

Are Cryptocurrencies Currencies?

Bitcoin as Legal Tender in El Salvador*

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Abstract

A currency’s essential feature is to be a medium of exchange. We leverage a quasi-natural experiment—El Salvador as the first country to make bitcoin legal tender—to study a cryptocurrency’s potential to be used in daily transactions. The government also launched and provided incentives to download and use a digital wallet named Chivo, which shares features with Central Bank Digital Currencies (CBDCs) and allows users to trade bitcoin and dollars. Were Chivo Wallet and bitcoin actually adopted after this “big push”? Conducting a representative face-to-face survey and relying on blockchain data to obtain *all* Chivo transactions, we document how usage of digital payments and bitcoin is low, concentrated, and has been decreasing over time. We find that privacy concerns are key barriers to adoption, which speaks to a policy debate on crypto and CBDCs that has had anonymity at its core. We also estimate the technology’s adoption cost and its network externalities.

Keywords: Bitcoin, Cryptocurrency, Medium of Exchange, Digital Payments, Central Bank Digital Currencies

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In its first form money is simply any commodity ... which any person will readily receive, and which, therefore, every person desires to have by him in greater or less quantity, in order that he may have the means of procuring necessities of life at any time.

William Stanley Jevons

1 Introduction and Summary

The introduction of digital currencies in general, and of cryptocurrencies in particular, is perhaps the most important development in monetary economics in the last decade. However, a currency’s key and defining role is to serve as medium of exchange (1, 2), and while cryptocurrencies are currently used as a store of value, they have not been adopted as a medium of exchange (3). Two hypothesis for this lack of adoption are a coordination failure, i.e. agents do not use it as a means of payment because they believe others will not accept it, and cryptocurrencies’ relatively large transaction fees given current technologies.¹

This paper leverages a unique quasi-natural experiment which can shed light on these hypothesis: On September 7th, 2021, El Salvador became the first country to make bitcoin legal tender via the “Bitcoin Law.” According to this law, not only bitcoin must be accepted as a means of payment for *taxes* and outstanding debts, but also all businesses are *required* to accept bitcoin as a medium of exchange for all transactions.² The Salvadorean government also launched an app called “Chivo Wallet,” a custodial wallet which allows users to digitally trade both bitcoin and dollars *without paying any transaction fees*. As an incentive to adopt, citizens who downloaded this app received a \$30 bitcoin bonus from the government, which is equivalent to 3.75 daily minimum wages in this dollarized Central American country with a per capita GDP of \$4,131.³ In other words, the government provided major adoption incentives—which could potentially solve the coordination failure—and also subsidized fees. Moreover, the COVID-19 pandemic provided an additional incentive to adopt touchless payment methods. If bitcoin has a chance to be used in transactions as a medium of exchange, this setting gave the cryptocurrency a prime opportunity.

Furthermore, central banks are considering alternatives to enter the era of digital payments. Nine out of 10 central banks are exploring central bank digital currencies (CBDCs), and more than one-half are developing them or running concrete experiments (8). A retail CBDC, a digital currency backed by a central bank with legal tender status, shares many features with a fast payment system such as Chivo Wallet. Thus, an analysis of Chivo’s implementation is informative to the debate surrounding CBDCs, and a comparison between bitcoin and dollar usage within the app is informative about the use of crypto in particular.

Were Chivo Wallet and bitcoin actually adopted after this *big push*? While there is a growing

¹Similar payment methods feature network externalities (4–6).

²While a means of payment is an object used to make purchases and settle debts, the concept of medium of exchange is broader; it is an object which is taken in exchange of something to then be exchanged for something else, without the “prerequisite” of an existing debt (7).

³This calculation considers an agricultural worker’s wage; alternatively, \$30 is 2.5 daily minimum wages for an industry worker.

interest to promote digital currencies among monetary authorities, and while this episode offers a rare opportunity to learn about the potential of cryptocurrencies to become a widely used payment method, access to data poses a challenge as El Salvador’s government reveals only selected information.⁴ To overcome this challenge, we conduct a nationally representative survey to generate data that would be otherwise unobtainable. The survey, which involved 1,800 households, was conducted via face-to-face interviews to avoid the selection issues which may emerge if the survey conditioned respondents on owning a phone or having internet access. We complement our survey results with an analysis using *all transactions* identified as involving Chivo leveraging data from the blockchain—a distributed public ledger.

From our survey, we document that over two-thirds of Salvadoreans (68%) are aware of the existence of Chivo Wallet. Those who are aware are disproportionately likely to own a cell phone with internet and to be banked, educated, young, and male. The former results are in stark contrast with the often repeated hypothesis stating that the use of crypto can particularly help the poor and unbanked; the face-to-face and representative nature of our data collection is ideal to allow us to speak directly to this topic, and in fact, find the opposite.

Not all of those who know about the app have tried to download it; just over half of all adults. The main reason *not* to download the app, conditional on knowing about it, is that users prefer to use cash, which was followed by mistrust. Both of these reasons can be related to the importance of privacy in the implementation of digital payments, given that Chivo is a custodial wallet and users are required to enter their personal information. The latter is similar to the case of several CBDCs (9, 10) and digital wallets, like Coinbase, in which users must identify themselves.

Most downloads took place just as Chivo was launched. In fact, 40% of all downloads happened in September 2021, and virtually no downloads have taken place in 2022. In line with this result, we document that Google trends for terms like “bitcoin” or “chivo” spiked in September 2021, and decreased dramatically afterwards as reported in Figure A1. Official data on remittances, shown in Figure A2, also exhibits a spike in September-October 2021 and a significant decrease thereafter. Put together, evidence suggests it is not just a matter of time for bitcoin and Chivo Wallet to be more broadly adopted, on the contrary, adoption has been decreasing over time, reaching record lows in recent months.

The main driver of adoption for households is reported to be the \$30 bonus, equivalent to 0.7% of annual income per capita. Only 20% of all respondents continued using Chivo after spending their bonus, and mainly for transactions in dollars; less than 10% continue to use it in transactions in bitcoin.⁵ We do not find evidence of Chivo Wallet being used to pay for taxes or to send remittances at a significant scale.⁶

⁴Most information comes from the president’s Twitter account. We tried, unsuccessfully, to contact multiple government entities to receive more quantitative information, including Chivo customer service, El Salvador’s Superintendency of the Financial System, Central Bank, and Casa Presidencial.

⁵The initial \$30 bonus had to be spent making payments in bitcoin, as it was intended to incentivize bitcoin usage.

⁶This is consistent with official reports from the Republic’s Reserve Bank of El Salvador, which found only 1.6% of remittances went through digital wallets in February 2022; the lowest percentage since Chivo’s creation. See Figure A2 for official data on remittances in bitcoin.

Among firms, only 20% accept bitcoin. Enterprises which accept bitcoin are very large and only 11.4% of firms report positive sales in bitcoin.⁷ On average, only 4.9% of all sales are paid in bitcoin, 88% of businesses transform money from sales in bitcoin into dollars, and 71% of them subsequently withdraw it in cash.

We then leverage that all bitcoin transactions are recorded on the blockchain to validate and better understand our survey results and to provide a window into the dynamics of Chivo’s activity using *all* of Chivo’s transactions in the blockchain. Chivo can be considered as a unique exchange which can also be used as a means of payment of mandatory acceptance, and comprehensive blockchain data allow us to provide new insights on its management and activity. We find that blockchain-recorded deposits (i.e. Chivo’s bitcoin purchases) tend to be small and relatively frequent; an active behavior which resembles the one by the right tail of Chivo users in El Salvador documented in our survey. Moreover, the analysis shows that withdrawals (i.e. Chivo’s bitcoin sales) tend to be large and happen rarely, and in synchrony with the pace of accumulated deposits; a pattern which suggests that withdrawals occur as part of Chivo’s bitcoin inventory management.⁸ Related, we find that there is an almost zero net accumulation of bitcoin within the wallet. This behavior is consistent with the one displayed by firms in El Salvador and documented in the survey, which tend to promptly convert all the bitcoin they receive into dollars. We conclude that, despite bitcoin’s legal tender status and the large incentives to promote Chivo Wallet, the cryptocurrency is not adopted at large by the population as a medium of exchange and digital payments are scarce and concentrated. These findings are informative about the intrinsic value of cryptocurrencies as means of payments, as viewed in the larger context of monetary models in economics, and about the scope of CBDCs in developing countries.⁹

Regarding broader lessons, we estimate the strength of network externalities in the adoption of digital payments, at the extensive and intensive margins. We find that there is a larger propensity to adopt the app for those whose network has adopted, and that the intensity of usage depends on network size. We also estimate the distribution of adoption costs and the willingness to pay for withdrawals and transfers between dollars and bitcoin. Our estimates indicate that the digital wallet would not be used without the subsidies. Lastly, we document that privacy and transparency concerns are the key barriers to the adoption of digital currencies.

Our work contributes to the study of cryptocurrencies (*Makarov and Schoar(2020), 11–15*), and complements these works by empirically analyzing adoption in a setting where incentives to adopt are high, have measurable variation, and there are no fees. Through the study of Chivo Wallet, we also speak to the analysis of CBDCs for which empirical evidence is scarce (*9, 16*) Appendix C includes a more detailed literature review.

⁷This result aligns with a study from the Chamber of Commerce and Industry of El Salvador, which finds 13.9% of businesses have made sales in bitcoin.

⁸For example, such that Chivo accumulates balances of bitcoin to lower the transaction cost of selling them.

⁹El Salvador is too small to affect the price of bitcoin, as reported in Figure A3; there were no large price changes following the Bitcoin Law or Chivo’s launching. Hence, the experiment is informative about whether, even if bitcoin has resale value, agents use it as means of payments.

2 The Context

El Salvador has been the stage of several monetary experiments. In 2001, the U.S. dollar became legal tender and the country’s only official currency.¹⁰ Later, on September 7th, 2021, El Salvador became the first country to make bitcoin legal tender through the “Bitcoin Law.”¹¹

The Bitcoin Law We now reproduce and discuss the most relevant articles of the Bitcoin Law. The first article of this law describes its main objective, endows bitcoin with a legal tender status, and reads as follows:

Article 1: The purpose of this law is to regulate bitcoin as unrestricted legal tender with liberating power, unlimited in any transaction, and to any title that public or private natural or legal persons require carrying out.

The Bitcoin Law also makes bitcoin a unit of account within the country, and according to Char-talism, endows it with value by accepting it as a means of payment for tax purposes. The Bitcoin Law also goes beyond the usual provisions of a legal tender, making bitcoin a medium of exchange of mandatory acceptance nationwide. The law reads:

Article 7: Every economic agent must accept bitcoin as payment when offered to him by whoever acquires a good or service.

Another relevant article of the law is related to *how* bitcoin usage will be implemented in the country. In particular, Article 8 mandates the government to provide the means to conduct transactions via bitcoin. How was the adoption of bitcoin facilitated and promoted by the state? The government’s answer was “Chivo Wallet.”¹²

The Chivo App Just as bitcoin became legal tender, the government launched Chivo Wallet, along with an educational campaign on how to use it. This digital wallet allows users to convert bitcoin into dollars and vice-versa without a fee, and to send or receive either currency.¹³ As shown in Figure A4, payments are made through the application by entering the recipient’s identification number or phone, and the payment amount.

Users can withdraw dollars from their wallet either by doing a transfer from their bank account or by withdrawing cash from a Chivo ATM without a fee.¹⁴ Similarly, they can load money into their wallets through an official website using a credit or debit card, or with cash via Chivo

¹⁰The former currency no longer circulated; prices, accounts, transactions were converted into dollars (17).

¹¹While there might be many reasons behind the decision, when the policy was announced, the president stated it would generate jobs, provide financial inclusion, and facilitate sending remittances.

¹²In El Salvador, “chivo” is a slang which means “cool.”

¹³El Salvador established a trust fund, which is known to have a limit of \$150 million, to allow for the automatic conversion of bitcoin into dollars without fees. Official details on the trust fund or Salvadorean bitcoin purchases have not been disclosed. Hitherto, the only sources of information have been the president’s Twitter posts, which indicate the country had acquired approximately 1,800 bitcoins as of April 2022.

¹⁴As of September 2021, there were 200 Chivo ATMs in El Salvador (see Figures A5 and A6), and 51 in the U.S.

ATMs. While funds remain in Chivo, they represent a claim to either dollars or bitcoin, which is not uncommon in payments platforms.¹⁵ The app can also be used to pay at local establishments. Moreover, Chivo is compatible with other bitcoin on-chain and Lightning wallets, and connects with El Salvador’s banking system to deposit or withdraw dollars from a bank account.¹⁶ Chivo can be used by registered Salvadorans, even if they reside abroad to facilitate sending remittances. Chivo also has a version intended for firms, which allows them to charge their clients and pay taxes.¹⁷ Chivo does not provide users with the key to their bitcoin. This makes it a “custodial” wallet in which transactions are not anonymous; users are required to enter their personal information after downloading the app, just as in the case of several CBDCs (9, 10).

Adoption Incentives Usage of bitcoin in El Salvador is related to Chivo’s adoption, and as an adoption incentive, citizens who downloaded the app could receive a \$30 bitcoin bonus from the government; a significant amount in this Central American country with a GDP per capita of \$4,131 (18). These \$30 are automatically deposited in their wallets, however, the money cannot be withdrawn as cash before first being transferred to another Chivo Wallet, as the bonus was intended to promote bitcoin usage. As another government incentive, users could get a significant discount per gas gallon if they paid using Chivo.¹⁸ Moreover, transactions in bitcoin usually involve significant fees. For instance, Bitcoin ATM fees can range from 5% to over 20%, with an average of about 8.5%, and transactions in bitcoin reached a fee of over \$60 per transaction in April 2021 and an average value of \$1.8 in February 2022. Transactions in bitcoin and conversions from bitcoin to dollars via Chivo Wallet *and* cash withdrawals at Chivo ATMs *do not incur any fee*. This can be interpreted as an additional government subsidy to incentivize bitcoin usage. In El Salvador, payments of public salaries and pensions remain in dollars. Allowing for these payments to be in bitcoin could have provided another adoption incentive.¹⁹ It is worth noting that El Salvador is relatively small, and is therefore a bitcoin price-taker; indeed, Figure A3 shows there were no large changes in the (global) price of bitcoin following the Bitcoin Law or Chivo’s launching. Thus, the experiment speaks about whether bitcoin is used as a means of payment given the above described incentives, despite the fact that it has a given resale value.

Bitcoin in Other Countries The lack of access to banking services and infrastructure increases the potential of digital payments to promote financial inclusion. In line with this, most of the top 20 countries in the 2021 Global Crypto Adoption Index are emerging economies. The Central African

¹⁵In other words, both dollars and bitcoin are a parallel digital asset with a fixed exchange rate. In Chivo, the price of bitcoin is adjusted in real time to its market price.

¹⁶The Lightning Network is a protocol which uses temporary payment channels that operate off-chain. After a channel is closed, payments are validated on the blockchain.

¹⁷For instance, a customer could pay the dollar price of an item in bitcoin, and the app would use the real-time exchange rate to charge her.

¹⁸Major gas stations dropped the gallon price by \$0.20 for customers who paid with Chivo between September and October, and another drop of \$0.30 per gallon was announced in November.

¹⁹For instance, during the 2001-2002 Argentinean crisis, several provinces introduced low-denomination bonds (“quasi money”) and used them to pay wages and other inputs. (19).

Republic (CAF) was the second country, after El Salvador, to make bitcoin legal tender in April 2022, the same month in which Panama approved its own Crypto Law.²⁰ Developed countries have not been absent from the crypto-stage. For instance, an Arizona senator proposed a bill to make bitcoin legal tender in the state in January 2022.²¹

3 Survey Instrument

We conduct a *nationally* representative *face-to-face* survey spanning 1,800 households during February 2022. This leads to results with a 95% confidence interval and a 1.94% margin of error. Respondents are all adults, which is a prerequisite to be eligible to use Chivo Wallet. The national survey was conducted in partnership with CID-Gallup.²² Interviewers were trained a week in advance in how to conduct the survey, and we implemented a pilot interviewing 50 people to ensure survey questions were clear. Our sample validation can be found in [Appendix D](#); the sample almost exactly matches total population shares in terms of gender, age, districts, and education levels. The sample is also representative in terms of bank account ownership.²³

The national-scale and face-to-face nature of the survey poses a challenge, as compared with an internet or phone survey. However, both features are important in our setting. First, understanding adoption patterns requires a sample that includes small cities and rural areas, as focusing on main population centers might bias results. Second, as bitcoin’s adoption through Chivo requires access to both a cell phone and an internet connection, a survey via phone or internet which conditioned respondents on having access to either communication method would mechanically bias results and underestimate adoption costs. Lastly, the face-to-face format preserves data quality while allowing us to conduct a longer survey with more detailed questions than would be feasible via phone or internet.²⁴

4 Results on Adoption

Payment Methods, Financial Inclusion, and Mobile Internet Connectivity Only one-third of the adult population in El Salvador owned a bank account at a financial institution in 2017 (20), which aligns with our survey’s results. We find that most transactions are paid in cash—in fact, over 50% of people *only* use cash. We also document that over 70% of respondents are unbanked, and almost 90% of them do not use mobile banking, as reported in [Figure A7](#).²⁵ We find that 64.6% of Salvadoreans have access to a mobile phone with internet, a prerequisite to

²⁰Panama and CAF are benchmarked against regions in El Salvador in Panel (b), [Figure 1](#).

