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The Economics contribution of Cryptocurrencies: A Portfolio Analysis in Cameroon

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Abstract :

This paper investigates the economic contribution of cryptocurrencies, notably bitcoins, in ameliorating the portfolio of a Cameroonian investor in international assets. The methods used are simple correlation, the dynamic conditional correlation of the MGARCH family as well as comparative analysis of portfolios based on the Markowitz modern portfolio theory. The results show that cryptomonaries/bitcoins remain good diversification tools, as their inclusion tends to improve the efficiency of a portfolio's border due to their very low correlation with other financial assets.

Keywords: Cryptocurrencies; Bitcoins; Portfolio; Cameroon.
Jel Classification Codes: C15, F21, G11

خلاصة :

تحقق هذه الورقة في المساهمة الاقتصادية للعملات غير المشفرة، ولا سيما العملة المعدنية، في تحسين حافظة المستثمر الكاميروني في الأصول الدولية .والأساليب المستخدمة هي ترابط بسيط، والعلاقة المشروطة الديناميكية لأسرة شركة ماغارش، فضلا عن التحليل المقارن للمحافظ استنادا إلى نظرية حافظة الأوراق المالية الحديثة في ماركويتز .وتظهر النتائج أن العملات المخفية/البيتونتين تظل أدوات جيدة للتنويع، لأن إدراجها يميل إلى تحسين كفاءة حدود حافظة الأوراق المالية نظرا لترابطها الشديد مع الأصول المالية الأخرى.

الكلمات الأساسية :العملات المشفرة؛ العملة المعدنية؛ الحافظة؛ الكاميرون.
رموز تصنيف جيل : C15, F21, G11

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1. INTRODUCTION

Ever since its introduction on the 1st January 2009 by Satoshi Nakamoto, cryptocurrencies and bitcoins, have been gaining grounds in the financial landscape as revolutionary means of payment and finance. Christine LAGARDE (2018) declared how the Financial Stability Board (FSB), was studying ways to monitor the growth of crypto assets with an eye towards identifying emerging threats to stability. In March 2018, the G20 agreed with the FSB's assessment that cryptocurrencies do not currently pose a threat to stability, but may do so at some point in time in the future, and also pointed out that these institutions agreed to continue further research on cryptocurrencies. The impact of cryptocurrencies has also been growing timidly over the years in other economies. A precise timestamp cannot mark the introduction of cryptocurrencies/bitcoins in Cameroon. However, its presence has been increasingly felt since the proliferation of Multi-Level Marketing (MLM) in late 2016. Many Cameroonians are being exposed to MLM, Ponzi and pyramiding schemes such as Mize, Origin Unite, Q-net, as well as many MLM schemes with bitcoins as their main underlying asset such as Bitconnect, Bitclub, Bitworld, etc. The increasing crackdown by the Cameroonian government of these fraudulent businesses as demonstrated by the closing down of the huge and popular MIDA Ponzi scheme (banned in 2018) and many others has made the public to develop a negative opinion about, not only quick money-making businesses but also bitcoins. Many people see bitcoins as a fraudulent and mysterious currency largely used as a vehicle for scamming, defrauding honest citizens and promoting illegal dealings. Kajatzi and Moro (2017) relay such sentiment as they point out how for most ordinary people, cryptocurrencies/bitcoins remain a mystery: an intangible and difficult to understand currency with little or no use in the real economy.

We are then faced with a problem where cryptocurrencies are gaining more attention from the international community by virtue of their potentials in technology, finance and exchanges in the real economy, while they face a great resistance in Cameroon.

The main objective of this paper is to evaluate the economic contribution of cryptocurrencies as an innovative tool of finance in Cameroon. Specifically, we are: 1-analysing the correlation between cryptocurrencies and other financial assets and 2- the contribution of cryptocurrencies to portfolio management. The following research questions were developed: 1-Which assets strongly or weakly correlate with bitcoins? 2- Do cryptocurrencies improve the efficiency of a portfolio? This leads to the formulation of the following hypothesis: 1- Bitcoins are weakly correlated to other financial assets. 2- The inclusion of bitcoins in a portfolio is likely to improve the efficiency of the portfolio.

