*ONCHAINVALUE*). A value of 1 for *ONCHAINVALUE* indicates the highest purchase power-adjusted cryptocurrency value received on blockchain. The slope coefficient on *TREATED (OUTFLOWSHARE)* **POST* is expected to be positive (negative) if the switching (income) effect dominates. The share of banked population in a country (*BANKEDSHARE*) is obtained from the Global Findex Database (Demirgüç-Kunt et al. 2018, 2022). If the switching effect dominates, the slope coefficient on *TREATED(OUTFLOWSHARE)*POST*BANKEDSHARE* is expected to be positive (negative) if cryptocurrency and banks are substitutes (complements).

A rich set of control variables are included to control for country-level factors that could influence cryptocurrency value received on blockchain. The first set of control variables are technological factors, including internet penetration (*INTERNET*) measured as the percentage of population that have access to Internet services and mobile phone ownership (*MOBILEPHONE*) measured as the percentage of population that owns at least one mobile phone in year *t*. Both variables are included because internet access and mobile phones provide the technological support for blockchain-powered transactions. The second set of control variables are economic factors and population size. The first economic variable is GDP per capita

(*GDPpercapita*), which is measured as GDP per capita in year *t*. GDP per capita is included because it captures the growth of economic activity, and, thus, the innate demand for cryptocurrencies as a medium of exchange. The second economic variable is inflation (*INFLATION*), which is measured as the inflation rate in year *t*. As pundits in Bitcoin claim, Bitcoin could serve as a store value and hedge against the debasement of fiat currencies and inflation. If so, the higher the inflation rate, the higher demand for cryptocurrencies as a store of value. The third economic variable is the foreign exchange rate of the local currencies against the U.S. dollar (*FOREX*), which is measured as the foreign exchange rate in year t. I include currency appreciation or devaluation as a control variable because some users, especially users in emerging markets, may turn to cryptocurrency to preserve their savings in the face of currency devaluation (Chainalysis 2021). The fourth variable is the natural log of the population (*POP*) in year *t*, which is included to control for the innate demand for cryptocurrency as a medium of exchange. The third set of control variables are included to control for other incentives to use cryptocurrencies. For instance, users could hold cryptocurrencies as alternative investments, such as stablecoins as safe assets (e.g., Makarov and Schoar, 2022). Therefore, negative financial market shocks could affect both the unbanked population and the demand for cryptocurrencies as an investment option. Therefore, this study includes both the return on equity market *(EQUITYRETURN)* measured as equity market return and the stock market capitalization *(STOCKMARKETSIZE)* measured as the total market capitalization of all listed companies as a percentage of total GDP in year *t*. The equity market return and the equity market capitalization are included to account for investment opportunities in stock markets because some users are motivated to bypass the traditional investment industry and wish to speculate in the cryptocurrency market for investment purposes. Hu, Lee, and Putniņš (2021) find that capital flight volume is over one-quarter of Chinese Bitcoin exchange volume. Accordingly, *CAPITALCONTROL* is included as an additional variable for other incentives to use cryptocurrency. *CAPITALCONTROL* captures the restrictions on capital flows imposed by each country and the value of the variable is obtained from Fernández et al. (2016), which is the same measure as that used by Makarov and Schoar (2020). All three sets of control variables are obtained from the World Bank Development Indicator Series. Furthermore, users increasingly adopted mobile money payment platforms for cross-border payments, such as M-PESA in Africa. The mobile money account ownership data is collected from the Global Findex Database. Accordingly, this paper includes the adoption of mobile money accounts. The mobile money account ownership (*MOBILEMONEY*) is measured as the percentage of the population owning a mobile money account in year *t*. The last control variable is a country's effectiveness as well as technical compliance with the FATF's anti-money-laundering and counterterrorism financing standards (*AMLSCORE*) in year *t*. Money-laundering and terrorist-financing risks at the country level are compiled by and obtained from Basel Institute on Governance. The money-laundering and terrorism-financing risk is included because cryptocurrency remains appealing for illicit activities, primarily due to its anonymity and the ease with which it allows users to send funds anywhere in the world. For instance, Foley, Karlsen, and Putniņš (2019) find that one-quarter of Bitcoin users were involved in illegal activities up to 2017. Amiram, Jorgensen, and Rabetti (2022) find that cryptocurrencies are used in informal money transfer markets for terrorism financing (e.g., the Hawala markets).

Panel A of table 1 lists the definitions and the sources for the main variables. As reported in panel B of table 1, there are 581 county-year observations with information available on both dependent variables and control variables except for *AMLSCORE*. Basel Institute on Governance requires at least a fourth-round Financial Action Task Force (FATF) Mutual Evaluation Report that measures effectiveness as well as technical compliance with AML and CTF standards. Therefore, the number of observations with the effectiveness score against money-laundering and illicit activities (*AMLSCORE*) decreased from 581 to 466, which means a 20% decrease in coverage. Panel A of table 2 presents the descriptive statistics on the difference-in-differences design. Sixteen percent of countries in the sample are classified as the treatment group. While the average remittance inflow from Russia and Belarus is $188.17 million, remittances are concentrated in treated countries to the extent that the average inflow to the treatment group is $795.45 million and the largest remittance inflow is close to $ 4.04 billion. On average, a treated country received about 4.42% of outward remittances from Russia and Belarus. As evident from the univariate comparison, the treatment group receive a higher cryptocurrency value as well as retail value on blockchain than the control group. On average, during the sample period from 2019 to 2022, 71% of the population have at least one account in financial institutions. However, there is a significant cross-country variation as evident from the standard deviation of 28% with the maximum of 100% and the minimum of 9%. For the sets of control variables, the average GDP per capita is $26,714, and the average inflation rate is 6.87% with a standard deviation of 35.35%. The average population is about 65.55 million and 70.71% of the population have access to the internet. Out of 100 adults, the average number of mobile phones is 120. The average market return is 7.48% and the average stock market capitalization accounts for 56.43% of GDP. The average mobile money account ownership is 11% with a standard deviation of 17%. The average score on the effectiveness of laws and procedures against money laundering and illicit activities is 4.97 out of a maximum of 10. Compared with the control group, the treatment group has a higher banked population, a larger population size, a higher internet and mobile phone penetration rate, but a lower ownership of mobile money accounts and a smaller stock market size.

The key identification assumption is that, if the bank-intermediated cross-border payment system experiences a negative shock that leads to reduced bank payments from Russia and Belarus, users in recipient countries are therefore more likely to receive funds via cryptocurrency. This will result in a greater increase or a lower decrease in cryptocurrency value received on blockchain in the treated countries than the control group, depending on the overall time trend. Figure 2 graphs on-chain value received for the treatment and control group over time. As clear from the top panel of figure 2, compared with the pre-shock period, the on-chain value received increased by 0.19% for the treatment group, whereas that for the control group decreased by 2.44%. Similarly, the on-chain retail value received increased by 0.20% for the treatment group, whereas that for the control group decreased by 2.50%. Both differences are significant statistically and economically.

Panel A of table 3 reports the multivariate regression results from the difference-in-differences design when the treatment effect is dichotomous. Following Petersen (2009), standard errors are cluster-adjusted by both country and year throughout all multivariate analyses. As reported in column 1, after controlling for technological and economic factors, including the adoption of mobile money payments and investment opportunities on the stock market, the slope coefficient on *POST*TREATED* is 0.436 and statistically significant with a $t(p)$-value of 3.103(0.01). The positive slope coefficient indicates that cryptocurrency value received on blockchain for recipient countries of bank-enabled remittances from Russia and Belarus in the pre-shock period are *higher* than the control group *after* the shock. Moreover, the slope coefficient on *POST*TREATED*BANKEDSHARE* is -0.501 and statistically significant with a $t(p)$-value of 3.122 (0.01). The negative slope coefficient suggests that the difference-in-differences in cryptocurrency value received on blockchain is more pronounced for countries with lower shares of banked population. The magnitude of the slope coefficient implies that, compared with the control group, with a one-standard-deviation increase in the share of banked population, cryptocurrency value received on blockchain for treated countries decreases by 14% after the shock. As reported in column 2, the results are similar after controlling for the effectiveness of procedures in place against money laundering and illicit activities. For instance, the slope coefficient on *POST*TREATED* is 0.549 and the slope coefficient on *POST*TREATED*BANKEDSHARE* is -0.638, both of which are statistically significant. In column 3 and column 4, when Russia, Belarus, and Ukraine are excluded from the analysis, the results are similar both quantitatively and qualitatively. The results as reported in panel A of table 3 imply that the switching effect dominates the income (demand) effect: despite the possible decline in disposable income available for outward remittances from Russia and Belarus, more users in the destination countries switch to receive cross-border funds in cryptocurrency after the shock, and consequently, there is an *overall* increase in cryptocurrency value received on blockchain among treated countries.

However, the potential effect of the removal of banks in Russia and Belarus from SWIFT is not equal for each treated country. Some destination countries receive a larger share of outward remittances from Russia and Belarus, while others receive a smaller share. Therefore, I use a continuous variable, *OUTFLOWSHARE*, to capture the *magnitude* of the effect. The higher the destination country's share, the greater the reliance of the country on bank-enabled outward remittances from Russia and Belarus, the greater the potential effect of the shock. Panel B of table 3 reports the difference-in-differences results when the treatment effect is a continuous variable. As reported in column 1, the slope coefficient on *POST*OUTFLOWSHARE* is 19.61 and statistically significant, suggesting that cryptocurrency value received on blockchain is higher for countries that receive a higher share of bank-intermediated cross-border payments from Russia in the pre-shock period. Moreover, the slope coefficient on *POST*OUTFLOWSHARE*BANKEDSHARE* is -21.99 and statistically significant with a *t*-value of -4.537. The negative slope coefficient suggests that, holding constant the economic importance of bank-intermediated remittance from Russia and Belarus in the pre-shock period, the difference-in-differences in on-chain value received is more pronounced for countries with lower shares of banked population. The magnitude of the coefficient indicates that, at the average share of bank-intermediated remittances from Russia and Belarus, with every one-standard-deviation increase in the share of banked population, cryptocurrency value received on blockchain decreases by 4.61% after the shock. As reported in column 2, the results are similar after controlling for effectiveness against money laundering and illicit activities (*AMLSCORE*). For instance, the slope coefficient on *POST*OUTFLOWSHARE* is 21.38 the slope coefficient on *POST*OUTFLOWSHARE*BANKEDSHARE* is -24.28, both of which are statistically significant. As reported in column 3 and column 4, the results are similar both quantitatively and qualitatively when the analysis excludes Russia, Ukraine, and Belarus. In terms of control variables, the slope coefficient on *AMLSCORE* is -0.039 and statistically significant, suggesting that cryptocurrency value received on blockchain is lower in countries with more effective laws and procedures in place against money laundering and other illicit activities. The positive slope coefficients on *POP* and *INTERNET* suggest that cryptocurrency value received on blockchain is higher in countries with larger population and better Internet access.

