CAPÍTULO XXX

BITCOIN FUTURES VALUATION. NON-FINANCIAL VARIABLES TO CONSIDER

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1. INTRODUCTION

Talking about the asset called Bitcoin is almost a philosophical question. To introduce the concept, one should start by explaining other related terms, such as cryptocurrency.

A cryptocurrency might be defined (following Houben and Snyers (2018)) as a broad array of technological developments that utilize a technique better known as cryptography. At the same time, cryptography is a technique of protecting information by transforming it (i.e., encrypting it) into an unreadable format that can only be decrypted by someone who possesses a secret key. Many cryptocurrencies are decentralized systems based on Blockchain technology, which is a distributed ledger enforced by a disparate network of computers. A defining feature of a cryptocurrency is that it has not been issued by any central authority, rendering it theoretically immune to government interference or manipulation. Distributed ledgers are divided into two broad classes (Treleaven et al., 2017): those that seek to minimize the roles of trusted and identifiable third parties; and those that explicitly rely on identifia-

ble third parties for some subset of the system's properties. Not all distributed ledgers are blockchains, but all blockchains are distributed ledgers.

The first blockchain-based cryptocurrency was Bitcoin. Bitcoins are defined as digital coins that can be sent through the Internet and are considered the first decentralized digital currency.

Yermack (2015) asserted that Bitcoin may be not be considered as a currency since it performs poorly as a unit of account and as a store of value. The high volatility of Bitcoin spot prices and the range of prices quoted on various Bitcoin exchanges were seen to damage Bitcoin's usefulness as a unit of account. If the introduction of Bitcoin futures and the ability to trade these futures would have resulted in a reduction in the variance of Bitcoin prices or facilitated hedging strategies, that could have mitigated pricing risk in the spot market. In that case, it is possible that the Bitcoin could have acted as a unit of account, moving it closer to being a currency.

We know that Bitcoin, and other digital assets, are considered as highly volatile investments. Therefore, a way to obtain some benefits and to reduce the cost of the investment might be investing in Bitcoin futures. Futures trading offers the possibility of speculating about any direction in the market, minimizing the risk (Hurst et al., 2010). Thanks to the leverage effect, it is possible to invest the same amount of money than in the spot exchange with a fewer number of contracts. Another contribution of futures is offering the opportunity to hedge existing positions straightforwardly (in both upward and downward market trends), allowing the investor to easily adjust the risk of the portfolio to any market environment.

Despite the enormous risk of this market, the use of cryptocurrencies has been steadily increasing in recent years. Today, there are thousands of alternate cryptocurrencies with unlike functions or specifications. Some of these currencies are clones of Bitcoin, while others are forks or new cryptocurrencies that split off from an already existing one. According to data from MARKET COIN CAP (2021), the capitalization of

the cryptomarket reached 3 Trillion dollars in October 2021, from 125 billion dollars in December 2018, an increase during 2021 of more than 300%.

CHART 1: Cryptomarket´s capitalization

Source: Coinmarketcap.com (November 2021)

The contribution of futures on Bitcoin to price discovery in Bitcoin spot

As the CME group defined “futures are standardized contracts to buy or sell a particular asset at a set price, on a set date in the future, in predefined quantity and quality”. Although the futures market is a market considered as "standard", in the case of Bitcoin futures, this standardization is not very easy due to the nature of the underlying asset, which is the price of the Bitcoin spot.

In mature financial markets, the differences between the price of the spot and the future is determined by technical factors, such as interest rate differentials, dividends or storage costs (depending on the underlying asset). In the case of Bitcoin and other digital assets, the price difference is more difficult to determine since it is mostly driven by supply and demand imbalances.

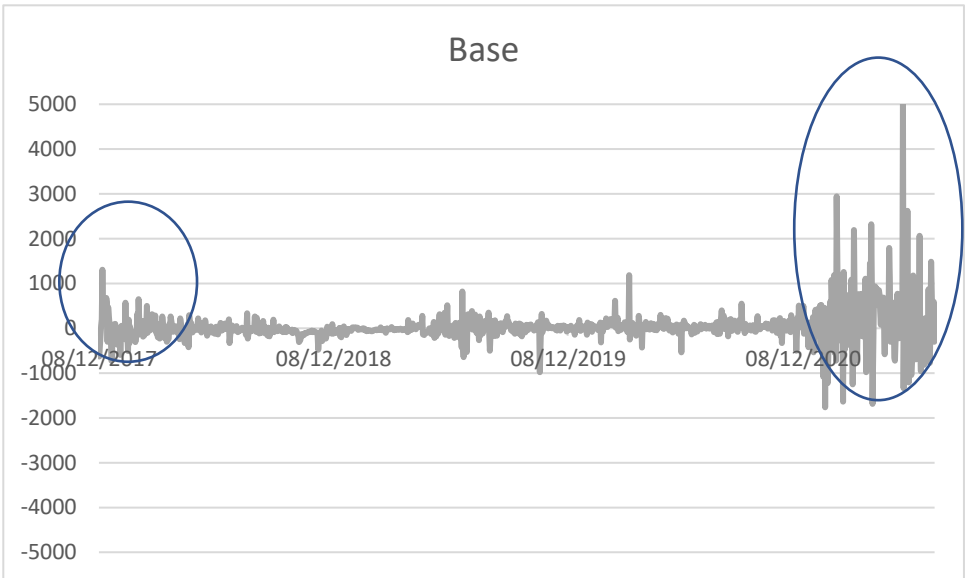
Therefore, a question that should arise from trading on Bitcoin futures is about the calculation of the theoretical futures value. This question has been already studied by Baur and Dimpfl (2019), based on

Hasbrouck (1995), and Gonzalo and Granger (1995) and Akyildirim et al. (2019).