2. Literature Review

2.1 Definition of Terms:

a. Cryptocurrencies: In a 2012 report on Virtual Currency Schemes, cryptocurrencies are defined as a form of unregulated digital money, usually issued and controlled by its developers, used and accepted among the members of a specific virtual community. The International Monetary Fund ("**IMF**") has categorised cryptocurrencies as a subset of virtual currencies, which it defines as digital representations of value, issued by private developers and denominated in their own unit of account. The European Banking Authority ("**EBA**") refers cryptocurrencies as virtual currencies, which it defines as digital representations of value that are neither issued by a central bank or public authority nor necessarily attached to a fiat currency but are used by natural or legal persons as a means of exchange and can be transferred, stored or traded electronically. As of 27 June 2017, 787 cryptocurrencies and 135

crypto-tokens have been launched and traded with a total market capitalisation of over US$98 Billion.

b. Bitcoins: Dimpfl (2017), Bitcoin is a cryptocurrency with no central monetary authority, country of origin, or physical representation, designed and created by the entity Nakamoto Satoshi (2008). He points to the fact that the market capitalization of Bitcoin more than doubled in 2016, increasing from 6.5 billion USD on 31 December 2015 to 15.5 billion USD on 31 December 2016. While Osterrieder, Chan, Chu, Nadarjah, (2017) point out that since 2009, numerous cryptocurrencies have been developed, with, as of February 2017, 720 in existence. Bitcoin is the largest and most popular representing over 81% of the total market of cryptocurrencies (CoinMarketCap, 2017). For this study, the term bitcoins shall be employed interchangeably with cryptocurrencies to mean the same thing.

c. Blockchain: Blockchain is a mechanism that employs an encryption method known as cryptography and uses (a set of) specific mathematical algorithms to create and verify a continuously growing data structure. He can takes the form of a chain of "transaction blocks", which functions as a distributed ledger (H. Natarajan, 2017).

d. Bitcoin Mining: Mining is the integral process wherein generation, transmission and validation of transactions of cryptocurrencies are done. The main purpose of mining is to generate and release new coins into the coin economy. Whenever a transaction takes place, miners validate them by including them into the block they are currently solving (Krishnan, Saketh and Vaibhav, 2015).

e. Portfolio: A Portfolio is an appropriate mix of or collection of investments held by an institution or a private individual. (Bogdan Bilaus, 2010) Portfolio management is the art and science of making decisions about investment mix and policy, matching investments to objectives, asset allocation for individuals and

institutions, and balancing risk versus performance.

f. Multi-Level-Marketing (MLM): Is a marketing strategy in which the sales force is compensated not only for sales they personally generate but also for the sales of others they recruit, creating a down line of distributors and a hierarchy of multiple levels of compensation.

2.2 Relationship between the terms.

A plethora of cryptocurrencies exists in international cyberspace, with bitcoins being the most popular. Bitcoins use the blockchain technology to maintain its feature of a fully decentralised currency without any central bank control over it. However, to maintain its supply and ensure that it remains sufficiently scarce, new bitcoins are injected in circulation only after a series of increasingly difficult computer algorithmic problems are resolved through what is called bitcoin mining. The demand and supply of bitcoins over the past years has given bitcoins an exceptional value. A value which has pushed many opportunists to exploit cryptocurrencies for hacking as well as for scamming the public into get-rich-quick money-making businesses. A value which has also enticed scholars from different fields to research on the properties of the cryptocurrencies. An important property which bitcoins and cryptocurrencies in general revealed to possess is their low correlation in relation to other financial assets. Poorly correlated assets stand as a cornerstone of the Modern Portfolio Theory which is widely utilised in finance. The more assets in a portfolio are poorly correlated, the more efficient the portfolio becomes in the form of better risk-reward ratio. . Financiers consequently seek to exploit this low correlation property that bitcoins have to investigate if they can benefit from them with the aim of optimizing the gains derived from their portfolios.

2.3 Evolution of cryptocurrencies and Bitcoins transaction

Raskin and Yermack (2016) recount how in a videotaped 1999

interview, Friedman seemed to anticipate the arrival of bitcoin ten years later when he stated, "I think that the Internet is going to be one of the major forces for reducing the role of government . . . The one thing that's missing, but that will soon be developed, is a reliable e-cash". They shed more light on what most observers consider as the first private digital currency to establish itself as a medium of exchange in the real economy: the M-Pesa, a currency denominated in mobile phone unit which was launched in Kenya by Safaricom in 2007. In 2008, Nakamoto Satoshi created the first bitcoin.

Bouveret Antoine (2018) showed how transactions involving bitcoins are done via two cryptographic keys. That is, the holder of bitcoins have one public key which is like a bank account number to send and receive bitcoins and a private key which is required to complete a transaction and eventually submit it for validation. To ensure that the same cryptocurrency is not spent twice, each member of the network verifies and validates transactions using technologies derived from cryptography. At the end of the transaction, the network members who verify and validate the transactions are usually rewarded with newly minted bitcoins. A detailed explanation of the functioning of bitcoins is beyond the scope of this paper. However, some in-depth explanations can be gotten from appendices in Catalini and Gans (2017) explaining: What is a Blockchain?, Proof of Work and Mining, Permissionless versus Permissioned Blockchains and Privacy of Transactions, Types of Transactions Enabled by Blockchain Technology, etc.