This study then examines whether the results are robust when cryptocurrency value received on blockchain is limited to those of retail value transfer in order to account for the possibility that users may prefer bank payment for large value cross-border transfer and prefer cryptocurrency for small value cross-border transfer. Retail value is defined as a cryptocurrency transaction worth less than $10,000 by Chainalysis. As reported in table 4, when the dependent variable is retail value received on blockchain (*ONCHAINRETAILVALUE*), the results are similar to those reported in table 3. For instance, the slope coefficient on *POST*TREATED* is positive and that on *POST*TREATED*BANKEDSHARE* is negative, both of which are statistically significant. To summarize, using the exogenous disruption to the bank-intermediated cross-border payment system in Russia and Belarus, this study identifies that cryptocurrency complements banks in the cross-border payment market to the extent that cryptocurrency primarily serves the segment of the population *without* banking access.

3.3. Cost of bank-intermediated cross-border payment and the difference-in-differences results

One implication of the conceptual framework is that the cost of bank-intermediated cross-border payment system affects user' preference for cryptocurrency relative to bank payment in the pre-shock period. Specifically, the higher the cost of bank-intermediated cross-border payment system, the more likely that payers choose cryptocurrency in the pre-shock period. Accordingly, I obtained the cost of receiving remittances (*BANKREMITCOST*) from the World Bank Remittance Price dataset. $BANKREMITCOST_{it}$ is calculated as the *weighted* average cost of users in the destination country *i* receiving $200 across all bank-intermediated remittance corridors and the weight used is the originating country *j*'s share of total inward remittances received by the recipient country *i*.

Table 5 presents the results on how the difference-in-differences results vary with the cost of bank-intermediated cross-border payments. The number of observations declined dramatically to 301 due to missing data on the cost of receiving bank-intermediated remittances. As reported in column 1, when the dependent variable is *ONCHAINVALUE*, the slope coefficient on *POST*TREATED* continues to be positive and the slope coefficient on *POST*TREATED*BANKEDSHARE* continues to be negative. Interestingly, the slope coefficient on *POST*TREATED*BANKREMITCOST* is -0.064 and statistically significant with a *t*(*p*) value of -2.117 (0.04). The negative slope coefficient suggests that, while treated countries receive a higher cryptocurrency value on blockchain than the control group after the shock, the difference-in-differences in cryptocurrency value received on blockchain is less pronounced for countries with more costly bank-intermediated remittance corridors in the pre-shock period. Similarly, as reported in column 2, when the dependent variable is *ONCHAINRETAILVALUE*, the slope coefficient on *POST*TREATED*BANKREMITCOST* is -0.094 and statistically significant with a *t*(*p*) value of -3.156

(0.01). To summarize the difference-in-differences in the shock-induced shift towards cryptocurrency is less pronounced when the bank-intermediated cross-border payment is more costly.

4. Change specification on the share of banked population and geography of cryptocurrency

Conditional on *identifying* that cryptocurrency expands financial access to the unbanked population in the cross-border payment market system, this study extends the analysis from the use of cryptocurrency as a medium of exchange to other use cases of cryptocurrency and derive a general bank-cryptocurrency relation and its comparative statistics. Specifically, this study investigates whether the cross-country variations in shares of banked (unbanked) population partially explain the cross-country distribution (geography) of cryptocurrency. To alleviate the concern for omitted correlated variables that are time invariant, this study employs a *change* specification and examines whether an increase (decrease) in the share of unbanked (banked) population is associated with an increase in cryptocurrency value received on blockchain. The assumption underlying the change specification is that the *change* in the share of banked (unbanked) population is unlikely to be caused by omitted correlated variables that are time invariant during the one-year window. In particular, this study uses the following change specification to examine the bank-cryptocurrency relation in change form:

$$CHGONCHAINVALUEit = \alpha + \boldsymbol{\beta 1} * \boldsymbol{CHGBANKEDSHAREit} + \beta 2 * CHGINTERNETit + \beta 3 * CHGMOBILEPHONEit + \beta 4 * CHGGDPpercapitait + \beta 5 * CHGINFLATIONit + \beta 6 * CHGFOREXit + \beta 7 * CHPOPit + \beta 8 * CHGEQUITYRETURNit + \beta 9 * CHGSTOCKMARKETSIZEit + \beta 10 * CHGCAPITALCONTROLit + \beta 11 * CHGMOBILEMONEYit + \beta 12 * CHGAMLSCOREit + \ year\ fixed\ effects + \ \varepsilon \quad Equation\ (2)$$

where the dependent variable is the change in the normalized index in cryptocurrency value received on blockchain for country *i* in year *t* relative to year *t -1* ($CHGONCHAINVALUE_{it}$), and, therefore, the variable of interest and control variables are all in change form. The variable of interest is the slope coefficient on the change in the share of banked population ($CHGBANKEDSHARE_{it}$), and the expected sign is negative. Year fixed effects are included to control for possible pandemic effects and time-series fluctuations in cryptocurrency prices.

Panel C of table 1 describes the sample formation process for the change specification. There are 348 (241) observations with (without) the change in effectiveness against money laundering and other illicit activities (*CHGAMLSCORE*). Panel A of table 6 presents the correlation tables of variables of interest and control variables in change form. On a univariate basis, *CHGBANKEDSHARE* is negatively correlated with *CHGONCHAINVALUE* as evident from the Pearson (Spearman) correlation coefficient of -0.276 (-0.288). Both correlation coefficients are statistically significant. Figure 3 illustrates the scatter plot between the change in the share of banked population and the change in cryptocurrency value received on blockchain.

Panel B of table 6 presents the multivariate results on the bank-cryptocurrency relation in change form after controlling for contemporaneous changes in economic and technological factors. As shown in column 1, the slope coefficient on *CHGBANKEDSHARE* is -0.360 and statistically significant with a *t*(*p*)-value of -4.542 (0.01). The magnitude of the slope coefficient implies that a one-standard-deviation decrease (increase) in the banked (unbanked) population is associated with an increase of 10.1% in cryptocurrency value received on blockchain. As shown in column 2, when *CHGAMLSCORE* is included as an additional control variable, the slope coefficient on *CHGBANKEDSHARE* is -0.326 and statistically significant with a *t*(*p*)-value of -3.017(0.01). Makarov and Schoar (2021) find that the Bitcoin ecosystem is dominated by large and concentrated players—one third of Bitcoin value is concentrated in 0.01% of accounts. To ensure that the results are not driven by large players and large value, this study uses the change in on-chain retail value received (*CHGONCHAINRETAILVALUE*) as an alternative dependent variable. As reported in column 3 and column 4, the slope coefficients on *CHGBANEDSHARE* are -0.356 and -0.324 respectively, both of which are statistically significant. In terms of control variables, as shown in column 1 and column 3, without controlling for *CHGAMLSCORE*, the slope coefficient on the change in foreign exchange rates against U.S. dollars (*CHGFOREX*) and that on the change in inflation (*CHGINFLATION*) are positive and statistically significant, suggesting that some users turn to cryptocurrency to preserve their savings in the face of currency devaluation and hedge against inflation. In all specifications, the slope coefficient on the change in mobile money accounts (*CHGMOBILEMONEY*) is positive and statistically significant, suggesting that the use of mobile money accounts facilitates the use of cryptocurrency.

Panel C of table 6 presents the bank-cryptocurrency relation in change form for the subsample of countries with high income versus the subsample of countries with low income and middle income. The partition is important because cross-border remittance inflow is likely to be economically more important for low-and-middle income countries. For instance, remittance inflows account for over 30% of GDP for Tajikistan and Kyrgyzstan. As shown in column 1 and column 2, when the subsample is limited to high-income countries, the slope coefficients on the change in banked share (*CHGBANKEDSHARE*) are not statistically significant. However, as shown in column 3 and column 4, when the subsample is limited to countries with low income or middle income, the slope coefficients on *CHGBANKEDSHARE* are -0.367 and -0.355 respectively, both of which are statistically significant. The comparative statistics suggest that the share of the banked population has a more pronounced effect on the geography of cryptocurrency received on blockchain among low-and-middle-income countries than high-income countries possibly because of the economic importance of remittance inflows for the former.

5. Explanations for the bank-cryptocurrency relation

5.1. Lack of trust in financial institutions as an explanation

Last, the study offers some explanations to *substantiate* the bank-cryptocurrency relation. Compared with traditional payment systems where users trust a third-party payment company to make sure funds are sent and received properly and where banks of the sender and the receiver validate transactions to minimize the risk of double spending, *only the sender and the recipient* participate in crypto transactions. Conceptually, one might consider blockchain to be a technology-based control system that can remove the need for a trusted third-party financial institution. Parties on the blockchain trust the blockchain to do the things that a bank would do in a more conventional transaction: facilitate the transfer, ensure sender authenticity, and vouch for the validity of the currency exchanged. The substitution between blockchain-powered technology and trust in third-party financial intermediaries implies that cryptocurrency value received on blockchain increase as lack of trust in financial institutions increases.

The Global Findex Survey asked adults why they do not have an account at a financial institution. Many respondents said they do not have an account because they distrust the banking system. For instance, in Ukraine, 54 percent of unbanked adults listed distrust in the financial system as one of the reasons for their lack of an account in 2021. More than one in three unbanked adults cited the same barrier in Argentina, Bolivia, Bulgaria, Colombia, Jamaica, and Russia. Accordingly, this study uses the percentage of respondents in a country or region that cite lack of trust in financial institutions as a barrier to financial account ownership as the country-level measure of distrust in financial institutions (*LACKTRUST*).

Compared with the World Value Survey measure, lack of trust in financial institutions from the Global Findex Survey is measured in 2017 and 2021, respectively, and therefore, it is possible to measure the change in trust in financial institutions for each country during the sample period. The autocorrelation in lack of trust in financial institutions as reported by the Global Findex Survey (*LACKTRUST*) is only 0.685 across the two measurement windows, implying a substantial time-series variation in lack of trust in financial institutions. In contrast, the World Value Survey Wave VII measures trust in banks for the five-year period from 2017 to 2022, which results in no time-series variation during the entire sample period. A second advantage is that the coverage of the Global Findex Survey is more comprehensive than alternative data sources. The Global Findex Survey in 2017 and in 2021 covers 138 and 119 countries, respectively. In contrast, the World Value Survey Wave VII covers 50 countries, and the Life in Transition Survey used in Saiedi, Broström, and Ruiz (2021) covers only 34 countries in Europe.

