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Sharia Compliance of Cryptocurrencies: Data-Driven Sharia Compliance Assessment

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ABSTRACT

In recent years, a significant percentage of the population has engaged in the trade and use of cryptocurrencies, demonstrating the widespread interest in the field. The usefulness of cryptocurrencies as an option to fiat currency is one of the most pressing issues that arise. The fiat money system is primarily reliant on commercial banks, which require bank accounts to process individual payments. The legality of cryptocurrencies has been susceptible to subjective interpretation, and this research presents a new objective AI methodology for determining whether currencies comply with Sharia. The framework consists of an unsupervised BIRCH clustering method that allows for the grouping of volatilities and logarithmic returns based on a variety of periodic data. The approach gave a solid rationale for deciding automatically which cryptocurrency may not comply with Sharia law. The results indicate that, over longer time intervals, the volatility of various cryptocurrencies vary substantially. This permits the proper distinction between cryptocurrencies that comply with Sharia and those that do not. The methodology proposes an automated and data-driven method to objectively establish the Compliance with sharia of cryptocurrencies, enabling users to readily determine whether it is permitted to use such cryptocurrencies.

Kata Kunci:
BIRCH, Cryptocurrency, Metaverse, Kepatuhan Syariah, Keuangan Islam

ABSTRAK

Kesesuaian Mata Uang Kropto dengan Prinsop2 Sharia: Penilaian Kepatuhan Bernasis Data. *Cryptocurrency telah menarik minat yang signifikan dalam beberapa tahun terakhir dengan proporsi yang signifikan dari masyarakat yang terlibat dalam perdagangan dan pemanfaatan cryptocurrency. Salah satu pertanyaan utama yang muncul adalah kegunaan cryptocurrency sebagai alternatif mata uang fiat. Pertanyaan tentang legalitas cryptocurrency telah menunjukkan beberapa interpretasi subjektif, dan artikel ini memberikan kerangka kerja AI objektif baru untuk penentuan kepatuhan Syariah untuk cryptocurrency. Kerangka kerja ini terdiri dari algoritma pengelompokan BIRCH tanpa pengawasan yang memungkinkan untuk mengelompokkan volatilitas dan pengembalian logaritmik berdasarkan berbagai pengukuran berkala. Kerangka kerja tersebut memberikan alasan yang kuat untuk secara otomatis menentukan cryptocurrency yang mungkin tidak sesuai dengan hukum Syariah. Hasilnya menguraikan bahwa untuk rentang waktu yang lebih besar, volatilitas antara cryptocurrency berbeda secara signifikan. Ini memungkinkan untuk membedakan secara akurat antara cryptocurrency yang sesuai dengan Syariah dan yang tidak sesuai. Kerangka kerja ini menyediakan pendekatan otomatis dan berbasis data untuk secara objektif menentukan kepatuhan Syariah terhadap cryptocurrency dan memungkinkan individu untuk dengan mudah menilai apakah diizinkan untuk menggunakan cryptocurrency tersebut.*

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INTRODUCTION

In recent years, a significant percentage of the population has engaged in the trade and use of cryptocurrencies, demonstrating the widespread interest in the field. There have been numerous conferences and seminars to discuss the nature and social benefits of cryptocurrencies (Valeri, Fondacaro, De Angelis, & Barella, 2020). The utility of cryptocurrencies as an option to fiat currency is one of the most urgent issues that arise. The fiat money system is highly dependent on commercial banks, which require bank accounts to process individual payments. Cryptocurrencies promote greater financial inclusion because they do not demand access to bank accounts. This is especially important for developing nations when a substantial segment of the population is underbanked or lacks access to a bank account.

Cryptocurrencies have been lauded as a means of enhancing the autonomy of individuals and reducing the transaction fees connected with such transactions. By definition, cryptocurrencies are digital and compete with conventional instruments such as cash payments, credit card transactions, and bank wire transfers. In this sense, cryptocurrencies compete with traditional fiat currencies by facilitating financial transactions for a large population in a predominantly decentralized manner. Since the emergence of cryptocurrencies, Islamic finance has taken a keen interest in the subject, as it lowers the barrier for individuals to get Islamic financial services and facilitates Muslims' access to financial services (Hasan, Hassan, & Aliyu, 2020).

