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ARTICLE

From Speculation to Survival Technique - The Role of Bitcoin in Different Economic Circumstances Based on the Analysis of Selected African Countries

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Abstract

The article aims to reveal that the relationship of the bitcoin-derived exchange rate with the inflation level in a crisis-driven economy allows the citizens to use bitcoin as a "survival" asset. We analyse data on bitcoin transactions in local currencies of selected African economies (Ghana, Kenya, Nigeria, and South Africa) up to January 2021. Based on the bitcoin data, we derive the unofficial exchange rate for each country and compare it to the official one. We show that in countries of high inflation, the discrepancies between the two rates may be so high that it is impossible to establish even a long-term relationship between them. Moreover, the difference between the monthly-averaged bitcoin-derived and official rate positively relates to inflation in the same month. It suggests that the citizens may utilise bitcoin money-like properties to overcome the consequences of high inflation, buying bitcoin for local money and selling for US dollars instead of using the direct exchange rate or simply using bitcoin to store their wealth.

Keywords: bitcoin; Africa; money; exchange rate; inflation

JEL classification: G00, G21, G51

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1. Introduction

Cryptocurrencies can be considered an alternative to fiat currencies or even a part of an alternative economy (Bouri et al., 2017). Nevertheless, in countries with stable currency systems, Bitcoin was adopted as an investment (speculative) asset rather than means of payment. Without institutional support (e.g. Sweden, Estonia, Venezuela), bitcoin or other cryptocurrency is unlikely to substitute traditional financial systems by the forces of grass-root initiatives. People are using incumbent money, so switching to Bitcoin would generate the costs of change and require many people doing it at once to become effective (network effects - see Luther, 2016). This situation favours the status quo.

Though, in some African countries, the situation may be considered different due to the financial markets' immaturity, relatively low insertion in global financial systems, high cost of money transfer, and low financial development (i.a., Egbetunde & Akinlo, 2015; Kliber & Świerczyńska, 2017; Tweneboah et al., 2020). The use of cryptocurrencies can potentially increase access to financial

services with the omission/substitution of the inefficient, traditional financial systems in the region. It also opens the possibility to "insert cryptocurrency solution", embed it as a tool into the existing system and utilize it to gain profit, as we claim, i.a., by exploiting the exchange rate discrepancies.

From the perspective of African countries, information technology and technology-driven information enables financial development (Asongu et al., 2019 a,b). The blockchain is already perceived as means to promote transparency and enhance transaction efficiency (Kshetri, 2017). The experiences of information and communication technology (ICT) progress in the recent decade, and the mPesa example in particular, have shown that the right technological and institutional setting may allow the introduction of a non-traditional monies system in the region (Nair & Emozozo, 2018). Several studies indicate that the development of ICT technology positively impacts African development and trade (Bankole et al., 2015; Ponelis & Holmner, 2015; Kayisire & Wei, 2016).

There is evidence of a plethora of Bitcoin applications in African countries, despite the overall low volume of transactions, compared to other regions (i.a., Nieman, 2015). One of the possible uses of Bitcoin in African countries is to send remittances (Economist, 2014; Rasul, 2018). It can decrease the costs of sending money via traditional intermediaries, which charge up to 12%. However, there are more experiences of the money-like use of cryptocurrencies in African markets. Bitcoin ATMs allow clients to insert local cash and change it into the cryptocurrency minted on the internet, which can be used at the businesses which have joined the scheme (see Cryptobriefing, 2018). We notice a growing number of platforms offering the exchange of cryptocurrencies and services which substitute financial systems, such as gift cards (iTunes, Amazon, Sephora) traded in bitcoins. Merchants have adopted Bitcoin within South Africa as a mode of payment (Nieman, 2015). According to New African Markets (2015), even before the peak in bitcoin prices, Bitsoko developed a mobile wallet that implements blockchain technology and mobile money to cut the cost of sending money between individuals in Kenya. Furthermore, BitFinance in Zimbabwe has rolled out a Bitcoin exchange that allows users to buy and sell bitcoins using mobile money or their bank accounts.

The conditions for distinct to high-income countries' evolution of bitcoin use in Africa are rooted in the characteristics of its markets. According to the World Development Indicators dataset, access to bank accounts in African countries is generally lower than in high-income countries, and the banking system is immature. Hence, cryptocurrencies appear as an alternative to store value. It is crucial for unstable markets with volatile foreign exchange rates, high inflation, and low trust in government and local currency (Stensås et al., 2019). At the same time, some African societies seem to be better prepared for the daily use of cryptocurrencies than elsewhere in the World. Despite the evidence supporting the money-like use of Bitcoin in Africa, it is noteworthy that the characteristics of Bitcoin make it susceptible to investment and speculation, like elsewhere. Bitcoin can be treated as an asset - some authors compare it to, e.g. gold (Dyhrberg, 2016a). As noticed by Kliber et al. (2019), investors' behaviour depends on the authorities and regulatory frameworks; the stricter the control over private investment in the country, the more willing the investors are to look for new opportunities. That makes African markets potentially open to cryptocurrency investment.

Two articles were the inspiration for this paper. The first one was Pieters (2016), who showed how the bitcoin-derived exchange rate can be used to assess the degree of capital control and that the bitcoin-derived exchange rate can approximate the unofficial exchange rate. Pieters (2016) shows that the rates can differ, suggesting that an active black-market exchange rate exists. The second article by Johnson (2019) uses a bitcoin-derived exchange rate to approximate the de-facto exchange rate of the bolivar to the US dollar. The author argues that in Venezuela, bitcoin helps people survive hyperinflation and plays thus a different role than in stable developed markets with a healthy financial system. The findings of Johnson (2019) have been corroborated by Kliber and Świerczyńska (2019) and Musiałkowska et al. (2020).

In our paper, we investigate how the relation of the bitcoin-derived exchange rate to the official one varies, depending on the inflation rate and the degree of financial openness (measured by the

KAOPEN index). The set of countries encompasses Ghana, Kenya, Nigeria and South Africa. According to the Global Digital Yearbook (2019), Kenya and Ghana score above the World average in terms of internet users who use their phones to pay for goods and services. The same report reveals that over 10% of South Africans and around 7% of Nigerians and Ghanaians owe cryptocurrencies (likewise above the 5.5% World average). [1]However, based on the data presented on the Statista website,[2] which presents respondents from 55 countries, 32% of Nigerians, 18% of South Africans, and 11% of Kenyans confirmed cryptocurrency ownership in 2020 (data for Ghana is not included; however, Broni et al.2020 confirm that the majority of users in Ghana are exceptionally positive about the idea of bitcoin aim to keep utilizing it).

We note that the economies constitute a subset of the ones included in Tweneboah et al. 2020 and - based on the characteristics of their stock exchanges (high level of capitalization and turnover) - we can assume that their financial markets are relatively well-developed. All these countries are open to international portfolio investment but differ in their level of openness. What is crucial for our study, the countries also differ in inflation levels.