2.4 Statistical properties of bitcoins

Shi, Chen, Wolfgang, Lee and Bobby Ong (2016) Proceeded with an econometric analysis of the dynamics of cryptocurrencies returns by exploring volatility modelling, option pricing, and forecasting. According to Dr. Kasper (2017), bitcoin volatility is known to be high, as he compared it to that of several currencies and assets like stocks, gold, etc. Leopoldo, Catania, and Grassi

(2017) concentrated on the dynamic properties of cryptocurrencies financial time series and not on their unconditional distribution as in previous studies, see Chu et al. (2015). Moreover, they investigated a larger set of cryptocurrencies that had not been done yet. Ardia (2018) shows how Phillip et al. (2018) use a stochastic volatility model to also find evidence of long-term memory in the volatility dynamics. They also use specifications which can account for structural breaks in GARCH, namely Markov switching GARCH models, to show that Bitcoin daily log returns indeed exhibit regime changes in their volatility dynamics. Bueno, Fortes, and Vlachoski (2017) in their paper investigate the empirical distribution of the Bitcoin exchange rate returns by using four types of widely-used heavy-tailed distribution and show that the Skewed t-distribution has the best empirical performance.

2.5 Bitcoin pricing and the detection of equilibrium exchange rate

Yang and Kim (2015) analyse a comprehensive bitcoin transaction dataset and investigate the interrelationship between the flow of bitcoin transactions and its price movement. Pieters (2016) demonstrate that internationally traded cryptocurrency can be used to detect both the existence and the magnitude of the distortion caused by capital controls and exchange rate manipulations. Lee, Chuen, Guo, and Wang (2017) results show that the correlations between the cryptocurrencies and traditional assets are low, and incorporation of CRIX index (an index of most prominent cryptocurrencies) will improve the performance of the portfolio that consists mainly of mainstream assets. Houy (2014) in his article led a study on the economics of bitcoin transaction fees by using a very simple partial equilibrium setting with a market for physical goods with bitcoins as a means of exchange. Adam Hayes (2014) aimed at identifying the likely source(s) of value that cryptocurrencies exhibit in the market place using cross-sectional empirical data

examining 66 of the most used cryptocurrencies.

2.6 Bitcoins Innovations in Finance and Cryptocurrencies in Cameroon

Kajtazi and Moro (2017) followed the approach of Brière et al. (2015), exploring the effect of bitcoins on the overall risk-return ratio of a portfolio of well-diversified assets. The authors, also hold that Bitcoin is theoretically disinflationary. Therefore, Bitcoin can act as an alternative to fiat currencies in fighting inflation. For Yermack (2013) bitcoin's daily exchange rates exhibit virtually zero correlation with widely used currencies and gold. Symitsi and Chalvatzis (2018) answer whether there is merit in introducing cryptocurrencies within portfolios of exchange rate, gold, oil, and stocks.

Following the 4th edition of the TRANSFORM AFRICA Summit in Kigali – Rwanda in 2018, the Cameroonian Minister of Post and telecommunications, made known the vision the government has on cryptocurrencies and their role in the digital economy to help bolster development.[1] The minister further hailed the importance of cryptocurrencies in an interview granted to Cameroon tribune by asserting that "cryptocurrencies can help solve our problems of development." Cameroonians also partakes in the creation of cryptocurrencies, contributing in increasing their total supply worldwide. The director general of PayKap on the 1st February 2018, put in circulation what is being qualified as the 1st Cameroonian cryptocurrency called Fricacoin (with abbreviation FRI). Its production is limited to 1 billion units and 1 million Fricacoins today is valued at about 10 Euros.

3. Research Data and Methodology

3.1 Data

The primary data was collected from respondents directly on the

[1] Transform Africa Summit, 7 – 10 May 2018 in Kigali Rwanda.
https://cameroon-report.com/economie/economie-numerique-le-cameroun-a-lhonneur-a-kigali/