Conventional fiat currencies are characterized by powerful central bank and state control over the various currencies and the financial activities that can be undertaken with each distinct fiat currency. In addition, the majority of fiat currencies are based on the charging of interest, which means that the central bank gives liquidity to other banks and then charges interest on a percentage of the delivered money. The loan rate varies from country to country, but in traditional finance, it is a crucial measure for attracting global investors. The central bank benchmark rate represents the interest rate at which banks can get funding from the central bank and consequently provide financial services for their clients. Due to their legitimacy as a means of commerce under Islamic law, ordinary currencies are recognized largely lawful when evaluating them (Abubakar, Hassan, & Haruna, 2019). As a means of exchange, cryptocurrencies are generally exempt from riba and, owing to their shared ownership premise, embody the maslahah and risk-sharing principles (Evans, 2015).

In contrast, cryptocurrencies may take the form of an informational commodity that resembles cash. There is a substantial possibility that some cryptocurrencies could vanish, resulting in severe losses for investors. In traditional finance, the question is whether cryptocurrencies can be used reliably as a medium of exchange; in Islamic finance, the focus is on whether they are consistent with Shariah rules. Several folks regard cryptocurrencies as a progression of the process of inventing and improving means of trade. It began with simple barter exchanges, such as trading a cow for rice, before the introduction of gold and silver coinage. This was then followed with the introduction of bank notes and should be seen as the beginning of the virtual currency era. This is a standard procedure, and proponents view it as a benefit for Islamic finance to assist the economy and add value to the community. The opinion is that bitcoin is comparable to other currencies and is subject to the same exchange rate constraints (Muedini, 2018). As a means of exchange, cryptocurrencies are generally exempt from riba and, owing to their shared ownership premise, embody the maslahah and risk-sharing principles (Evans, 2015). In contrast, cryptocurrencies may take the form of an informational commodity that resembles cash. There is a substantial possibility that some cryptocurrencies could vanish, resulting in severe losses for investors.

In traditional finance, the question is whether cryptocurrencies can be used reliably as a medium of exchange; in Islamic finance, the focus is on whether they are consistent with Sharia rules. Several folks regard cryptocurrencies as a progression of the process of inventing and improving means of trade. It began with simple barter exchanges, such as trading a cow for rice, before the introduction of gold and silver coinage. This was then followed with the introduction of bank notes and should be seen as the beginning of the virtual currency era. This is a standard procedure, and proponents view it as a benefit for Islamic finance to assist the economy and add value to the community. The opinion is that bitcoin is comparable to other currencies and is subject to the same exchange rate constraints (Muedini, 2018).

This indicates that there must be a spot exchange devoid of leverage and futures, and that there should be no currency speculation. This entails that the exchange must support a legitimate, actual transaction in addition to the concept of exchanging currency for currency. Bitcoin has been exchanged on a number of open-market exchanges, and while its prevalence is currently restricted, it is gaining recognition in a number of nations. The legalization of bitcoin in two countries accelerated the acceptance of cryptocurrencies as legitimate means of commerce. Nonetheless, several cryptocurrencies have severe market manipulation issues, which may result in considerable currency volatility and may wipe out the investments of investors (Aloui, ben Hamida, & Yarovaya, 2021). Hence, it becomes critical to review this cryptocurrencies compliance with sharia law. Thus, this study aims to discover whether and under what conditions cryptocurrencies comply with Sharia law, as well as what requirements must be met.

LITERATURE REVIEW

When evaluating cryptocurrencies, a basic guideline should be considered. Any product that may serve as a form of payment must be seen as valuable. Any product that may function as a means of payment must be seen as money and should be handled as such. In contrast, a number of opponents argue that a currency devoid of inherent value should not be regarded as a legitimate means of trade. Therefore, only gold or silver currency may comply with Sharia law (Aloui, ben Hamida, & Yarovaya, 2021).

A second position is that an appropriate digital currency must have a unit of measure for its worth. This suggests that a monetary commodity is required. This indicates that paper notes or digital currencies must have a standard weight and be redeemable with a commodity standard, such as gold. There is no single document in Islamic law that outlines the standards for what constitutes money and how it must flow. As noted above, this necessitates an assessment of how both traditional and contemporary Muslim scholars see money and the modern mechanisms for money circulation from a Sharia (Abubakar, Hassan, & Haruna, 2019).