According to the traditional models based on the Cost-of-Carry Model, a cash-settled future with a nonpaying dividend underlying should be valued basically by adding the cost of carry to the spot price. We pose two questions: does this model of valuation apply to Bitcoin futures? And the second one: do the real base and the theoretical base (calculated comparing real futures price and theoretical futures price versus spot price, respectively) match following the traditional valuation models?

We must recognize that the answer to both questions is complex and end up being negative. In point of fact, if we calculate the difference between Bitcoin futures price and the spot price, we discovered that the first is valued below the second on more than the 39.5% of the trading days (negative base), as can be noted in Chart 2.

CHART 2: Difference between spot and futures price on Bitcoin: Real base from December 2017 to June 2021



Source: Our elaboration based on Gemini and CBOE markets

Based on Chart 2, we can conclude that the real base (comparing market Bitcoin futures price vs spot price) has been highly volatile over the past 4 years, particularly in two periods (circled in the chart): at the beginning of the futures trading market and in the last months.

Following Bohl et al (2011), Corbet et al. (2018) and Akyildirim et al. (2019) futures markets lead in the price discovery of Bitcoin spot prices since the beginning of the Futures market. This relationship is found to somewhat diminish assuming that it was a function of novelty, with a dominant presence of unsophisticated investors which overwhelmed the price discovery process. Over time, this novelty diminished, particularly as sophisticated institutional investors entered the market. These features add a difficulty to the calculation of the future value, providing less consensus on the adjustment of the future price in the market (Baur and Dimpfl, 2019).

Nevertheless, the literature on Bitcoin futures markets is limited, one of the aims of this paper is to contribute to several aspects scarcely developed. In our study, three aspects of the Bitcoin futures valuation will be explored.

First, following the studies of Baur and Dimpfl (2019), Hasbrouck (1995) and Gonzalo and Granger (1995), our research is based on the Cost-of-Carry Model, incorporating new variables like the hardforks effect, or some differences between spot and futures i.e. the spot market opens seven days a week whilst futures markets are closed during weekends.

Secondly, some relevant variables will be incorporated to the original model, testing four different hypothesis before arriving to the final model, once the influence of each one on the Bitcoin futures has been found.

Finally, the useful implications for investors will be discussed.

The four hypothesis tested are:

- Hypothesis 1: Hardfork issue reduces the Bitcoin futures price (it works as a sort of dividend)

- Hypothesis 2: The effect of volatility on weekends is negative on Bitcoin futures price (it makes investors to prefer spot to future Bitcoin)
- Hypothesis 3: The effect of volatility on market closing hours is negative on Bitcoin futures price
- Hypothesis 4: The effect of volatility of the previous week is negative on Bitcoin futures price

This paper is structured as follows. After the introduction, the next section presents the theoretical review and hypotheses development. The third section describes the methodology, followed by the exposition of the results, the discussion and finally the conclusions and further research guidelines.

2. THEORETICAL FRAMEWORK

The investigation of price discovery between spot and futures markets relies mainly on Cost-of-Carry model. Howerver, Bitcoin has been identified to contain pricing inefficiencies (Sensoy (2019), Urquhart (2016)). The relationship between prices of both assets has been widely analyzed in the literature based in different underlying assets. Chang and Lee (2015) found evidence of a long-run relationship between spot and futures prices of oil; as well as Ballester et al. (2016), studied the case of the electricity market in which they found a unidirectional causality from the futures market to the spot market for 1-month-1-quarter-ahead and maturities. This result might be indicative of the agents using the price of the futures market as a valuable reference (Malliaris and Ziemba, 2015).

Stein (1976) considered possible to determine whether changes in spot and futures prices have occurred overall as a result of changes in the excess supply of current production or due to changes in price expectations. For his part, French (1986) considered that forecasting based on futures prices is not better than forecasting based on spot prices, consistently with the evidence of Fama and French (1987).

Specifically, based on Bitcoins, Akyildirim (2019) verified that Bitcoin futures dominate price discovery relative to spot markets. In addition,

CBOE futures are found to be the leading source of informational flow when compared directly to their CME equivalent.

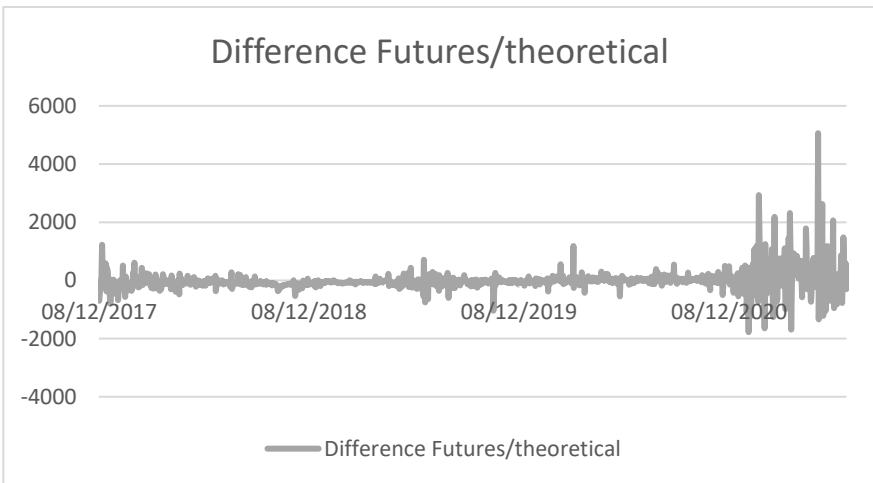
Following Baur and Dimpfl (2019), the price of Bitcoin considering only the cost of carry can be written as follows in formula 1:

$$F_t^T = S_t * e^{r*(T-t)} \qquad (1)$$

Where T is the maturity date, t the day of the futures valuation, S the spot price, and r the yield of the 1- month US Treasury bill.