field in 2018. It has 5 variables and 210 observations. For secondary data, first and foremost, the exchange rate of bitcoins against FCFA (BTCXAF). This is the key data to measure bitcoins ability in improving a portfolio. Then, international securities such as oil, gold and a number of prominent hard currencies like the US dollar (exchange rate of the US dollar, Euro and the Chinese Yuan with respect to the FCFA). These assets were selected as they represent major assets in international trade. Thus, the secondary data is a time-series data with 2145 observations of daily asset prices, spanning from 16/07/2010 to14/09/2018 and 6 variables presented in the form of Open, Close, High and Low prices. However, closed prices representing the last values of transactions at the end of each trading day shall be used. Also, log-returns of the variables are used to obtain the returns and variance of portfolios, given the different securities daily returns. Alain Ruttiens (2013) presents the computation of daily returns as:

$$return = log\left(\frac{Close\_Price_t}{Close\_Price_{t-1}}\right)$$

Also, in a bid to follow the standard practice in financial reporting, final results such as standard deviations and returns shall be annualised. Alain Ruttiens (2013) annualised returns calculation:

$$r_y = r_d \text{ x } n.$$

Where r_d represents daily returns and n = 250 days, being the number of trading days annually.

3.2 Methodology

To investigate Cameroonians perception of bitcoins, simple count and percentage comparisons supplemented by bar charts and pie charts shall be used on the primary data collected. To analyse

bitcoins contribution to portfolio, this research paper largely follows the methodology employed by Symitsi and Chalvatzis (2018). Both constant correlation and dynamic conditional correlation shall be conducted to measure the strength of the relationship between bitcoin and the other assets. Then the equal-weighted portfolio, the constrained global minimum variance portfolio strategies, as well as the Sharpe ratio shall be used to measure and compare the contribution of bitcoin in series of portfolios, with and without bitcoins.

3.2.1 Correlation coefficient and Dynamic Conditional Correlation

A correlation analysis is performed on the Bitcoin/FCFA against each security in the portfolio so as to measure the ability of the Bitcoin/FCFA to improve the risk-return of the portfolio from diversification. It is expected to be low according to literature review. The low correlation goes a long way to qualify the bitcoin as an asset very good for diversification since assets with low correlation in a portfolio have the tendency to reduce the risk of the portfolio. Given that interpreting the actual value of σ_{XY} is difficult, because X and Y may have different units of measurement, scaling the covariance by the standard deviations of the variables eliminates the units of measurement, which defines the correlation between X and Y:

$$\boldsymbol{\rho} = \frac{\mathbf{Cov(X,Y)}}{\left(\sqrt{\mathbf{Var(X)}}\right)\left(\sqrt{\mathbf{Var(Y)}}\right)}$$

Dynamic conditional correlation takes into account the dynamic time-series nature of the data. This technique has been applied by a number of authors in order to conduct a better analysis on portfolio management, notably Yilmaz T. (2010) and Symitsi and Konstantinos (2018).The dynamic conditional correlation (DCC) model proposed by Engle (2000) is used. Berg, Yanxiang, and Lien (2005) describe its procedure. They start by pointing out that the

DCC model is a multivariate GARCH (MGARCH) estimator with the following specification:

$$\boldsymbol{E_{t-1}(r_t r_t) = H_t = D_t R_t D_t} \qquad (1)$$

Where r_t is a $nx1$ vector of mean zero residuals obtained from the AR models and D_t is a diagonal matrix given by:

$$\boldsymbol{D_t = diag\left\{\sqrt{Er_{it}^2}\right\}} \qquad (2)$$

The steps for estimating the DCC are as follows:

Step 1: Estimate a univariate AR-GARCH(1,1) model of each variable.This produces consistent estimates of the time-varying variance (D_t) for the hedging instrument.

Step 2: Calculate the standardized residuals $\boldsymbol{\varepsilon_t = D_t^{-1} r_t}$, where r_t is the residual from the AR_GARCH model.

Step 3: Estimate an ARMA(1,1) model on $\boldsymbol{e_{i,j,t} = \varepsilon_{i,t}\varepsilon_{j,t}}$, $\boldsymbol{e_{i,j,t} = \varepsilon_{i,t}\varepsilon_{j,t}}$ and $\boldsymbol{e_{j,j,t} = \varepsilon_{,t}\varepsilon_{j,t}}$ jointly:

$$\boldsymbol{e_{i,j,t} = a_0 + a_1 e_{i,j,t-1} + u_t - \beta_1 u_{t-1}} \qquad (3)$$

The parameters for the covariance and variance processes are assumed to be the same. Thus the parameters in Equation 3 are estimated by stacking the variance and covariance series of $e_{i,i,t}$ together. Equation 3 is derived from the following GARCH(1,1) process of the covariance between instruments *i* and *j* :

$$\boldsymbol{q_{i,j,t} = \bar{\rho}_{i,j} + \alpha\left(e_{i,j,t-1} - \bar{\rho}_{i,j}\right) + \beta\left(q_{i,j,t-1} - \bar{\rho}_{i,j}\right)} \qquad (4)$$

Where $\boldsymbol{\bar{\rho}_{i,j} = a_0 /(1 - \alpha_1)}$, $\boldsymbol{a = a_1 - \beta_1}$ and $\boldsymbol{\beta = \beta_1}$

Step 4: Calculate the variances of instruments *i* and *j* and the covariance between them ($\boldsymbol{q_{i,j,t}}$).