The Islamic tradition has a long history of monetary perspectives. Several allusions are made to the dinar and dirham, two circulating currencies that are valuable but not desirable in and of themselves. In general, it is believed that a measure of value that is generally recognized by people must be a currency, and that the Riba principles must be applied to it. In general, it is believed that money should not be a commodity that can be sold on various terms, but rather a measure of worth. The measurement exemplifies the efficient cause (Illah) of money as the most important factor. This is owing to the historical relationship between dinars and dirhams, which were weighed rather than numbered. This suggests that if money is generated from common minerals and can be measured, then Riba rules will apply. In addition, the efficiency derives from the inherent value, such as gold or silver composition. Lastly, efficiency derives

from the unit of value measurement or account. This means that money may be manufactured out of anything as long as it functions as a unit of worth (Billah, 2019).

When assessing the current circulation of money, it is necessary to examine the fundamental Islamic prohibitions. This consists of interest (Riba), uncertainty (Gharar), excessive risk, and speculation (Maysir). In addition to the technique for money emission, the principal characteristics are the commodity nature of money, the amount of emission, and the money supply. In addition, the management of the banking sector's liquidity, inflation, Zakat payment concerns, and the avoidance of Islamic law restrictions are important factors (Asif, 2018).

When examining the present circulation of money, it is vital to consider the fundamental Islamic prohibitions. This comprises of curiosity (Riba), uncertainty (Gharar), excessive risk, and speculation (Maysir). In addition to the technology for money emission, the major features are the commodity nature of money, the volume of emission, and the money supply. In addition, the management of the banking sector's stability, inflation, Zakat payment problems, and the avoidance of Islamic law constraints are crucial variables (Asif, 2018).

In general, money emission is not limited to gold and silver and can be made from any substance. While financial obligations such as Sukuk are secured by actual assets, money is not a financial asset but rather a medium of exchange (Alam & Zameni, 2019). The quantity of money that can be released is not specified by Islamic law, which is a crucial factor. However, the money should be distributed according to the needs of the economy.

There are two distinct techniques to money emission. The first is the mechanism through which a central authority, such as the finance ministry, issues money. These funds are issued to finance the government's budget shortfall and are used to cover state expenses. The strategy results in regular inflation, but has no banned ingredients. If there is a Central Bank that allocates money on a competitive basis to commercial banks, then the difficulty is that it may charge interest, which is prohibited in Islamic finance (Hasbi & Mahzam, 2018).

Liquidity management is a crucial responsibility of the central bank, which normally draws loans or deposits funds in a competitive manner. This suggests that Sharia compliance poses issues for conventional monetary regulatory mechanisms. In many instances, the central bank is seen as risk-free, which defies the fundamental tenets that money cannot produce value on its own and that a liability justifies a profit. Given that the central bank may be regarded as risk-free, it would be improper for individuals to participate in business risks without assuming responsibility risks themselves (Islamy, 2021).

Inflation is a significant element and refers to a prolonged increase in the pricing of goods and services. Inflation is acknowledged by Sharia law, where demand-pull inflation may be created by population expectations and cost-push inflation is caused by global forces. This is not in contradiction with Sharia law. The Islamic rule prohibits excessive emissions that cause inflation. This is the same as the damage caused by Riba. The volume of money issuance is strictly regulated in conventional monetary circulation. This conforms with Islamic law (Abozaid, 2020).

Another important factor is Zakat payment, which is obligatory for all Muslims who meet specific requirements. If a person's funds reach Nisab and they are not invested, then these savings will reduce by 2.5% year due to the Zakat deduction. This may be an essential consideration for cryptocurrencies and can be used for Zakat calculations (Chowdhury & Razak, 2019).

Avoiding Islamic law bans on the use of cryptocurrencies is a final important consideration. This encompasses inequality monetary circulation and, more recently, social injustice resulting from the disproportionate distribution of wealth. This may result in society's marginalization and people's poverty.

METHODOLOGY

Shariah requirements on permissible mediums of exchange play a critical role, and as outlined above, there is no explicit prohibition of cryptocurrencies. In contrast, most of the requirements relate to how these mediums of exchange are utilized and their purposes, as well as the real value of these currencies.