Theoretically, the theoretical price of the future should include the cost of carry added to the spot. As a matter of fact, this expectation is not the case since the theoretical future price has been trading above the future (considering the cost of carry) on 64% of the days, with an average difference of -144 dollars (Chart 3). That shows a negative base, especially in the two circled periods. Those results coincide with those obtained when observing the real base (Chart 2).

CHART 3: Difference between theoretical price and real price of futures on Bitcoin (from 2019 to June 2021)



Source: Our elaboration based on the Gemini and CME markets

Accordingly, after different calculations of theoretical bitcoin futures price based on this formula (1), we consider that this equation is clearly not sufficient to explain the behavior of Bitcoin futures. Therefore, some added factors should be introduced in the formula. We show them below.

FIRST FACTOR: THE CREATION OF HARDFORKS

The introduction of cryptocurrencies has created many new concepts. One of them is fork. A definition[1] could be: "A Bitcoin fork is a term describing a split in the Bitcoin network. A fork can result in the creation of new coins that can be claimed by existing Bitcoin owners". Blockchain promotes a decentralized network that makes it very difficult to implement changes and requires every one of the thousands of participants to agree on the update of the system (Zamyatin et al., 2019). However, we can find two types of possible changes in the system: softforks and hardforks.

The loosely defined terms softfork and hardfork have established themselves as descriptors of different classes of upgrade mechanisms for the underlying consensus rules of (proof-of-work) blockchains (Zamyatin et al., 2019). They can be defined as follows,

I. Consensus (*softfork*) occurs when participants agree on a software change, which is compatible with the old versions. In this case, no new coin would be issued.
II. A *hardfork* occurs when a number of participants in the network implement a software improvement without consensus of the rest, implying that, from a certain moment, the Bitcoin holder will receive a number of the new cryptos created because the new software will start a new blockchain string, and the "old" Bitcoin will no longer be accepted in the new network. Of course, the new cryptocurrency will not be usable in the old Bitcoin blockchain system.

Many of these new listed coins have little or no value, but some have had relative success because it is a sort of dividend. The problem is that one must forecast whether this new asset will be worthless or not.

Since the Bitcoin holder will have access to these hardforked crypto assets and the futures holder will not, it could be another possible explanation for the futures'

[1] The Beginner's Guide to Bitcoin Forks and How to Claim them (2019). https://99Bitcoins.com/Bitcoin-forks/

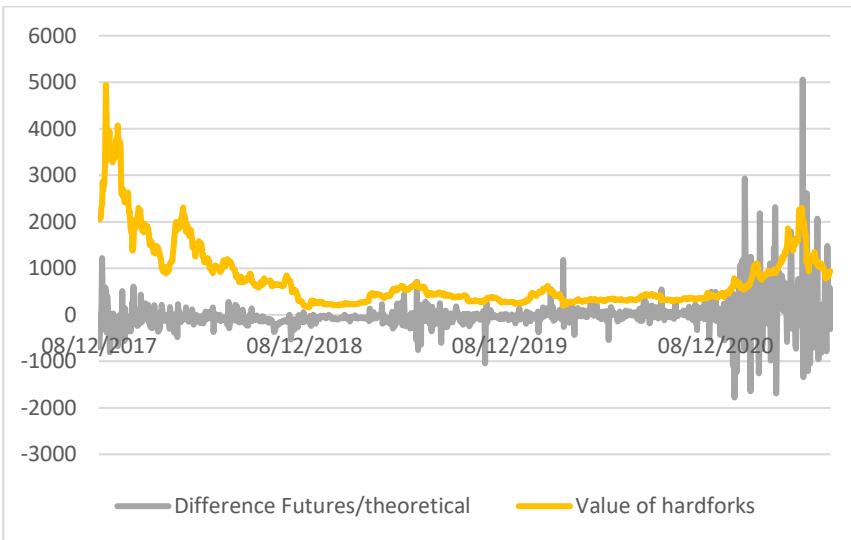
negative bias. The main hardforks since the beginning of the futures market, are the following (Table 1).

TABLE 1: Bitcoin fork and Bitcoin hardfork since the beginning of futures market

Bitcoin (BTC) Litecoin (LTC) Junkcoin (JKC) Lukycoin (LKY) Dogecoin (DOGE) Monacoin (MONA) LitecoinCash (LCC) CloakCoin (CLOAK) Einsteinium (EMC2) Feathercoin (FTC) Bitcoin Cash (BCH)	Dash (DASH) PIVX (PIVX) Blocknet (BLOCK) Bitcoin Gold (BTG) Zcash (ZEC) Zclassic (ZCL) Bitcoin Private (BTCP) ZenCash (ZEN) Komodo (KMD) Qtum (QTUM)	Bitcoin Diamond (BCD) Peercoin (PPC) Novacoin (NVC) Blackcoin (BLK) Stratis (STRAT) Greencoin (GRE) Vertcoin (VTC) BitcoinDark (BTCD) Hshare (HSR) Nexus (NXS)	Decred (DCR) DigiByte (DGB) Syscoin (SYS) Reddcoin (RDD) Elastos (ELA) Emercoin (EMC) Groestlcoin (GRS) NavCoin (NAV) Viacoin (VIA)