We analyse data from LocalBitcoins exchange in two subperiods. The length of the first one varies (2015-2019) for each country in the sample. Its start depends on data availability, and the end is, in each case, the beginning of 2019, just before the speculative attack on the exchange. The second subperiod is the same for each currency and covers the March 2019-January 2021 data, beginning with the change of anonymity in the LocalBitcoins and encompassing the COVID-outbreak moment.

Based on the LocalBitcoins data, we calculate the bitcoin-derived exchange rates. We investigate long-run relationships between the two using the ARDL approach and interpret the results considering the country's financial openness. We also calculate the mark-ups between the bitcoin-derived and the official rates. The non-zero value of the markup denotes the possibility of earning extra profit through converting local currency to the dollar (or vice versa) using the Bitcoin platform instead of the official exchange rate. Furthermore, the discrepancy between the official rate and the market one suggests the existence of the black-market exchange rate. We run a simple Kendall test to verify the correlation between the mark-ups and inflation level. We conclude that in the high-inflation period, the relationship is present, and it ceases with the decline of inflation. Our results support the findings of Johnson (2019) that in high-inflation economies, the degree of discrepancy between the rates and the degree of capital control is the highest (Nigeria, Ghana), and we suggest that Bitcoin can be used as a means of survival asset. Our results corroborate the finding that in countries with high inflation levels and volatility, the interest in Bitcoin increases as people attempt to store value in an independent, relatively easily accessible, non-government-controlled asset, a cryptocurrency.

2. Methodology

In our study, we follow the approach of Pieters (2016). We compute the bitcoin-derived exchange rate using LocalBitcoins data. We analyse cointegration relationships between the exchange rates (bitcoin vs USD and Euro) using the Pesaran-Phillips-Schmidt (Pesaran et al., 2001) test to check whether there is a long-run relationship. Additionally, we check for the value of possible markup and using Kendall's test, verify whether there exists any relationship between the average monthly markup and inflation.

2.1 Computing Bitcoin-Derived Exchange Rates

Following Pieters (2016) we will denote by B_t^C the price of bitcoin in local currency, while by B_t^{USD} – the price of bitcoin in dollars at the day t. The exchange rate between the US dollar and the local currency inferred from the bitcoin price will be denoted by $E_t^{B,C}$. Therefore:

1. In Egypt 3,6%, in Kenya 2,6%, and in Morocco 1,7% of internet users owe cryptocurrencies (Global Digital Yearbook, 2019).
2. https://www.statista.com/statistics/1202468/global-cryptocurrency-ownership/

$$E_t^{B,C} = \frac{B_t^C}{B_t^{USD}} \tag{1}$$

As mentioned before, the characteristics of the bitcoin exchange rate and its relations to other exchange rates may reveal information about the economy, with some limitations. First, Pieters (2016) notes that it is possible that the constructed bitcoin exchange rate $E_t^{B,C}$ is unrelated to the official exchange rate and reflects the activity of the diaspora and more importantly, the global bitcoin community. In such a case, the bitcoin exchange rate would not fully capture country specifics. Second, Pieters & Vivanco (2016) show that bitcoin exchanges vary in bitcoin price variations and fluctuations (see also Kliber & Włosik, 2019 and Matkovskyy, 2018).

These problems can be solved if the analysis of the bitcoin exchange rates is based on the LocalBitcoins data. First, this platform offers the user interface in the local language (even if it is French or English in the case of African countries) - thus, enhancing the local people to use it. Next, the use of African currencies is rare, and when one buys bitcoin in, e.g. Ghana Cedi, it is plausible to assume that it is a citizen of Ghana, not an international investor. It is rather unlikely that global investors, or even diaspora, trade with African currencies. Secondly, the number of people using smartphones in Africa is relatively high compared to the general infrastructure development in the region (Świerczyńska, 2019). Moreover, the openness to the use mobile phones and smartphones for multiple purposes, such as sending money, varies across the region yet remains at comparatively high levels in sub-Saharan Africa, e.g., 50,1% of people aged over 15 use their mobile phones to send money in Kenya (Global Financial Development Database, 2019).

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2.2 Co-integration Test

The bitcoin prices in local currencies are very unpredictable and have different properties than those of other financial instruments. Thus, the Johanssen cointegration test, requiring all variables to be I(1), may not always be appropriate to study the long-run relationships between the official and bitcoin-derived exchange rates (see: Peters, 2016). Thus, we use an alternative approach based on the autoregressive distributed lags model (further: ARDL). To illustrate the ARDL modelling approach, we will consider the following simple model:

$$E_t^{B,C} = \alpha + \beta E_t^{O,C} + \epsilon \tag{2}$$

where by $E_t^{B,C}$ denotes (as previously) the bitcoin-derived exchange rate, while $E_t^{O,C}$ – the official one. Model (2) can be written in an error-correcting form (conditional ECM – see Pesaran et al. 2001) as:

$$\Delta E_t^{B,C} = \beta_0 + \sum_{i=1}^{p} \beta_i \Delta E_{t-i}^{B,C} + \sum_{j=1}^{q} \gamma_j \Delta E_{t-j}^{O,C} + \theta_0 E_{t-i}^{B,C} + \theta_1 E_{t-1}^{O,C} + \epsilon_t, \tag{3}$$

3. We note the fact that even though there is a possibility that the bitcoin-derived exchange rate will not be related to the "real" unofficial ones. Single transactions by major bitcoin holders may impact the rates of exchange. Furthermore, the bitcoin exchange rate can also be unrelated to the currency's unofficial (black market) value, especially in countries with low internet penetration rates.

where

$$\epsilon_t \sim iidN(0, \sigma), while \quad \Delta E_t^{B,C} = E_t^{B,C} - E_{t-1}^{B,C}$$

To verify the co-integration relationship, we test the hypothesis $H_0 : \theta_0 = \theta_1 = 0$. The F-statistics of the test have non-standard distribution. Pesaran et al. (2001) supply bounds on the critical values for the asymptotic distribution of it. The lower bound is based on the assumption that all of the variables are I(0), and the upper bound is based on the assumption that all of the variables are I(1). If the computed F-statistic falls below the lower bound we would conclude that the variables are I(0), so no cointegration is possible, by definition. If the F-statistic exceeds the upper bound, we conclude that we have cointegration. Finally, if the F-statistic falls between the bounds, the test is inconclusive. To check the robustness of the results, a "Bounds t-test" is performed (Pesaran et al. 2001). If the tests reject the null hypotheses of no-cointegration, we compute the long-run relationships coefficient as:

$$\beta = -\frac{\theta_1}{\theta_0}$$

The limitation of the test is that the direction of the causality relationship should be known in advance. However, in our case, it is reasonable to assume that if any causal relationship exists it is from the official to the bitcoin-derived exchange rate. Thus, we take this assumption for granted.