Once the parameters in Equation 3 are estimated, one can calculate the covariance from Equation 4 using initial values of $\boldsymbol{q_{i,j,t}}$ set to $\boldsymbol{a_0 /(1 - \alpha_1)}$

Step 5: Calculate the correlation between instruments *i* and *j*

$$\boldsymbol{\rho_{i,j,t}} = \frac{\boldsymbol{q_{i,j,t}}}{\sqrt{\boldsymbol{q_{i,i,t}q_{j,j,t}}}} \qquad (5)$$

3.2.2 Portfolio return, variance, performance measures and Sharpe Ratio

Beste, Leventhal, Williams and Dr. Lu (2002) presented Markowitz portfolio return and variance calculations. Portfolio return is given as**:** $\mu_P = \sum_{i=1}^{n} x_i \cdot \mu_i$ where x_i represents the weights of each security on a proportional basis, and its sum must be equal to one. The variable μ_i represents the expected return on investment of the i^{th} security**.** The variance of the portfolio on its part is given as**:**

$\sigma^2 = \sum_{i=1}^{n} x_i^2 \cdot \sigma_i^2 + \sum_{i=1}^{n} \sum_{j<i} x_i x_j Cov(i,j)$

With $Cov(i,j)$ representing a measure of covariance between the i^{th} and the j^{th} asset.

Amenawo, Riman, and Eyoanwan (2016) as well as Alexander Kempf and Christoph Memmel (2006) show how to minimize the risk of a portfolio for a given level of return, as well as the resulting weights of each variable.

$$\boldsymbol{Min\ w'_t \sum_t w_t}$$

$$w_{MV} = \frac{\sum_t^{-1} I}{I' \sum_t^{-1} I}$$

$$\mu_{MV} = \mu' w_{MV} = \frac{\mu \sum_t^{-1} I}{I' \sum_t^{-1} I}$$

$$\sigma^2{}_{MV} = w'_{MV} \sum w_{MV} = \frac{1}{I' \sum_t^{-1} I}$$

s.t w'_tI = 1 and $w'_t \geq 0$

Where w_t is an $N \times 1$ vector of portfolio weights invested in each portfolio, $\sum_t w_t$ is the $N \times N$ covariance matrix and I is an $N \times 1$ vector of ones. w_{MV} is the weights of the global minimum variance

portfolio. The first constraint ensures that the sum of all weights is equal to one, while the second constraint ensures that the weights are all positive each. μ_{MV} and σ^2_{MV} both represent the return and variance of the global minimum variance portfolio.

According to Investopedia.com, the Sharpe ratio developed by Nobel laureate William F. Sharpe is the average return earned in excess of the risk-free rate per unit of volatility or total risk.

$$\boldsymbol{Sharpe\ Ratio} = \frac{\boldsymbol{R_P - R_f}}{\boldsymbol{\sigma_p}}$$

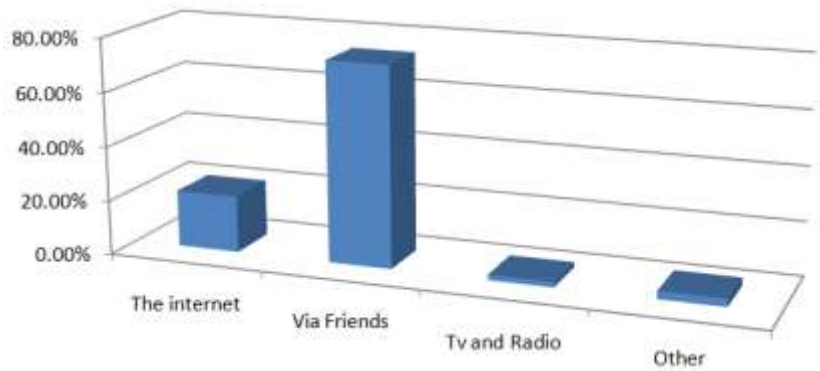
Given R_P = Return of portfolio, R_f = Risk free rate, σ_p = Standard deviation of portfolio

4. RESULTS

4.1 Analysing Cameroonians knowledge of cryptocurrencies

From the questionnaire administered a staggering 74% of respondents reported they learned about cryptocurrencies from friends, colleagues, family members, etc. This is closely followed by the internet through which people gain awareness at the tune of about 21%.