Source: Bitcoin Forks (July 2021)

CHART 4: Differences between futures and underlying prices, with and without hardforks

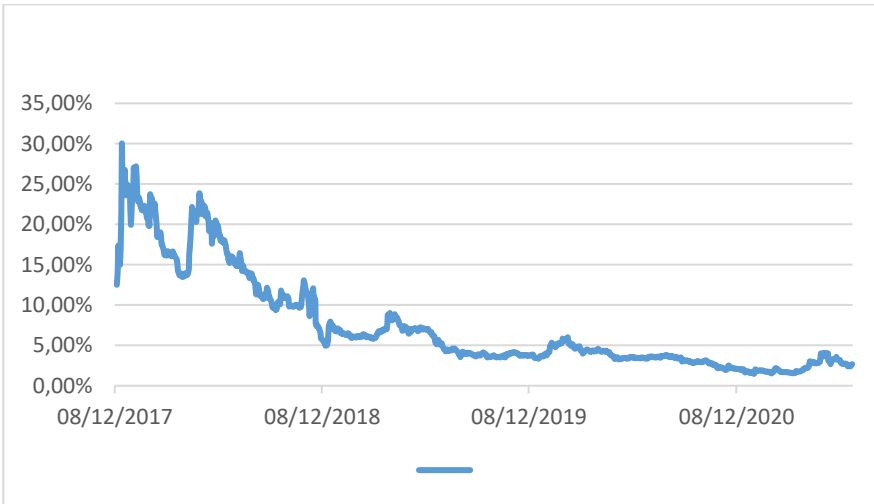


Source: Our elaboration based on the Gemini and CBOE markets

To verify whether the effect of a fork issue is important to explain the pricing of the futures, we have calculated the average differences between futures and underlying prices. We have found a score of 40306 dollars (which means that 36 dollars would be the average for all days, independently of the fork issue). But when we make the same calculation for the days with forks 64% of them will have a negative base (Chart 4). Therefore, the issue of a fork seems to be an important input for the valuation of Bitcoin futures.

To demonstrate this effect, we have reconstructed the total value of the hardforked coins, showing that only 7 out of 25 coins had a value of more than 1 cent until June 14, 2019. That is, only 28% of them had some value (Chart 5).

CHART 5: Percentage of value of the Bitcoin futures represented by the hardforked coins if the investor had held the underlying asset and had not sold until June 14, 2019



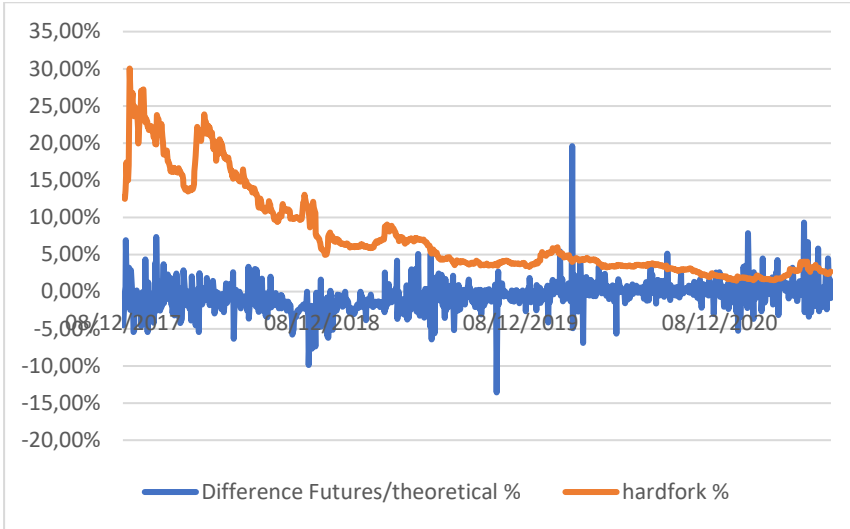
Source: Our elaboration based on the Gemini and CBOE markets

As can be observed in chart 5, the maximum amount of the futures prices that might be explained by the value of the hardforked accounts 30%, but with the passage of time there is a clear reduction in the importance of hardforks when compared with the level of Bitcoin. There are two possible explanations for this fact:

1) Hardforks are not important to the explanation of the prices of Bitcoin futures and/or spot;

2) Futures establish an erroneous forecast about the price of these new assets.

CHART 6: Comparison of the percentage that represents the value of the hard-forked coins and the difference between assets and future (real base)



Source: Our elaboration based on the Gemini and CME markets

The second explanation is much more likely to be the correct one. Participants in the market will surely consider the "split" of the two currencies. The problem is the difficulty in valuing the new crypto asset. Most of them are worthless a few weeks/months after the hardfork issue, but some will provide a sort of dividend. The difference between these forks and the stock dividend is that the latter is paid in the same assets of the payer of the dividend, while the former introduces a new asset with no previous valuation.