2.3 Construction of Mark-ups

Pieters (2016) notes that the bitcoin-derived exchange rate level should not be considered the proper level of the unofficial exchange rate, as various other market forces can influence it. Thus, to account for such forces, the author advises relating the exchange rate to the euro-dollar exchange rate derived from bitcoin. Pieters (2016) makes two assumptions:

- The conversions between the US dollar and the Euro face minimal financial barriers in the official exchange rate market, so the official USD-EUR exchange rate also represents the unofficial USD-EUR exchange rate.
- The US dollar and the Euro are the most traded currencies on each bitcoin exchange – therefore, the bitcoin US dollar-Euro exchange rate should represent the least distorted bitcoin exchange rate.

For these two reasons, Pieters (2016) uses the deviation between the official and bitcoin USD-EUR exchange rates to identify bitcoin-specific trends in the market. Let us denote by M_t^C the mark-up of the currency pair at the moment t, $E_t^{B,EUR}$, and $E_t^{O,EUR}$ – the exchange rates of the Euro, respectively: the bitcoin-derived and the official one. We compute the mark-up of the EURUSD exchange rate as follows:

$$M_t^{EURUSD} = \frac{E_t^{B,EUR} - E_t^{O,EUR}}{E_t^{O,EUR}} \tag{4}$$

Following Pieters (2016), we assume that the mark-ups in most traded currencies, BTC-USD and BTC-EUR, is the "natural" mark-up for that exchange. Thus, following Pieters, we will adjust the mark-up found for all the analysed currencies by the EUR-USD mark-up, i.e.:

$$\tilde{M_t^C} = M_t^C - M_t^{EURUSD} \tag{5}$$

2.4 Relationship Between The Mark-up Value and Inflation Level

The non-zero value of the mark-up denotes the possibility of earning extra profit through converting local currency to a dollar (or vice versa) using the Bitcoin platform instead of the official exchange rate. Secondly, it shows the discrepancy between the official rate and the market one, suggesting the existence of the black-market exchange rate. In such a situation, people may prefer to locate their wealth in bitcoin, which may still be perceived as safer than the high inflation-driven local currency. To verify whether the value of the mark-up is related to financial openness (as suggested by Pieters) and to inflation-induced instability, in the last step of the research, we calculate Kendall's test for the relationship between the adjusted mark-up value and inflation level.

3. Data and Countries Description

3.1 Countries Characteristics: Exchange Rate, Access to Capital and Inflation

Table 1 presents the analysis period and the official exchange rate regime during the respective period. The information on the exchange rate regime is taken from the IMF (2018) report. We analyse data in two sub-periods. The length of the first varies, depending on data availability, but in each case ends in January 2019. The second sub-period covers the period from March 2019 to January 2021. We cut the February data because of substantial outliers in the USDBTC exchange rate. Similar outliers have not been present in the EURBTC series, nor any of the Bitcoin prices in local currencies. We assume that the outliers must have been caused by the attack on LocalBitcoins at the end of January 2019. Thus, we decided to remove the period from the end of January to the end of February from the analysis, to reduce possible noise. Thus, the first period is the introduction and the rise of the popularity of bitcoins in the countries. At that time, minimum regulations have been present in the LocalBitcoins. The second period was chosen in such a way as to cover the "stabilisation" period as well as the moment of the outbreak of the pandemic so that we can notice any change in the nature of the time-series processes.

Table 1. Description of Exchange Rates – Time Span of Analysis, Exchange Rate Regime and Exchange Rate Structure

Country	Period 1 time-frame	Exchange rate regime	Exchange rate structure	Barriers to capital access (KAOPEN)	FDI, net inflows (% of GDP)*	FDI, net inflows*
Ghana	02.08.2017-01.01.2019	Floating	Dual exchange rates	H	5,6	3,40
Kenya	27.05-2015-01.01.2019	Stabilized arrange-ment	–	IM	1,5	1,23
Nigeria	09.05.2017-01.01.2019	Stabilized arrange-ment	Multiple exchange rates	IM	0,8	3,31
South Africa	01.01.2015-01.01.2019	Floating	–	H	1,0	3,62

Note: H- high, L-low, IM-intermediate, FDI – foreign direct investment, the data represents the mean value for the period 2016-2019. *BoP, current US$ billion.
Source: own elaboration based on LocalBitcoins, 2018; IMF, 2018; KAOPEN index, WDI data 2021.

The sample countries include the ones with a high and moderate rate of cryptocurrency ownership and use of the Internet and phones as means of payment. When analysing our results, we try to explain the differences among the countries by the type of exchange rate regime and the barriers to capital access. Following Pieters (2016), we consider the KAOPEN index of Chinn and Ito (2006).

The index is based on the binary dummy variables that codify the tabulation of restrictions on cross-border financial transactions reported in the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (Chin & Ito, 2008). KAOPEN is the first principal component of the original variables on regulatory controls over current or capital account transactions, multiple exchange rates, and the requirements of surrendering export payoffs (Chinn & Ito, 2008). With the inflow of new data, the authors update the index to include the most recent year's data using the entire sample of the original variables, including corrected/fixed data.

The barriers to capital access should be related to exchange rate regimes and mark-ups: floating exchange rates tend to have low mark-up and low barriers, while managed ones – high mark-up and high barriers. However, the declared regime of the exchange rate does not always reflect the de facto one, and it may happen that although KAOPEN would suggest low barriers, access to capital will be difficult or limited. This is mostly because KAOPEN considers institutional solutions - the extensity of capital controls based on the information from the IMF's Annual Report on Exchange Arrangements and Exchange Restrictions (further: AREAER) (see Chin and Ito, 2006). In contrast, some countries may adopt open access policies, yet, for other reasons, the investors may not engage in the market. This is viable in particular for countries with scarce capital or with non-formal barriers (e.g. low security of investment, corruption), unattractive to investors. Notably, when confronted with the FDI inflows to countries, the KAOPEN does not seem to reflect the practice of foreign investors' behaviour.

In Figure 1 we present the inflation rate in the analysed countries. The figure is accompanied by Table 2 presenting the inflation rate data over the years 2010-2019, the average and standard deviation in that period.

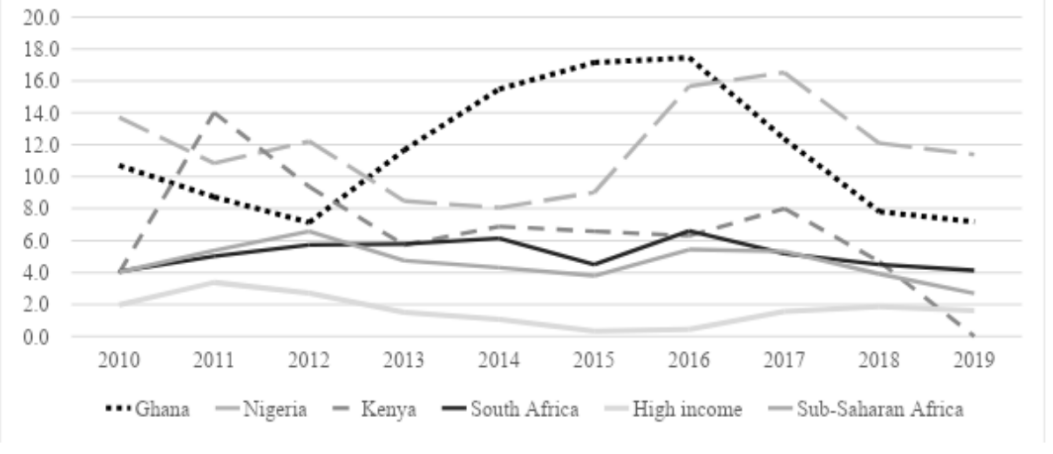

Figure 1 Yearly inflation rate (CPI) in \% in the analysed countries over the period 2010 - 2019
Source: own elaboration based on World Development Indicators, 2021.