To assess the validity of the trust measure, this study examines the correlation between trust in financial institutions as reported by the Global Findex Survey and a similar measure from the World Value Survey. This study uses the answer to the question: “Could you tell me how much confidence you have in them: is it a great deal of confidence, quite a lot of confidence, not much confidence or none? Banks” to measure trust in banks from the World Value Survey Wave VII. Specifically, *WVSLACKTRUSTBANK* is measured as the percentage saying, “I have not much confidence in banks or none at all.” As reported in panel A of table 7, based on 33 countries covered in both the Global Findex Survey and the World Value Survey, the Pearson (Spearman) correlation between the percentage of adults citing lack of trust in financial institutions as a barrier to financial account ownership as reported by the Global Findex Survey and the percentage saying that "I have not much confidence in banks or none at all" as reported by the World Value Survey is 0.842 (0.790). The correlation coefficients validate the use of the percentage of adults that cite lack of trust in financial institutions as a barrier to financial account ownership as reported by the Global Findex Survey as a proxy for country-level distrust in financial institutions.

A potential concern is that cryptocurrency value received on blockchain and lack of trust in financial institutions could be endogenously determined by some omitted *unobservable* country characteristics. To alleviate the concern for omitted correlated variables that are time invariant, this study employs a change specification to examine whether a negative (positive) change in trust in financial institutions is associated with an increase (decrease) in cryptocurrency value received on blockchain. The assumption underlying the change specification is that a change in trust in financial institutions is unlikely to be caused by omitted variables that are time invariant during the one-year window. For instance, related concepts of culture, such as generalized trust, uncertainty avoidance, individualism versus collectivism, long-term versus short-term orientation (e.g., Hostefe 1980, 2001), tightness versus looseness (e.g., Gelfand et al. 2011), and religious beliefs (e.g., Stulz and Williamson 2003), are unlikely to change from one twelve-month window to the next. The change in lack of trust in financial institutions (*CHGLACKTRUST*) is calculated as the change in the percentage of adults citing lack of trust in financial institutions as a barrier to financial account ownership from the 2021 survey relative to the 2017 survey. As reported in panel A of table 6, on a univariate basis, *CHGLACKTRUST* is positively correlated with *CHGONCHAINVALUE* as evident from the Pearson correlation of 0.191 and the Spearman correlation of 0.252. *CHGBANKEDSHARE* is replaced with *CHGLAKTRUST* in equation (2).

Panel B of table 7 presents the results. As shown in column 1 and column 2, after controlling for contemporaneous changes in other factors, the slope coefficients on *CHGLACKTRUST* are 0.441 and 0.511 respectively, both of which are statistically significant with a *t*-value of 3.980 and 3.262. A one-standard-deviation increase in lack of trust in financial institutions is associated with an increase of 2.27% in cryptocurrency value received on blockchain. The *positive* association between the change in *lack* of trust in financial institutions and the change in cryptocurrency value is consistent with the interpretation that lack of trust in third-party financial institutions increases the reliance on blockchain-powered control systems to mitigate counterparty risks, therefore encourages participation in *nontraditional* markets such as crypto markets.

Chainalysis also measures the peer-to-peer (P2P) exchange trade volume (deflated by PPP per capita) at the country level. As P2P exchange trades are carried out on P2P trading platforms, i.e., they are not recorded on blockchain, this study uses *off-chain* cryptocurrency exchange trade volume as the dependent variable in the placebo test. As shown in column 3 and column 4 of panel B of table 7, when the dependent variable is the change in exchange trade volume on P2P platforms that are not carried out on blockchain ($CHGP2PEXCHANGETRADE_{it}$), the slope coefficients on *CHGLACKTRUST* are not statistically significant. The insignificant slope coefficient suggests that lack of trust cannot explain the geography of crypto transactions that are not carried out on blockchain, which is consistent with the institutional feature that off-chain crypto transactions do not utilize blockchain-powered systems but rely on P2P trading platforms to make sure funds are sent and received properly.

5.2. High cost of financial accounts ownership as another explanation

Another frequently cited reason for not having an account at a financial institution is that conventional financial services are too expensive. For instance, as reported in the 2017 Global Findex Survey, almost sixty percent of unbanked adults cited high costs of financial account ownership as a barrier in Brazil, Colombia, and Peru. Accordingly, this study uses the percentage of respondents in a country or region that cite high costs as a barrier to financial account ownership as the country-level measure of perceived high costs of financial account ownership (*HIGHCOST*). To mitigate the concern for omitted correlated variables that ae time invariant, this study again employs a change specification. The change in perceived high costs of financial account ownership (*CHGHIGHCOST*) is calculated as the change in the percentage of adults that cite high costs as a barrier to financial account ownership respectively from the 2017 survey to the 2021 survey. Accordingly, *CHGBANKEDSHARE* is replaced with *CHGHIGHCOST* in equation (3).

As shown in column 1 of panel C of table 7, when the dependent variable is the change in on-chain value received, the slope coefficient on *CHGHIGHCOST* is 0.183 and statistically significant. Using the change specification, this study finds that cryptocurrency value received on blockchain increase as high costs of financial accounts are perceived to be greater barriers to financial account ownership. In contrast, as reported in column 3 and column 4, when the dependent variable is the change in off-chain cryptocurrency exchange trades, the slope coefficient on *CHGHIGHCOST* is not statistically significant. The comparison suggests that perceived excessive costs of ownership of financial accounts explain the geography of cryptocurrency received o blockchain but cannot explain that of off-chain crypto transactions.

To summarize, this study finds that lack of trust in financial institutions increases the *on-chain* cryptocurrency value transferred, but not for crypto transactions carried off blockchain. The positive association between lack of trust in financial institutions and on-chain crypto transactions implies that lack of trust in financial institutions increases the reliance on blockchain-powered control systems to mitigate counterparty risks and, thus, encourages participation in cryptocurrency transactions that are carried out on blockchain. However, the substitution between trust in financial intermediaries and blockchain-powered control systems is less pertinent for crypto transactions that are not carried out on blockchain. While perceived high costs of financial account ownership is a barrier to financial account ownership, P2P payment systems using cryptocurrency lower the cost of disbursing and receiving funds.

6. Conclusion

Using estimated indexes based on transaction-by-transaction data on blockchain, this study studies whether a peer-to-peer payment system using cryptocurrencies substitutes or complements for banks and money transfer operators (MTOs) in the cross-border payment market. Based on a developed conceptual framework, this study uses an exogenous shock in the bank-intermediated cross-border payment system and find that cryptocurrency value received on blockchain is higher for treated countries relative to the control group after the shock. Moreover, the difference-in-differences in on-chain value received is more pronounced for countries with higher shares of unbanked population. Furthermore, this study extends the analysis from the cross-border payment market to other use cases of cryptocurrency and finds that cross-country variations in shares of banked population explain a sizable portion of the cross-country distribution of cryptocurrency incremental to other economic and technological factors. Cryptocurrency value received on blockchain increases as the share of unbanked population increases and lack of trust in financial institutions partially explain the bank-cryptocurrency relation. Overall, this study provides the first large-sample cross-country evidence that a peer-to-peer payment system using cryptocurrencies bypasses the conventional banking system and meets the demand that would otherwise be unmet by traditional financial intermediaries. The results highlight the potential of blockchain technology in enhancing financial inclusion.

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Figure 1

Cross Border Money Transfer Flow with Banks and MTOs

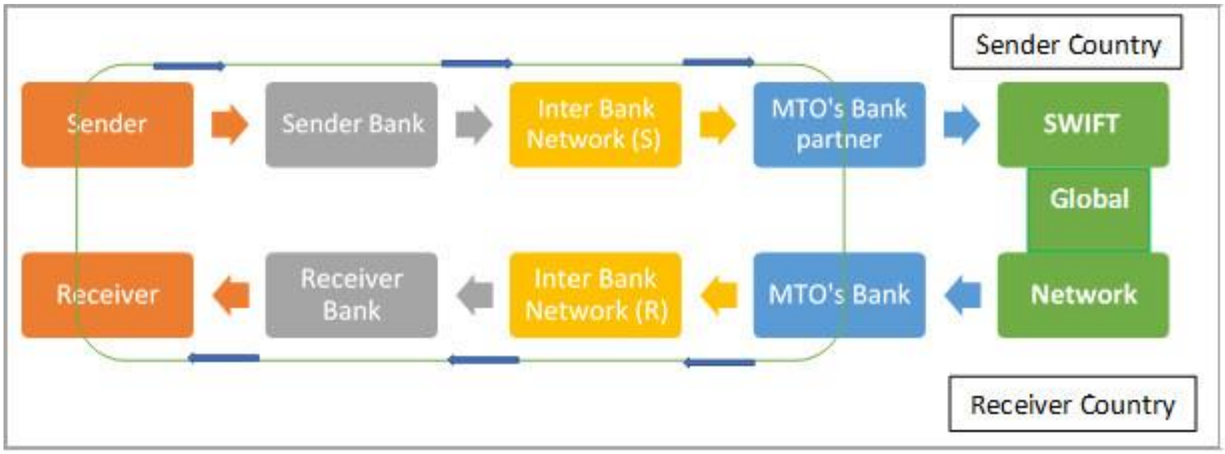
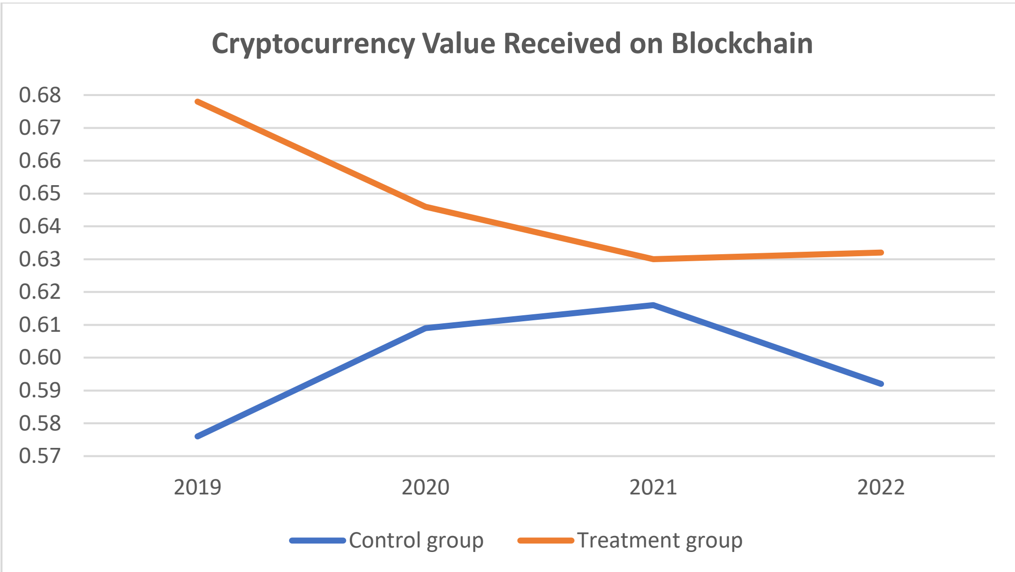