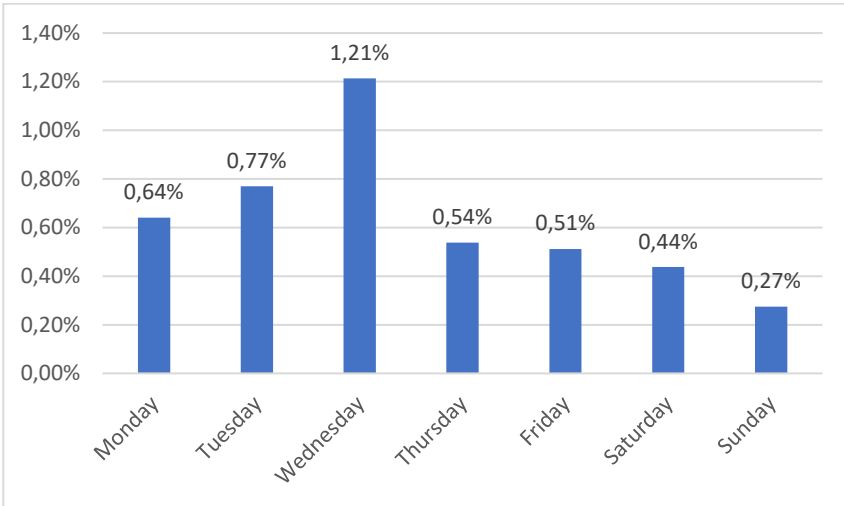
2ND FACTOR: THE VOLATILITY AND PROFITABILITY OF BITCOIN DURING WEEKENDS

One of the possible reasons explaining why futures have been trading with a negative base could be that, during weekends, the underlying asset is active in several OTC markets, providing asset holders with the opportunity to trade. This option is not available to futures contract holders.

It seems that Bitcoin holders (in Chart 7) do have the possibility of trading on Saturday (the most bullish day for Bitcoins) and on Friday, especially after the closing of the futures markets. These two days are, by far, the most attractive for

trading activities, which is a problem for a non-seven-days-a-week market. However, Sunday is not truly a very special day for Bitcoin markets, although it is more profitable than Mondays, Wednesdays or Thursdays.

Chart 7: Average profitability every day of the week in Bitcoin Gemini market



Source: Our elaboration based on the Gemini market

The return of the market during the weekends, although is less than the other days of the week represents more than 0.7%, that means that the holder of a futures contract might be willing to trade during weekends what it is not possible in an organized market. This is another factor to prefer spot to futures.

3RD FACTOR: THE VOLATILITY DURING CLOSING HOURS

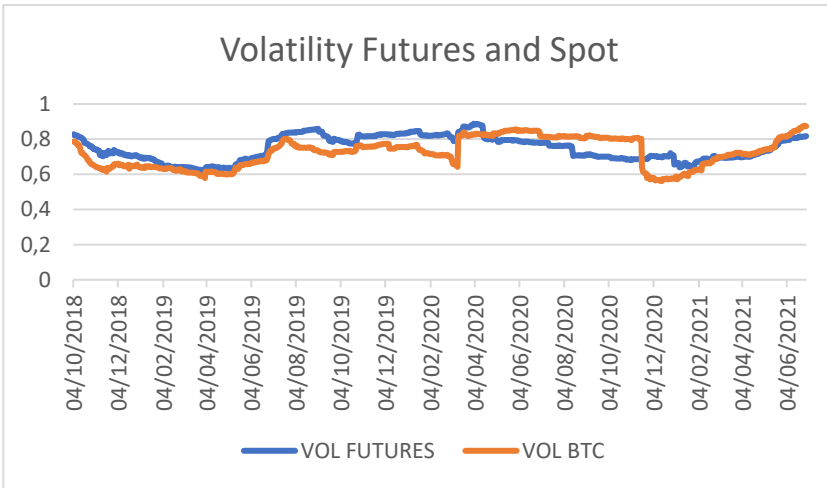
There is another effect caused by the Bitcoin spot market not closing on any day of the week, while futures are not tradable. Bitcoin Futures Market remained opened, from Sunday to Friday, only 6:45 hours in the regular session, although possible to trade in the CME Globex continuously with one hour break versus the 24 hours trading, 7 days a week of the spot market. Therefore, only 26.875% of the total market movement can be captured with futures contracts.

The limitation of trading hours is one of the main differences between the spot and the derivatives market. It is a point at issue for Bitcoin trading because an important part of the movements of the asset occurs during the weekends, when the futures market is closed.

This is an important effect due to the high volatility of this asset, probably exerting a negative effect on its valuation.

To verify this impact of volatility on valuation, we have calculated the daily volatility of the Bitcoin returns in the Gemini market, and we have annualized it. The results are shown in Chart 8, where it can be seen that the fluctuation range is 50-90%, with an average value close to 80%. The volatility of futures tend to be higher in bearish periods as the contrary happens in a bullish environment.

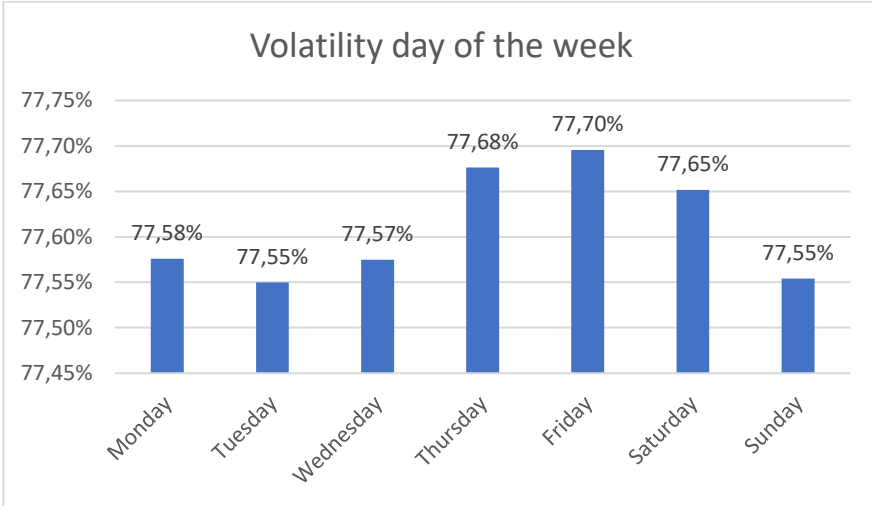
CHART 8: Yearly volatility of the return on Bitcoin in the Gemini market. Calculation based on an annualized daily volatility



Source: Our elaboration based on the Gemini market and CME

Volatility is always extreme, including weekends, as we can note in chart 9. Most of the days of the week show annual volatilities of approximately 78%. During the weekends, this volatility is slightly less important than the average of the rest of the week. But in the case of Bitcoin futures the closing day of Saturday represent a day with a very similar volatility to the rest of days, so with these impressive levels of volatility, all traders would be very reluctant to leave open positions during weekends and renounce to the trading in a day with almost 78% volatility.