Next, we classify our countries depending on inflation level and capital access barriers (See Table 3). Our sample comprises countries with moderate and high inflation and capital openness characteristics. Apart from that, we note that South Africa has the most stable inflation rate, whereas Ghana has the most volatile one (see Table 2).

3.2 Bitcoin Trade in The Analysed Economies – Local Bitcoin Platform

Figure 2 presents the volume of bitcoin trade in local currencies in the LocalBitcoins platform. Trade volume can approximate liquidity in the market as well as the interest in such forms of investment.

Table 2. Yearly inflation rate (CPI) in % in the analysed countries

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	M	SD
G	10,7	8,7	7,1	11,7	15,5	17,1	17,5	12,4	7,8	7,2	11,6	4,0
N	13,7	10,8	12,2	8,5	8,1	9,0	15,7	16,5	12,1	11,4	11,8	2,9
K	4,0	14,0	9,4	5,7	6,9	6,6	6,3	8,0	4,7	..	7,3	3,0
SA	4,1	5,0	5,7	5,8	6,1	4,5	6,6	5,2	4,5	4,1	5,2	0,9

Abbreviations: G-Ghana, N-Nigeria, K – Kenya, SA - South Africa; M – mean value, SD – standard deviation for years 2010-2019.
Source: own elaboration based on World Development Indicators, 2021.

Table 3. Yearly inflation rate (CPI) in % in the analysed countries

	Financial openness (KAOPEN): barriers to access capital:	
Inflation rate:	**Moderate**	**High**
Moderate	Kenya	South Africa
High	Nigeria	Ghana

Data reveals that Bitcoin gained the most popularity in South Africa, Nigeria and Kenya, which supports the literature review results. In the case of South Africa, where the rand is one of the most volatile currencies in the World, the use of cryptocurrencies is endorsed by the authorities. In the case of Ghana, we observe a gradual increase in interest.

Also, as Pieters (2016) notes, bitcoin measures of trade volume are misleading because a bitcoin is highly (infinitely) divisible: the smallest bitcoin unit is the bitcoin-Satoshi, which equals 10-9 bitcoin (a hundred-millionth of a bitcoin). Therefore, a trading volume of "1 bitcoin" could indicate a hundred million trades, especially in low-income countries, while the bitcoin trade is most popular among individual investors with small capital.

That may explain the case of Ghana, which – as stated in the Introduction – is a country where already 7% of citizens owe cryptocurrencies (which is higher than the world average). Such high interest is not visible in Figure 2, which presents only the value of volume. Another explanation for the numbers in Ghana may be that LocalBitcoin is not the country's most popular platform for cryptocurrency trade. Many Ghanaians use Coinmama and Kraken and most recently migrated to Paxful, which now took over 90% of the Ghanaian bitcoin trade, according to Matt Ahlborg on https://coingape.com.

For comparison, in Figure 3, we present the volume of bitcoin trade in US dollars (left pane) and EUR (right pane) on the same exchange, LocalBitcoins. The popularity of the BTC-USD trade diminished drastically from 2015 to 2019. This trend is similar to the South African rand. However, the scale of trade in rands is still considerably lower. The change of interest in the Euro-trade is less visible.

Nevertheless, one observed a peak of interest in the first half of 2018, which followed the increase of the bitcoin price in the second half of 2017. However, it should be noted that LocalBitcoins, a company registered in Finland, introduced the AML and KYC restrictions on user identification worldwide in 2019, which caused a drop in bitcoin trade volume. However, trade volume on other platforms like Luno and Paxful increases. In terms of prices in the studied period, the peak noted in 2018 was recently doubled. The strike of COVID-19 first hit bitcoin prices down in the first quarter of the year, but then it started bouncing back, attracting more users and sharply increasing prices (cf Luno Exchange data). The number of traders willing to pay above-market rates for Bitcoin increased in South Africa by 2% above market, in Nigeria by 15%, in Kenya by 7%, and in Ghana by 1% (https://www.estate-living.co.za/news/has-the-covid-19-pandemic-affected-the-cryptocurrency-market/). That is explainable by the fact that in the crisis, in developing markets

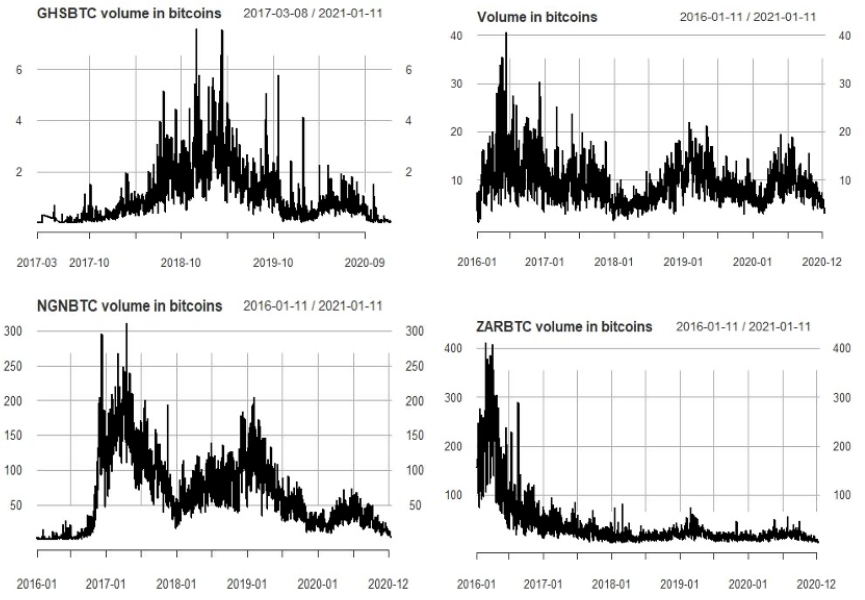

Figure 2 Volume of trade of bitcoin in local currencies in the analysed periods
Note: The order of figures:, Ghana, Kenya, Nigeria, South Africa.

with inflation problems and the risk of economic turmoil, people may turn to assets unrelated to their economies and geographic aspects.