Figure 2

Comparison between the treatment group and the control group over time



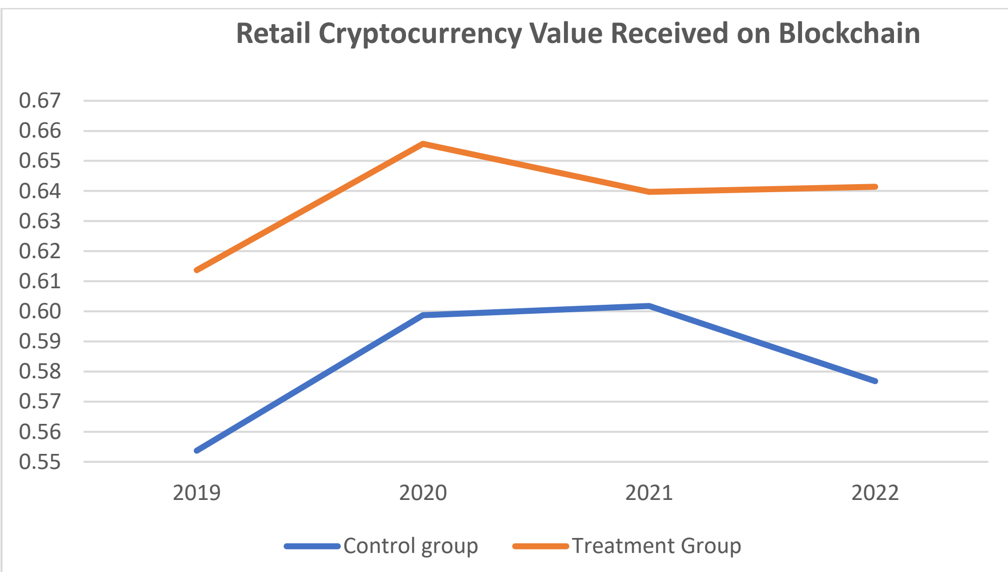


Figure 3

Scatter Plot on the Change in Banked Population and the Change in Cryptocurrency Received on Blockchain

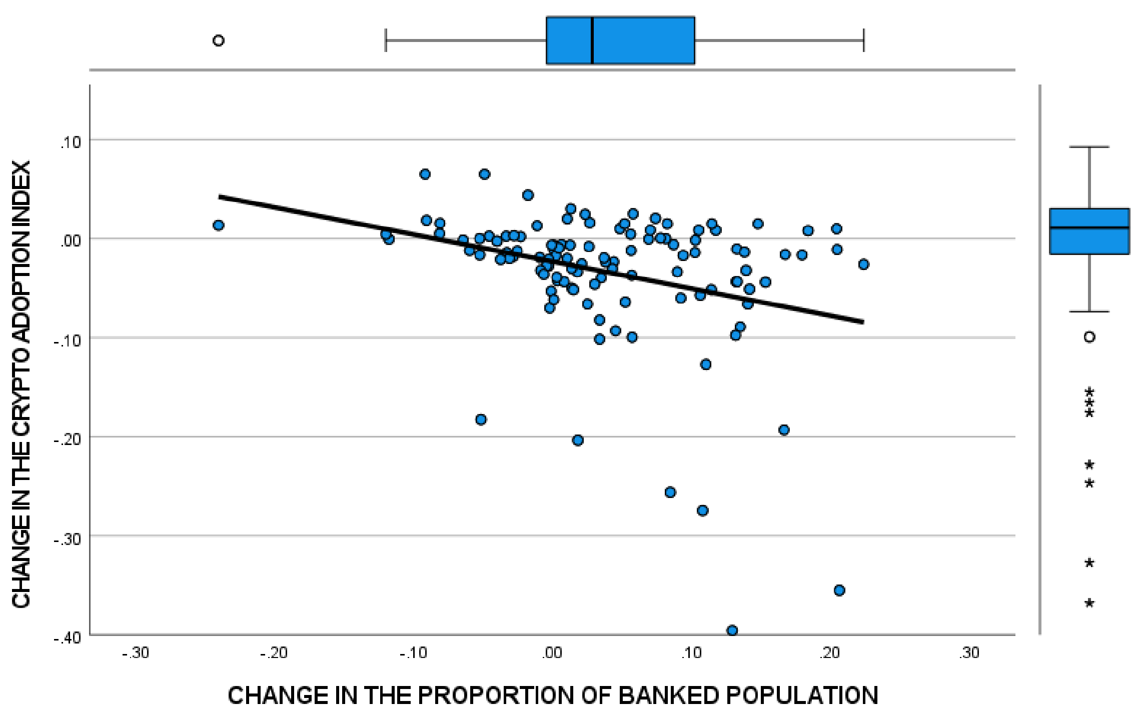


Table 1
Variable Definitions, Data Source, and Sample Formation

Panel A: Variable definitions and sources

VARIABLE	DEFINITION	SOURCE
ONCHAINVALUE$_{it}$	The normalized rank of a country's cryptocurrency value received on blockchain as compiled by Chainalysis in year *t* with the maximum value of 1 for the country with the highest on-chain value received (deflated by PPP per capita) and the minimum of 0 for the country with the lowest on-chain value received.	Chainalysis https://go.chainalysis.com/2021-geography-of-crypto.html
CHGONCHAINVALUE$_{it}$	The change in *ONCHAINVALUE* in year *t* relative to *t-1*.	Chainalysis
ONCHAINRETAILVALUE$_{it}$	The normalized rank of a country's on-chain retail value received as compiled by Chainalysis in year *t* with the maximum value of 1 for the country with the highest on-chain retail value received (deflated by PPP per capita) and the minimum of 0 for the country with the lowest on-chain retail value received. A retail cryptocurrency value is defined as a transaction with a value less than $10,000.	Chainalysis
CHGONCHAINVALUE$_{it}$	The change in *ONCHAINRETAILVALUE* in year *t* relative to *t-1*.	Chainalysis
P2PEXCHANGETRADE$_{it}$	The normalized rank of a country's volume of on-chain exchange trades on P2P platforms (deflated by PPP per capita) as compiled by Chainalysis in year *t* with the maximum value of 1 for the country with the highest volume of P2P cryptocurrency exchange trade and the minimum value of 0 for the country with the lowest volume of P2P cryptocurrency exchange trade.	Chainalysis
CHGP2PEXCHANGE TRADE$_{it}$	The change in *P2PEXCHANGETRADE* in year *t* relative to *t-1*.	Chainalysis
BANKEDSHARE$_{it}$	The percentage of a country's adult population that has at least one account in a financial institution in year *t*.	Global Findex Database https://www.worldbank.org/en/publication/globalfindex
CHGBANKEDSHARE$_{it}$	The change in *BANKEDSHARE* in year *t* relative to *t-1*.	Global Findex Database
TREATEDi	A dummy variable set to 1 for countries that receive at least 0.1% of bank-enabled outward remittances from Russia and Belarus during 2021, and 0 otherwise.	Knomad https://www.knomad.org/data/remittances
REMITTANCE$_{it}$	Bank-enabled remittance inflows from Russia and Belarus in year *t*.	Knomad
OUTFLOWSHARE$_{it}$	The destination country's share of cross-border payments sent from Russia and Belarus in 2021.	Knomad
POST$_t$	A dummy variable set to 1 for periods after March 2022 and 0 otherwise.	
BANKREMITCOST$_{it}$	The weighted average cost of receiving $200 via bank-enabled remittance corridors in percentage.	WORLD BANK

$LACKTRUST_{it}$	The percentage of respondents in a country that cite high costs of financial accounts as a barrier to financial account ownership in year *t*.	Global Findex Database
$CHGLACKTRUST_{it}$	The change in *LACKTRUST* in year *t* relative to *t-1*.	Global Findex Database
$WVSLACKTRUSTBANK_{i}$	The percentage saying that "I have not much confidence in banks or none at all" when responding to the question: "Could you tell me how much confidence you have in them: is it a great deal of confidence, quite a lot of confidence, not much confidence or none at all? Banks"	World Value Survey Wave 7 https://www.worldvaluessurvey.org/WVSDocumentationWV7.jsp
$HIGHCOST_{it}$	The percentage of respondents in a country that cite high costs as a barrier to financial account ownership in year *t*.	Global Findex Database
$CHGHIGHCOST_{it}$	The change *HIGHCOST* in year *t* relative to *t-1*.	Global Findex Database
$GDPpercapita_{it}$	Gross domestic product (GDP) per capita converted into U.S. dollars using purchase power parity (PPP) in year *t*	World Bank https://data.worldbank.org
$CHGGDPpercapita_{it}$	The percentage change in *GDPpercapita* in year *t* relative to year *t-1*.	World Bank
$INFLATION_{it}$	Inflation rate in year *t*.	World Bank
$CHGINFLATION_{it}$	The change in *INFLATION* in year *t* relative to *t-1*.	World Bank
$FOREX_{it}$	The foreign exchange rate of a county's local currencies against U.S. dollars in year *t*	World Bank
$CHGFOREX_{it}$	The change in *FOREX* in year *t* relative to *t-1*.	World Bank
$INTERNET_{it}$	The percentage of the population with access to Internet in year *t*.	World Bank
$CHGINTERNET_{it}$	The change in *INTERNET* in year *t* relative to *t-1*.	World Bank
$MOBILEPHONE_{it}$	The number of mobile phones per 100 adults in year *t*.	World Bank
$CHGMOBILEPHONE_{it}$	The change in *MOBILEPHONE* in year *t* relative to *t-1*.	World Bank
POP_{it}	The number of the population size in millions in year *t*	World Bank
$CHGPOP_{it}$	The change in the number of the population in millions in year *t* relative to *t-1*	World Bank
$EQUITYRETURN_{it}$	The return on the country's equity market index in year *t*	World Bank
$CHGEQUITYRETURN_{it}$	The change in *EQUITYRETURN* in year *t* relative to *t-1*.	World Bank
$STOCKMARKETSIZE_{it}$	The total market capitalization of all listed companies as a percentage of total GDP in year *t*	World Bank
$CHGSTOCKMARKETSIZE_{it}$	The change in *STOCKMARKETSIZE* in year t relative to *t-1*.	World Bank
$MOBILEMONEY_{it}$	The percentage of the population with mobile money accounts in year *t*	World Bank
$CHGMOBILEMONEY_{it}$	The change in *MOBILEMOENY* in year *t* relative to *t-1*.	Global Findex Database
CAPITALCONTROLit	The restrictions on capital flows in year t	Fernández et al. (2016)
CHGCAPITALCONTROLit	The change in *CAPITALCONTROL* in year *t* relative to *t-1*.	
AMLSCORE	The index measures a country's effectiveness of laws and procedures in place against money laundering and other illicit activities in year *t*	Basil Institute of Governance https://baselgovernance.org/basel-aml-index
$CHGAMLSCORE_{it}$	The change in *AMLSCORE* in year *t* relative to *t-1*.	Basil Institute of Governance

Table 1

(continued)

Panel B: Sample formation for the identification strategy using the difference-in-differences design