CHART 9: Average annual volatility by day of the week



Source: Our elaboration based on the Gemini market

4TH FACTOR: THE EFFECT OF VOLATILITY OF THE PREVIOUS WEEK

This factor studies the impact of periods of high volatility (very common on this market) on the futures price, in order to test this impact the volatility of the previous week would be used as a variable to see its influence on the actual futures price.

3. METHODOLOGY

3.1. THE SAMPLE

Multiple databases have been used to carry out the study:

Daily prices of the closest to maturity futures on Bitcoin from the CME, from the beginning of this asset in November 2017 to June 30, 2021 (Source: CME official closing prices).

In order to verify the conclusions extracted with the CME futures, the authors will use as well daily prices of the closest to maturity futures on Bitcoin from the CME from July 2021 to October 2021

The same data range has been used for the Bitcoin spot (Source: Gemini market prices).[2]

- The same time frame is used for the yield of the one-month US Treasury bill (Source: US Department of Treasury).
- In order to check the effect of the weekend behavior of the spot market on the futures prices (the derivative market remains closed during the weekend) a dummy variable will be used.

3.2- Estimations and Statistical validation

Following the purpose of the study, the estimation of a model based on Baur and Dimpfi (2019) that allows calculating the Bitcoin future price based on the spot price, the variables initially included in the analysis are the following:

- Futures prices, as endogenous variable (F)
- Bitcoin Spot price (S)
- 1-month US Treasury Bill yield (r)
- Time to expiration (T) and current date (t)
- The value of all the hardforked assets from Bitcoin. We call it Synthetic (Phf)
- Dummy variable for the weekend effect. We call it profitability during weekends or volatility during weekends (Vwe)
- To test the effect of the volatility of the spot market when the futures market is closed the difference between intraday volatility of spot and futures will be used (Vmc)
- Volatility of the spot market during previous week (Vpw)

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[2] https://gemini.com/prices/Bitcoin/. The Gemini platform allows one to invest in Bitcoin and other cryptocurrencies with advanced trading features and secure storage. Following the explanation of this platform, Bitcoin is the breakthrough cryptocurrency developed by pseudonymous creator Satoshi Nakamoto. It is a decentralized digital asset that one can buy, store, trade, and exchange on an open, global computer network. Bitcoin is referred to by many as "digital gold". It has the largest market cap of any cryptocurrency, and only 21 million Bitcoins will ever exist in total. All Bitcoin transactions are recorded in an immutable ledger known as the blockchain and are stored in online or offline wallets. A Bitcoin is divisible into smaller units, with the smallest unit (a satoshi) worth 0.00000001 Bitcoins.

It is not easy to measure the importance of these factors on determining the futures price. An econometric perspective will be used with a data base of the CBOE markets (closed in July 2019). Finally the authors will proposed a formula for the futures price determination.

The initial proposed model will be represented by the following formula (2):

$$F_t^T = S_t * e^{r*(T-t)} - Phf_t - Vpw - Vmc_t - Vwe_t \quad (2)$$

Where *Phf* represents the forecasted price of any new coin arising from a hardfork, *Vpw* the effect of volatility of the previous week, *Vmc* the effect of volatility during closing hours, and *Vwe* the effect of volatility on weekends.

Firstly we analyze correlations among all considered variables (Table 2). We will use a similar model to the one used in Chen and Tsai (2017) although including some additional variables.

Table 2: Correlation among every return of every variable included in the study

	Futures	Spot	US 1 M	Phf	Vpw	Vmc	Vwe
Futures	100,00%						
Spot	78,52%	100,00%					
US 1 M	3,91%	-1,08%	100,00%				
Phf	59,57%	75,56%	0,65%	100,00%			
Vpw	-5,83%	-5,63%	-4,98%	-3,41%	100,00%		
Vmc	-6,33%	-0,82%	19,32%	-5,48%	15,83%	100,00%	
Vwe	-1,97%	2,24%	-16,90%	1,92%	8,50%	2,79%	100,00%

Source: Our elaboration based on the Gemini and CME markets

The first conclusion is that returns of all exogenous variables proposed seems to be correlated (negatively or positively) specially futures and spot Bitcoin contracts. All returns tend to have the forecasted relationship in accordance with out assumptions, but the hardforks, these do not act as a dividend (it will hold a negative relationship if that was the case).

The initial model will try to explain the Bitcoin futures returns with the variables included in Table 2 is shown in Table 3.