²¹Bill SB 1341 was introduced by state Sen. Wendy Rogers.

²²CID-Gallup has over 40 years conducting surveys in Latin America. It has an office in El Salvador which periodically conducts large-scale surveys.

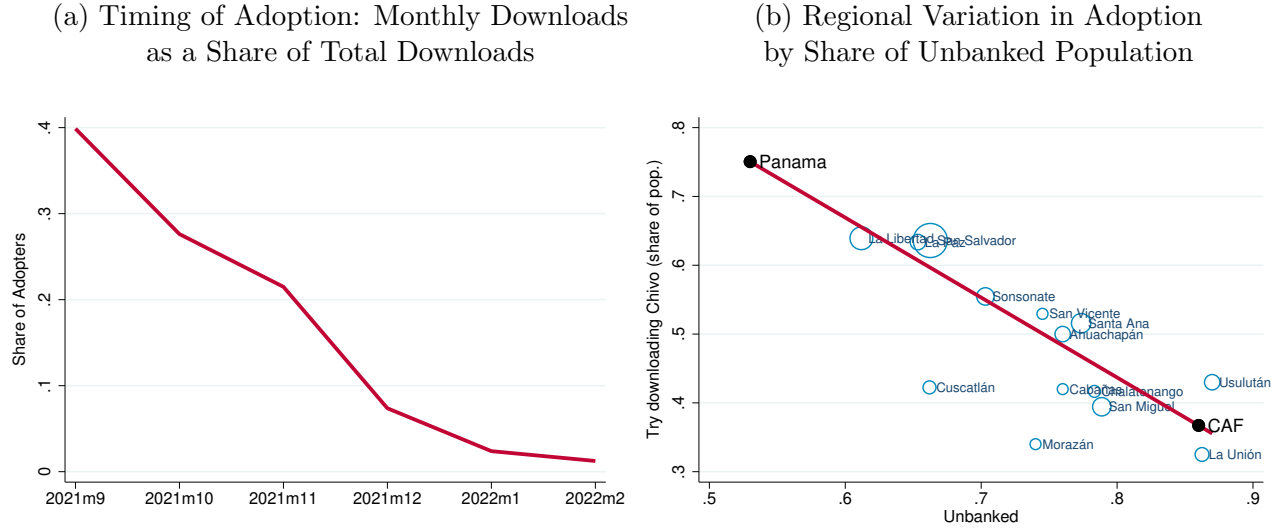
²³Total population shares match the General Directorate of Statistics and Censuses’ 2021 projections.

²⁴Approximate survey length was 27 minutes. To obtain candid responses, respondents were guaranteed confidentiality and notified that the survey aimed to inform academic research.

²⁵More details on financial inclusion in El Salvador are provided in [Table B1](#).

adopt Chivo.²⁶

Figure 1: Chivo Wallet’s Adoption



Notes: Panel (a) shows the month in which each user in our sample downloaded Chivo, as a share of total downloads. Panel (b) shows the relationship between the share of people who have tried to use of Chivo Wallet and the fraction of people who do not have access to a bank account El Salvador, by department. Panel (b) also includes, for comparison, the shares of unbanked in Panama and the Central African Republic (CAF).

Knowledge About Chivo and Downloads We find 68% of potential users know about the app’s existence. Most of those who are aware of the app found out through social media, followed by TV and radio, news, and friends and family, as summarized by Figure A8. Most Salvadoreans who are aware of the app own a cell phone with internet. We also find banked, educated, and young males are more likely to know about Chivo, as shown in Table B2. Moreover, conditional on knowing about Chivo, these characteristics also make a person more likely to try to adopt it, as documented in Table 1.²⁷ People with these demographics also tend to download the app on their own and without help (see Table B3). Almost 78% of those who are aware of the app have tried to download it. Importantly, most downloads happened just as Chivo was launched. Panel (a) of Figure 1 shows 40% of all downloads occurred in September 2021 and there have been virtually no downloads in 2022. The latter suggests our survey is already capturing the most relevant share of adopters of this digital wallet.

Not all users agree with the widespread use of Chivo Wallet. Individuals who agree tend to own a mobile phone with internet, and to be younger and male. Columns 1-3 in Table B4 show people who agree with the use of Chivo are 0.3 percentage points more likely to download the app,

²⁶We collected data on access to a cell-phone with internet ourselves, as information on cell-phone and internet access was only available for each one separately in household surveys. Figures A9 and A10 provide details on these measures separately and other demographics relying on survey data.

²⁷Table 1 relies on a linear probability model. Results are robust to other specifications, in particular, Columns (1) and (3) of Table B7 show the marginal effects under a logit model.

and Columns 4-6 show individuals who are *less likely* to agree also tend to be those who need help installing the app.

Table 1: Adoption of Chivo Wallet

<i>Dependent variable: Have you tried to download Chivo?</i>				
	(1)	(2)	(3)	(4)
Cell Phone with Internet	0.1085*** (0.036)			0.0757** (0.035)
Unbanked		-0.1132*** (0.023)		-0.0815*** (0.026)
Middle School			0.0849*** (0.023)	0.0676** (0.024)
High School+			0.1168*** (0.029)	0.0832** (0.036)
Age 25-34			-0.0236 (0.014)	-0.0241* (0.013)
Age 35-44			-0.0480 (0.032)	-0.0473 (0.032)
Age 45-54			-0.0969* (0.045)	-0.0888* (0.041)
Age 55+			-0.1349*** (0.029)	-0.1238*** (0.028)
Female			-0.0292 (0.021)	-0.0089 (0.020)
Single			-0.0567** (0.023)	-0.0528** (0.023)
Observations	1,224	1,224	1,224	1,224
R-squared	0.019	0.023	0.041	0.055
Department Fixed Effects	Y	Y	Y	Y

Notes: The sample only includes respondents who knew about the existence of Chivo Wallet. Standard errors are clustered by department.

Reasons to Download Chivo The key factor to download the app was the \$30 bonus—equivalent to 0.7% of annual income per capita. Other reasons deemed as the most important ones were the contactless nature of the payment method in the midst of the pandemic and the potential to receive remittances. Figure A11 summarizes all reasons regarded as most important.

Chivo Usage by Households Most respondents spent their \$30 bonus to pay for expenses in bitcoin, and almost 20% of those who downloaded the app have not used their bonus.²⁸ However, most users did not keep using Chivo after spending their bonus. Table 2 presents descriptive statistics on Chivo Wallet’s usage among those who downloaded it *and* who report using the app after spending the bonus. A salient feature of people who downloaded Chivo, and kept using it after spending their bonus, is that they are more likely to be young, educated, male, banked, and much

²⁸ According to Chivo’s regulations, users must spend their bonus in bitcoin, to incentivize its usage. Some people found ways to circumvent this restriction; for instance, sending the bonus to a family member and asking her to withdraw the money from a Chivo ATM.

more likely (26%) to be using other digital wallet besides Chivo to conduct transfers.²⁹ Distance to a Chivo ATM and facing issues with the app, however, are not good predictors of whether the user remains active, suggesting these are not the binding barriers to sustain usage.³⁰

Over one-half of these “active users” have not made a cash withdrawal from a Chivo ATM, although the mean number of withdrawals is 2.59, given the presence of extreme values in the right tail.³¹ The number of payments and transfers received or sent is also largely driven by very active users in the right tail. Deposits in dollars is the only statistic where users in the 25th percentile have a non-zero value. We can conclude active Chivo users transact in dollars more than bitcoin, as the average amount of payments and transfers, sent or received, is consistently larger in dollars.

Table 2: Descriptive Statistics: Active Chivo Wallet Users

	(1) Mean	(2) Std. Dev.	(3) 10th	(4) 25th	(5) Median	(6) 75th	(7) 90th
ATM withdrawals	2.5	8.7	0	0	0	2	4
Avg. amount ATM withdrawals (in dollars)	54.9	65.6	10	20	30	60	120
Payments/transfers sent in bitcoin	2.3	7.8	0	0	0	2	5
Payments/transfers sent in dollars	9.2	24.8	0	0	1	5	20
Avg. amount payments/transfers sent in bitcoin (in dollars)	32.5	38.2	3	10	20	42.5	80
Avg. amount payments/transfers sent in dollars (in dollars)	39.6	47.1	7	12	20	50	100
Payments/transfers received in bitcoin	2.1	7	0	0	0	1	4
Payments/transfers received in dollars	6.2	18	0	0	0	2	15
Avg. amount payments/transfers received in bitcoin (in dollars)	51.3	77	2	10	25	55	100
Avg. amount payments/transfers received in dollars (in dollars)	55.3	78.9	5	15	30	70	120
Deposits in bitcoin	1.31	3.9	0	0	0	1	2.5
Deposits in dollars	4.4	13.8	0	0	1	2	10

Notes: The table shows distribution of responses to the questions: i) How many times per month do you withdraw money from Chivo ATMs?, ii) what is the average amount of your ATM withdrawals?, iii) how many payments or transfers you perform per month using Chivo Wallet in bitcoin or in USD?, iv) what is the average amount of your payments or transfers in bitcoin or in USD?, v) how many payments or transfers you received per month using Chivo Wallet in bitcoin or in USD?, vi) what is the average amount of your payments or transfers your received in bitcoin or in USD?, vii) how many times have you deposited money to your Chivo Wallet in bitcoin or in USD?. We divide the number of deposits by the months a person has been active in Chivo to convert them to a monthly variable and we round the values to the closest integer. The sample includes those who kept using it after spending their \$30 bonus (20.6% of respondents). We drop observations above the 99th percentile to avoid extreme outliers.

Reasons Not to Download Chivo Over 21% of respondents knew about Chivo Wallet, but did not try to download it. The reasons not to download it are summarized in Panel (a) of Figure A13. The most important reason was that users prefer to use cash. The second most relevant reason not to download Chivo was trust issues—respondents did not trust the system or bitcoin itself.³² Privacy and security are at the heart of the debate around CBDCs and bitcoin. Concerns regarding lack of anonymity and secure transactions could then explain, at least partially, the main

²⁹These findings regarding the prominence of young adoption is in line with (21).

³⁰Table B5 shows no evidence of technical issues with the app being a concern by constructing a dummy equal to one if the user faced problems using the app.

³¹Figures A5 and A6 show Chivo ATMs’ location. Figure A12 displays mean distances to a Chivo ATM across population shares.

³²Mistrust is also the main reason not to agree with the use of Chivo (Figure A16).

two reasons not to download the app, as cash is an anonymous payment method.³³ The next most frequent reason mentioned was not owning a phone with internet, followed by the technology being complicated. In sixth place, Salvadoreans mentioned technical difficulties using the app; Figure A14 summarizes the main reported problems.

Reasons Not to Use Bitcoin Panel (b) of Figure A13 reports the main reasons why individuals do not use bitcoin. For over 50% of respondents, the most relevant reason not to use bitcoin was that they do not understand it nor trust it. Trust and transparency seem to be more salient than uncertainty, as bitcoin’s volatility is mentioned by less than 10% of respondents.

Taxes and Remittances By law, bitcoin can be used to pay taxes. Chartalism implies endowing a currency with the power to pay taxes gives it value as a means of exchange.³⁴ However, only 5% of Salvadoreans have paid taxes via Chivo. Moreover, in El Salvador, some households receive over 60% of their income from remittances, as summarized in Figure A15. Yet, Chivo is not widely used to receive remittances from abroad; 3% (8%) of people have received remittances in bitcoin (dollars) via Chivo. This finding aligns with reports from the Central Reserve Bank of El Salvador, which find only 1.45% of remittances were received via digital wallets on March 2022, and provides external validation to our survey.³⁵

Regional Variation Panel (b) of Figure 1 shows important regional variation in the probability of downloading Chivo depending on the share of unbanked population in each department. It also benchmarks the Central African Republic—the second country to make bitcoin legal tender—and Panama—which enacted a crypto law in April 2022—with respect to departments in El Salvador, given our estimates and their share of unbanked population. Figures A18 and A19 also show regional differences in adoption and awareness about Chivo depending *both on average income and share of unbanked* per department. Departments with higher levels of development tend to be more active using Chivo. The share of users who continue using the application after spending the \$30 dollar bonus in departments such as San Salvador and La Libertad, which have the highest income per capita in the country, is twice as large as in departments with low income per capita, such as Usulután and Chalatenango.³⁶ Similarly, departments with a larger share of unbanked population witness as little as half the adoption levels as departments where most of the population has access to banking services.

³³Note that, in the U.S., apps to trade bitcoin are required to gather information on the identity of the trader, thus, bitcoin is not associated with anonymity in the U.S., just as in El Salvador’s case.

³⁴Chartalism is discussed in Appendix C.

³⁵Figure A2 reports official monthly data on remittances in bitcoin, and Figure A17 summarizes our results.

³⁶In general, extending income-adoption relations requires caution, as countries with higher income like Panama may have higher adoption of digital payments (e.g., card or mobile) and, thus, lower incentives to adopt a Chivo-type service (22). However, adoption of digital payments in Panama is similar to that in El Salvador; in Panama 13.3% of people over 15 years old report having borrowed from a financial institution or used a credit card, while 11.5% is the corresponding percentage in El Salvador. Moreover, in *both* countries, 6.5% of people over 15 years old have made a payment using their mobile phone or internet, according to the World Bank’s G20 Financial Inclusion Indicators.

Discussion Panel (a) of Figure 2 sums up results in this section. We document over two-thirds of Salvadoreans are aware that Chivo Wallet exists. Not all of those who know about the app have tried to download it; just over half of all respondents. The main reason *not* to download Chivo Wallet is that individuals prefer to pay in cash, followed by mistrust; these motifs may be related to privacy concerns. The main reason to download the app is to use the \$30 bonus offered by the government, but less than half of those who were able to download Chivo continued to use it after spending the bonus—20% of adult citizens—and mostly to transact in dollars, not in bitcoin.

Moreover, most individuals who used Chivo after spending the bonus do not engage with the app intensively; the median user reports no ATM withdrawals and no payments, sent or received, in bitcoin in a given month. To put this in perspective, the median *daily* transactions per person across means of payments is between 1.3-1.4 in several countries (23), and Chivo’s developer indicates there are 0.001-0.003 daily transactions per adult.³⁷ Further, we do not find evidence of Chivo being used to pay for taxes or to send remittances at a significant scale.

Overall, we document bitcoin is not being widely used as a medium of exchange and Chivo’s usage is low. The latter stands despite the big push exerted by the government, which involved endowing bitcoin with legal tender status through the Bitcoin Law, the \$30 bonus, gas discounts, and no fees; and despite the pandemic’s incentive to use touchless payment methods.

4.1 Other Lessons Beyond Chivo

Chivo and Strategic Complementarities Some technologies are likely to feature network externalities; i.e. a user’s benefit of adopting is increasing in the number of users who have adopted (6). Arguably, such complementarities are an inherent feature of digital payment methods and give a potential role for policy to improve allocations.³⁸ Thus, we can draw broad lessons applicable to other payment technologies from the analysis of Chivo.