Figure 1: How Cameroonians Discover Cryptocurrencies

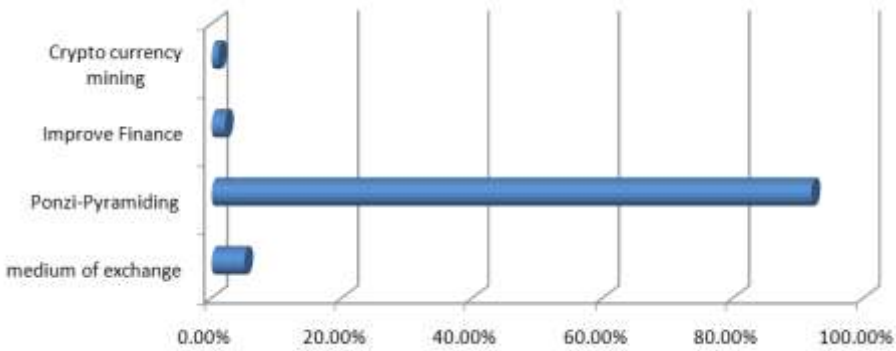


Source: Author's formulation in excel 2007

A whopping 92% of respondents believe cryptocurrencies as more of Ponzi-pyramiding schemes which, just like the MIDA, promises skyrocketing returns on investment, but being also very risky. Only about 5% of the respondents actually think of cryptocurrencies as

currencies as performing medium of exchange functions in an economy.

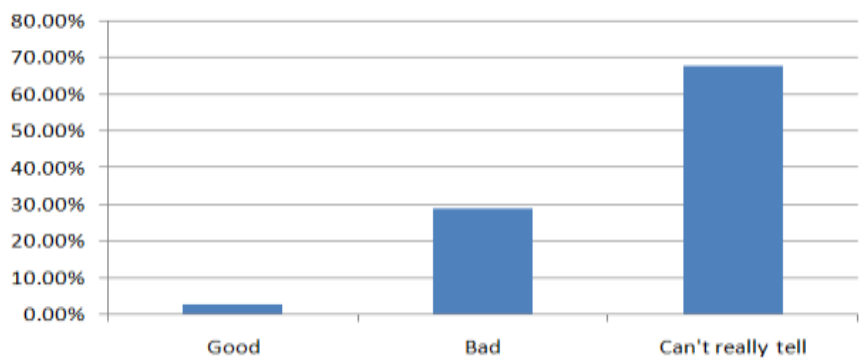
Figure 2: Knowledge of Cryptocurrencies Advantages



Source: Author's formulation in Excel 2007

The study then seeks to find the perception of the respondents about cryptocurrencies, to know if they could invest in it. While only 3% though of cryptocurrencies as good, 29% regarded it as bad. The majority of the respondents (68%) couldn't make a clear-cut judgement.

Figure 3: Peolple's perception of cryptocurrencies



Source: Author's formulation in Excel 2007

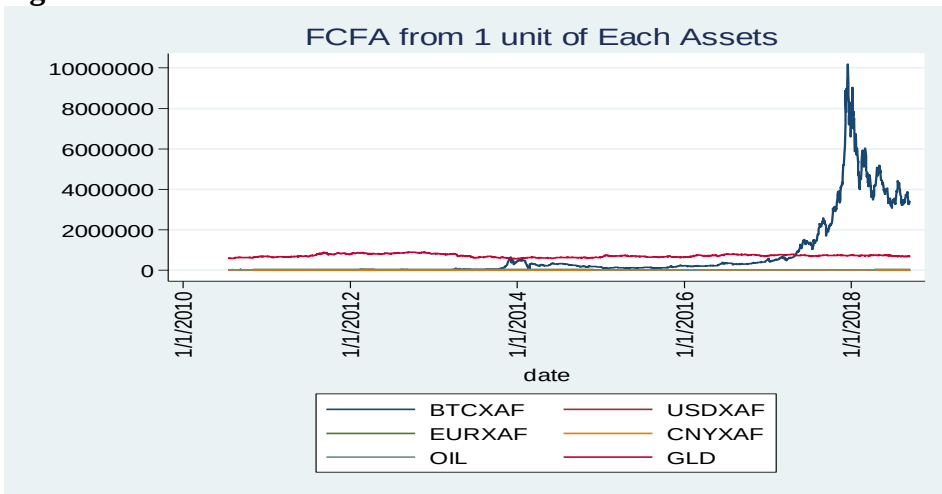
4.2. Analysing the contribution of cryptocurrencies on portfolio

4.2.1. Asset prices

The movement of bitcoin/FCFA (BTCXAF) prices over time exhibit very high prices and volatility compared to all the other

assets. As of this day, the exchange rate of 1BTC to FCFA stands at 3 443 680.77 FCFA[2]. It is observed when bitcoin was born, 16/07/2010, 1 bitcoin was exchanged for 26.07 FCFA. Then, the BTCXAF reached its maximum rate at 10 187 899 FCFA on Dec 15, 2017, before heading steadily downwards to the current rate.