Table 3: First Model with all the exogenous variables to explain Bitcoin Futures

	Coefficients	T Student	Lower 95%	Higher 95%
Interception	-0,00422764	-0,87112771	-0,01374998	0,0052947
Spot	0,81940583	27,8072478	0,7615871	0,87722456
US 1 M	190,342852	2,92947226	62,8532679	317,832436
Phf	-0,00272721	-0,13641409	-0,04195442	0,03649999
Vpw	0,00045384	0,08441571	-0,01009515	0,01100284
Vmc	-0,00682523	-3,50448967	-0,01064661	-0,00300385
Vwe	-0,00384706	-1,37509514	-0,00933644	0,00164233

The following results can be observed:

- The intercept is negative. That is really important because explains the reason why the base tends to be negative in the futures market and in many occasions futures are trading below spot.
- All the returns of all the variables considered are significant in the explanation of the futures.
- Finally, the importance of spot, US 1M and hardfork returns are, by far, the most important.

Based on the scarce correlation shown by some of the variables, we have tested different models, introducing different combination of the variables, finishing developing a Final Model considered as the optimal model. We obtained the results showed in Table 4.

Table 4: Final Model with spot, US 1 M and Hardfork returns to explain Bitcoin Futures return

	Coeficients	*T Student*	*Lower 95%*	*Higher 95%*
Interception	-0,00390837	-1,96105975	-0,00781886	2,1189E-06
Spot	0,81304371	27,5324755	0,75510153	0,87098589
US 1 M	160,481574	2,55178424	37,0837681	283,879379
Phf	0,00278775	0,13919041	-0,0365103	0,04208581

Based on this final model, the results and implications for the research will then be studied.

4. RESULTS

After introducing several explanatory variables in the initial model, we proposed the formula 2 as the Final Model, considering that the return of Bitcoin futures depends on the following exogeneous variables. That model changes slightly the cost of carry traditional formula and represents a better valuation for futures.

$$F_t^T = S_t * e^{r*(T-t)} - Phf_t \qquad (2)$$

Once we have obtained the drivers of the price discovery for the futures return, the next step would be to make the regression on the prices with the variables that explain accurately the returns, with the following results showed in Table 5.

Table 5: Final Model statistical data

Multiple Correlation	0,99967301
R^2	0,99934613
Adjusted R^2	0,99934255
Typical Error	357,302288
Data Simple	1104

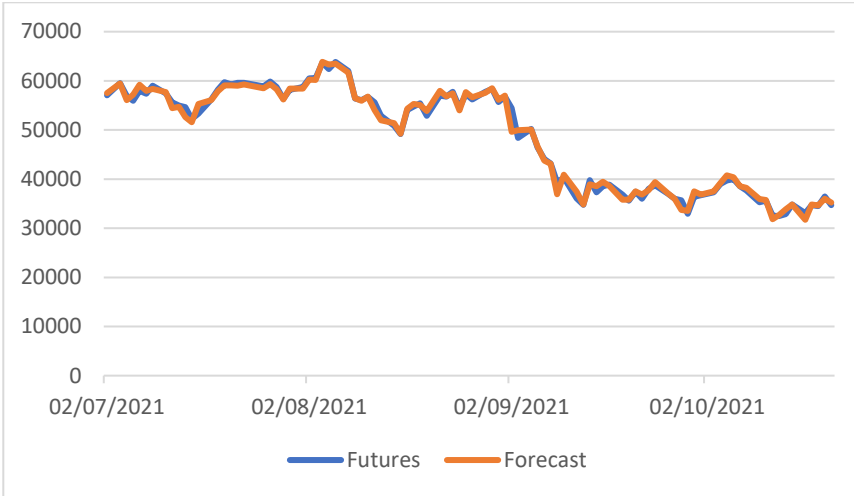
We can observe that all variables are statistically relevant, according to the *t* statistic test of acceptance with 99% significance and adjusted R^2 (99,8%). From the econometric point of view, this is the best model among the studied set. The sign of the coefficients is self-explanatory:

- The intercept is negative, therefore it seems that participants in the futures market maintain a consistent negative base towards spot (perhaps due to the stricter rules of this organized market compared to the spot)
- The spot has a coefficient of 1, as we would expect.
- Yield is positively related to futures price, in line with expectations.

The completely unexpected outcome is that the return of the synthetic asset composed from the hardforked assets (Ph^t) correlates positively with futures return. That could mean that investors do not perceive these assets as a dividend, but as a measure of the attractiveness of the crypto market itself.

In order to check the fit of the selected model, we have forecasted the value of the futures from July first to November 2021 with the model finding a very robust accuracy as can be appreciate in Chart 10.

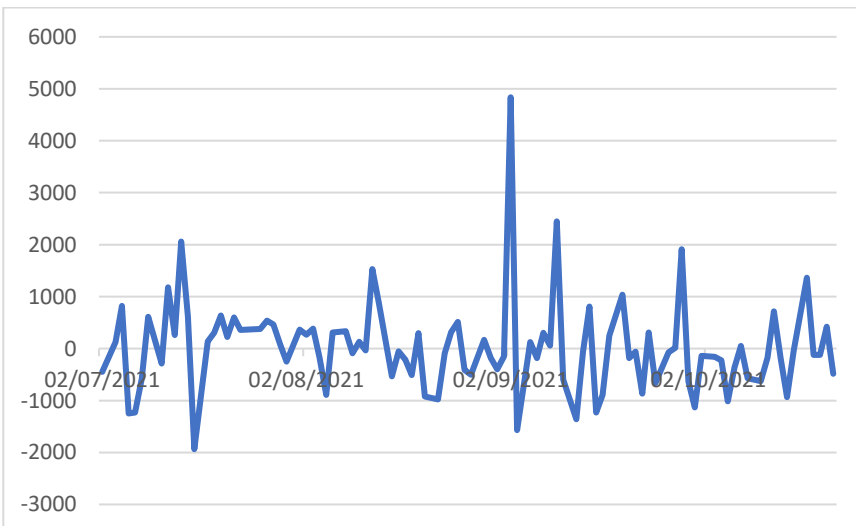
Chart 10: Comparison of the real futures and the forecasted ones based on the Final Model



Source: Our elaboration based on the Gemini, bond and CME futures

Based on this model, we have calculated the residuals of the model (obtained with the difference between Forecasted futures price and Real futures price) (Chart 11) and it turned out that they keep the desired properties, especially homoscedasticity.