We test for the presence of network externalities in the adoption of Chivo Wallet using information on the share of an individual’s relatives and close friends who have downloaded Chivo.³⁹ As awareness about the app might depend on the network itself, this analysis includes respondents who know about Chivo, but excludes those who found out about the app from family and friends. The latter aims to isolate the effect of strategic complementarities from a learning story. We find evidence of network externalities both in the decision to adopt the app and on how intensively people use it, as reported in Table 3 using a linear probability model. Columns (1) and (2) show that users whose share of friends and family who have downloaded Chivo is one are 25% more likely to have tried to download it. Columns (3) and (4) document that if friends and relatives regularly use Chivo, users are 30% more likely to engage with the app after spending their bonus. These

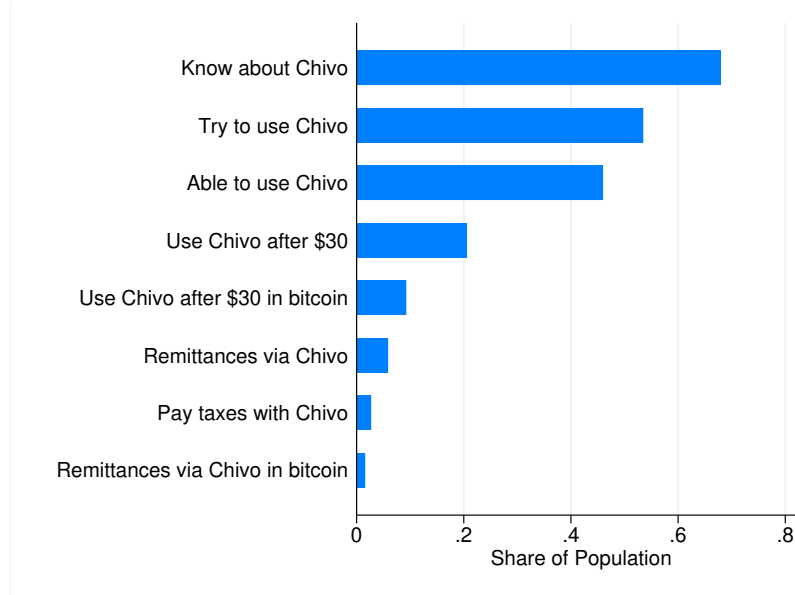
³⁷Source: “Chivo Wallet registra un promedio de 6,000 transacciones por día, según experto argentino,” *Diario El Mundo*, November 2021. Estimate obtained based on an adult population of 4.3 million.

³⁸The diffusion of many technologies is also shaped by learning; this mechanism, however, does not necessarily create an externality or room for policy interventions to improve outcomes.

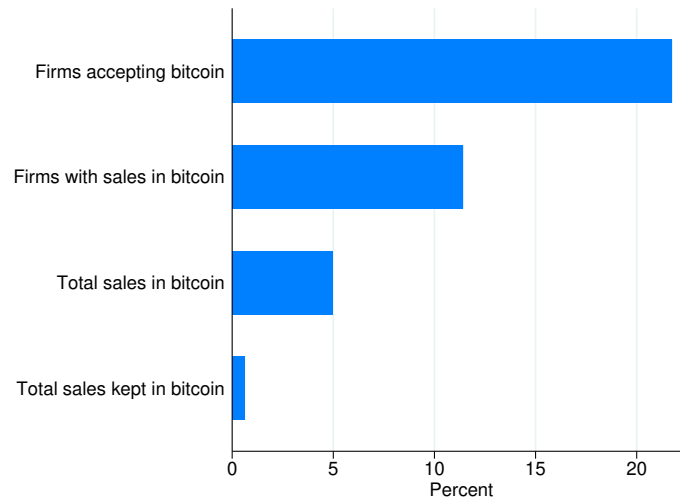
³⁹We first ask about their network size including only close friends and relatives with whom they have had contact in the last three months. We then ask how many of these relatives and friends have downloaded Chivo.

Figure 2: Taking Stock

(a) Awareness and Individual Use of Chivo Wallet



(b) Acceptance and Use of Bitcoin Among Firms



Notes: Panel (a): The figure shows shares with respect to all the sample. Thus, it is subject to a 1.94% margin of error. Panel (b): The top two bars in the figure show percentages with respect to all surveyed owners and employees who knew about payment methods at the firm. The bottom two bars show percentages with respect to total sales.

results are unlikely to be driven by sorting, as coefficients remain statistically equal when excluding demographic controls (Table B6). Results are also robust to using alternative specifications; Columns (2) and (4) of Table B7 show that marginal effects using a logit model are consistent and very close to our baseline results.

Table 3: Impact of Relatives and Close Friends on Usage of Chivo Wallet

	(1) Have you tried to download Chivo?	(2) Have you tried to download Chivo?	(3) Did you keep using Chivo after spending the \$30 bonus?	(4) Did you keep using Chivo after spending the \$30 bonus?
Share of friends with Chivo	0.2515*** (0.030)	0.2532*** (0.026)		
Share of friends who use Chivo regularly			0.3136*** (0.032)	0.3078*** (0.037)
Phone with internet		0.0702* (0.039)		0.0855 (0.056)
Unbanked		-0.0550 (0.036)		-0.1157** (0.047)
Demographic Controls	Y	Y	Y	Y
Observations	792	792	609	609
R-squared	0.099	0.108	0.153	0.170
Department Fixed Effects	Y	Y	Y	Y

Notes: The table shows the relationship between the number of friends and relatives who have adopted Chivo, and the likelihood of adopting it. We only consider users who know about the app, but who did not find out about it through family or friends. Demographic controls include: education, age, gender, and marital status. Standard errors are clustered by department.

Adoption Costs We leverage the familiarity with the \$30 introductory bonus and ask two questions to estimate the distribution of (self-reported) adoption costs. The first question is: *How large does the bonus need to be to convince you to download Chivo?*, and was directed to people who had not downloaded the app, but knew about it (14.5% of respondents). The second question is: *What is the minimum bonus that would have convinced you to download Chivo?*, and was directed to people who had downloaded the app (53.5% of respondents).

Table B8 displays our results. While the mean reported value is \$30, the median user would have accepted \$20, and there are people in the 10th percentile who would have adopted it even without a bonus. The adoption cost is larger for individuals with certain demographics; unbanked respondents report \$6.9 higher cost than those who are banked, people without a cellphone with internet report \$8.6 higher cost than those with one, it is \$2.9 costlier for households with only primary education to adopt compared with those with higher education, and finally, women report \$8.9 higher cost than men.

Variable Costs Chivo Wallet allows users to withdraw cash from Chivo ATMs and convert bitcoin into dollars without a fee. However, outside Chivo Wallet, most providers charge significant

fees. Table B9 shows the maximum reported willingness to pay to withdraw 100 dollars at a Chivo ATM is \$3.3 on average. This amount is less than half of the mean fee to purchase cash at Bitcoin ATMs outside El Salvador. Moreover, the median respondent had a willingness to pay of only \$1. These findings suggest Chivo users would not engage in cash withdrawals if they faced non-subsidized fees. Table B9 also reports the average willingness to pay to convert bitcoin into dollars is \$2.9, and the median user would be willing to pay only \$0.05. These amounts are much smaller than any transaction cost of exchanges, indicating the wallet would not be used without the subsidies.

Impact on Usage of Other Payment Methods If users adopt Chivo Wallet, they might substitute away from other payment methods like cash and cards. We find some evidence consistent with this substitution. We document 10% of users who have downloaded Chivo have decreased their use of cash and 11% have reduced their use of debit cards.⁴⁰ The government also offered a discount of about 8% per gallon for purchases with Chivo, which allows us to measure the elasticity of substitution between Chivo and other payment methods, as detailed in Appendix E. While the sample size is small, estimated elasticities are positive and large. This implies the welfare costs of policies disincentivizing other payment methods (like cash) are lower if digital payments are available.

4.2 Acceptance of Bitcoin by Firms

The Bitcoin Law states all economic agents must accept bitcoin, but this does not necessarily translate into all firms effectively doing so.⁴¹ To study the extent to which firms accept bitcoin, we rely on a subset of respondents *who identified themselves as owners of firms or as employees who knew about the payment methods accepted by their employer*, and who then answered a series of questions about their business.

Results are summarized by Panel (b) of Figure 2. First, we document that while almost all firms accept cash, slightly over 20% accept bitcoin.⁴² Among those which accept bitcoin, three quarters started accepting it just as the law was enacted. Only 11.4% of firms have positive sales in bitcoin. This estimate aligns with results from two independent surveys, which targeted firms of all sizes and across sectors. First, a survey ran by the Salvadoran Foundation for Economic and Social Development (FUSADES) toward the end of 2021 indicates 10% of businesses have made sales in bitcoin.⁴³ Second, the Chamber of Commerce and Industry of El Salvador (Camarasal) conducted a survey in February 2022 which reports 13.9% of businesses have made sales in bitcoin.⁴⁴ Further, our survey indicates 81% of firms accepting bitcoin have not seen a change in their sales since starting to accept it; Camarasal reports a similar estimate (91.7%). We also find that—while the

⁴⁰More details are reported in Figure A20.

⁴¹Businesses which refuse to accept bitcoin are operating in violation of local regulations and exposed to sanctions under the Consumer Protection Law.

⁴²The share that accepts cards is only a little over 25%.

⁴³“Institutional Position N.106,” *FUSADES*, December 2021.

⁴⁴“First Business Survey 2022,” *Camarasal*, March 2022.

median firm makes no sales in bitcoin—4.9% of all sales have been paid in bitcoin through Chivo Wallet, mainly to large firms. This estimate is consistent with the one by FUSADES, which lies between 1-5%.

Second, we document firms which accept bitcoin are mostly large and in the fifth quintile of the firm size distribution.⁴⁵ These large firms are also more likely to accept cards. Third, most firms which report sales in bitcoin convert them into dollars: 71% convert sales into dollars and then withdraw them as cash, 17% convert sales into dollars and keep them in Chivo, and only 12% of firms store their sales in bitcoin within Chivo. Finally, we find 11% of firms have increased prices since bitcoin became legal tender, which is consistent with the hypothesis that firms might be transferring costs related to the cryptocurrency (e.g. volatility) to customers.⁴⁶

5 Into the Blockchain: An Examination of Chivo Wallet’s Transactions in the Public Ledger

So far, our conclusions are drawn from the survey data we collected. This section leverages that all bitcoin transactions are recorded on the blockchain—a distributed public ledger—to analyze Chivo Wallet’s activity based on actual transaction data. This exercise allows us to validate and better understand our survey results. Moreover, the analysis using transaction-level data for all of Chivo’s transactions on the blockchain also provides new insights into who and how bitcoin transactions are carried in El Salvador.

Transactions on the blockchain are grouped in blocks of a few thousand transactions which appear in the ledger every 10 minutes, on average (24). On the ledger, each transaction details the amount of bitcoins transmitted, a time stamp, and the sender and receiver under pseudonymous addresses. To undertake our examination, we use blockchain data downloaded through the Crystal Blockchain Platform and verified by Bitfury Crystal Blockchain, which is a leading provider of anti-money laundering tools and analytic solutions. We then leverage a database which groups addresses with the same owner into clusters, which are then connected to real-world entities.⁴⁷

It is important to understand which Chivo transactions would show up in the blockchain, and which ones would not. As of today, verifying a bitcoin transaction on the blockchain is both costly and takes several hours.⁴⁸ Given this constraint, many wallets which use bitcoin for relatively small payments do *not* verify all transactions on the blockchain. Instead, they rely on a clearing house, the most commonly used one being the Lightning Network, and are custodial wallets. Chivo Wallet is no exception, thus, transactions from one Chivo wallet to another one, in general, would

⁴⁵Table B10 shows results robust to controlling for the sector of the firm. Findings are very similar if only including responses from the firm’s owner or from an employee who reports to work in sales.

⁴⁶Figure A21 shows (i) a summary of the results on prices from the consumer’s perspective—21% have encountered higher prices at some businesses—and (ii) the full distribution of shares of sales in bitcoin across firms. Figure A22 summarizes findings on firms.

⁴⁷Namely, Bitfury Crystal Blockchain uses a proprietary algorithm which groups the addresses with the same owner into clusters—typically the same owner controls many addresses. The company then collects data from various resources on the internet to link clusters to real-world entities.

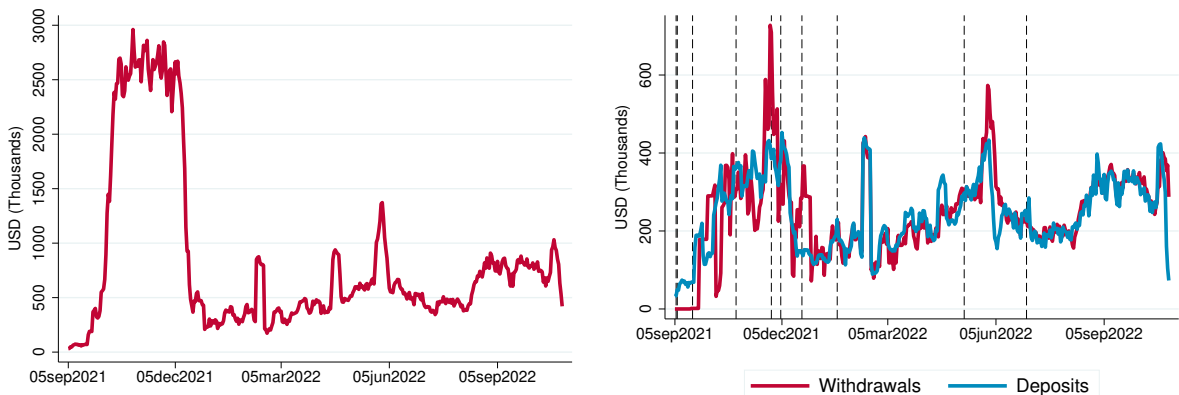
⁴⁸While it can be verified faster, this extra speed incurs an additional cost.

not show up on the blockchain. Transactions between different addresses owned by Chivo as an entity do appear on the blockchain, and we label them as *internal* transactions.⁴⁹ Transactions from Chivo to *external* crypto wallets also show up in the public ledger. These would include, for example, payments from tourists visiting El Salvador and paying in bitcoin for goods or services from their foreign wallets.

According to the Bitfury Crystal Blockchain data, as of November 3rd, 2022, Chivo Wallet was associated with 142,148 addresses, which were involved in 425,514 transactions and a total of 3,424 BTC deposited into Chivo. These are *all* the transactions that can be identified as involving Chivo, either as buyer or as a seller of bitcoin. Figure 3 summarizes some of the observed dynamics. As shown in Panel (a), the total transactions in bitcoin, expressed in dollars, reached their peak between October and December 2021, and decreased significantly thereafter. The latter is consistent with the results of our survey, which document high activity within the first months of Chivo’s operation and a sharp decrease thereafter.

Figure 3: Chivo Wallet’s Blockchain Transactions

- (a) Total transactions, both internal and external (in USD) (b) External deposits and withdrawals (in USD)



Notes: Panel (a): The figure shows the total number of transactions in Chivo Wallet, including internal transactions, and external withdrawals and deposits in USD. We convert bitcoin’s value into USD as otherwise the patterns would also reflect bitcoin’s price changes, which are significant in this time period. Panel (b): The figure shows the dynamics of external withdrawals and deposits. The vertical dashed lines date moments when El Salvador’s government announced a bitcoin purchase.

While Panel (a) shows all activity, Panel (b) considers only external transactions and decomposes them as total deposits into Chivo and withdrawals from Chivo.⁵⁰ First, the co-movement between both types of external transactions is remarkable. Second, an analysis of the average size of each type of transaction, reported in Figure A23, shows that deposits are composed by many small and relatively frequent transactions; for example, these could be transactions from tourists

⁴⁹As noted in Footnote 44, one entity can own several addresses, but these are not transactions between Chivo wallets owned by individuals.

⁵⁰Thus, this figure considers transactions which involve an address that can be identified as Chivo and another address.

visiting El Salvador to use bitcoin or residents from El Salvador who had bitcoin in other wallets.⁵¹ Their active behavior resembles the one documented by the right tail of Chivo users in El Salvador, who are extremely active as documented in Table B5. The magnitude of inflows of bitcoin in the survey and on the blockchain data also align. According to our survey, between 221,000-334,000 dollars flow into Chivo per day, whereas according to blockchain data this amount is approximately 245,000 dollars per day.⁵²

Third, a joint analysis of Panel (b) of Figure 3 and Figure A23 shows that withdrawals (i.e. sales of bitcoin by Chivo) tend to be large and happen rarely, and in synchrony, with the pace of accumulated deposits. This pattern suggests that withdrawals occur as part of Chivo’s bitcoin inventory management, such that Chivo accumulates balances of bitcoin to lower the transaction cost of selling them. This behavior is consistent with the almost zero net accumulation of bitcoin within the wallet shown in Figure A24. Interestingly, this behavior resembles the one displayed by firms in El Salvador, which as explained in Section 4.2, tend to convert all the bitcoin they receive into dollars almost immediately.