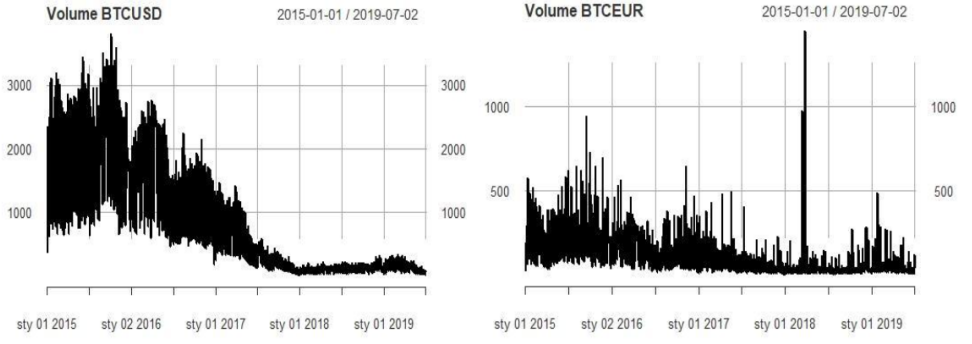

Figure 3. Volume of bitcoin trade in USD (left pane) and euro (right pane) in LocalBitcoins over the period 2015-2019

Table 4 presents the basic descriptive statistics of the bitcoin returns and standard deviation in respective markets. That supports the observations typical to traditional markets that liquidity is associated with risk (measured by volatility). Respectively, the lowest volatility (measured by standard deviation) was detected in Kenya, South Africa and Nigeria, with the highest volume in bitcoin trade. When we compare the periods: before and after 2019, we observe that bitcoin volatility did not change much within the markets. Contrariwise, the means of the returns have grown. That suggests that the crisis driven by COVID-19 could have presented an opportunity to profit from cryptocurrency trade. While the means of the return were quite diversified in the sample countries in the first period, they seem to be very similar recently. Notably, in Ghana, the means of return

Table 4. Mean and standard deviation of bitcoin log- returns in local currency and in analysed periods – LocalBitcoins

	Period 1:			Period 2: 2019-2020	
Country	**Time frame of Period 1**	**Mean of BTC returns in local currency**	**Standard deviation of BTC returns in local currency**	**Mean of BTC returns in local currency**	**Standard deviation of BTC returns in local currency**
Ghana	02.08.2017-01.01.2019	0.026	5.428	0.561	5.166
Kenya	27.05-2015 -01.01.2019	0.224	3.835	0.549	3.981
Nigeria	09.05.2017-01.01.2019	0.115	4.373	0.599	4.095
South Africa	01.01.2015-01.01.2019	0.192	4.312	0.541	4.179

Note: In the table, we present the basic descriptive statistics of the bitcoin log-returns and standard deviation in respective markets in two analysed subperiods. The length and time span of the Period 1 differs from country to country, depending on data availability.

grew significantly while volatility slightly decreased, which could suggest that the market gained more stability. It is also consistent with the assumption that the pandemic could have moved trade to cashless transactions. The pandemic could have created an additional incentive for the African countries to intensify priorly existing interest in using cryptocurrencies. The links between COVID and cryptocurrencies are also suggested by research (Demir et al., 2020).

4. Results

As an opening step of the research, we derive the EUR-USD rate from LocalBitcoins bitcoin price and, based on it, we construct the "natural" markup of LocalBitcoins. Next, we calculate the bitcoin-derived exchange rates of all the remaining currencies. We test the cointegration relationship in EUR-USD rates and, consecutively, the long-run relationships between the remaining official and bitcoin-derived exchange rates. We show that in high-inflation economies, such relationships may not be present. Eventually, we calculate the mark-ups for the African currencies, adjust them for the EURUSD markup and verify whether the value of the markup is related to the inflation level. Eventually, we discuss the possible role of Bitcoin in the studied economies.

4.1 Official and Bitcoin-derived Exchange Rates

Figure 4 presents the discrepancies between the official and bitcoin-derived EUR-USD exchange rates. We observe that the official rate was systematically higher than the Bitcoin-derived one. Our results show that for the years: 2015, 2016, and 2017 the average deviation oscillated around -8 to -9 %, while in 2018, to -7.5%. This outcome is similar to the results of Pieters (2016). Her results for the years 2014-2015 revealed an average deviation of -7% in the LocalBitcoins exchange. In 2019-2020 the average deviation amounted to -2.33%.

Figure 5 presents the official (black) and bitcoin-derived exchange rates for the analysed African countries in the two sub-periods. In the case of South Africa, the official and bitcoin-derived exchange rates were almost the same. One could have exchanged rand for US dollars directly or via the bitcoin-trading platform and pay approximately the same amount of rands for 1 US dollar (minus the manipulation price). On the contrary, in the case of Ghana, Nigeria and Kenya, one can find huge discrepancies between the two rates. For Ghana and Nigeria, the long-run relationship between the two rates has not been present in the first period. In the second one, the official rate seemed to draw a trend for the bitcoin-derived one.

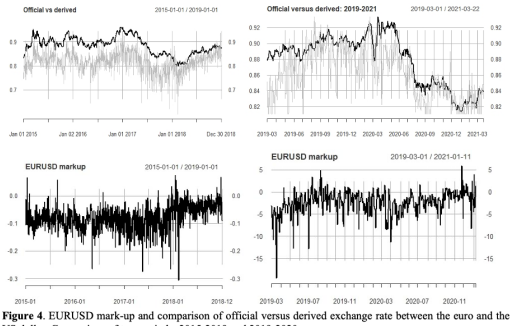

Figure 4. EURUSD mark-up and comparison of official versus derived exchange rate between the euro and the US dollar. Comparison of two periods: 2015-2019 and 2019-2020

Nevertheless, especially in Nigeria, the discrepancies were high. In most of the sub-periods, the value of 1 USD was higher according to the official exchange rate than the bitcoin-derived one. Such a situation is profitable for citizens who can use Bitcoin platforms to obtain dollars cheaper than in an official way. Yet, in Nigeria, starting from March 2020, the official rate was lower than the bitcoin-derived one. That could have been the effect of the very high and growing inflation rate. A similar pattern was observed in Ghana in 2017 when the inflation rate reached 12% (but was already dropping from 17% in 2016 – see Table 2). Of course, there are some conversion costs that the user has to cover. Therefore we get a clearer picture when we analyse the values of the mark-ups (Section 5.3).

4.2 Analysis of Common Trends Between the Official and Bitcoin-Derived Rates in Africa

In the next step of our analysis, we look for the long-run relationships between the official and bitcoin-derived exchange rates. We start with testing the long-run relationships between EUR-USD exchange rates. Based on the data presented in Figure 4, we can see that the bitcoin-derived exchange rate is lower, which explains the negative markup obtained for this currency pair. Based on the results of the KPSS test, we reject the null hypothesis of the stationarity of both series. In contrast, the ADF test does not allow us to reject the null hypothesis of non-stationarity. Based on the Johanssen cointegration test (also supported by the ARDL analysis), we derived the long-term relationship in the following form:

$$E_t^{B,EUR} = 0.593 \cdot E_t^{B,EUR}$$

- for the period ending up in 2019

$$E_t^{B,EUR} = 0.796 \cdot E_t^{B,EUR}$$

- for the period 2019-2020

That implies that LocalBitcoin's trend is to increase by 59 cents for every dollar increase in the official exchange rate in the first period while by 80 in the second. The result denotes a long-run divergence of the trends and is consistent with the finding of Pieters (2016). The author shows that exchanges exist where the coefficient equals 1 (e.g. ANXBTC), which denotes that the trends are ideally shared. The author explains the deviations with the market-specific factors (such as liquidity issues). Pieters and Vivanco (2017) and Matkovskyy (2019) also show that LocalBitcoins has more substantial price volatility than other exchanges meaning that the price of Bitcoin varies daily by a high degree.