	Total number of observations
Cryptocurrency value received on Blockchain are available from Chainalysis (*ONCHAINVALUERECEIVED*)	614
Financial account ownership is available from Findex (*BANKEDSHARE*)	619
Observations with both *ONCHAINVALUERECEIVED* and *BANKEDSHARE* available	605
Observations with missing information on control variables	*(24)*
Final sample with available information on variables of interest and control variables (excluding the change in the risk of money laundering)	**581**
Observations with missing information on the effectiveness of procedures against money laundering and terrorism financing from Basel Institute on Governance	*(115)*
Final sample with available information on all variables, including the change in the risk of money laundering	**466**

Panel C: Sample formation for the change specification

	Total number of observations
Changes in cryptocurrency value received on chain (*CHGONCHAINVALUERECEIVED*) are available	580
Changes in financial account ownership (*CHGBANKEDSHARE*) are available	490
Observations with both *CHGONCHAINVALUERECIEVED* and *CHGBANKEDSHARE* available	444
Observations with missing information on changes in control variables	*(96)*
Final sample with available information on change variables of interest and changes in control variables (excluding the change in the risk of money laundering)	348
Observations with missing information on the change in the effectiveness of procedures against money laundering and terrorism financing from Basel Institute on Governance	*(97)*
Final sample with available information on all explanatory variables, including the change in the risk of money laundering	251

Table 2
Descriptive Statistics

Panel A: Descriptive statistics for the identification strategy using a difference-in-difference design

	Entire sample						*Control*		*Treatment*	
	N	***Mean***	***Median***	***Std***	***Min***	***Max***	***N***	***Mean***	***N***	***Mean***
TREATED	581	0.16	0.00	0.37	0.00	1.00	488	1.00	93	0.00***
REMITTANCE	581	188.17	0.79	1204.18	0.00	4034.17	488	0.00	93	795.45***
OUTFLOWSHARE	581	0.70%	0%	2.42%	0%	65.00%	488	0%	93	4.42%***
POST	581	0.15	0.00	0.36	0.00	1.00	488	0.15	93	0.15
ONCHAINVALUE	581	0.60	0.62	0.25	0.01	1.00	488	0.59	93	0.65**
ONCHAINRETAILVALUE	581	0.59	0.60	0.25	0.01	1.00	488	0.58	93	0.64**
BANKEDSHARE	581	0.71	0.84	0.28	0.09	1.00	488	0.68	93	0.87***
INTERNET	581	70.71	78.12	23.12	9.80	100.00	488	68.84	93	80.54***
MOBILEPHONE	581	119.71	120.51	29.67	37.40	291.65	488	118.12	93	128.04***
GDPpercapita	581	26,715	20,244	21,2051	1,230	116,518	488	26164	93	29610
INFLATION	581	6.87	2.58	35.35	-3.23	557.20	488	7.50	93	3.54
FOREX	581	686.71	8.85	3545.08	0.30	42,000	488	769.06	93	254.60
POP	581	65.55	11.83	202.36	0.37	1412.36	488	56	93	118***
EQUITYRETURN	581	7.48	0.00	29.47	-36.97	501.92	488	7.00	93	9.99
STOCKMARKETSIZE	581	56.43	10.85	183.42	0.00	1777.54	488	63.26	93	20.58**
MOBILEMONEY	581	0.11	0.00	0.17	0.00	0.73	488	0.12	93	0.07**
CAPITALCONTROL	581	0.29	0.23	0.24	0.00	0.85	488	0.28	93	0.30
AMLSCORE	466	4.98	4.89	1.07	2.36	8.22	386	5.01	80	4.82
BANKREMITCOST(%)	301	7.01	5.80	4.57	1.07	28.09	34	7.25	93	5.12**

** difference between the treatment group and the control group is statistically significant with *p*-value < 0.05 & *** ***p***-value < 0.01

Table 2
(continued)

Panel B: Top decile of cryptocurrency value received on blockchain and banked share

Period from July 2019 to June 2020		Period from July 2020 to June 2021		Period from July2021 to June 2022	
Country	**banked%**	**Country**	**banked%**	**Country**	**banked %**
China	.80	China	.89	India	.77
Vietnam	.30	India	.77	US	.95
India	.80	US	.95	China	.89
Ukraine	.63	Vietnam	0.30	Vietnam	0.30
US	.93	Brazil	.84	Philippines	.46
Brazil	.70	Ukraine	.84	Brazil	.84
Russia	.76	Thailand	.94	Thailand	.94
South Korea	.95	Russia	.89	Ukraine	.84
Philippines	.32	Turkey	.73	Russia	.89
Turkey	.68	Philippines	.46	UK	1.00
Indonesia	.48	Pakistan	.16	Turkey	.73
South Africa	.67	UK	1.00	Lebanon	.21
Pakistan	.18	South Korea	.99	Pakistan	.16
Nigeria	.39	Argentina	.66	Argentina	.66
UK	.96	Nigeria	.45	Indonesia	.51

Panel C: Bottom decile of cryptocurrency value received on blockchain and banked share

Period from July 2019 to June 2020		Period from July 2020 to June 2021		Period from July2021 to June 2022	
Country	**banked%**	**Country**	**banked%**	**Country**	**banked %**
Libya	0.66	Malta	0.96	Mauritius	0.90
Mongolia	0.93	Jamaica	0.73	Uruguay	0.74
Namibia	0.77	Zimbabwe	0.29	Senegal	0.28
Malta	0.97	Cyprus	0.93	Nicaragua	0.23
Montenegro	0.68	Bosnia	0.79	Cyprus	0.93
Trinidad	0.81	Uruguay	0.74	Bosnia	0.79
Tajikistan	0.47	North	0.85	Burkina Faso	0.21
Turkmenistan	0.41	Paraguay	0.27	Zambia	0.24
Botswana	0.45	Nicaragua	0.23	Mali	0.28
Bahrain	0.83	Namibia	0.66	Malta	0.96
Luxembourg	0.99	Mali	0.28	Tajikistan	0.39
Malawi	0.23	Tajikistan	0.39	Namibia	0.66
Gabon	0.34	Iceland	1.00	Malawi	0.20
Haiti	0.28	Gabon	0.28	Gabon	0.28
Chad	0.09	Malawi	0.20	Iceland	1.00

Table 2
(Continued)

Panel D: Descriptive statistics for the change specification

	N	*Mean*	*Median*	*Std*	*Min*	*Max*
CHGONCHAINVALUERECEIVED	348	0.011	0.005	0.067	-0.156	0.334
CHGP2PEXCHANGEVOLUME	348	-0.030	-0.051	0.159	-0.362	0.465
CHGBANKEDSHARE	348	0.038	0.025	0.078	-0.240	0.224
CHGLACKTRUST	348	0.003	0.000	0.051	-0.245	0.230
CHGHIGHCOST	348	0.002	0.000	0.063	-0.326	0.214
CHGREMITTANCEIN	348	0.105	0.025	1.288	-0.693	17.716
CHGREMITTANCEOUT	348	-0.063	0.000	0.395	-1.000	2.274
CHGMOBILEMONEY	348	0.048	0.000	0.099	-0.190	0.520
CHGGDPpercapita	348	-0.3%	-0.2%	6.7%	-25.6%	16.0%
CHGINFLATION	348	-0.9%	0.4%	34.1%	-45.8%	81.9%
CHGFOREX	348	0.013	-0.003	0.085	-0.102	0.725
CHGINTERNET	348	1.761	0.000	2.832	-5.622	16.701
CHGMOBILEPHONE	348	-0.002	0.000	0.031	-0.129	0.101
CHGPOP	348	0.008	0.007	0.011	-0.041	0.033
CHGEQUITYRETURN	348	0.1%	0.0%	23.5%	-59.9%	172.7%
CHGSTOCKMARKETSIZE	348	6.391	0.000	43.372	-5.607	428.088
CHGMLRISK	251	-0.094	-0.040	0.375	-1.360	1.540

Table 3

Difference-in-Differences Design in Response to an Exogenous Shock

Panel A: Bank-cryptocurrency relation when the treatment effect is dichotomous

		Dependent Variable = **ONCHAINVALUE**			
		All observations		Excluding Russia, Belarus, and Ukraine	
		Column 1	Column 2	Column 3	Column 4
Explanatory variables	*Predicted sign*	Coefficient (*T*-value)	Coefficient (*T*-value)	Coefficient (*T*-value)	Coefficient (*T*-value)
Intercept		Included	Included	Included	Included
POST		-0.002 (-0.206)	-0.024* (-1.774)	-0.002 (-0.212)	-0.024* (-1.812)
TREATED		0.114 (0.943)	0.152 (1.232)	0.078 (0.638)	0.114 (0.953)
POST*TREATED	***(+)***	***0.436*** (3.103)***	***0.549*** (4.216)***	***0.473*** (3.913)***	***0.585*** (4.884)***
BANKEDSHARE		0.180 (1.221)	0.179** (2.355)	0.172** (2.134)	0.168*** (2.238)
*TREATED*BANKEDSHARE*		-0.103 (-0.933)	-0.150 (-1.072)	-0.071 (-0.535)	-0.116 (-0.857)
POST*TREATED*BANKEDSHARE	***(?)***	***-0.501*** (3.122)***	***-0.638*** (-3.812)***	***-0.534*** (-3.771)***	***-0.673*** (-4.146)***
INTERNET		0.003** (2.026)	0.001 (0.820)	0.003* (1.936)	0.001 (0.820)
MOBILEOWNERSHIP		0.001 (0.482)	0.001 (0.198)	0.001 (0.482)	0.001 (0.198)
MOBILEMONEY		-0.076 (-0.918)	0.025 (0.346)	-0.076 (-0.918)	0.025 (0.346)
Ln(POP)		0.136*** (16.264)	0.137*** (17.972)	0.136*** (16.264)	0.135*** (17.097)
Ln(GDPpercapita)		-0.030 (-0.913)	-0.027 (-0.843)	-0.030 (-0.913)	-0.027 (-0.843)
INFLATION		0.001 (0.213)	-0.001*** (-3.365)	0.001 (0.213)	-0.001*** (-3.557)
FOREX		-0.001 (-0.805)	-0.001 (-0.022)	-0.001 (-0.805)	-0.001 (-0.022)
EQUITYRETURN		0.001 (0.258)	0.001 (-1.047)	0.001 (0.258)	0.001 (-1.047)
STOCKMARKETSIZE		0.001 (0.888)	0.001** (2.043)	0.001 (0.888)	0.001** (2.043)
CAPITALCONTROL		0.001 (0.128)	0.002 (1.066)	0.001 (0.385)	0.001 (1.470)
AMLSCORE			-0.038** (-2.479)		-0.040** (-2.594)
Standard errors cluster-adjusted		By country	By country	By country	By country
N		581	466	571	457
Adjusted *R*-squared		70.8%	74.0%	70.1%	73.4%

*** p<0.01, ** p<0.05, * p<0.10

Table 3

(continued)