6 Lessons, Scope, and Limitations

Our analysis speaks to the potential of a cryptocurrency to act as a medium of exchange and to the implementation of CBDCs. El Salvador’s government provided a big push to incentivize the use of digital payments and bitcoin, including a large sign-up bonus and subsidized fees. Bitcoin is not only endowed with legal tender status, allowing the currency to be used to pay taxes and debts, but also must be accepted by any economic agent by law.

Our results show that, despite all incentives and the enhanced attractiveness of contactless payments in the midst of the pandemic, bitcoin is not widely used as a medium of exchange and usage of Chivo is low. Most downloads took place just as Chivo was launched. Since then, adoption and levels of remittances via Chivo have been decreasing over time. These results suggest it is not just a matter of time for usage of bitcoin and Chivo Wallet to increase. Privacy and transparency concerns appear to be key barriers to adoption. Moreover, we document this payment technology has a large fixed cost of adoption, and it features strong strategic complementarities. Our findings lay out the challenges faced by digital payments and cryptocurrencies to become widely accepted, and are relevant for countries studying the viability of CBDCs and of crypto as a currency. Moreover,

⁵¹The fees paid for these deposits tended to be higher closer to Chivo’s launch (see Figure A25), which would be consistent with more urgency from bitcoiners trying to pay for goods and services when Chivo’s hype was at its peak. Throughout the period, fees for deposits into Chivo tend to be higher than those paid for withdrawals, which also points to more urgency on the deposits’ front compared with withdrawals.

⁵²Flows from the blockchain data have a standard deviation of 184,300. To calculate these flows using our survey, we focus on inflows of bitcoin into Chivo from other wallets, since these are the transactions recorded on the blockchain. Thus, our population of interest consists of individuals who have deposited bitcoin into Chivo and have transferred bitcoin to wallets other than Chivo; approximately 2% of the adult population of El Salvador. For this sample, we compute total deposits per day as the difference between the total amount sent per day and the total amount received per day in the app including transactions in both dollars and bitcoin, since convertibility across currencies is free within the app. To estimate the total deposits in bitcoin per day, we multiply total deposits times the share of deposits in bitcoin (17.3%).

our survey work using a representative sample sheds light on how it is the already wealthy and banked who use on crypto, which stands in stark contrast with recurrent hypothesis which claim that the use of crypto may help the poor and unbanked the most.

An analysis relying on all blockchain transaction-level data from Chivo allows us to validate and better understand our survey results, and is a unique opportunity to provide new insights on the dynamics of Chivo’s activity. The latter is valuable, in particular, as Chivo is a unique exchange in that it can also be used as means of payment by law.

Further, an analysis of this experience is informative in drawing broader lessons on the likelihood of success of CBDCs and a cryptocurrency. Assuming that the implementation of a digital wallet is similar in other contexts, our estimates allow us to explore what would be the adoption of the technology in other countries. Two interesting cases are the Central African Republic, which recently made bitcoin legal tender, and Panama, a Central American country which also enacted a Crypto Law and where the US dollar is the official currency, as in El Salvador.

El Salvador lies in the middle of these countries in both income per capita and access to banking services. The Central African Republic has an income per capita of approximately 418 USD and Panama of approximately 12,172 USD, and as in El Salvador, the alternative to bitcoin—the CFA franc—is a stable currency.⁵³ Approximately 13.7% of the population in the Central African Republic has access to a bank account, whereas in Panama this number is around 46.5% (see Panel (b) of Figure 1). Given our estimates, in the Central African Republic only 37-45% of the population would have been aware of the app’s existence, 8-14% would continue using the app given similar adoption incentives as in El Salvador, and less than 2% would use the application for remittances. In the case of Panama, income per capita is substantially higher than in El Salvador, as is access to banking services. We estimate that more than 95% of the adult population in Panama would be aware of the technology, between 30-56% would continue using it after spending the relevant adoption incentives, and 10-30% would use it for remittances. The last two estimates are *cut in half* when considering payments in bitcoin in either country.

⁵³The introduction of a cryptocurrency could lead to different outcomes in countries such as Argentina and Turkey, where the local currency is unstable and there are restrictions to capital mobility.

References

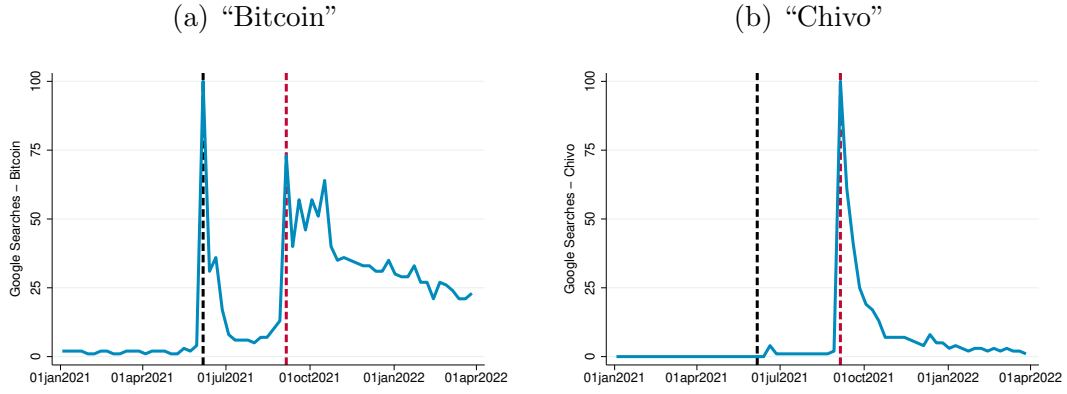
1. W. Jevons, *Money and the Mechanism of Exchange*, The International scientific series (D. Appleton, 1875).
2. N. Kiyotaki, R. Wright, *Federal Reserve Bank of Minneapolis Quarterly Review* **16**, 18 (1992).
3. T. S. Umlauf (Discussion paper prepared for the “Prices, Business Fluctuations and Cycles . . . , 2018).
4. N. Crouzet, A. Gupta, F. Mezzanotti, Shocks and technology adoption: Evidence from electronic payment systems, *Tech. rep.*, Northwestern University Working Paper (2019).
5. D. Duffie, *CoinDesk’s 2019 Year in Review* (2020).
6. F. Alvarez, D. Argente, F. Lippi, E. Méndez-Chacón, D. Van Patten, Strategic Complementarities in a Dynamic Model of Fintech Adoption (2022).
7. N. Kiyotaki, R. Wright, *Journal of Political Economy* **97**, 927 (1989).
8. A. Kosse, I. Mattei, *BIS Papers* (2022).
9. D. Duffie, K. Mathieson, D. Pilav, *Available at SSRN 3837669* (2021).
10. D. Duffie, *Foreign Affairs* (2022).
11. D. Duffie, *Asian Monetary Forum, May, mimeo* (2019).
12. N. Borri, *Journal of Empirical Finance* **50**, 1 (2019).
13. J. M. Griffin, A. Shams, *Journal of Finance* **75**, 1913 (2020).
14. I. Makarov, A. Schoar, Blockchain analysis of the bitcoin market, *Tech. rep.*, National Bureau of Economic Research (2021).
15. Y. Liu, A. Tsyvinski, *The Review of Financial Studies* **34**, 2689 (2020).
16. R. Auer, *et al.*, *Annual review of economics* **14**, 697 (2022).
17. A. Swistona, Official dollarization as a monetary regime: Its effects on el salvador, *IMF Working Papers 11/129*, International Monetary Fund (2008).
18. World Bank, Gdp per capita (current usd) (2020). Data retrieved from national accounts, <https://data.worldbank.org/indicator/NY.GDP.PCAP.CD>.
19. G. B. Gorton, E. W. Tallman, *Fighting Financial Crises: Learning from the Past* (University of Chicago Press, 2018).
20. CNIEF, Política nacional de inclusión financiera para el salvador (2021).

21. M. Brown, N. Hentschel, H. Mettler, H. Stix, *Journal of Monetary Economics* (2022).
22. Z. Wang, P. Han (2021).
23. J. Bagnall, *et al.* (2014).
24. I. Makarov, A. Schoar, Blockchain analysis of the bitcoin market, *Tech. rep.*, National Bureau of Economic Research (2021).
25. F. Alvarez, D. Argente (2022).

APPENDIX

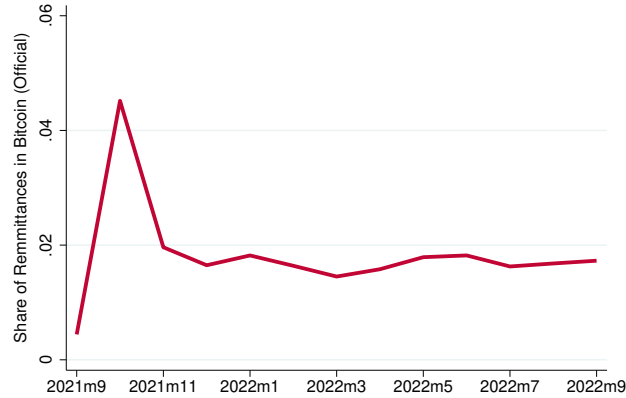
A Additional Figures

Figure A1: El Salvador - Google Trends



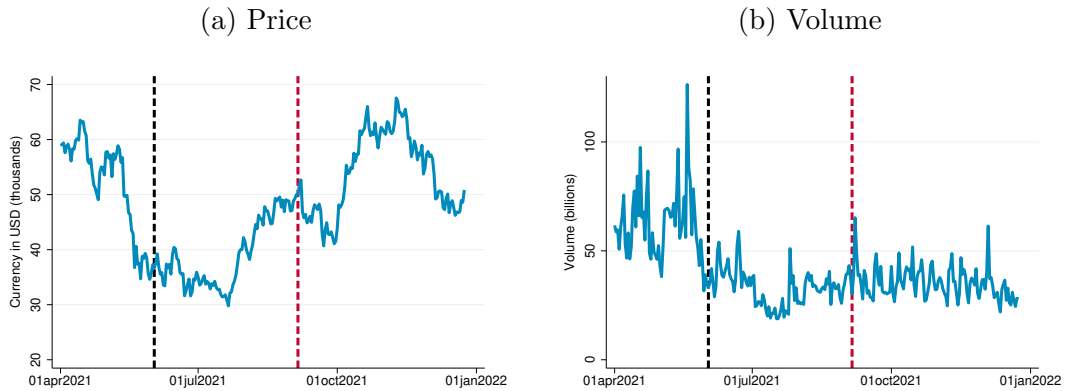
Notes: The graphs show the popularity of different words or phrases in Google Search (as measured by Google trends) in El Salvador before and after the introduction of Chivo Wallet. The vertical line denotes the week bitcoin was declared legal tender and the week Chivo Wallet was launched.

Figure A2: Remittances in Bitcoin (Share of Total)—Official Statistics



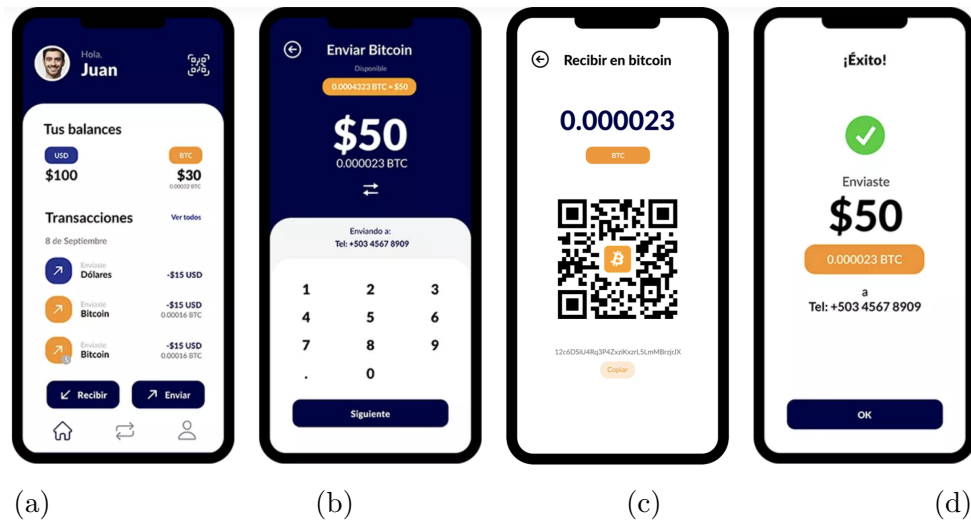
Notes: The figure shows the share of monthly remittances received in bitcoin. The data comes from the Central Bank of El Salvador (*Banco Central de Reserva de El Salvador*). Remittances amount for 572.64 millions (USD) in February 2022.

Figure A3: Bitcoin - Price and Volume



Notes: The graphs show the daily open price of bitcoin and the volume of transactions. The vertical line denotes the day bitcoin was declared legal tender and the day Chivo Wallet was launched. The source is Yahoo Finance.

Figure A4: The Chivo App



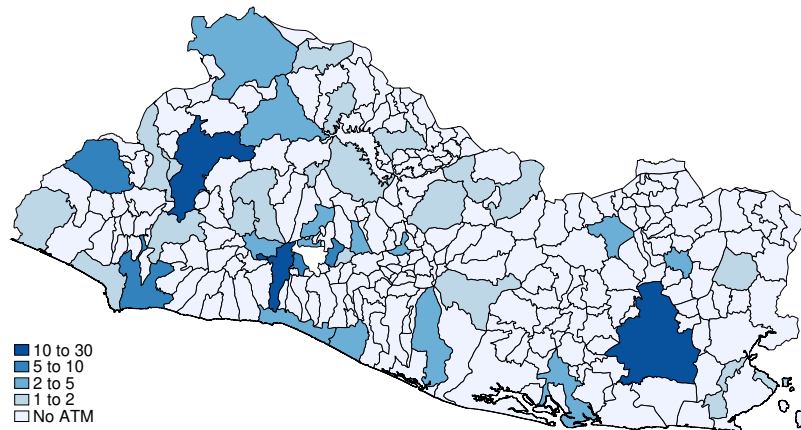
Notes: The figure displays samples of screenshots of Chivo Wallet's interface. Panel (a) shows how the app shows balances both in dollars and in bitcoin, and can carry-out transactions in both currencies. Panel (b) is an example of how a user can send \$50 in bitcoin (0.000023 BTC) to another user using the recipient's phone number. Panel (c) is an example of a user that received 0.000023 BTC. Panel (d) is the next step after Panel (b), and shows that the transaction was completed successfully. Source: <https://chivowallet.com>.

Figure A5: Chivo ATMs



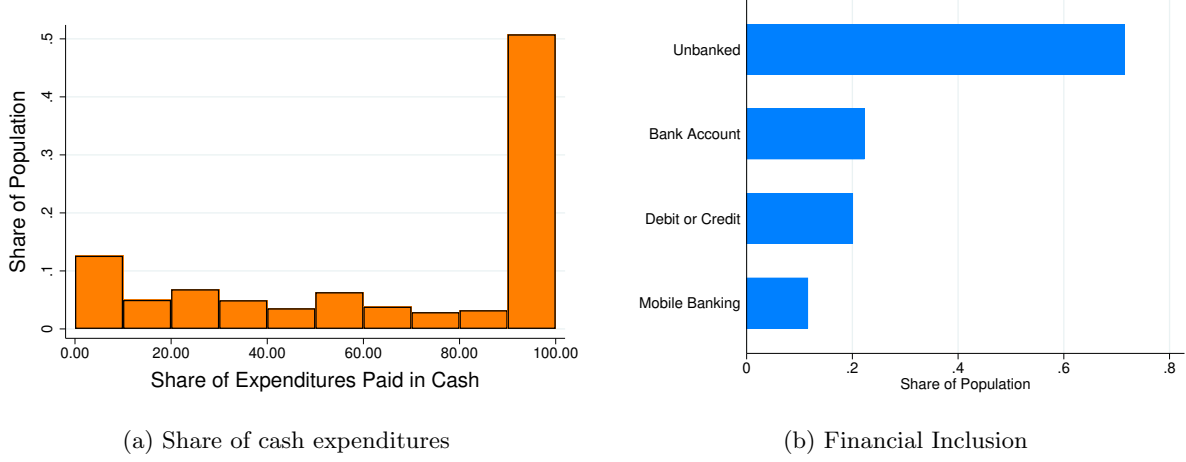
Notes: The figure shows the location of Chivo ATMs in San Salvador. Source: <https://chivowallet.com>.