This distinct behaviour of the bitcoin price may stem from the fact that LocalBitcoins is a decentralized peer-to-peer exchange. Users post advertisements on the website, stating exchange rates and payment methods for buying or selling bitcoins. Other users reply to these advertisements

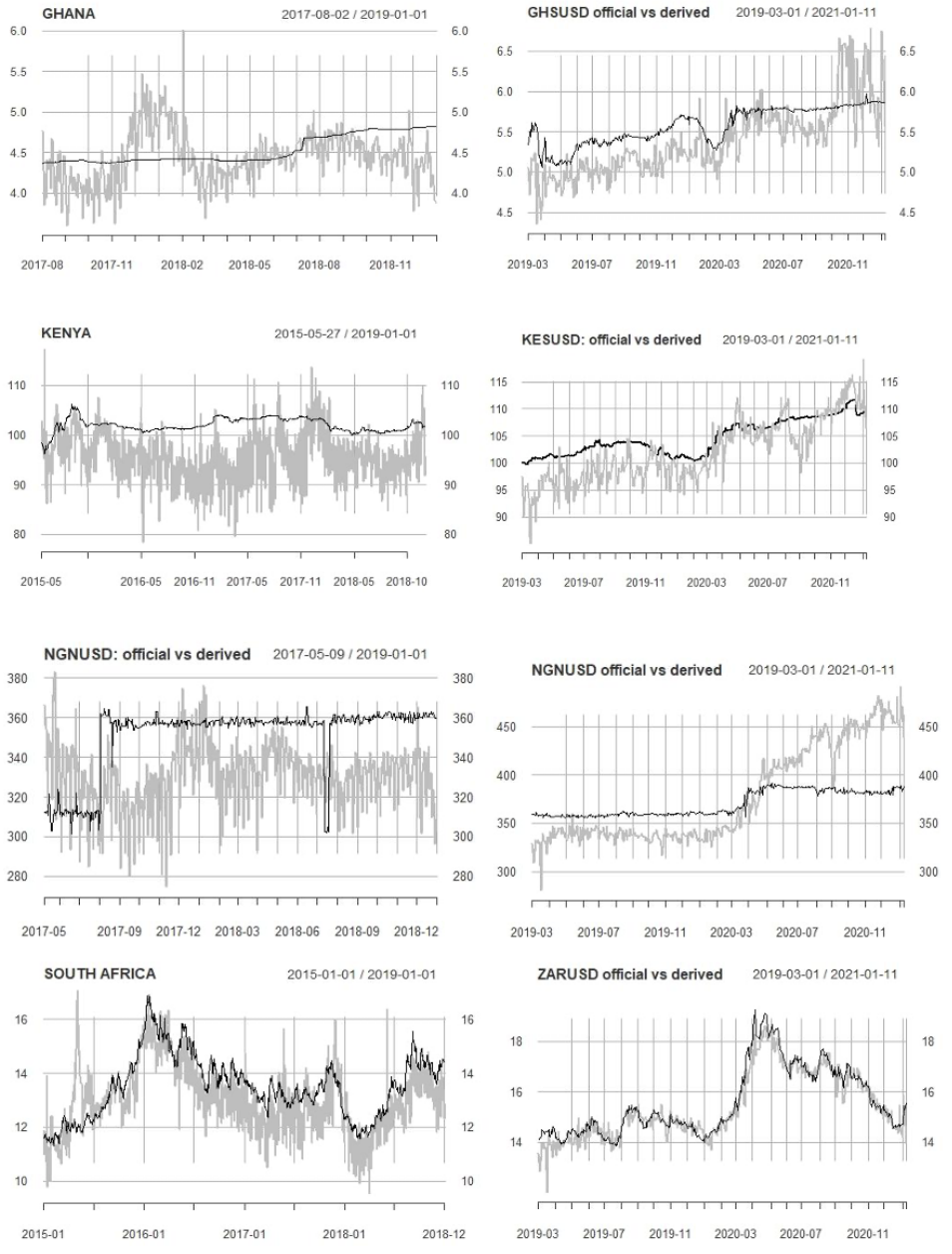

Figure 5. Official versus bitcoin-derived exchange rates
Note: The order of figures: Egypt, Ghana, Kenya, Morocco, Nigeria, South Africa, Zambia.

and make the payment in their specified payment method. That feature and the slower increase of the bitcoin-derived exchange rate than the official one creates an additional opportunity for speculation. We observe that these opportunities decreased starting from 2019, possibly due to the change of anonymity conditions because of the European Union's 5th Anti-Money Laundering Directive, which came into effect on March 18th, 2019.

Next, we tested for the existence of the long-run relationships between the two types of exchange rates in African economies. As in all the cases, the KPSS-ADF testing technique did not allow us to formulate unanimous conclusions about the stationarity of at least one tested pair. We used the bound test and ARDL model to verify the possible long-run relationship between the series. If the series appeared cointegrated, we computed the coefficient – of long-run relationships between the pairs. Next, following Pieters (2016), we confront it with the KAOPEN index value. The results are presented in Table 6.

Table 6. Test for the existence of common trends between bitcoin-derived and official exchange rates

	Period 1		**Period 2**	
Country:	Cointegration	β	Cointegration	β_1
KAOPEN: Countries with high barriers				
Ghana	N	-	Y	0.672
South Africa	Y	**1.225**	Y	1.08
KAOPEN: Countries with moderate barriers				
Kenya	Y	**1.103**	Y	0.66
Nigeria	N	-	Y	0.24

Note: In the table, we present the results of the bound test of Pesaran et al. (2001) for the existence of common trends between bitcoin-derived and official exchange rates. "Y" and "N" in columns: Cointegration denote whether cointegration was present in the data (Y denotes that the long-run relationship was present, while N- that the respective hypothesis was rejected). If the cointegration was present in the data, we estimated the coefficient β of equation (2).

We can see a clear difference between the two analysed periods. In the first one, the long-run relationships between the official and bitcoin-derived exchange rates existed in the case of South Africa and Kenya. The rates do not follow the same trend in the remaining cases of Ghana and Nigeria (both classified as high-inflation countries, see Tab. 3). On the contrary, in the second period, 2019-2021, the long-run relationship was present in all the cases. Moreover, the parameter beta decreased to 1.08 in the case of South Africa and 0.66 in the case of Kenya. In the case of Nigeria, it amounted only to 0.24, which means that the LocalBitcoin trend was to increase by 24 cents for every unit increase in the official exchange rate.