Figure 4: The Value of 1 Unit of Each Asset in Terms of FCFA



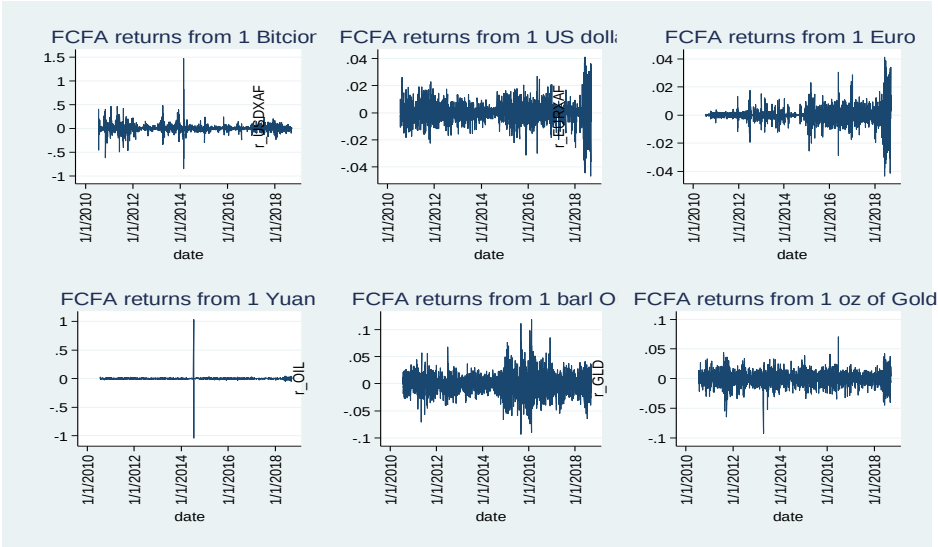
Source: Author's formulation in Stata 14.2, from data on assets prices

4.2.2 Asset returns

Bitcoins daily log returns in FCFA display the widest volatility. The Chinese Yuan also displays volatility which is more or less high due to the spike it recorded together with bitcoins in 2014 causing huge volatility in their maximum and minimum values. All the other assets display relatively similar volatility of daily log returns. This is very consistent with financial literature which holds that daily returns tend to be very small compares to returns in higher time frames.

[2] The current exchange rate of Bitcoins against the Franc FCA (BTCXAF) on the 09/14/2018

Figure 5: Daily Returns of Each Asset in FCFA



Source: Author's formulation in Stata 14.2, from data on assets prices

4.2.3 Analyses of correlation results

Correlation between the returns from Bitcoin vis-à-vis other currencies tends to be very low, if not the lowest. For instance, the correlation coefficient between Bitcoin returns and Chinese Yuan returns tends to be the lowest, standing at 0.0019. On the other hand, the correlations between the other assets not involving the bitcoins are all higher than those involving the bitcoins. For example, the correlation between the returns of US Dollar and Euro stands out to be the highest, at around 0.5874, followed by the correlation between the return of US dollar and Gold which stands at 0.46. The extremely low level of correlation between the bitcoin and the other financial securities is a good indicator that bitcoins are a good portfolio diversification asset. This result is consistent with the financial literature which ascertains a weak correlation between cryptocurrencies and other traditional assets.

Table 1: Correlation Coefficients for All Assets

	R.BTCXAF	R.USDXAF	R.EURXAF	R.CNYXAF	R.OIL	R.GLD
R.BTCXAF	1.0000					
R.USDXAF	-0.0303	1.0000				
R.EURXAF	0.0037	0.5874	1.0000			
R.CNYXAF	0.0019	0.1766	0.1172	1.0000		
R.OIL	-0.0035	0.2593	0.2411	0.0500	1.0000	
R.GLD	0.0347	0.4668	0.3592	0.1335	0.2232	1.0000

Source: Author's formulation in Stata 14.2

After taking into account the dynamic time-series nature of the data, the dynamic conditional correlation matrix also replicates the results of the constant correlation matrix.