Figure A6: Location of Chivo ATMs



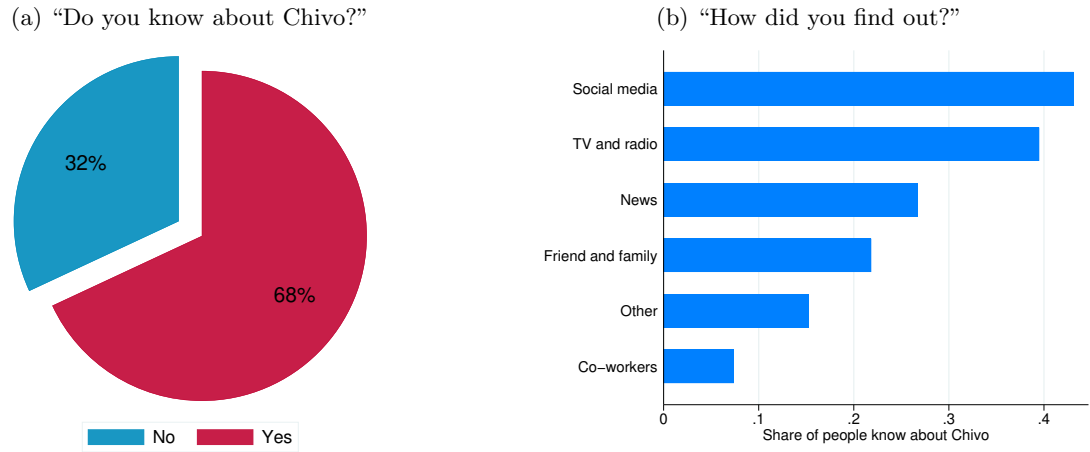
Notes: The figure shows the location of the 201 Chivo ATMs in El Salvador at the municipality level.

Figure A7: Use of Cash and Financial Inclusion in El Salvador



Notes: The figure shows the distribution of the share of expenditures paid in cash. Data was collected by the authors through the survey described in Section 3.

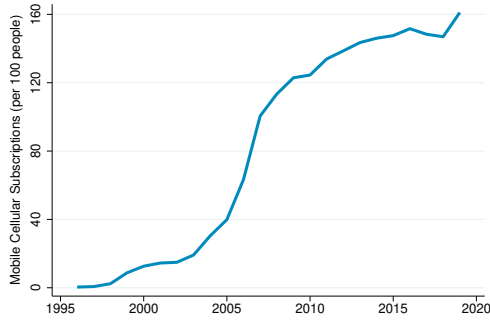
Figure A8: Knowledge about Chivo



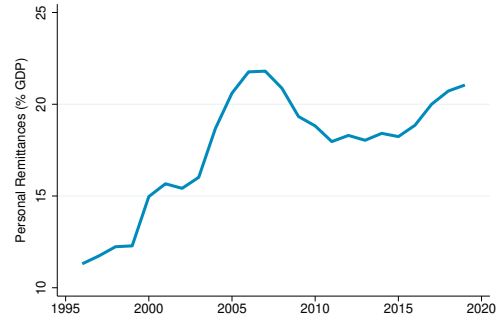
Notes: The figure summarizes responses to questions related to awareness about the Chivo App. Data was collected by the authors through the survey described in Section 3.

Figure A9: El Salvador - Demographic Information

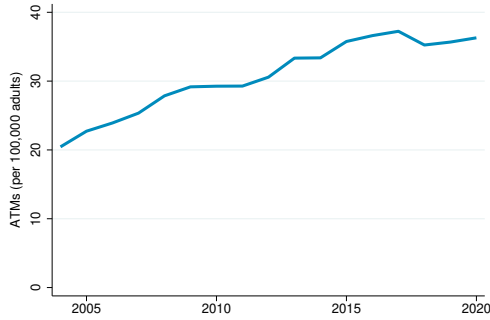
(a) Cell Phones



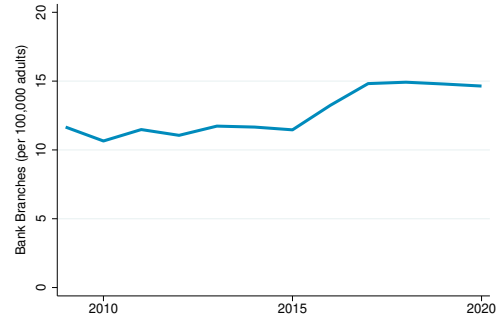
(b) Remittances



(c) ATMs

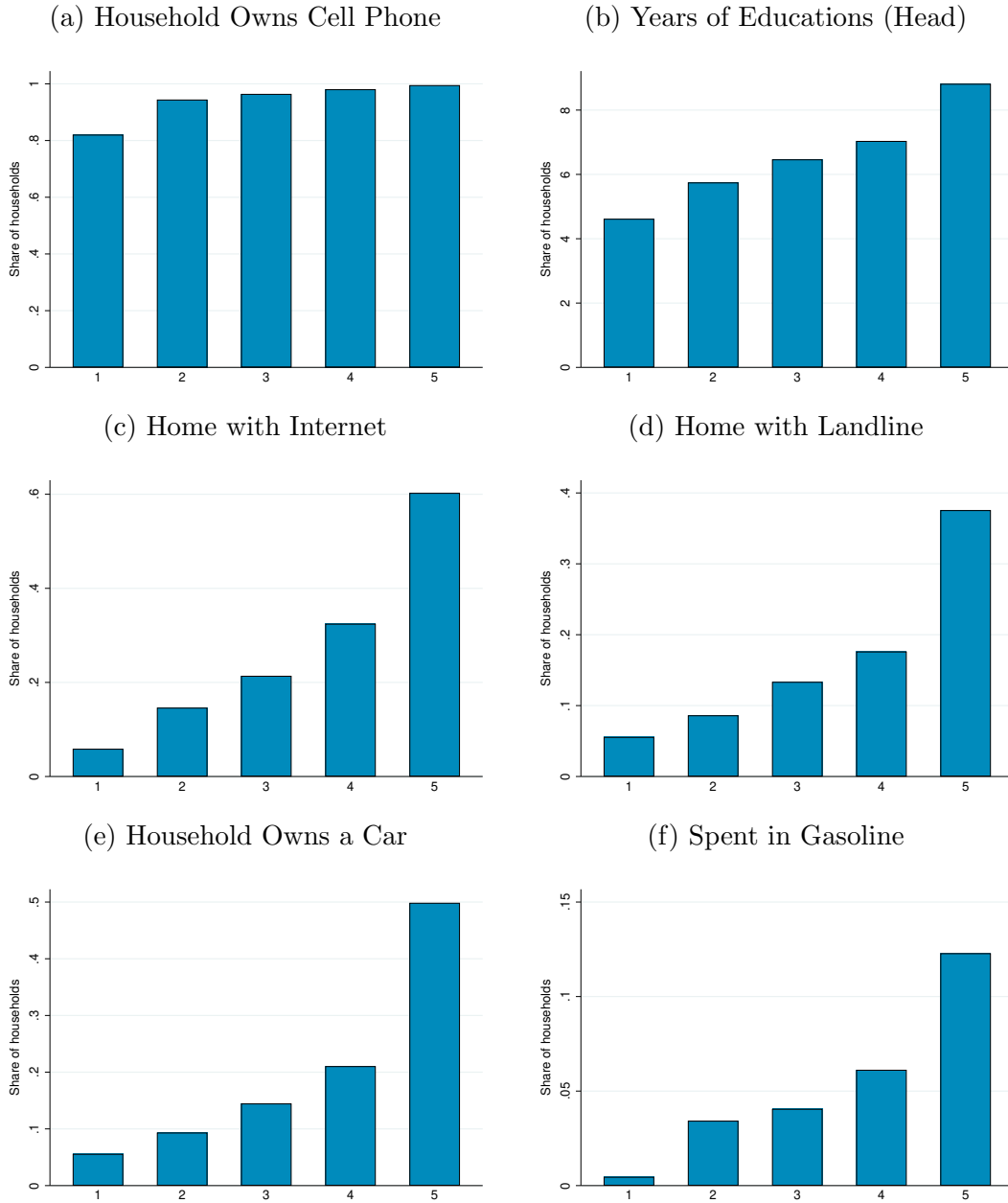


(d) Bank Branches



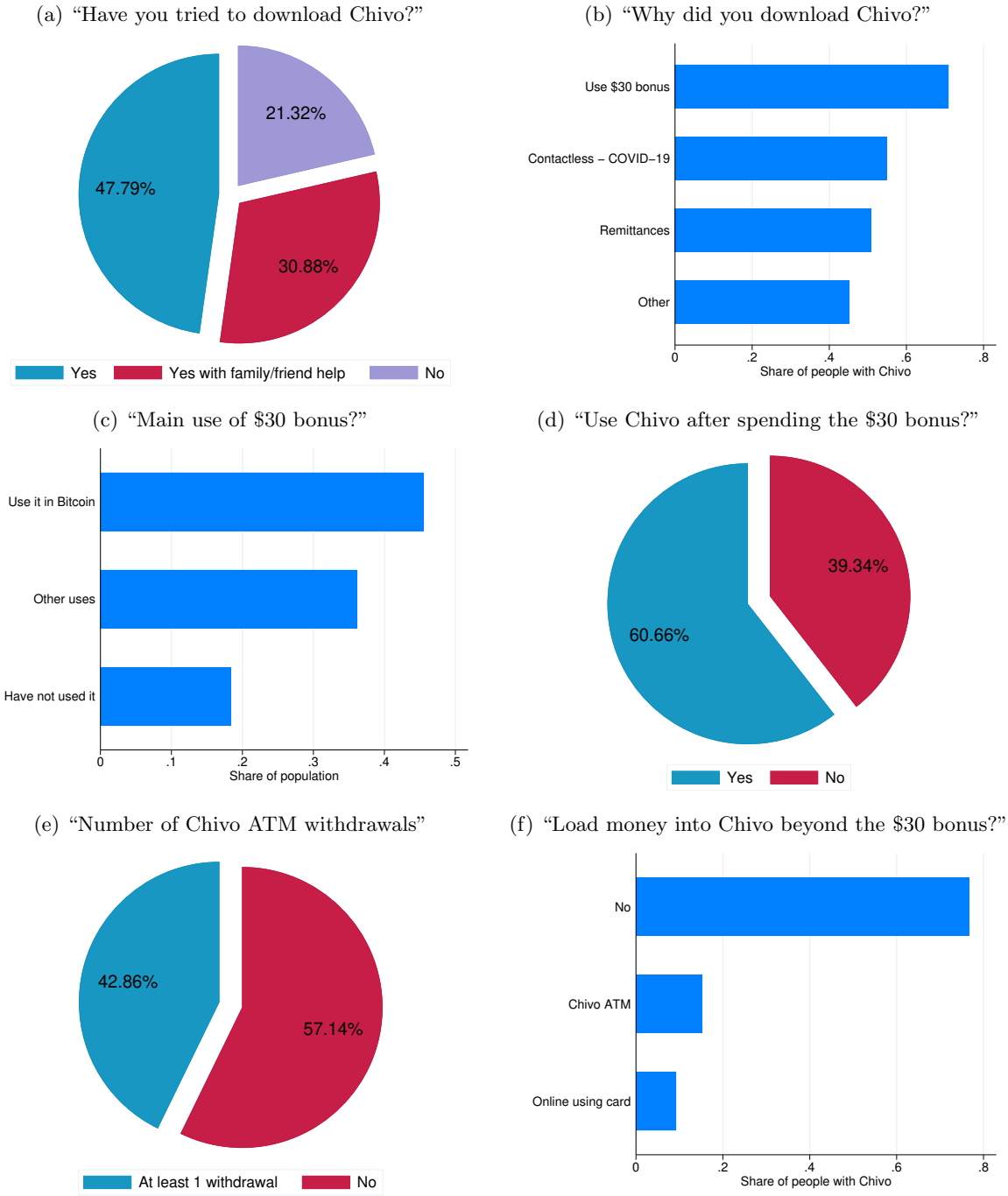
Notes: Panel (a) shows the number of mobile cellular subscriptions per 100 people and Panel (b) the share of GDP of personal remittances in El Salvador. Panel (c) shows the number of automated teller machines (ATMs) per 100,000 adults and Panel (d) the number of commercial bank branches per 100,000 adults. The source of the information is the World Bank, a detailed description can be found in [Appendix F](#).

Figure A10: El Salvador - Demographic Information by Income Quintile



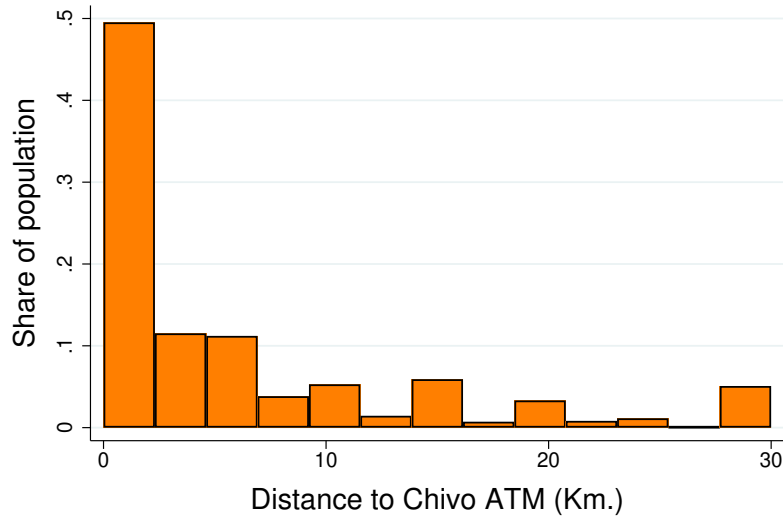
Notes: The figure shows the cross-sectional distribution of several variables by income quintiles. Panel (a) shows the fraction of households who own a cell phone. Panel (b) shows the years of education of the household's head. Panel (c) the share of households that have internet at home. Panel (d) the share of households with a landline at home. Panel (e) the share of households who own a car. Panel (d) the share of households reporting having spent money in gasoline over the last month. The data comes from the 2020 Multipurpose Household Survey (EHPM), a detailed description can be found in [Appendix F](#).

Figure A11: Adoption and Use of Chivo Wallet



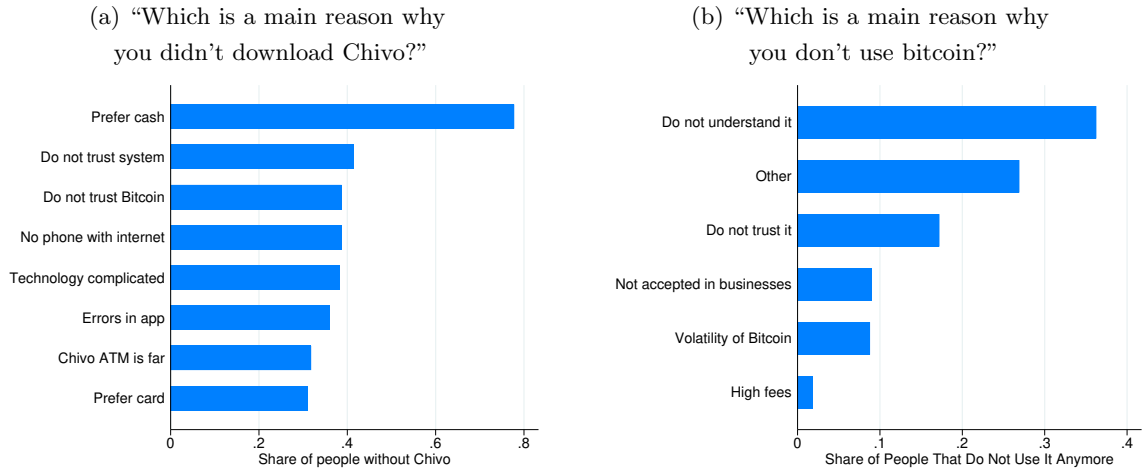
Notes: The figure shows answers conditional on knowing about the existence of the Chivo App. Data was collected by the authors through the survey described in Section 3.

Figure A12: Distance to a Chivo ATM



Notes: The figure shows the distance to a Chivo ATM for different shares of the population.