These results support the hypothesis that the pandemic intensified Bitcoin's presence in the studied African economies. There is also evidence of growing interest in bitcoins for investment and storing value, to mitigate local turmoil risks, and to support business and daily activities and money transfers inside and outside the economy. On the other hand, the results do not support the conclusion that the relationship between the bitcoin-derived and the official exchange rates is related to the KAOPEN value or the de facto inflow of foreign capital. Instead, we can suspect that inflation plays a crucial role here. The long-run relationships seem to break down when inflation increases enormously (Ghana and Nigeria in the first sub-period). To verify this hypothesis, we decided to analyse the mark-ups obtained for each exchange rate and the respective country's inflation level.

4.3 Mark-Up-Corrected Deviation From The Official Exchange Rates

The analysis of markup reveals that the de facto exchange rate also deviates from the official exchange rate in African countries. In Figure 5, we present the changes in the adjusted markup over time. In the first period, the mark-ups of GHSUSD and NGNUSD behaved somewhat erratically and changed from -10 to even 40%. The mark-ups of KESUSD and ZARUSD oscillated over values -10 to 10. However, outliers were also present in the series – e.g. in 2015 in the case of ZARUSD. When it comes to the second sub-period, which also covered the COVID outbreak, we can see an evident change of trend in NGNUSD starting from March 2020. The NGNUSD markup started to grow steadily since that moment. There is also a clear outlier in the KESUSD markup series dated March 2020. We find no apparent reaction to COVID-outbreak can in the ZARUSD markup. GHSUSD markup seems to have changed its nature more at the end of 2020 than in March.[4]

Table 5. Existence of mark-up and adjusted mark-up in bitcoin-derived exchange rates for selected African economies

	Period 1			Period 2: 2019-2020	
Country	**Time span of Period 1**	**Mark-up**	**Adjusted mark-up**	**Mark-up**	**Adjusted mark-up**
Ghana	02.08.2017-01.01.2019	-1.92\%	3.31\%	-3.74\%	-1.39\%
Kenya	27.05-2015-01.01.2019	-5.97\%	2.17\%	-2.51\%	-0.16\%
Nigeria	09.05.2017-01.01.2019	-5.65\%	0.09\%	1.90\%	4.28\%
South Africa	01.01.2015-01.01.2019	-3.05\%	4.45\%	-0.91\%	1.45\%

Note: In the table, we present the average value of the mark-up (eq. 5) and adjusted mark-up (eq. 6) in the analysed periods. The time span in the first sub-period for each country depends on the data availability and hence varies in the sample. The non-zero value of the markup denotes the possibility to earn extra profit through converting local currency to dollars (or vice versa) using the Bitcoin platform, instead of the official exchange rate. Secondly, it shows the discrepancy between the official rate and the market one, suggesting the existence of the black-market exchange rate. It also suggests that in such a situation, people may prefer to locate their wealth in Bitcoin, which may be still perceived as safer than the high inflation-driven local currency.

Table 5 presents the average markup value in the analysed periods. The time span in the first sub-period for each country depends on the data availability and hence varies in the sample. We can observe that in the first period, in all the cases, the markup was negative. However, after the correction by the market-specific markup (the EUR-USD one), we obtain high and positive markups for all the countries. In the second sub-period, the adjusted mark-ups became negative in Ghana and Kenya.

In the first period, we observed the highest adjusted markup for South Africa: 4.45%, then for Ghana: 3.31%, for Kenya: 2.17%, and for Nigeria, only 0.09%. The situation changed in the second period when the highest adjusted markup was found for Nigeria: 4.28%. It appears that the pandemic opened the opportunity for businesses in Africa to escape the risks related to business payments to suppliers, particularly from China. According to Reuters (2020), monthly cryptocurrency transfers to and from Africa made by individuals and small businesses (under $10,000) increased by over 55% in a year and reached $316 million in June 2020 (Chainalysis, 2021). Also, the number of transfer

4. Interestingly, this probably should not be related to actual COVID country-specific situations but to the general World COVID information outbreak. The data on new cases and deaths in the studied countries does not align with the mark-up peaks (June and December for Ghana, Nigeria and South Africa; August, November, and March for Kenya) (https://github.com/CSSEGISandData/COVID-19). That implies the effect of the World information over country information impact on the market behaviours, which is also supported by the data on the highest interest for the "COVID-19" phrase search by Google Trends in March 2020 (Google Trend, 2021 verified 24.03.2021). That, however, is a topic that would require further investigation.

transactions rose by almost half, surpassing 600,700, according to Chainalysis data. The portal notes that this activity rise was noticeable in Nigeria, South Africa and Kenya. That may be the evidence of money-like, not purely investment, use of Bitcoin in the studied region.