Panel B: Bank-cryptocurrency relation when the treatment effect is continuous

		Dependent Variable = **ONCHAINVALUE**			
		All observations		Excluding Russia, Belarus, and Ukraine	
		Column 1	Column 2	Column 3	Column 4
Explanatory variables	*Predicted sign*	Coefficient (*T*-value)	Coefficient (*T*-value)	Coefficient (*T*-value)	Coefficient (*T*-value)
Intercept		Included	Included	Included	Included
POST		-0.008 (-0.743)	-0.030** (-2.338)	-0.005 (-0.525)	-0.027** (-2.146)
OUTFLOWSHARE		1.851* (1.793)	1.936** (2.095)	2.105 (0.703)	1.244 (0.429)
POST*OUFLOWSHARE	***(+)***	***19.608*** (6.055)***	***21.380*** (4.904)***	***19.310*** (4.306)***	***24.668*** (4.326)***
BANKEDSHARE		0.173** (2.244)	0.159** (2.181)	0.170** (2.191)	0.155** (2.133)
*OUTFLOWSHARE*BANKEDSHARE*		-1.464 (-1.192)	-1.427 (-1.285)	-0.109 (-0.021)	1.595 (0.313)
POST*OUTFLOWSHARE*BANKEDSHARE	***(-)***	***-21.996*** (-4.537)***	***-24.278*** (-3.570)***	***-23.205*** (-3.052)***	***-31.561*** (-3.538)***
INTERNET		0.003** (2.026)	0.001 (0.820)	0.003* (1.936)	0.001 (0.820)
MOBILEOWNERSHIP		0.001 (0.482)	0.001 (0.198)	0.001 (0.482)	0.001 (0.198)
MOBILEMONEY		-0.076 (-0.918)	0.025 (0.346)	-0.076 (-0.918)	0.025 (0.346)
Ln(POP)		0.136*** (16.264)	0.137*** (17.972)	0.136*** (16.264)	0.135*** (17.097)
Ln(GDPpercapita)		-0.030 (-0.913)	-0.027 (-0.843)	-0.030 (-0.913)	-0.027 (-0.843)
INFLATION		0.001 (0.213)	-0.001*** (-3.365)	0.001 (0.213)	-0.001*** (-3.557)
FOREX		-0.001 (-0.805)	-0.001 (-0.022)	-0.001 (-0.805)	-0.001 (-0.022)
EQUITYRETURN		0.001 (0.258)	0.001 (-1.047)	0.001 (0.258)	0.001 (-1.047)
STOCKMARKETSIZE		0.001 (0.888)	0.001** (2.043)	0.001 (0.888)	0.001** (2.043)
CAPITALCONTROL		0.001 (0.281)	0.002 (1.007)	0.001 (0.853)	0.001 (1.067)
AMLSCORE			-0.039** (-2.593)		-0.039** (-2.549)
Standard errors cluster-adjusted		By country	By country	By country	By country
N		581	466	571	457
Adjusted *R*-squared		71.3%	74.7%	70.4%	73.8%

*** $p<0.01$, ** $p<0.05$, * $p<0.10$

Table 3

(continued)

Table 3 uses a difference-in-differences design to identify the bank-cryptocurrency relation in response to an exogenous shock to the bank-enabled cross-border payment system. This table reports the regression results as specified in the following equation:

$$ONCHAINVALUEit = \alpha + \beta 1 * TREATED(OUTFLOWSHARE)it + \beta 2 * POSTit + \boldsymbol{\beta 3} * \boldsymbol{TREATED(SHAREOUTFLOW)it * POSTit} + \beta 4 * BANKEDSHARE + \beta 5 * TREATED(SHAREOUTFLOW)it * BANKEDSHAREit + \boldsymbol{\beta 6 POSTit * TREATED(SHAREOUTFLOW)it * BANKEDSHAREit} + \beta 7 * INTERNETit + \beta 8 * MOBILEPHONEit + \beta 9 * GDPpercapitait + \beta 10 * INFLATIONit + \beta 11 * FOREXit + \beta 12 * POP + \beta 13 * CAPITALCONTROLit + \beta 14 * MOBILEMONEYit + \beta 15 * AMLSCOREit + \varepsilon \quad Equation\ (1)$$

The variables are all defined in table 1. The dependent variable is the normalized index of cryptocurrency value received on blockchain deflated by GDP per capita ($ONCHAINVALUE_{it}$). As reported in panel A, $TREATED_i$ is 1 if country *i* is a destination country that receives more than 0.1% of outward bank-enabled remittances from Russia and Belarus. The variables of interest include the slope coefficient on $TREATED_i*POST_t$ and the slope coefficient on *POST*TREATED*BANKEDSHARE*. As reported in panel B, $OUTFLOWSHARE_{it}$ is country *i*'s share of outward bank-enabled remittances from Russia and Belarus. The variables of interest include the slope coefficient on $SHAREOUTFLOW_i*POST_t$ and the slope coefficient on $POST_t*OUTFLOWSHARE_i*BANKEDSHARE_{it}$

Table 4

Difference-in-Differences Design for Small Value in Response to an Exogenous Shock

Panel A: Bank-cryptocurrency relation when the treatment effect is dichotomous

		Dependent Variable = **ONCHAINRETAILVALUE**			
		All observations		Excluding Russia, Belarus and Ukraine	
		Column 1	Column 2	Column 3	Column 4
Explanatory variables	*Predicted sign*	Coefficient (*T*-value)	Coefficient (*T*-value)	Coefficient (*T*-value)	Coefficient (*T*-value)
Intercept		Included	Included	Included	Included
POST		-0.002 (-0.206)	-0.024 (-0.774)	-0.002 (-0.212)	-0.024* (-1.812)
TREATED		0.114 (0.943)	0.152 (1.232)	0.078 (0.638)	0.114 (0.953)
POST*TREATED		***0.486*** (3.936)***	***0.569*** (4.699)***	***0.530*** (4.913)***	***0.607*** (5.508)***
BANKEDSHARE		0.180 (1.221)	0.199** (2.148)	0.172** (2.134)	0.168*** (2.238)
*TREATED*BANKEDSHARE*		-0.103 (-0.933)	-0.150 (-1.072)	-0.071 (-0.535)	-0.116 (-0.857)
POST*TREATED*BANKEDSHARE		***-0.524*** (3.759)***	***-0.636*** (-4.178)***	***-0.561*** (-4.794)***	***-0.668*** (-4.605)***
INTERNET		0.003** (2.108)	0.001 (0.820)	0.003* (1.936)	0.001 (0.820)
MOBILEPHONE		0.001 (0.482)	0.001 (0.198)	0.001 (0.482)	0.001 (0.198)
MOBILEMONEY		-0.076 (-0.918)	0.025 (0.346)	-0.076 (-0.918)	0.025 (0.346)
Ln(POP)		0.136*** (16.264)	0.137*** (17.972)	0.136*** (16.264)	0.135*** (17.097)
Ln(GDPpercapita)		-0.030 (-0.913)	-0.027 (-0.843)	-0.030 (-0.913)	-0.027 (-0.843)
INFLATION		0.001 (0.213)	-0.001*** (-3.365)	0.001 (0.213)	-0.001*** (-3.557)
FOREX		-0.001 (-0.805)	-0.001 (-0.022)	-0.001 (-0.805)	-0.001 (-0.022)
EQUITYRETURN		-0.001** (-2.088)	0.001 (-1.047)	0.001 (0.258)	0.001 (-1.047)
STOCKMARKETSIZE		0.001 (0.888)	0.001** (2.043)	0.001 (0.888)	0.001** (2.043)
CAPITALCONTROL		0.001 (0.181)	0.002 (0.766)	0.001 (0.458)	0.001 (1.321)
AMLSCORE			-0.038** (-2.367)		-0.039** (-2.448)
Standard errors cluster-adjusted		By country	By country	By country	By country
N		581	466	571	457
Adjusted *R*-squared		74.6%	77.5%	73.8%	76.9%

*** p<0.01, ** p<0.05, * p<0.10

Table 4
(continued)

Panel B: Bank-cryptocurrency relation when the treatment effect is continuous

		Dependent Variable = **ONCHAINRETAILVALUE**			
		All observations		Excluding Russia, Belarus and Ukraine	
		Column 1	Column 2	Column 3	Column 4
Explanatory variables	*Predicted sign*	Coefficient (*T*-value)	Coefficient (*T*-value)	Coefficient (*T*-value)	Coefficient (*T*-value)
Intercept		Included	Included	Included	Included
POST		Included	Included	Included	Included
OUTFLOWSHARE		-0.008 (-0.743)	-0.030** (-2.338)	-0.005 (-0.525)	-0.027** (-2.146)
POST*OUTFLOWSHARE		1.851* (1.793)	1.936** (2.095)	2.105 (0.703)	1.244 (0.429)
BANKEDSHARE		***19.530*** (5.054)***	***20.838*** (4.024)***	***19.569*** (4.319)***	***22.752*** (3.998)***
*OUTFLOWSHARE*BANKEDSHARE*		0.173** (2.244)	0.159** (2.181)	0.170** (2.191)	0.155** (2.133)
POST*OUTFLOWSHARE*BANKEDSHARE		-1.464 (-1.192)	-1.427 (-1.285)	-0.109 (-0.021)	1.595 (0.313)
INTERNET		***-21.787*** (-4.367)***	***-23.595*** (-3.059)***	***-22.644*** (-2.947)***	***-28.272*** (-3.134)***
MOBILEPHONE		0.003** (2.026)	0.001 (0.820)	0.003* (1.936)	0.001 (0.820)
MOBILEMONEY		0.001 (0.482)	0.001 (0.198)	0.001 (0.482)	0.001 (0.198)
Ln(POP)		-0.076 (-0.918)	0.025 (0.346)	-0.076 (-0.918)	0.025 (0.346)
Ln(GDPpercapita)		0.136*** (16.264)	0.137*** (17.972)	0.136*** (16.264)	0.135*** (17.097)
INFLATION		-0.030 (-0.913)	-0.027 (-0.843)	-0.030 (-0.913)	-0.027 (-0.843)
FOREX		0.001 (0.213)	-0.001*** (-3.365)	0.001 (0.213)	-0.001*** (-3.557)
EQUITYRETURN		-0.001 (-0.805)	-0.001 (-0.022)	-0.001 (-0.805)	-0.001 (-0.022)
STOCKMARKETSIZE		0.001 (0.258)	0.001 (-1.047)	0.001 (0.258)	0.001 (-1.047)
CAPITALCONTROL		0.001 (0.218)	0.002 (0.976)	0.001 (0.483)	0.001 (1.390)
AMLSCORE			-0.039** (2.478)		-0.039** (2.420)
Standard errors cluster-adjusted		By country	By country	By country	By country
N		581	466	571	457
Adjusted *R*-squared		74.3%	76.2%	72.7%	75.9%

*** p<0.01, ** p<0.05, * p<0.10

Table 4

(continued)