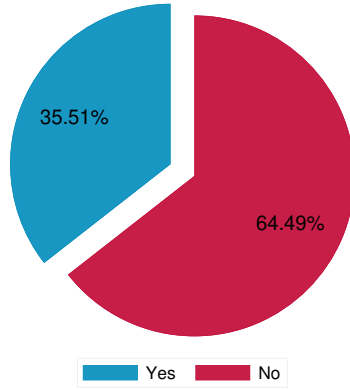
Figure A13: Reasons Not to Download Chivo



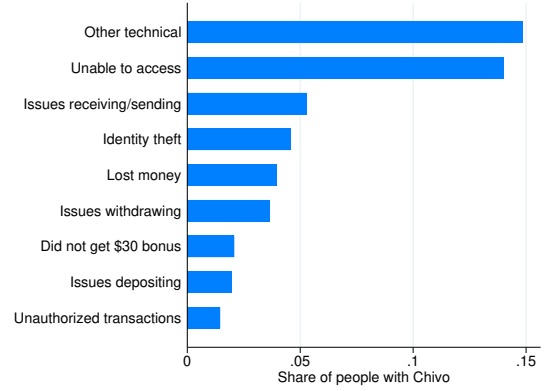
Notes: Respondents were allowed to choose more than one option deemed as most important. Data was collected by the authors through the survey described in Section 3.

Figure A14: Problems Using Chivo

(a) “Did you have problems using Chivo?”



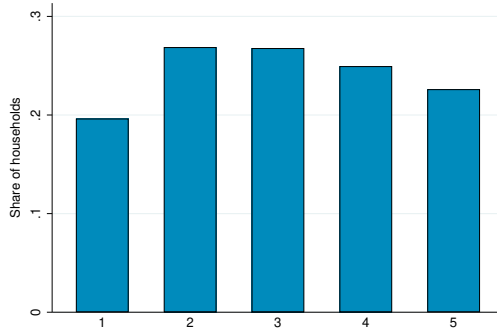
(b) “What were the main problems?”



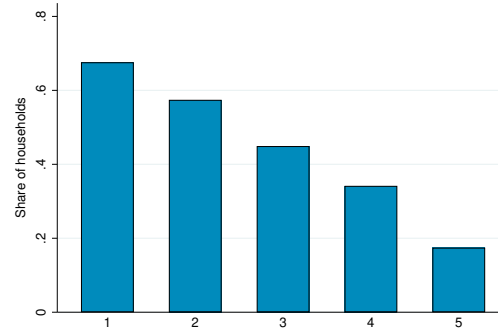
Notes: The table summarizes problems faced by respondents who tried to download Chivo, conditional on knowing about the existence of the Chivo App. Data was collected by the authors through the survey described in Section 3.

Figure A15: El Salvador - Remittances by Income Quintile

(a) Households Receiving Remittances

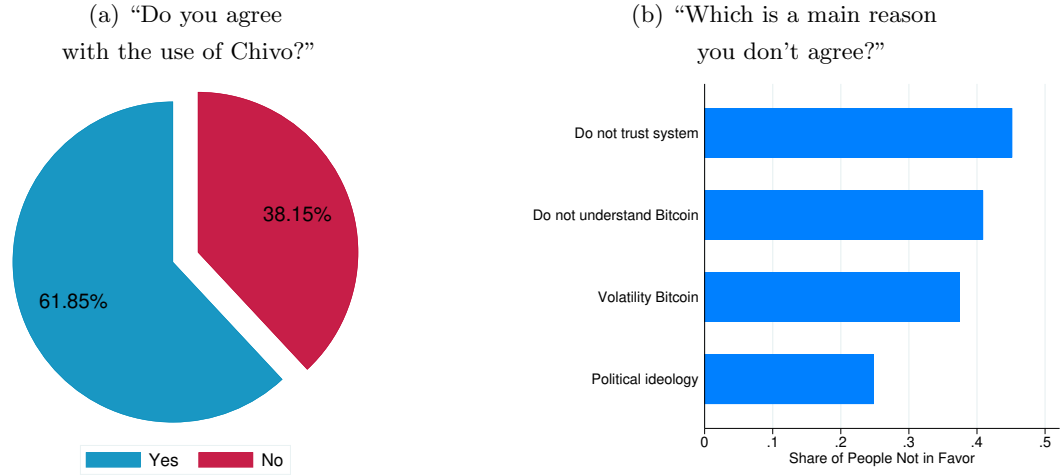


(b) Share of Income from Remittances



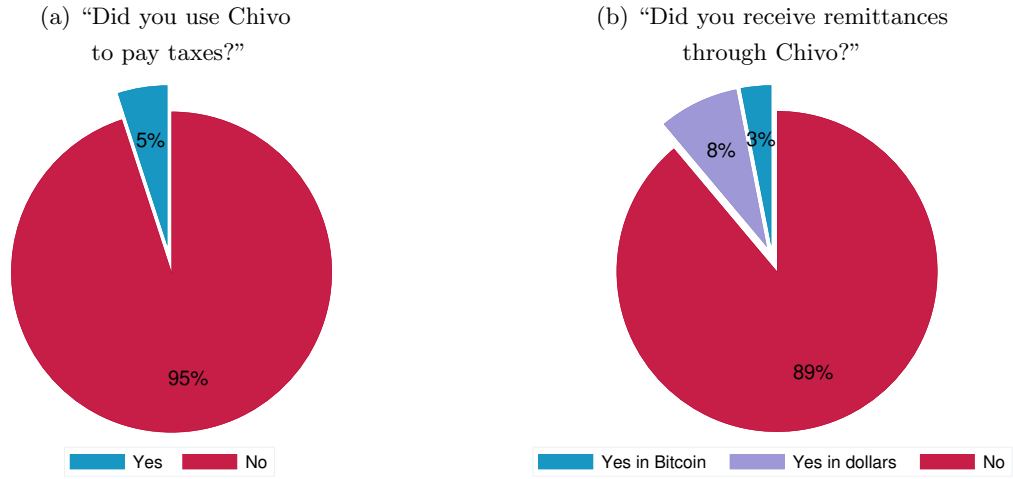
Notes: The figure shows the cross-sectional distribution of several variables by income quintiles. Panel (a) shows the fraction of households who receive remittances. Panel (b) shows the fraction of total households’ income from remittances, conditional on receiving remittances over the last month. The data comes from the 2020 Multipurpose Household Survey (EHPM), a detailed description can be found in [Appendix F](#).

Figure A16: Attitude Towards the Chivo App



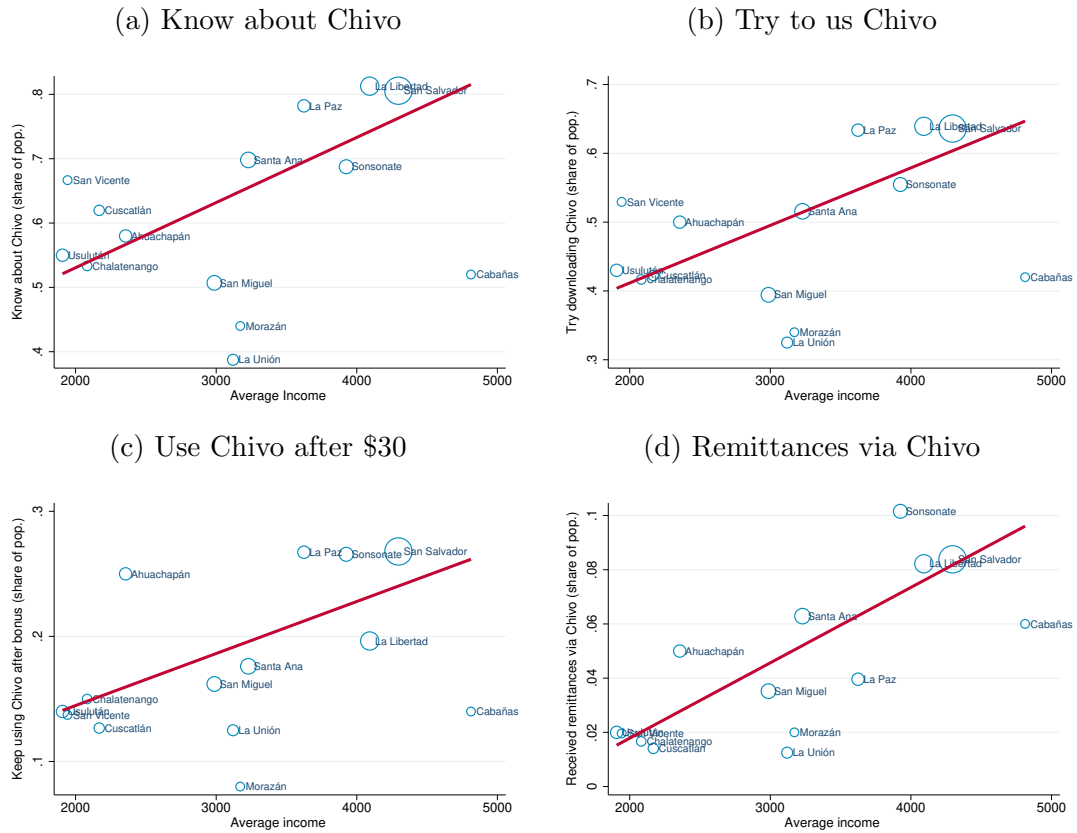
Notes: The table summarizes the main reasons why respondents do not agree with Chivo, conditional on knowing about the existence of the Chivo App. Data was collected by the authors through the survey described in Section 3.

Figure A17: Chivo, Taxes, and Remittances



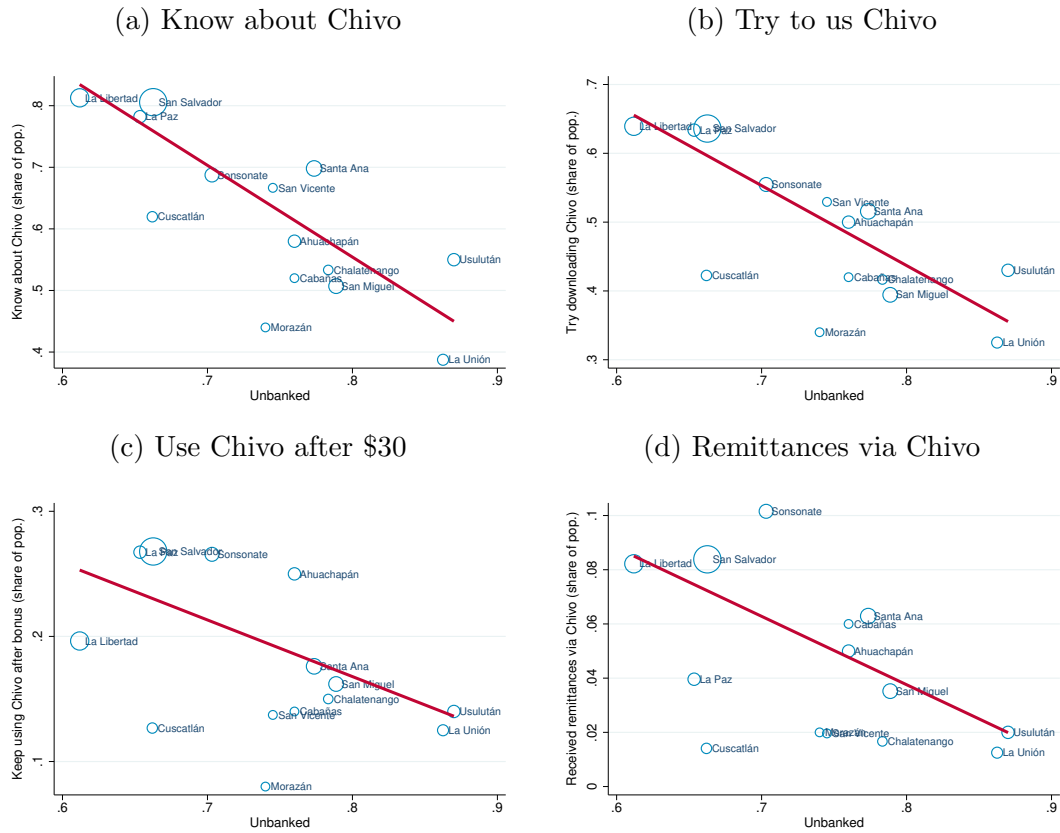
Notes: The figure shows answers conditional on having downloaded the Chivo App. Data was collected by the authors through the survey described in Section 3.

Figure A18: Awareness and Use of Chivo Wallet by Department - Income



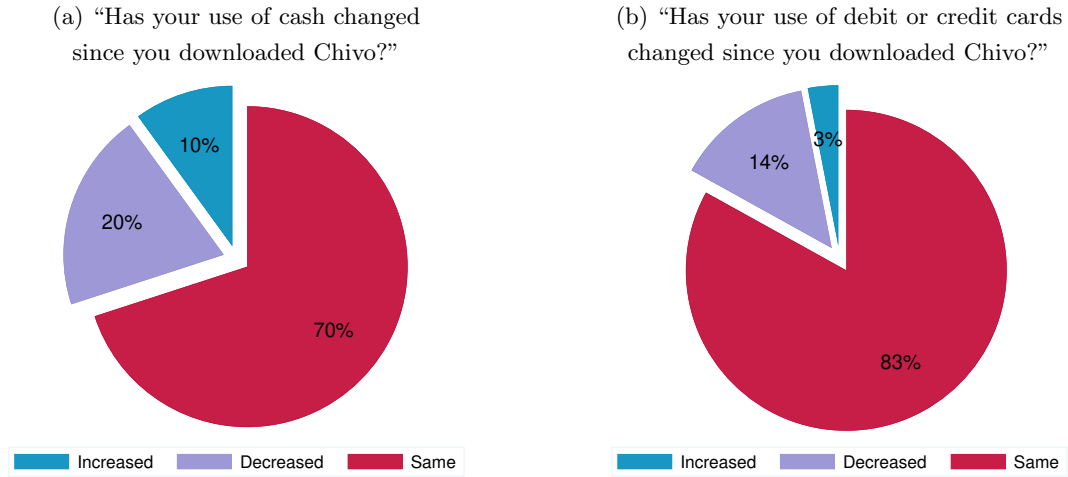
Notes: The figure shows the level of awareness and use of Chivo Wallet according to the average income per capita in each department of El Salvador. Panel (a) shows the share of people that know about Chivo. Panel (b) shows the fraction of people that has tried to use Chivo. Panel (c) shows the fraction of people that continued using Chivo after spending the \$30 dollar bonus. Panel (d) shows the fraction of people that received remittances via Chivo.

Figure A19: Awareness and Use of Chivo Wallet by Department - Banking Services



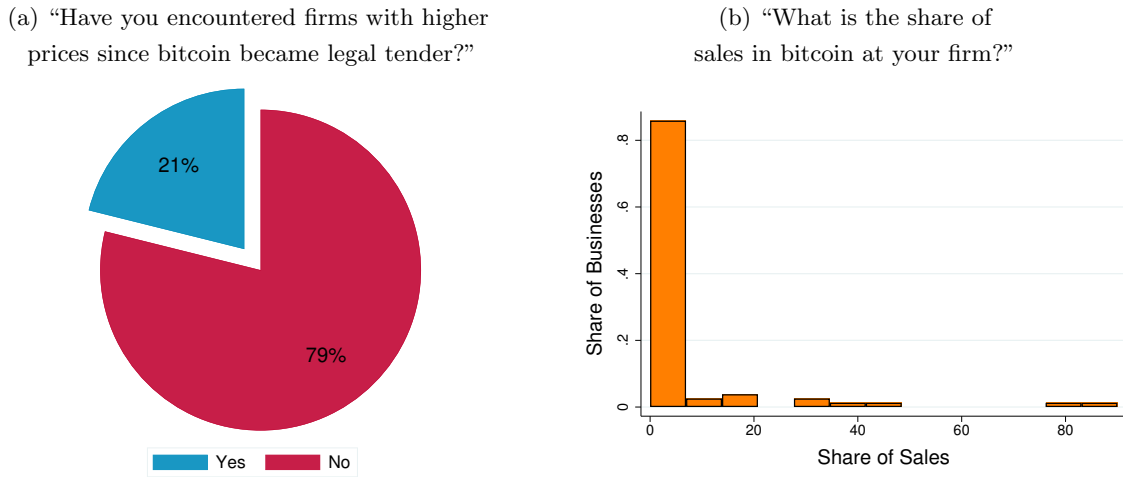
Notes: The figure shows the level of awareness and use of Chivo Wallet according to the fraction of people who do not have access to a bank account in each department of El Salvador. Panel (a) shows the share of people that know about Chivo. Panel (b) shows the fraction of people that has tried to use Chivo. Panel (c) shows the fraction of people that continued using Chivo after spending the \$30 dollar bonus. Panel (d) shows the fraction of people that received remittances via Chivo.