While the goal and application are crucial for evaluating cryptocurrencies, another factor that should be considered is how volatile and pricey they are relative to traditional currencies. Volatility and price performance analysis offer vital information for deciding whether a currency might offer stability or might resemble a gambling instrument more, which is against Islamic law.

Determining whether a currency represents a medium of exchange or a speculative instrument is a significant challenge given that it is typically very subjective. When investigating whether currencies are legitimate money of exchanges, and comply with Sharia, the volatility of the currencies are considered (Ahmed, 2021).

Currency volatility is typically defined as the change in the price of the currency within a given target time range. This suggests that there may be different levels of volatility depending on the time horizon, which might be daily, weekly, or monthly. Although daily volatility may be relatively modest for currencies, volatility over a longer time horizon may be significant. People typically connect high volatility with instability and an increased chance of loss. Investors almost completely lost their money because of the extreme volatility that followed Terra's sharp decline in value. In such cases, it is rather simple to determine that a particular cryptocurrency is completely forbidden by Sharia. Other cryptocurrencies face difficulties due to what is considered a high level of volatility, which makes them more like gambling than a reliable medium of trade. The topic of what amount of volatility clearly indicates that the market is in a bear market comes considering the substantial volatility in generally widely accepted currencies, such as the Japanese Yen, Malaysian Ringgit, Russian Rouble, and others (Taghdiri, 2020).

The most common method of measuring volatility is to calculate the standard deviation of the currency swings over the specified time frame. As a percentage of the difference between the levels at which the returns are computed, the fluctuations are preferentially taken into account on a scaled basis. There are several ways to calculate returns, with ordinary or logarithmic returns being the most popular. Ordinary and logarithmic returns are equal when they equal zero, but for tiny returns, they are roughly equal (Beik, Nurzaman, & Sari, 2019).

The key benefits of logarithmic returns include their symmetry, ease of compounding, time-additive nature, and inability to experience negative investment prices. These variations also have an impact on how the standard deviation, a measure of volatility, is evaluated.

To accurately depict the volatility estimates, the computation of the volatility is a crucial step in the analysis of volatility. The traditional volatility measure is

$$\sigma_t = \sqrt{\left(\frac{(H_t - L_t)^2}{2} - (2\ \log 2 - 1){C_t}^2\right)}$$

Where C_t is the logarithm of the ratio between the closing price, and opening price at the time t, H_t is the logarithm of the ratio between the high price at time t, and the opening price, and L_t is the logarithm of the ratio between the low price and opening price at time t (Enoksen, Landsnes, Lučivjanská, & Molnár, 2020).

The volatility measure can be computed for various time ranges, being on a daily basis, weekly or monthly basis and takes into account both the inter-period volatility in addition to the closing and opening prices (Kim, Trimborn, & Härdle, 2021).

The values can be used to estimate thresholds for the Sharia compliance of cryptocurrencies and build a standard for widely accepted metrics to assess the Islamic permissibility after the volatility and other related aspects of these currencies have been identified. When there is no specific label for the data, unsupervised learning allows for the discovery of patterns. Unsupervised learning makes it possible to ascertain how similar different cryptocurrencies are to one another and whether they share any characteristics in the context of Sharia compliance of currencies. This enables grouping cryptocurrencies into compliant and non-compliant ones based on the issue and determining the effects of each of the influencing elements (Fakhfekh & Jeribi, 2020)

The k—means clustering algorithm is one of the most frequently used clustering techniques. Each observation belongs to the cluster with the closest mean after the algorithm divides the n observations into k clusters. The algorithm's goal is to reduce within-cluster deviations for each cluster. The k-median and k-medoids clustering algorithms may be used since they more accurately depict the Euclidean distances if the variances are insufficient to calculate the distances and group the points according to them (Fränti & Sieranoja, 2018).

Hierarchical clustering, which creates a hierarchy of clusters, is another crucial technique. Agglomerative methods, where each observation has its own cluster and the clusters are paired as one moves up the hierarchy, or divisive methods, where all observations begin in a single cluster and the splits are carried out recursively, can be used to do this. The advantage of hierarchical clustering is that it can handle noisy datasets (Pavlidis, Plagianakos, Tasoulis, & Vrahatis, 2006).