Table 2: Dynamic Conditional Correlation Coefficients for All Assets

	R.BTCXAF	R.USDXAF	R.EURXAF	R.CNYXAF	R.OIL	R.GLD
R.BTCXAF						
R.USDXAF	-0.0238699					
R.EURXAF	-0.0014619	0.5914833				
R.CNYXAF	-0.0055116	0.2542534	0.156565			
R.OIL	0.0011385	0.2628514	0.2220968	0.0725182		
R.GLD	0.0479543	0.4369952	0.3644583	0.1502381	0.2451553	

Source: Author's formulation in Stata 14.2

4.2.4 Portfolio analysis

The results obtained are consistent with the financial literature on Markowitz portfolio theory since portfolio return and portfolio risk are directly related. For example, the 2 assets portfolio has high annual return of 70% with very high volatility of 66.17% standard deviation for portfolio including Bitcoin, and also high annual return of 1.8% with high volatility of 11.2% standard deviation for portfolio without bitcoins. The returns and risk keep falling as the number of assets in the portfolio increase. At the 6 assets portfolio, we notice a remarkable drop in both risk and returns. The portfolio with bitcoins displays a lower risk of 25.46% and a lower return of 24.52%. This represents the

efficient frontier of our portfolio. The findings are also consistent with the notion of diversification in that, increasing the number of assets in a portfolio reduces the risk of the portfolio.

4.2.5 Comparative analyses of portfolios

We can observe that for each portfolio type, returns from portfolios with bitcoins are always higher than those without bitcoins. A more straightforward comparison can be done on a risk-adjusted return basis given by the Sharpe ratios. The sharp ratio was computed using the risk-free annual rate of the 2018 Cameroonian sovereign bond which stood at 5.6% per annum. The negative Sharpe ratio displayed for the portfolio without bitcoins simply describes a situation in which the risk premium of a portfolio is lower than the risk-free rate.

Table 3: Different Naive Portfolio Sizes With and Without the Inclusion of Bitcoins

		Return	Standard Dev.	Sharpe Ratio
2 assets portfolio	With BTC	70.19%	66.17%	0.976122
	Without BTC	1.84%	11.20%	-0.33571
3 assets portfolio	With BTC	46.94%	44.32%	0.932762
	Without BTC	1.22%	8.89%	-0.49269
4 assets portfolio	With BTC	35.73%	35.97%	0.837642
	Without BTC	1.46%	19.12%	-0.21653
5 assets portfolio	With BTC	29.04%	29.71%	0.788991
	Without BTC	1.67%	17.08%	-0.23012
6 assets portfolio	With BTC	24.52%	25.46%	0.743026
	Without BTC	1.72%	15.20%	-0.25555

Source: Author's formulation in Excel 2007, from data on assets returns.

4.2.6 Optimal portfolio

Considering the above comparison of portfolios with and without bitcoins, an optimal solution on the composition of assets which shall satisfy the minimum variance condition is employed using the global minimum variance of the two portfolios. The aim is to obtain the optimal weights needed to yield the best returns given minimum risk. The optimal portfolio which minimises the portfolio variance produces portfolio

returns for the bitcoin portfolio which are much higher (1.48% per annum) than portfolio returns of the no bitcoin portfolio (0.88% per annum). The optimal portfolio also gives valuable information on the weights of the assets in each portfolio.

Table 4: Comparative Table between Optimal Portfolio Weights With and Without Bitcoins

	Optimal portfolio with Bitcoin				Optimal Portfolio Without bitcoin		
ASSETS	**weights**			**ASSETS**	**weight**		
R.BTCXAF	0.44%	**Portfolio return**	1.48%	**R.BTCXAF**		**Portfolio return**	0.88%
R.USDXAF	20.43%	**PortfolioVariance**	0.007154	**R.USDXAF**	20.16	**PortfolioVariance**	0.007187
R.EURXAF	77.23%	**Port. SD**	8.46%	**R.EURXAF**	77.74	**Port. SD**	8.48%
R.CNYXAF	0.31%			**R.CNYXAF**	0.31%		
R.OIL	0.25%			**R.OIL**	0.25%		
R.GLD	1.34%			**R.GLD**	1.54%		
TOTAL	100%			**TOTAL**	100%		

Source: Author's formulation in Excel 2007, from data on assets prices.

5. CONCLUSION

The research shows that the average Cameroonian has a shallow understanding of cryptocurrencies. The results obtained from comparing sets of portfolios with and without bitcoins show that portfolios with bitcoins present a better risk – reward ratio as opposed to the portfolios without bitcoins. This we attribute to the very low correlation between bitcoins and the other portfolio assets.

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