Figure A20: Changes in Use of Cash and Cards



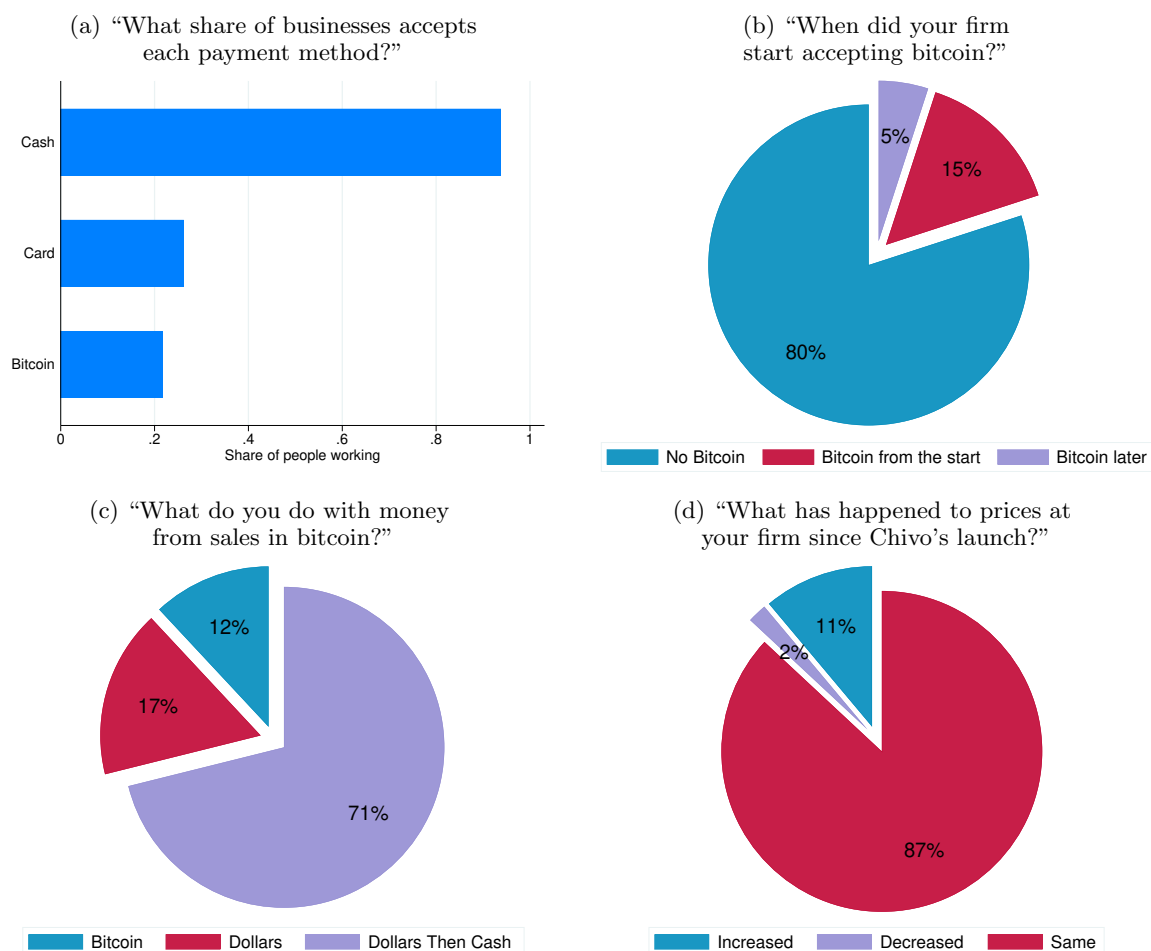
Notes: The figures show the changes in the use of cash and cards since the implementation of Chivo Wallet, considering responses of users who have downloaded the app. Data was collected by the authors through the survey described in Section 3.

Figure A21: Bitcoin, Prices, and Sales



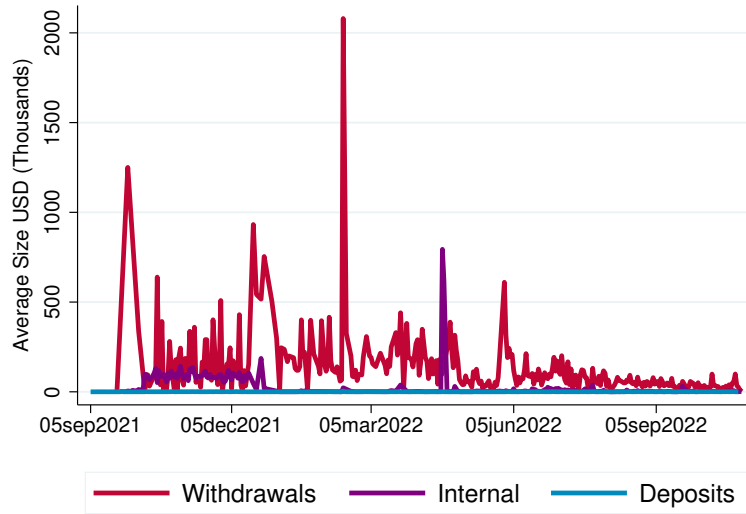
Notes: Panel (a) is based on responses of all individuals. Panel (b) is based on responses of a subsample of individuals who identified themselves as owners of firms, or employees at firms who knew about the accepted methods of payment of their employer. Data was collected by the authors through the survey described in Section 3.

Figure A22: Bitcoin Acceptance by Firms



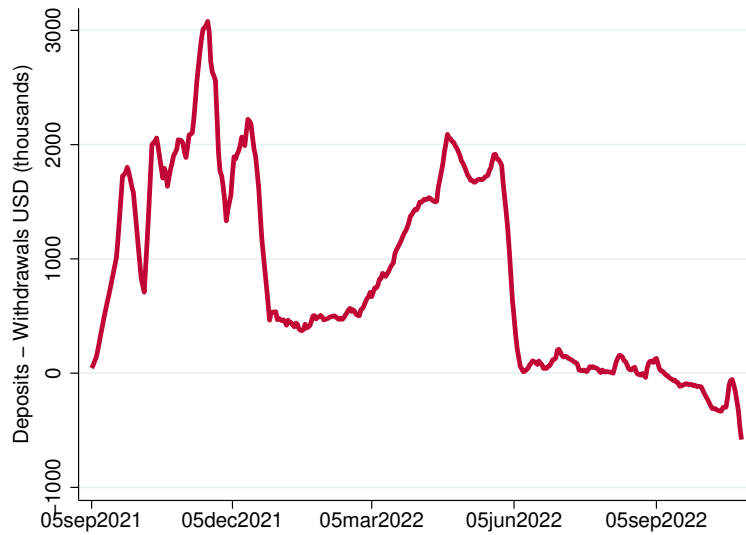
Notes: The figures are based on responses of a subsample of individuals who identified themselves as owners of firms, or employees at firms who knew about the accepted methods of payment of their employer. Data was collected by the authors through the survey described in Section 3.

Figure A23: Chivo's Blockchain Transaction Size by Type



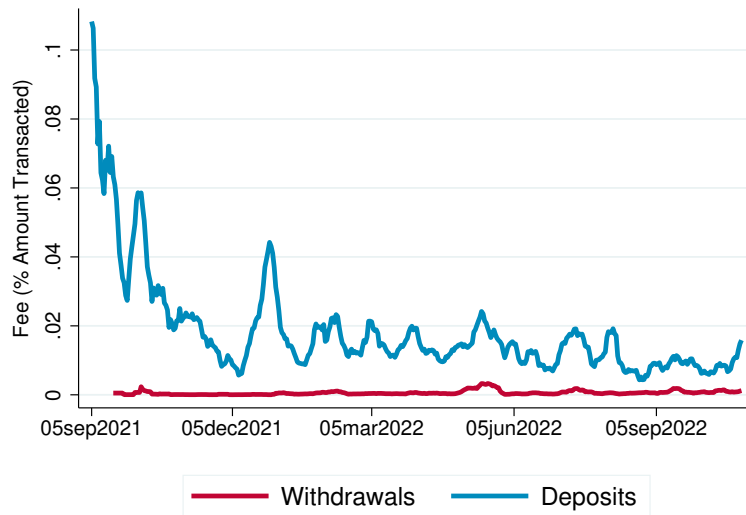
Notes: The figure shows the average transaction size involving Chivo Wallet from blockchain data, by type.

Figure A24: Chivo's Blockchain Net Balance (Deposits Minus Withdrawals)



Notes: The figure shows Chivo Wallet's net balance (deposits minus withdrawals), based on blockchain data.

Figure A25: Average Fee of Chivo's Blockchain Transactions, by Type



Notes: The figure shows the average transaction fee involving Chivo Wallet from blockchain data, by type.

B Additional Tables

Table B1: Financial Inclusion

Notes: The table shows several indicators of financial inclusion for El Salvador. Indicators are reported as the share of adults (age 15+) in the country in 2017. The source of the data is the Global Financial Inclusion data set gathered by the World Bank. The indicators of financial inclusion measure how people save, borrow, and make payments.

	(2) % age 15+ (2017)
Account	30.4
Borrowed any money in the past year	22.6
Credit card ownership	5.7
Debit card ownership	18.9
Financial institution account	29.3
Made digital payments in the past year	18.2
Mobile money account	3.5
Used a mobile phone or the internet to access an account	6.3

Table B2: Knowledge about Chivo and Respondent Characteristics

<i>Dependent variable: Do you know about Chivo?</i>				
	(1)	(2)	(3)	(4)
Unbanked	-0.2033*** (0.024)			-0.0834** (0.029)
Phone with Internet		0.3093*** (0.016)		0.1901*** (0.015)
Middle School			0.1973*** (0.027)	0.1670*** (0.033)
High School+			0.2525*** (0.041)	0.2012*** (0.046)
Age 25-34			-0.0346 (0.020)	-0.0324* (0.017)
Age 35-44			-0.1088*** (0.022)	-0.0921*** (0.026)
Age 45-54			-0.1888*** (0.037)	-0.1527*** (0.027)
Age 55+			-0.3319*** (0.028)	-0.2616*** (0.023)
Female			-0.0763*** (0.018)	-0.0480** (0.017)
Single			-0.0238 (0.020)	-0.0176 (0.017)
Observations	1,800	1,800	1,800	1,800
R-squared	0.180	0.120	0.251	0.292
Department Fixed Effects	Y	Y	Y	Y

Notes: The table shows the characteristics of respondents who knew about the existence of the Chivo App. Standard errors are clustered by department. Standard errors are clustered by department. Data was collected by the authors through the survey described in Section 3.

Table B3: Help Downloading Chivo

Dependent Variable: Did you need help downloading the Chivo App?

	(1)	(2)	(3)	(4)
Unbanked	0.1676*** (0.043)			0.0743* (0.037)
Phone with Internet		-0.1334*** (0.036)		-0.0313 (0.037)
Middle School			-0.1593*** (0.033)	-0.1455*** (0.031)
High School+			-0.2665*** (0.031)	-0.2395*** (0.036)
Age 25-34			-0.0018 (0.042)	-0.0013 (0.041)
Age 35-44			0.1540*** (0.045)	0.1574*** (0.044)
Age 45-54			0.4079*** (0.055)	0.4049*** (0.050)
Age 55+			0.4305*** (0.072)	0.4337*** (0.068)
Female			0.1906*** (0.025)	0.1753*** (0.025)
Single			-0.0224 (0.048)	-0.0247 (0.047)
Observations	963	963	963	963
R-squared	0.050	0.035	0.286	0.291
Department Fixed Effects	Y	Y	Y	Y

Notes: The table shows the characteristics of respondents who tried to download Chivo with help from a family member or friend, conditional on knowing about the existence of the Chivo App. Standard errors are clustered by department. Data was collected by the authors through the survey described in Section 3.

Table B4: Views with Respect to Chivo Wallet

Dependent Variable: Do you agree with the use of Chivo Wallet?

	(1)	(2)	(3)	(4)	(5)	(6)
Download Chivo	0.3113*** (0.038)	0.3009*** (0.036)	0.2818*** (0.034)			
Download Chivo with Help				-0.1740*** (0.038)	-0.1672*** (0.038)	-0.1068*** (0.029)
Unbanked		-0.0228 (0.035)	-0.0122 (0.029)		-0.0267 (0.018)	-0.0253 (0.018)
Phone with Internet		0.0591* (0.028)	0.0182 (0.029)		0.0249 (0.041)	0.0090 (0.040)
Middle School			0.0049 (0.027)			0.0187 (0.022)
High School+			-0.0280 (0.035)			-0.0164 (0.037)
Age 25-34			-0.1037*** (0.033)			-0.0586* (0.028)
Age 35-44			-0.2321*** (0.042)			-0.1580*** (0.046)
Age 45-54			-0.2819*** (0.040)			-0.1926*** (0.042)
Age 55+			-0.2060*** (0.037)			-0.1068*** (0.032)
Female			-0.0777** (0.034)			-0.0568** (0.024)
Single			0.0385 (0.030)			0.0240 (0.040)
Observations	1,224	1,224	1,224	963	963	963
R-squared	0.079	0.082	0.137	0.048	0.049	0.074
Department Fixed Effects	Y	Y	Y	Y	Y	Y

Notes: The table shows the characteristics of respondents who agree with the use of Chivo Wallet, conditional on knowing about the existence of the Chivo App. Columns (3), (4), and (6) consider only respondents who have downloaded the app. Standard errors are clustered by department. Data was collected by the authors through the survey described in Section 3.

Table B5: Impact of relatives and close friends on usage of Chivo (no controls)

	(1) Have you tried to download Chivo?	(2) Have you tried to download Chivo?	(3) Did you keep using Chivo after spending the \$30 bonus?	(4) Did you keep using Chivo after spending the \$30 bonus?
Share of friends with Chivo	0.2577*** (0.038)	0.2577*** (0.038)		
Share of friends who use Chivo regularly			0.3658*** (0.063)	0.3658*** (0.063)
Demographic controls	N	N	N	N
Observations	792	792	609	609
R-squared	0.063	0.063	0.057	0.057
Department Fixed Effects	N	N	N	N

Notes: The table shows the relationship between the number of friends and relatives who have adopted Chivo, and the likelihood of adopting the digital wallet. We consider only responses of users who know about the existence of the app, but who did not find out about it through family or friends. Robust standard errors are reported in parenthesis.

Table B6: Marginal Effect (Logit) for Tables 1 and 3

	(1) Have you tried to download Chivo?	(2) Have you tried to download Chivo?	(3) Did you keep using Chivo after spending the \$30 bonus?	(4) Did you keep using Chivo after spending the \$30 bonus?
Share of friends with Chivo		0.2325*** (0.020)		
Share of friends who use Chivo regularly				0.2944*** (0.032)
Unbanked	-0.0891*** (0.029)	-0.0576 (0.039)	-0.1350*** (0.031)	-0.1097** (0.046)
Phone with Internet	0.0663** (0.029)	0.0692* (0.037)	0.0684 (0.046)	0.0879 (0.058)
Demographic controls	Y	Y	Y	Y
Observations	1,224	792	943	600
Department Fixed Effects	Y	Y	Y	Y

Notes: The table shows the marginal effect, under a logit model, of different variables on the likelihood of adopting the digital wallet and keep using it. We consider only responses of users who know about the existence of the app, but who did not find out about it through family or friends. Robust standard errors are reported in parenthesis.

Table B7: Determinants of Whether Users Remain Active After Spending the Bonus

	(1)	(2)	(3)	(4)
Problems using app.	-0.0146 (0.018)		-0.0016 (0.016)	0.0171 (0.015)
> median distance to ATM		0.0121 (0.024)	0.0138 (0.026)	-0.0029 (0.022)
Unbanked			-0.1859*** (0.035)	-0.1428*** (0.035)
Phone with Internet			0.1141** (0.042)	0.0642 (0.042)
Middle School				0.0605 (0.040)
High School+				0.1241** (0.041)
Age 25-34				-0.0438 (0.045)
Age 35-44				-0.1496*** (0.037)
Age 45-54				-0.2043*** (0.048)
Age 55+				-0.2946*** (0.049)
Female				-0.1243*** (0.031)
Single				-0.0433 (0.033)
Observations	943	943	943	943
R-squared	0.018	0.018	0.063	0.129
Demographic Controls	Y	Y	Y	Y
Department Fixed Effects	Y	Y	Y	Y

Notes: The table shows the relationship between user characteristics and the likelihood of using Chivo after spending the \$30 bonus. The variable *Problems using the app* is a dummy equal to one if the user faced problems using the app. Standard errors are clustered by department.