The BIRCH method, a balanced, iterative reducing and clustering employing hierarchies that adheres to the hierarchical clustering strategy, was the preferred clustering form. The two main parameters of the BIRCH algorithm, the number of clusters and the threshold for the separation, are flexible. The algorithm's ability to manage dataset noise and produce accurate data segmentations is just one of its many advantages. The algorithm, a type of hierarchical clustering, takes advantage of the fact that it is robust to data uncertainty and operates much more quickly than traditional agglomerative hierarchical clustering algorithms. Because of this, the method is effective for difficult clustering procedures like determining Sharia conformity (Zhang, Ramakrishnan, & Livny, 1997).

RESULT AND DISCUSSION

Many cryptocurrencies are compared to one another to evaluate the framework. The major fiat currencies and cryptocurrencies are included in the examined cryptocurrency pairs, which are listed in Table 1 according to market value. Given that the USD is the most used in international finance and a significant reserve currency, it was presumed to be the reference currency. The other currencies were picked to symbolize a range of various pairs from both developed and developing countries. The biggest cryptocurrencies by market capitalization were chosen for the coin pairs as well. Beginning on January 1st, 2015, and ending on August 1st, 2022, the time frame covered having enough data for both fiat currencies and cryptocurrencies.

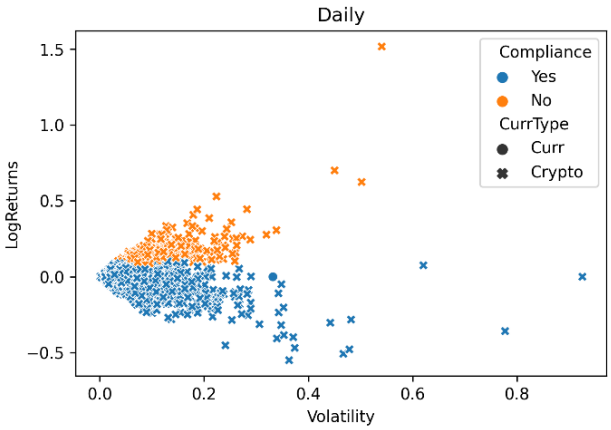
Table 1: Currency and Cryptocurrency Pairs

Currency Pairs	Cryptocurrency Pairs
EUR/USD	BTC/USD
JPY/USD	ETH/USD
GBP/USD	BNB/USD
RUB/USD	XRP/USD
IDR/USD	ADA/USD
EGP/USD	SOL/USD
CAD/USD	DOGE/USD
TRY/USD	DOT/USD
MYR/USD	DAI/USD
SGD/USD	TRX/USD
THB/USD	
INR/USD	

The volatility and logarithmic return for all the pairings were determined on a daily, weekly, monthly, and quarterly basis. Based on the volatilities and logarithmic returns in Sharia-compliant and non-compliant pairs, the pairs were then grouped. Each time point was taken into consideration as a data point in the clustering since both volatilities and logarithmic returns varied over the time range. The pair is not regarded as compliant if there is a time period during which the point does not satisfy compliance, such as one of extremely high volatility or returns.

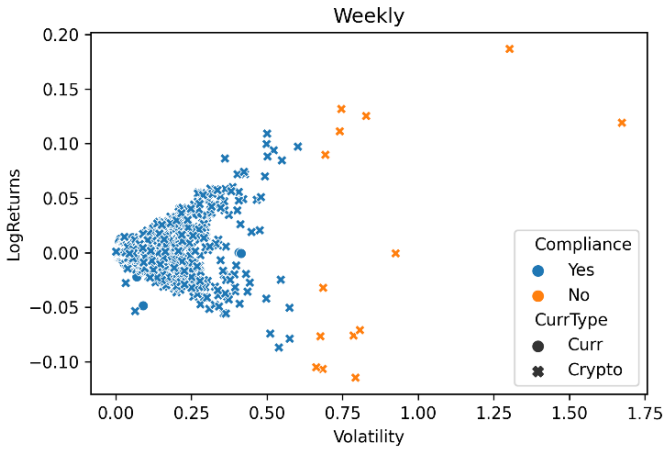
Figures 1 to 4 show the clustering for daily to quarterly sampling periods serve as examples of the findings. Figure 1 shows how the data may be clustered based mostly on logarithmic returns when looking at daily returns vs volatility. The information is grouped based on compliance and the type of currency, such as fiat or cryptocurrency. As previously mentioned, the logarithmic returns of the various cryptocurrencies make it difficult to discern between compliant and non-compliant currencies with any degree of accuracy.