Table 4 uses a difference-in-differences design to identify the bank-cryptocurrency relation in response to an exogenous shock to the bank-enabled cross-border payment system. This table reports the regression results as specified in the following equation:

$$ONCHAINRETAILVALUEit = \alpha + \beta 1 * TREATED(OUTFLOWSHARE)it + \beta 2 * POSTit + \boldsymbol{\beta 3} * \boldsymbol{TREATED}(\boldsymbol{SHAREOUTFLOW})\boldsymbol{it} * \boldsymbol{POSTit} + \beta 4 * BANKEDSHARE + \beta 5 * TREATED(SHAREOUTFLOW)it * BANKEDSHAREit + \boldsymbol{\beta 6POSTit} * \boldsymbol{TREATED}(\boldsymbol{SHAREOUTFLOW})it * \boldsymbol{BANKEDSHAREit} + \beta 7 * INTERNETit + \beta 8 * MOBILEPHONEit + \beta 9 * GDPpercapitait + \beta 10 * INFLATIONit + \beta 11 * FOREXit + \beta 12 * POP + \beta 13 * CAPITALCONTROLit + \beta 14 * MOBILEMONEYit + \beta 15 * AMLSCOREit + \varepsilon \quad Equation\ (1)$$

The variables are all defined in table 1. The dependent variable is the normalized index of retail cryptocurrency value received on blockchain deflated by GDP per capita ($ONCHAINRETAILVALUE_{it}$). A retail cryptocurrency value is defined as a transaction value that is less than \$10,000 by Chainalysis. As reported in panel A, $TREATED_i$ is 1 if country *i* is a destination country that receives more than 0.1% of outward bank-enabled remittances from Russia and Belarus. The variables of interest include the slope coefficient on $TREATED_i*POST_t$ and the slope coefficient on *POST*TREATED*BANKEDSHARE*. As reported in panel B, $OUTFLOWSHARE_{it}$ is country *i*'s share of outward bank-enabled remittances from Russia and Belarus. The variables of interest include the slope coefficient on $SHAREOUTFLOW_i*POST_t$ and the slope coefficient on $POST_t*OUTFLOWSHARE_i*BANKEDSHARE_{it}$

Table 5

The Bank-cryptocurrency Relation and the Cost of Bank-enabled Cross-border Payment

		Dependent variable = ***ONCHAINVALUE***	Dependent variable = ***ONCHAINRETAILVALUE***
		Column 1	Column 2
Explanatory variables	*Predicted sign*	Coefficient (T-value)	Coefficient (T-value)
Intercept		Included	Included
$POST_i$		-0.004 (-0.158)	-0.018 (-0.937)
$TREATED_t$		0.213* (1.685)	0.193** (2.073)
$POST_t$*$TREATED_i$		***0.817*** (4.278)***	***0.956*** (6.391)***
$BANKEDSHARE_{it}$		0.125 (1.327)	0.145 (1.463)
$TREATED_i$*$BANKEDSHARE_{it}$		-0.304 (-1.782)	-0.301** (-2.091)
$POST_t$*$TREATED_i$*$BANKEDSHARE_{it}$		***-0.660*** (-4.742)***	***-0.593*** (-4.161)***
$BANKREMITCOST_{it}$		0.004 (0.855)	0.007 (1.515)
$POST_t$*$TREATED_i$*$BANKREMITCOST_{it}$		***-0.064*** (-2.117)***	***-0.094*** (-3.156)***
All control variables including $AMLSCORE_{it}$		Included	Included
Standard errors cluster-adjusted		By country	By country
N		301	301
Adjusted R-squared		74.3%	81.8%

*** p<0.01, ** p<0.05, * p<0.10

Table 5 uses a difference-in-differences design to examine whether the bank-cryptocurrency relation in response to an exogenous shock varies with the cost of the bank-enabled cross-border payment system. This table reports the regression results as specified in the following equation:

$$ONCHAINVALUEit = \alpha + \beta 1 * TREATED(OUTFLOWSHARE)it + \beta 2 * POSTit + \boldsymbol{\beta} 3 * TREATEDit * POSTit + \beta 4 * BANKEDSHARE + \beta 5 * TREATED(SHAREOUTFLOW)it * BANKEDSHAREit + \beta 6 POSTit * TREATEDit * BANKEDSHAREit + \boldsymbol{\beta 7} * \boldsymbol{BANKREMITCOSTit} + \boldsymbol{\beta} 8 * \boldsymbol{POSTit} * \boldsymbol{TREATED}it * \boldsymbol{BANKREMITCOSTit} + \beta 9 * INTERNETit + \beta 10 * MOBILEPHONEit + \beta 11 * GDPpercapitait + \beta 12 * INFLATIONit + \beta 13 * FOREXit + \beta 14 * POP + \beta 15 * CAPITALCONTROLit + \beta 16 * MOBILEMONEYit + \beta 17 * AMLSCOREit + \varepsilon \quad Equation\ (1)$$

The variables are all defined in table 1. *$TREATED_i$* is 1 if country *i* is a destination country that receives more than 0.1% of outward bank-enabled remittances from Russia and Belarus. *BANKREMITCOST*$_{\text{it}}$ is the weighted average cost of receiving $200 via bank-enabled remittance corridors in percentage. The variable of interest is the slope coefficient on *POST*TREATED*BANKREMITCOST*.

Table 6

Change Specification on the Bank-Cryptocurrency Relation

Panel A: Correlation table (Pearson correlation lower diagonal and Spearman correlation upper diagonal)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) CHGONCHAINVALUE	1.000	-.288**	.252**	.290**	.296**	-0.046	0.076	0.080	0.059	.315**	.160*	-.194**	0.088
(2) CHGBANKEDSHARE	-.276**	1.000	-.605**	-.539**	-.274**	0.018	-0.018	0.040	.418**	-.369**	-0.072	0.024	-0.051
(3) CHGLACKTRUST	.191**	-.539**	1.000	.811**	.591**	-0.003	0.060	0.092	-.288**	.346**	0.114	0.011	-0.084
(4) CHGHIGHCOST	.182*	-.418**	.800**	1.000	.626**	-0.009	0.086	0.064	-.276**	.220**	0.090	0.038	-0.061
(5) CHGGDPpercapita	-0.026	0.109	-0.123	-0.015	0.033	1.000	.436**	-.308**	-0.034	-.176*	.310**	-.239**	.319**
(6) CHGINFLATION	-0.035	-0.061	0.133	0.056	-0.129	-0.085	1.000	-0.074	-0.030	-0.033	.328**	-.153*	.314**
(7) CHGFOREX	-0.002	-0.008	0.061	0.092	.255**	-0.142	-.585**	1.000	0.046	.252**	-0.076	0.036	-0.161
(8) CHGMOBILEPHONE	-0.003	.401**	-.329**	-.292**	-.262**	-0.033	0.034	-0.092	1.000	-.161*	-0.027	-0.056	0.010
(9) CHGINTERNET	0.003*	.101	-.391	-.112	-.126	-0.023	0.044	-0.029	1.000	-.061	-0.125	-0.066	0.008
(10) CHGPOP	.184*	-.310**	.220**	.193**	.206**	-.201**	-0.073	.209**	-0.139	1.000	-0.004	-0.008	0.025
(11) CHGEQUITYRETURN	.159*	-.198**	.150*	0.131	.174*	.199**	0.063	-0.061	-0.004	0.077	1.000	-0.022	0.096
(12) CHGSTOCKMARKETSIZE	-0.048	-0.058	0.020	0.020	-0.011	-0.071	-0.010	-0.015	-0.052	-0.023	0.001	1.000	-0.044
(13) CHGMLRISK	0.206	-0.149	0.006	-0.007	-0.024	.211*	-0.066	-0.058	-0.023	0.074	0.068	-0.007	1.000

*Correlation is significant with *p*-value < 0.05; **correlation is significant with *p*-value < 0.01

Table 6
(continued)

Panel B: Multivariate regression results on change in banked shares and changes in cryptocurrency transactions

		Dependent variable = ***CHGONCHAINVALUE*$_{it}$**		Dependent variable = ***CHGONCHAIN RETAILVALUE*$_{it}$**	
		Column 1	Column 2	Column 3	Column 4
Explanatory variables	*Predicted sign*	Coefficient (*T*-value)	Coefficient (*T*-value)	Coefficient (*T*-value)	Coefficient (*T*-value)
Intercept		Included	Included	Included	Included
***CHGBANKEDSHARE*$_{it}$**	***(-)***	***-0.360*** (-4.542)***	***-0.326*** (-3.017)***	***-0.356*** (-4.407)***	***-0.324*** (-2.976)***
CHGGDPpercapita$_{it}$		-0.003** (-2.245)	-0.003 (-1.543)	-0.003** (-2.264)	-0.003 (-1.525)
CHGINFLATION$_{it}$		0.001*** (2.342)	0.001 (1.391)	0.001*** (2.429)	0.001 (1.391)
CHGFOREX$_{it}$		0.160** (3.131)	0.048 (0.677)	0.166** (3.211)	0.048 (0.677)
CHGINTERNET		0.003 (1.026)	0.001 (0.820)	0.003 (1.062)	0.001 (0.920)
CHGMOBILEPHONE$_{it}$		-0.043 (-0.502)	-0.111 (-0.979)	-0.043 (-0.502)	-0.111 (-0.979)
CHGPOP$_{it}$		-0.504 (-0.934)	0.542 (0.798)	-0.504 (-0.934)	0.542 (0.798)
CHGEQUITYRETURN$_{it}$		0.001** (2.422)	0.001 (0.924)	0.001** (2.398)	0.001 (0.924)
CHGSTOCKMARKETSIZE$_{it}$		-0.001 (-1.613)	-0.001 (-0.460)	-0.001 (-1.396)	-0.001 (-0.460)
CHGCAPITALCONTROL		0.001 (0.675)	0.001 (0.747)	0.001 (0.675)	0.001 (0.474)
CHGMOBILEMONEY		0.066* (1.824)	0.082** (2.500)	0.070* (1.952)	0.087** (2.696)
CHGAMLSCORE$_{it}$			-0.014 (-1.476)		-0.015 (-1.588)
Year fixed effect		Included	Included	Included	Included
Cluster-adjusted standard error		By year and country	By year and country	By year and country	By year and country
N		348	251	348	251
Adjusted *R*-squared		30.1%	24.5%	20.1%	20.3%

*** $p<0.01$, ** $p<0.05$, * $p<0.10$

Table 6

(Continued)