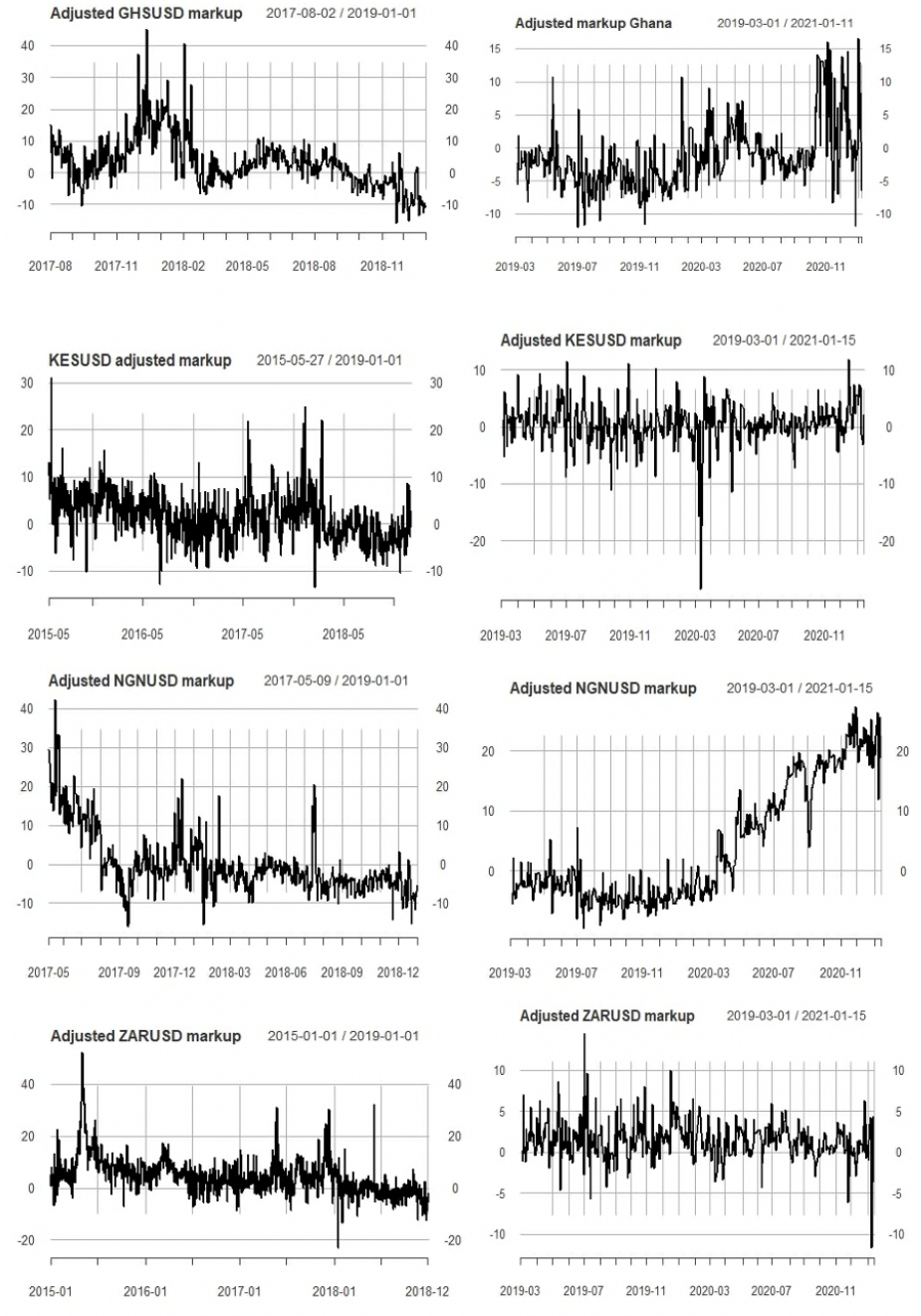

Figure 5 Adjusted mark-up computed for the analysed exchange rates (in percentage points)
Note: The order of figures: Ghana, Kenya, Nigeria, South Africa.

Analysing Figure 5, we notice that the adjusted markup values are higher for countries classified as high-inflation ones. Therefore, we ran a simple Kendall test to verify the correlation between the adjusted mark-ups and inflation level. Table 6 presents the results. We note that all the values are positive – except for South Africa in both periods and Kenya in period 2, where the values are insignificantly different from 0. We can conclude that the relationship is present in the high-inflation period, while it ceases with the decline of inflation. Such a result supports the findings of Johnson, who analysed the bitcoin-derived exchange rate in Venezuela. It is also consistent with the conclusions of Naryan et al. (2019), who documented a relationship between the bitcoin price growth and inflation in Indonesia.

4.4 Role of Bitcoin in Economies Under Crisis

Table 6 presents the difference between the official and bitcoin-derived exchange rates. Pieters (2016) claimed that the existence of the long-run relationship between the official and bitcoin-derived rate depends on the degree of the openness of the economy to capital. In the previous paragraphs, we showed that long-run relationships exist in countries with high (South Africa) and moderate (Kenya) barriers to capital access and relatively low inflation.

According to our results, the role of bitcoins in the African countries' economies depends neither on the exchange rate type nor the volume of bitcoin transactions, the openness to capital, market liquidity and even not by the legal framework (in some African countries, investors trade cryptocurrencies despite the official ban). As further discussed, in the analysed cases, bitcoin trade adjusts to the specifics of the economy – in particular, to the inflation rate.

Table 6: Values of Kendall's Tau Between The Adjusted Mark-up and Inflation in Two Subperiods

	Period 1	Period 2
Kenya	0.207 (0.039)	0.127 (0.412)
Nigeria	0.526 (0.001)	0.743 (<0.001)
Ghana	0.556 (0.001)	0.363 (0.025)
South Africa	0.075 (0.45)	0.171 (0.291)

Note: p-values in brackets

We can suspect that Bitcoin can play a role of a complementary means of exchange and storage of value in these countries – as in Venezuela (Johnson, 2019). That can be supported by the fact mentioned above that the use of cryptocurrencies by individuals in Ghana and Nigeria is above the World average (see the Introduction). We notice that the low volume of bitcoin trade in Ghana is consequently growing (Figure 2) and shifting to Paxful, which we do not detect, suggesting that the citizens discover the additional possibilities of its use. The high popularity of Bitcoin in Nigeria suggests that Nigerians already use it to remedy the growing inflation rate. The lack of integration of bitcoin-derived with the official rate suggests that the black market for currency is present in this country. The lack of integration between the bitcoin-derived and the official rate may also suggest the inefficiency of the foreign exchange market (see, e.g. Bahmani-Oskooee and Tanku, 2006).

5. Conclusion

Our study was motivated by the works of scholars analysing Bitcoin's role in crisis-driven economies (e.g. Venezuela). They pointed out that in countries of extreme hyperinflation, investing in Bitcoin can be less risky than storing value in domestic money and more available for the citizens than seeking traditional safe-haven assets. We were also inspired by the paper of Pieters (2016), who showed how Bitcoin could be used to calculate the de-facto exchange rate.

We analysed the bitcoin trade in Ghana, Kenya, Nigeria, and South Africa, which are different economies, but all score relatively high in terms of crypto-assets possession by individuals. The set of

countries comprises two with very high inflation rates (Ghana and Nigeria). We show that in 2016–2019, the bitcoin-derived exchange rate was so diverse from the official one in these countries that it is impossible to establish a long-run relationship between them. However, in 2019–2021, covering pandemic-related economic turmoil, we detected long-run relationships in all four economies. Our study impugns the findings of Pieters (2016), who claimed that this is a sign of high barriers to accessing capital. Instead, we suggest that it is inflation that makes them diverse.

We claim that individuals in Ghana, Kenya, Nigeria, and South Africa noticed the opportunity to store value in bitcoins. The growing value of the bitcoin trade volume in these countries and the increasing share of individuals owning cryptocurrencies support that belief. The interest in Bitcoin (measured by the trade volume) was the highest in South Africa, the most technologically advanced sub-Saharan economy. However, we also notice a growing interest in using cryptocurrency in Nigeria. Cryptocurrencies allow one to profit from the difference between the official and the black-market exchange rate and mitigate the risk of high inflation in trade. That is why Nigerian firms started using bitcoins to pay their suppliers. Hence, we also note the growing interest in the money-like use of cryptocurrency in some African countries. Our results suggest that the pandemic contributed to the growth of interest in cryptocurrencies and their use in transactions.

Based on the results of our study, we can say that bitcoin (cryptocurrencies) application in African countries is both investment (including speculation, as in mature economies) and an alternative way to store value when inflation gets too high. It is noticeable that in Africa, there is a strong demand for non-formal and cheap financial services, including storage and transfer of value, especially in the case of countries with the high inflation rate and limited trust in local currency (Świerczyńska, 2019). Moreover, African markets have already proven "social capability" (Abramovitz, 1986) to absorb technology by leapfrogging in the case of the mobile phone market. That makes the region exceptional in terms of Bitcoin use compared to others, especially the majority of high-income countries. The limitation of the research is the size of the countries in the sample; hence it may be specified that the results relate to the countries in the region of sub-Saharan Africa, which are middle-income, represent relatively high cellular penetration rates (over 88%) and cryptocurrencies possession among individuals. Further research should seek to test our hypothesis on a larger sample, which is restrained by the current data availability on cryptocurrencies, allowing cross-country comparisons for the region.

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