Chart 11: Residuals obtain in Final Model



Source: Our elaboration based on the Gemini, bond and CBOE markets

To further analyze the results obtained, we calculated also a confusion matrix, comparing the forecasted return (positive or negative) against the real value with the following results (Table 6).

Table 6: Confusion Matrix on the Final Model

Real/ Forcasted	Positive Return	Negative Return
Positive Return	42.78%	8.65%
Negative Return	8.76%	39.82%

Source: Our elaboration based using CME futures on Bitcoin, and the forecasted futures by our model

In general terms, the homoscedasticity is kept pointing to the robustness of this model, results of the confusion matrix point to a quite symmetric nature of results. Also, the results of this study demonstrate that most of the hypothesis initially considered did not show its relevance. Most of our assumptions were based on the idea that Bitcoin futures prices would have a similar behavior to the stock futures, but in fact it tends to be closer to the commodities futures (coinciding with Akyildirim et al., 2019).

Comparing initial hypothesis and the final findings we can conclude that the model only supports one of the Hypothesis considered.

As we considered in the Hypothesis 1, there is an effect induced by the hardforked assets prices. Data shows that the price of the hardforked assets do not behave as if they were a sort of dividend, just on the contrary they are positively correlated with futures prices, when a regression using prices is conducted taking into account that this synthetic asset at maximum represents 8% of the futures prices (Chart 8). This conclusion does not support the Hypothesis 1 that expected a negative influence of hardforks on futures price.

Following with Hypothesis 2, it seems clear that there is a backward effect that goes beyond the weekend effect or any other related to the less extended hours of trading in the futures market. The effect of volatility on weekends affects positively on Bitcoin futures price, however with no relevant statistic value. Data is not completely clear about this fact, the acceptance of this variable as explanatory of futures prices is not conclusive.

Hypothesis 3 has been tested finding that the acceptance of this variable as explanatory of futures prices is proposed, although its explanatory capacity is very scarce.

Finally, we found out that the effect of the volatility of the previous week affects negatively the futures price, following the Hypothesis 4, however this effect has a very scarce level of acceptance from the statistical point of view.

5. CONCLUSIONS

The introduction of Bitcoin futures by CME coincides with Bitcoin prices reaching record highs of approximately US$20,000 before falling to less than US$8000 during 2018. This occurrence leads us to question the relationship between futures and market prices.

Following this idea, numerous studies have been published looking at this relationship, specifically for Bitcoins, reaching different conclusions. Some have suggested that the Bitcoin futures market dominates the price discovery process (Kapar and Olmo 2019), following Gonzalo and Granger's common factor component to quantify the contribution as a weighted combination of the futures and spot market (1995); that is, they believe that the model clearly reflects the leadership of the Bitcoin futures markets with respect to the spot market. However, there are other authors who have suggested otherwise, such as Corbet et al. (2018) and Baur and Dimpfl (2018), who relied on the information share methodology of Hasbrouk (1995) and Gonzalo and Granger (1995)) and found that the spot price leads the futures price.

For their part, Baur and Dimpfl (2018) in their empirical analysis concluded that the spot market also leads price discovery but with significant variations across time, and besides that price discovery was stronger when the Bitcoin prices were at highs, compared to the periods with lower prices. Akyildirim (2019) verified the view that Bitcoin futures dominate price discovery relative to spot markets (the same as Alexander (2019) in the BitMex market), and additionally that CBOE futures are found to be the leading source of informational flow, compared directly to their CME equivalents.

We consider that, unlike the Hasoruk Model (Hasoruk, 1995) and Gonzalo and Granger (1995), the value of the futures will be determined by, at least, the following variables:

- A constant that explains the preference of participants to hold the spot instead of the futures, very similar to the backwardation effect in commodity futures. In that sense we fully support the view of Bitcoin futures behaving more like a commodity than a stock or currency future.
- The cost of carry, unfortunately due to the very low rates that happened during the analysis period, it is very complex to verify fully if the effect of interest is similar to other similar assets, more research is needed when interest rates raise.

- We found a relatively small and positive effect from the value of the hardforked assets. In fact, they do not behave as a dividend but rather its effect sometimes compensate the backward effect totally or partially. We found that sixty-four percent of the days with forks, the base is negative (Chart 4). It can be said that futures overreact to these "dividends", systematically reflecting the lack of efficiency of Bitcoin futures. Therefore, the issue of a fork seems to be an input for the valuation of the futures on Bitcoin, however not very important to the explanation of the futures prices and Bitcoin prices.
- The pricing of Bitcoin futures in general, is close to the commodity ones much more than to any other asset class (coinciding with Akyildirim et al., 2019)
- The analysis conducted in this paper shows that volatility has increased in the Bitcoin spot market around the announcement of trading in Bitcoin futures. In the period covered by this study, hedging portfolios constructed with futures could not mitigate the risk inherent in the underlying spot market. Both hedging strategies considered resulted in an increase in volatility. The price discovery analysis indicates that price is focused on the spot market, in keeping with the argument that the traders in the futures market are uninformed noise traders. These results together support the conclusion of Yermack (2015) that Bitcoin should be seen as an asset of a speculative nature.

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