Panel C: Comparative statistics on high versus low-and-middle income subsamples

		Dependent Variable = ***CHGONCHAINVALUE**$_{it}$*			
		High Income Subsample		Low-and-Middle Income Subsample	
		Column 1	Column 2	Column 3	Column 4
Explanatory variables	*Predicted sign*	Coefficient (*T*-value)	Coefficient (*T*-value)	Coefficient (*T*-value)	Coefficient (*T*-value)
Intercept		Included	Included	Included	Included
***CHGBANKEDPOP**$_{it}$*		***-0.096 (-0.777)***	***-0.084 (-0.650)***	***-0.367*** (-3.311)***	***-0.355** (-1.965)***
CHGGDPpercapita$_{it}$		0.001 (-0.711)	-0.001 (-0.421)	-0.001 (-0.021)	-0.001 (-0.421)
CHGINFLATION$_{it}$		-0.001 (-1.241)	-0.001 (-1.143)	-0.001 (-1.637)	-0.001 (-1.343)
CHGFOREX$_{it}$		-0.050 (-1.072)	-0.125 (-1.194)	-0.059 (-1.042)	-0.095 (-1.193)
CHGINTERNET		0.003 (1.028)	0.001 (0.920)	0.003 (1.012)	0.001 (0.822)
CHGMOBILEPHONE$_{it}$		0.018 (0.330)	0.048 (0.488)	0.128** (2.442)	0.062 (0.780)
CHGPOP$_{it}$		0.844** (2.024)	0.948 (1. 650)	0.526 (1.482)	0.617 (1.273)
CHGEQUITYRETURN$_{it}$		0.001 (0.842)	0.001 (1.139)	0.001 (0.787)	0.001 (1.039)
CHGSTOCKMARKETSIZE$_{it}$		-0.001 (-1.178)	-0.001 (-1.461)	-0.001* (-1.757)	-0.001 (-1.631)
CHGCAPITALCONTROL		0.001 (0.777)	0.001 (0.467)	0.001 (0.467)	0.001 (0.782)
CHGMOBILEMONEY		0.066 (0.824)	0.072 (1.501)	0.060* (1.925)	0.084** (2.696)
CHGAMLSCORE$_{it}$			0.021 (1.510)		0.017 (1.321)
Year fixed effect		Included	Included	Included	Included
Cluster-adjusted standard error		By year and country	By year and country	By year and country	By year and country
N		154	133	194	118
Adjusted *R*-squared		44.4%	43.3%	12.8%	21.8%

*** p<0.01, ** p<0.05, * p<0.10

Table 6

(continued)

Table 6 uses a change specification to examine the bank-cryptocurrency relation. This table reports the regression results as specified in the following equation:

$$CHGONCHAINVALUERECEIVEDit = \alpha + \boldsymbol{\beta 1} * \boldsymbol{CHGBANKEDSHAREit} + \beta 2 * INTERNETPENETRTIONit + \beta 3 * CHGMOBILEPHONEit + \beta 4 * CHGGDPpercapitait + \beta 5 * CHGINFLATIONit + \beta 6 * CHGFOREXit + \beta 7 * CHGEQUITYRETURNit + \beta 8 * CHGEQUITYMARKETSIZEit + \beta 8 * CHGCAPITALCONTROLit + \beta 10 * CHGMOBILEMONEYit + \beta 11 * CHGAMLSCOREit + year\ fixed\ effects + \varepsilon$$

The variables are all defined in table 1. As reported in panel B, the dependent variable is the change in the normalized index of cryptocurrency value received on blockchain deflated by GDP per capita (*CHGONCHAINVALUE*). As reported in panel C, the dependent variable is the change in the normalized index of retail cryptocurrency value received on blockchain deflated by GDP per capita (*CHGONCHAINRETAILVALUE*). A retail cryptocurrency value is defined as a transaction value that is less than $10,000 by Chainalysis. The variables of interest include the slope coefficient on *CHGBANKEDSHARE*, which is measured as the share of banked population at county *i* in year *t* minus that in year *t-1*.

Table 7

Explanations for the Relation between the Unbanked Share and Cryptocurrency Adoption

Panel A: Validity of lack of trust in financial institutions from the Global Findex Survey

	Spearman correlation with *WVSLACKTRUSTBANK* (the percentage of the population saying that "I have not much confidence in banks or none at all" as reported by the World Value Survey)	Spearman correlation with *WVSLACKTRUSTBANK* (the percentage of the population saying that "I have not much confidence in banks or none at all" as reported by the World Value Survey)
LACKTRUST (the percentage of adults citing lack of trust in financial institutions as the reason for having no bank accounts as reported by the Global Findex Survey)	0.842	0.790
N	33	33
P-value of the correlation	*0.01*	*0.01*

Table 7

(continued)

Panel B: Lack of trust in financial institutions as an explanation

		Dependent variable = ***CHGONCHAINVALUE***$_{it}$		Dependent variable = ***CHGP2PEXCHANGETRADE***$_{it}$	
		Column 1	Column 2	Column 3	Column 4
Explanatory variables	*Predicted sign*	Coefficient (*T*-value)	Coefficient (*T*-value)	Coefficient (*T*-value)	Coefficient (*T*-value)
Intercept		Included	Included	Included	Included
CHGLACKTRUST$_{it}$	***(+)***	***0.441****** ***(3.980)***	***0.511****** ***(3.262)***	***0.127*** ***(0.664)***	***-0.059*** ***(-0.169)***
CHGGDPpercapita$_{it}$		-0.003** (-2.496)	-0.003* (-1.703)	-0.001 (-0.651)	-0.001 (-0.404)
CHGINFLATION$_{it}$		0.001 (1.475)	0.001 (0.482)	-0.001*** (-2.929)	-0.001* (-1.879)
CHGFOREXRATE$_{it}$		0.111 (1.645)	-0.015 (-0.249)	0.206 (1.422)	0.341* (1.878)
CHGINTERNETPENETRATION		0.003 (1.028)	0.001 (0.920)	0.003 (1.012)	0.001 (0.822)
CHGMOBILEPHONE$_{it}$		-0.096 (-1.044)	-0.120 (-1.279)	0.647*** (3.052)	0.399 (1.711)
CHGPOP$_{it}$		-0.141 (-0.307)	0.806 (1.288)	2.242** (2.060)	1.319 (0.882)
CHGEQUITYRETURN$_{it}$		0.001** (2.615)	0.001 (0.686)	0.001** (2.103)	0.002*** (3.358)
CHGSTOCKMARKETSIZE$_{it}$		-0.001 (-1.076)	0.001 (0.297)	-0.001** (-2.470)	-0.001 (-1.456)
CHGCAPITALCONTROL		0.001 (0.671)	0.001 (0.846)	0.001 (0.659)	0.001 (0.835)
CHGMOBILEMONEY		0.049 (1.411)	0.054* (1.758)	0.108 (0.808)	0.120 (0.473)
CHGMLRISK$_{it}$			-0.004 (-0.377)		0.027 (0.869)
Year fixed effect		Included	Included	Included	Included
Cluster-adjusted standard error		By year and country	By year and country	By year and country	By year and country
N		348	251	348	251
Adjusted *R*-squared		26.3%	24.6%	18.7%	19.7%

*** $p<0.01$, ** $p<0.05$, * $p<0.10$

Table 7

(continued)

Panel C: High costs of financial account ownership as an explanation

		Dependent variable = ***CHGONCHAINVALUE$_{it}$***		Dependent variable = ***CHGP2PEXCHANGETRADE$_{it}$***	
		Column 1	Column 2	Column 3	Column 4
Explanatory variables	*Predicted sign*	Coefficient (*T*-value)	Coefficient (*T*-value)	Coefficient (*T*-value)	Coefficient (*T*-value)
Intercept		Included	Included	Included	Included
CHGHIGHCOST$_{it}$	***(+)***	***0.183** (2.130)***	***0.145 (1.248)***	***0.068 (0.302)***	***0.055 (0.200)***
CHGGDPpercapita$_{it}$		-0.004** (-2.460)	-0.003 (-1.436)	-0.002 (-0.664)	-0.001 (-0.404)
CHGINFLATION$_{it}$		0.001 (1.640)	0.001 (0.482)	-0.001*** (-2.852)	-0.001* (-2.014)
CHGFOREX$_{it}$		0.127* (1.902)	0.048 (0.249)	0.206 (1.422)	0.334* (1.878)
CHGINTERNETPENETRATION		0.003 (1.081)	0.001 (0.941)	0.003 (1.112)	0.001 (0.844)
CHGMOBILEPHONE$_{it}$		-0.172** (-2.335)	-0.256** (-2.565)	0.630*** (3.341)	0.478* (1.881)
CHGPOP$_{it}$		-0.001 (-0.195)	1.006 (1.388)	2.254** (2.019)	1.234 (0.807)
CHGEQUITYRETURN$_{it}$		0.001*** (2.941)	0.001 (1.086)	0.001** (2.097)	0.002*** (3.285)
CHGSTOCKMARKETSIZE$_{it}$		-0.001 (-1.201)	0.001 (0.297)	-0.001** (-2.469)	-0.001 (-1.451)
CHGCAPITALCONTROL		0.001 (0.557)	0.001 (0.703)	0.001 (0.645)	0.001 (0.936)
CHGMOBILEMONEY		0.062* (1.709)	0.069** (2.235)	0.121 (0.878)	0.130 (0.788)
CHGAMLSCORE$_{it}$			-0.006 (-0.587)		0.027 (0.888)
Year fixed effect		Included	Included	Included	Included
Cluster-adjusted standard error		By year and country	By year and country	By year and country	By year and country
N		348	251	348	251
Adjusted *R*-squared		19.9%	20.3%	19.0%	20.2%

*** $p<0.01$, ** $p<0.05$, * $p<0.10$

Table 7
(continued)

Table 7 uses a change specification to explain the bank-cryptocurrency relation. This table reports the regression results as specified in the following equation:

$$CHGONCHAINVALUE(CHGP2PEXCHANGETRADE)it = \alpha + \boldsymbol{\beta 1} * \boldsymbol{CHGLACKTRUST}(\boldsymbol{CHGHIGHCOST})\boldsymbol{it} + \beta 2 * INTERNETPENETRTIONit + \beta 3 * CHGMOBILEPHONEit + \beta 4 * CHGGDPpercapitait + \beta 5 * CHGINFLATIONit + \beta 6 * CHGFOREXit + \beta 7 * CHGEQUITYRETURNit + \beta 8 * CHGEQUITYMARKETSIZEit + \beta 8 * CHGCAPITALCONTROLit + \beta 10 * CHGMOBILEMONEYit + \beta 11 * CHGAMLSCOREit + \ year\ fixed\ effects + \ \varepsilon$$

The variables are all defined in table 1. The dependent variable is the change in the normalized index of cryptocurrency value received on blockchain deflated by GDP per capita (*CHGONCHAINVALUE*) and the change in the normalized index of exchange trade volume on P2P platforms deflated by GDP per capita (*CHGP2PEXCHANGETRADE*). As reported in panel B, the variable of interest is the slope coefficient on *CHGLACKTRUST*, which is calculated as the change in the percentage of adults citing lack of trust in financial institutions as a barrier to financial account ownership from the 2021 survey relative to the 2017 survey. As reported in panel C, the variable of interest is the slope coefficient on *CHGHIGHCOST*, which is calculated as the change in the percentage of adults that cite high costs as a barrier to financial account ownership respectively from the 2017 survey to the 2021 survey.