Table B8: Self-reported adoption cost of Chivo Wallet (in USD)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Mean	Std. Dev.	10th	25th	Median	75th	90th
Adoption cost	30.0	69.5	0.0	5.0	20.0	30.0	50.0

Notes: The table shows the distribution of the self-reported adoption cost of Chivo Wallet in US dollars. Estimates based on answers from users that know about Chivo Wallet, approximately 68% of respondents. We exclude users who had not downloaded Chivo but report numbers below \$30, as well as users who downloaded Chivo and report values over \$30, and re-weight the sample accordingly.

Table B9: Willingness to Pay for withdrawals and transfers

	(1) Mean	(2) Std. Dev.	(3) 10th	(4) 25th	(5) Median	(6) 75th	(7) 90th
Max fee to withdraw 100 USD	3.3	9.1	0.0	0.0	1.0	5.0	8.0
Max fee to convert BTC to USD	2.9	9.8	0.0	0.0	0.05	2.0	5.0

Notes: The table shows distribution of responses to two questions: i) What would be the maximum fee you would be willing to pay to withdraw 100 dollars? and ii) What would be the maximum fee you would be willing to pay to convert bitcoin to dollars?. Both answers are in USD. The sample of users include those that know about Chivo Wallet.

Table B10: Bitcoin Acceptance and Firm Size

<i>Dependent Variable: Does the firm accept bitcoin?</i>				
	(1)	(2)	(3)	(4)
2nd Quantile	0.0058 (0.045)	0.0098 (0.046)	-0.0219 (0.069)	-0.0309 (0.075)
3rd Quantile	0.0634 (0.056)	0.0641 (0.058)	0.1112 (0.075)	0.1022 (0.076)
4th Quantile	0.0316 (0.023)	0.0364 (0.025)	0.1156* (0.058)	0.1188* (0.059)
5th Quantile	0.1192* (0.061)	0.1203 (0.069)	0.1860** (0.078)	0.1849* (0.085)
Observations	513	513	258	258
R-squared	0.011	0.029	0.028	0.038
Owner/Working in Sales	N	N	Y	Y
Sector	N	Y	N	Y

Notes: This regression is based on responses of a subsample of individuals who identified themselves as owners of firms, or employees at firms who knew about the accepted methods of payment of their employer. Standard errors are clustered by sector. Data was collected by the authors through the survey described in Section 3.

C Related Literature

Related Literature A legal tender “only means that the state provides a definite medium of exchange and defines precisely what that is” (26). Our examination shows that the designation of bitcoin as legal tender does not imply it becomes a general medium of exchange as defined by previous work (27), that is, an object “which is habitually, and without hesitation, taken by anybody in exchange for any commodity.”

Important references in the literature (28) argue that “acceptability” makes an object more likely to become a medium of exchange. In this framework, which itself builds on previous work (29), acceptability is a social convention; a property of an equilibrium where the use of a medium of exchange and its acceptability are determined endogenously. The model can be extended (30) and show that government policy can influence what is used as a medium of exchange, in particular, policies that influence what the government itself accepts in transactions. The Salvadorean experience allows us to document that requiring all businesses to accept bitcoin, providing large incentives to increase its adoption, and accepting it as a means to pay for taxes might not be enough to move to an equilibrium where bitcoin is used as medium of exchange.

In a related manner, the introduction of bitcoin in El Salvador is also informative about theories where the intrinsic value of money is given by the government. Chartalism, a predecessor of Modern Monetary Theory, identifies taxation as the decisive factor in the formation of money. For instance, Adam Smith describes that “A prince who should enact that a certain proportion of his taxes should be paid in paper money of a certain kind might thereby give a certain value to this paper money” (31, p. 328). Classics like Jevons (26) place a key role on taxes to give value to paper money.¹ Aligned with this notion, literature developed shortly afterward (32) shows how the government, through taxation, has the means to make people desire money at its face value. More recently, work by Starr (33) reads: “How can we eliminate the possibility of the price of money being zero in equilibrium?... Taxes can be used to create a demand for money independent of its usefulness as a medium of exchange, thereby ensuring that its price will not fall to zero” (33, p. 46). The concept described in these works is regarded as “tax-driven money.” It implies that, if the state endows a currency as legal tender, it can give it value as a payment method and promote its acceptance as a medium of exchange through allowing the public to use it to pay taxes. We contribute to this long-standing literature by studying whether accepting a digital currency to pay for taxes is indeed a sufficient condition for it to become widely accepted as a currency.

Our paper relates to work studying the adoption of payment methods beyond cash (34, 35), which has focused on identifying the determinants of consumers’ adoption decisions of credit and debit cards. An exception (36), studies the adoption of mobile money in Kenya. The technology we study, i.e. Chivo Wallet, differs in two important aspects from mobile payment technologies launched in other countries. First, it was launched and sponsored by the central government

¹This seminal work (26) describes that “Inconvertible paper money may be freely issued, but an attempt may be made to keep up its value by receiving it in place of coin in the payment of taxes” (26, p.).

so that its design and adoption are similar to that envisaged for central bank digital currencies. Second, unlike apps analyzed in complementary studies, Chivo Wallet allows for payments in a cryptocurrency, in addition to payments in the local currency. Finally, the app was launched nationwide along with generous incentives to adopt, some of which changed over time, which allows us to provide statistics on the distribution of adoption costs among adopters and non-adopters.

Our work also relates to recent work studying the degree of substitutability between payment methods (37–40). We quantify the degree of substitutability between mobile payments and other payment methods and found it to be larger than the substitutability between cash and cards.

The paper, through the study of Chivo Wallet, also speaks to the literature on CBDCs, in which empirical evidence is scarce (41). As in the case of Chivo, recent policy briefs argue that CBDCs should not be bearer instruments (42). This is the case, for instance, of China’s CBDC (43), and is also the case of Chivo Wallet. Moreover, while Chivo is not backed by a central bank, it is backed by the government and does not require to be linked to a bank account, just as would be the case with a CBDC.

Finally, our work contributes to the study of cryptocurrencies. Empirically, the literature has focused on the risks faced by individuals (44, 45), arbitrage opportunities and price manipulation (46, 47), Bitcoin network and its main participants (48), and the determinants of asset pricing in the case of crypto (49). Our results complement these works by empirically analyzing the dynamics of adoption in a setting where incentives to adopt are high and have measurable variation across the country. The paper is also related to the growing theoretical literature on cryptocurrencies, which has built models stressing the network effects of its adoption (50–52), the cost of its production (53, 54), and the determinants of cryptocurrency prices (49, 55–57). Complementary to these studies, our work quantifies the network effects present in a setting with potential for the widespread adoption of bitcoin, and the impact of this payment method on local prices.

D Sample Validation

Table D1: Sample Validation

	(1)	(2)	(3)
	Total Sample	Share Sample	Share Population (2021)
Gender			
Male	846	47%	47%
Female	954	53%	53%
Age			
18-24	307	17%	20%
25-34	417	23%	25%
35-44	347	19%	17%
45-54	320	18%	14%
55+	409	23%	24%
Education			
Elementary School	947	53%	58%
Middle School	620	34%	30%
High School	233	13%	12%
Districts			
Ahuachapán	100	5.6%	5.7%
Cabañas	50	2.8%	2.4%
Chalatenango	60	3.3%	2.9%
Cuscatlán	71	3.9%	4.2%
La Libertad	219	12.2%	12.6%
La Paz	101	5.6%	5.6%
La Unión	80	4.4%	3.7%
Morazán	50	2.8%	3.1%
San Miguel	142	7.9%	7.4%
San Salvador	489	27.2%	27.4%
San Vicente	51	2.8%	2.8%
Santa Ana	159	8.8%	8.9%
Sonsonate	128	7.1%	7.9%
Usulután	100	5.6%	5.5%

Note: Column (1) reports the total number of interviews. Column (2) the share of interviews by category. Column (3) reports the same share in the total population of El Salvador, as reported by the General Directorate of Statistics and Censuses (DIGESTYC) in their projections for 2021. Districts correspond with the 14 “*departamentos*” in the country.

E Gasoline Subsidies and Elasticity of Substitution

We construct two groups: a treatment group composed of those who know about the gas discount, and a control group which includes those who *do not* know about the gas discount.²

Following 40, we first define the share of gas (g) expenditures paid with Chivo as

$$s_{chivo} \equiv \frac{p_{chivo}^g}{p_{chivo}^g + p_{other}^g}.$$

Then, we define α as the share of expenditures paid with Chivo under no discount (i.e. for the control group). We linearize the optimal choice of share of expenditures paid with Chivo Wallet, under a CES utility function, as a function of the relative prices p_{chivo}^g/p_{other}^g , such that the first-order approximation around $p_{chivo}^g/p_{other}^g = 1$ is given by

$$s_{chivo} = \alpha - (\eta - 1)\alpha(1 - \alpha) \ln \frac{p_{chivo}^g}{p_{other}^g},$$

where η is the elasticity of substitution. Results are presented in Table E1. We find that the estimate of the elasticity of substitution between Chivo Wallet and other payment methods ranges from 12.9 to 17.1 across different specifications; a magnitude larger than the elasticity of substitution between cash and cards (40). This implies that the welfare costs of policies disincentivizing payment methods (such as cash) are lower if digital payment methods are available. Nonetheless, our estimates must be interpreted with caution, as they are based on a small and very specific subsample of users who are likely to be more elastic than the average person in El Salvador.

Table E1: Elasticity of Substitution Between Chivo Wallet and Other Payment Methods

<i>Dependent variable: Share of gas expenditures paid with Chivo Wallet</i>				
	(1)	(2)	(3)	(4)
η	-14.4783*** (3.713)	-13.9307*** (3.934)	-14.2921** (5.621)	-17.1795** (7.241)
Unbanked		-0.0221 (0.084)		-0.0941 (0.099)
Phone with Internet		0.0648 (0.059)		0.0883 (0.086)
Demographic Controls	N	N	Y	Y
Observations	49	49	49	49
R-squared	0.060	0.067	0.130	0.260

Notes: The table shows the estimates of the elasticity of substitution using a subsample of individuals who owned a car, had gas expenditures, and had downloaded Chivo Wallet. Robust standard errors are reported in parenthesis. Data was collected by the authors through the survey described in Section 3.

²Panels (e) and (f) of Figure A10 include details on car ownership and gas expenditures by quintile. See Figure E1 for an example of one of the ads.

Figure E1: Discount for Paying Gas with Chivo



Notes: The figure shows one of the advertisements displayed in Nayib Bukele's Twitter account (El Salvador's president), which promised a discount of \$30 per gallon for people who paid for gas using Chivo Wallet.

F Data Description

Multipurpose Survey on Households (EHPM)

The Multipurpose Survey on Households (EHPM in Spanish) is conducted annually and is gathered by the General Directorate of Statistics and Censuses (DIGESTYC). The survey gathers data on the socioeconomic and demographic characteristics of households and covers individual households in the entire country (both urban and rural areas, and both the formal and informal sectors). It also contains questions covering topics such as education, household expenses, agriculture, employment, living conditions, and health. The survey is collected through in-person interviews. We use the latest survey corresponding to 2020. The sample size for this survey is 37,030 persons and 10,755 households.

World Bank Open Data

Here we describe the indicators shown in [Figure A9](#). Mobile cellular subscriptions (per 100 people) for El Salvador are subscriptions to a public mobile telephone service that provides access to the PSTN using cellular technology. The indicator includes (and is split into) the number of postpaid subscriptions, and the number of active prepaid accounts (i.e. that have been used during the last three months). The indicator applies to all mobile cellular subscriptions that offer voice communications. It excludes subscriptions via data cards or USB modems, subscriptions to public mobile data services, private trunked mobile radio, telepoint, radio paging and telemetry services. The source is the International Telecommunication Union (ITU). Personal remittances received (% of GDP) comprise personal transfers and compensation of employees. Personal transfers consist of all current transfers in cash or in-kind made or received by resident households to or from nonresident

households. Personal transfers thus include all current transfers between resident and nonresident individuals. Compensation of employees refers to the income of border, seasonal, and other short-term workers who are employed in an economy where they are not resident and of residents employed by nonresident entities. Data are the sum of two items defined in the sixth edition of the IMF's Balance of Payments Manual: personal transfers and compensation of employees. The source is the World Bank, which based the estimates on the IMF balance of payments data, and World Bank and OECD GDP estimates. Automated teller machines (ATMs) (per 100,000 adults) are computerized telecommunications devices that provide clients of a financial institution with access to financial transactions in a public place. The source is the International Monetary Fund, Financial Access Survey. Commercial bank branches (per 100,000 adults) are retail locations of resident commercial banks and other resident banks that function as commercial banks that provide financial services to customers and are physically separated from the main office but not organized as legally separated subsidiaries. The source is the International Monetary Fund, Financial Access Survey.

Global Financial Inclusion

The data is gathered by the World Bank and provides over 800 country-level indicators of financial inclusion summarized for all adults (age 15+). The indicators of financial inclusion measure how people save, borrow, make payments and manage risk. The data cover more than 150 economies. The most current data for El Salvador is that of 2017, which we use in our baseline calculations.

Supplementary References

26. W. Jevons, *Money and the Mechanism of Exchange*, The International scientific series (D. Appleton, 1875).
27. K. Wicksell, Lectures on political economy. volume ii: Money and credit (1906).
28. N. Kiyotaki, R. Wright, *Federal Reserve Bank of Minneapolis Quarterly Review* **16**, 18 (1992).
29. N. Kiyotaki, R. Wright, *Journal of Political Economy* **97**, 927 (1989).
30. S. R. Aiyagari, N. Wallace, *Journal of Economic Theory* **74**, 1 (1997).
31. A. Smith, *An Inquiry into the Nature and Causes of the Wealth of Nations* (McMaster University Archive for the History of Economic Thought, 1776).
32. E. Cannan, *The Economic Journal* **20**, 394 (1910).
33. R. M. Starr, *Econometrica* **42**, 45 (1974).
34. R. Borzekowski, K. K. Elizabeth, A. Shaista, *Journal of money, credit and banking* **40**, 149 (2008).
35. B. Yang, A. T. Ching, *Management Science* **60**, 903 (2014).
36. T. Suri, *Annual Review of Economics* **9**, 497 (2017).
37. A. Deviatov, N. Wallace, *Review of Economic Dynamics* **17**, 287 (2014).
38. F. Alvarez, F. Lippi, *Journal of Monetary Economics* **90**, 99 (2017).
39. F. Alvarez, D. Argente, *The Quarterly Journal of Economics* **137**, 1737 (2022).
40. F. Alvarez, D. Argente (2022).
41. R. Auer, *et al.*, *Annual review of economics* **14**, 697 (2022).
42. D. Duffie, K. Mathieson, D. Pilav, *Available at SSRN 3837669* (2021).
43. D. Duffie, *Foreign Affairs* (2022).
44. D. Duffie, *Asian Monetary Forum, May, mimeo* (2019).
45. N. Borri, *Journal of Empirical Finance* **50**, 1 (2019).
46. I. Makarov, A. Schoar, *Journal of Financial Economics* **135**, 293 (2020).
47. J. M. Griffin, A. Shams, *Journal of Finance* **75**, 1913 (2020).
48. I. Makarov, A. Schoar, Blockchain analysis of the bitcoin market, *Tech. rep.*, National Bureau of Economic Research (2021).
49. Y. Liu, A. Tsyvinski, *The Review of Financial Studies* **34**, 2689 (2020).
50. E. Pagnotta, A. Buraschi, *SSRN Electronic Journal* (2018).
51. B. Biais, A. Menkveld, C. Casamatta, C. Bisière, M. Bouvard, Equilibrium bitcoin pricing, *2019 Meeting Papers 360*, Society for Economic Dynamics (2019).
52. L. W. Cong, Y. Li, N. Wang, Tokenomics: Dynamic Adoption and Valuation, *NBER Working Papers 27222*, National Bureau of Economic Research, Inc (2020).
53. L. Cong, Z. He, J. Li, *SSRN Electronic Journal* (2018).
54. M. Sockin, W. Xiong, A Model of Cryptocurrencies, *NBER Working Papers 26816*, National Bureau of Economic Research, Inc (2020).
55. S. Athey, I. Parashkevov, V. Sarukkai, J. Xia (2016).
56. L. Schilling, H. Uhlig, *Journal of Monetary Economics* **106**, 16 (2019). SPECIAL CONFERENCE ISSUE: “Money Creation and Currency Competition” October 19-20, 2018 Sponsored by the Study Center Gerzensee and Swiss National Bank.
57. U. J. Jermann, *Journal of Macroeconomics* **69** (2021).