Figure 1: Daily Volatility Versus Logarithmic Returns Comparison



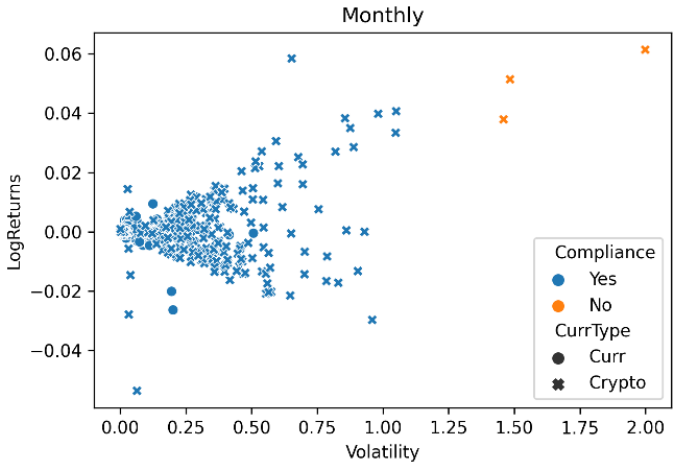
Weekly logarithmic returns and volatility parameters show Figure 2 that the clustering is relatively separated by a critical volatility threshold of 0.65 irrespective of the logarithmic returns. Separately, a separation purely based on the volatility may also not be adequate given that returns may be entirely disregarded for determining the compliance.

Figure 2: Weekly Volatility Versus Logarithmic Returns Comparison.



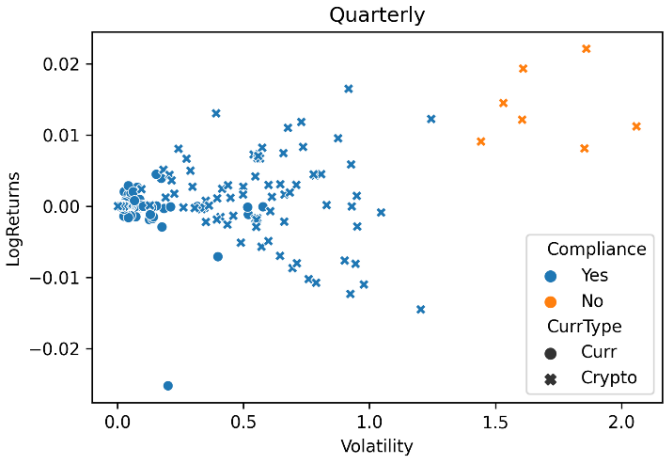
Analysis of Figures 3 and 4 reveals that the separation is heading in the direction of greater volatility values with a very small number of cryptocurrencies not complying. The findings show that identifying whether cryptocurrencies are Sharia compliant may not be possible using daily volatility and logarithmic return comparisons. The topic of how long the volatility must be known for the separation must also be addressed. In comparison to weekly, monthly, or quarterly comparisons, daily returns result in a relatively weak separation.

Figure 3: Monthly Volatility Versus Logarithmic Returns Comparison



Dogecoin, Solana, Ada, and BNB are a few examples of cryptocurrencies that are not Sharia-compliant because of their high volatility and speculative nature. These cryptocurrencies all show notable volatility when considering quarterly volatility data. Similar conclusions are obtained about illegal cryptocurrencies like Dogecoin and BNB when comparing quarterly statistics.

Figure 4: Quarterly Volatility Versus Logarithmic Returns Comparison



CONCLUSIONS

In recent years, cryptocurrencies have gained a lot of attention, and a sizable segment of society is now involved in cryptocurrency trade and usage. To examine the nature of cryptocurrencies and how they benefit society, there have been numerous conferences and seminars. The usefulness of cryptocurrencies as a substitute for fiat currencies is one of the key queries that come up. The commercial banks, which need bank accounts to process payments for people, are a major component of the fiat money system. The advantage of cryptocurrencies is that they allow for broader financial inclusion and do not require access to bank accounts. This is especially crucial for developing countries when a sizable segment of the population is underbanked or lacks access to a bank.

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