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What can be expected from the Bitcoin?

"Vires in Numeris"

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1. Introduction

Only recently developed by the Japanese academic Satoshi Nakamoto (2008), the Bitcoin is a virtual currency that can be traded all over the world. Even though the money has been printed on several occasions the essence of the Bitcoin lies in the fact that it exists entirely on the digital highway. The coins themselves are a string of code that can be stored in the so-called wallet on your own computer. Subsequently, the Bitcoins can be used in transactions all over the internet, provided that the other person accepts the Bitcoin as a means of payment. The most remarkable thing about all this is that neither a government nor any financial institution is involved in any part of this transaction or in the regulation of the currency.

Currently, the main users of the Bitcoin are technologically interested geeks who want to use the newest innovations, anarchists who have lost trust in the governments and the banking systems, and speculative risk-seekers looking for a new gamble. However, this is quickly changing due to the increase in the value of the Bitcoin and the attention that it gets in the news.

In the academic sphere, little research has been done on the subject and the research that has been done is mostly technical and concerns cryptography rather than economics. However, my belief is that the Bitcoin is a rare, new phenomenon worth researching on the economic level as well. The fact is that this string of code, of which the Bitcoin exists, is worth intrinsically nothing. So, people are willing to spend an increasing amount of money on something that is literally worthless, with no guarantee that the Bitcoin will be worth anything in the future. If an explanation could be found where the value of the Bitcoin is derived from or what influences the value of the Bitcoin, a future for the Bitcoin can be predicted much better than before. Therefore the question is raised:

"How does day-to-day financial data influence the value of the Bitcoin?"

The literature that is investigated concerns the theory of fiat money, money without intrinsic value, and investigates what drives the value of this fiat money. Subsequently, financial data will be collected and used in the analysis to see what affects the value of the Bitcoin. Finally, a conclusion will be drawn from the results of this analysis that will show what has an effect on the value of the Bitcoin. After that, several suggestions will be given for an expansion of this research in several ways.

2. Literature Review

Fiat money

Fiat money is defined as money without intrinsic value, as an object that is accepted in exchange not for its use in consumption or production, but for its use in exchange in a short or longer period of time (Papadopoulos, 2009). Other definitions include "Currency that a government has declared to be legal tender, despite the fact that it has no intrinsic value and is not backed by reserves" (Investopedia) and "Paper money or coins of little or no intrinsic value in themselves and not convertible into gold or silver, but made legal tender by fiat (order) of the government" (Financial Times Lexicon). Fiat money has been present almost as long as money has been and nowadays almost all money that is used in the world constitutes of fiat money.

As the definitions of fiat money illustrate, fiat money is in itself intrinsically worthless. It cannot be consumed or used in production, therefore not attaining any commodity value. The only value that fiat money can build on is its value in future exchange. However, as future exchange has a high degree of uncertainty, a user of fiat money is not willing to accept and use this fiat money, in comparison to a currency that has a higher degree of certainty in future exchange. The concept of fiat money is mostly based on faith and the trust that the fiat money will be valuable in the future. Therefore several theories have been developed as to why people would accept fiat money. Three theories will be explained in more detail.

Fiat money under the state theory of money

The commodity theory of money has long been the best theory for explaining money, suggesting that money is only held to spend later on another good that is desired by the owner of the money. The theory claims that money is valuable because it is used in exchange and it is only accepted as money, because other people accept it due to their higher liquidity (Menger, 1892). However, the occurrence of fiat money could not be explained by the commodity theory of money. Agents would have to assume that other agents would accept fiat money and because this is not the optimal individual strategy, there would be no reason as to believe that fiat money will be accepted.

A better explanation of fiat money is provided by the state theory of money, where the government backs the currency by use of legal documents and incurs the payment of taxes. As has been first recognized by Adam Smith paper money can obtain value, when it is used in the payment of taxes, as this would incur a relevant use for this fiat money (Smith, 1776). A different reason comes from the goal of the government to grow and sustain the economy, which can be done best when everyone uses the same currency. In order to attain this goal, the government makes a promise to the people who use the fiat money that it will be valuable in exchange. In this way, they

sustain the fiat currency leading to much higher certainty in future exchange. This action by the government reinforces the faith in fiat money and its use can be explained.

Fiat money in an infinite market

In many theories, the assumption is made that agents accept fiat money, because the market of fiat money is infinitely long, e.g. (Kiyotaki & Wright, 1989). This assumption would make sure that the market never fails and thereby deletes the uncertainty factor in future exchange and would explain the use of fiat money. However, this phenomenon is never observed in the real world, rendering this assumption and explanation of the use of fiat money implausible.

Fiat money in a finite economy

In response to the previous assumption that fiat money can thrive in an infinite economy, Kovenock and De Vries developed a theory called helicopter money (Kovenock & De Vries, 2002) that can explain the existence of fiat money in a finite economy. They constructed the theory as follows: the economy consists of three people, agent A, agent B, and agent C. They would come together three times in pairs, so first A and B met, then B and C met, and then C and A met, not necessarily starting with A meeting B. A desires goods of B, B desires goods of C and C desires goods of A. Their initial endowment consists of goods that are already valuable to them, making the option of autarky possible. However, when eliciting the option to trade, their total utility would increase. There is no coincidence of wants, making commodity trade impossible and the only way to trade is through fiat exchange.

Then fiat money is pumped into the economy, by giving it to one of the agents, making him the first link in the economy. He can choose to trade or to stay autarkic. If he chooses to stay autarkic, the economy ends at that point. However, the best option for the first link in the economy would be to opt for trade, because he can only gain from that. The subsequent problem results from uncertainty, because the first agent knows that he is the first agent. However, the second and the third agents do not know if they are the second or third link in the economy. This is relevant, because the third and last agent that receives the fiat money will lose from it, because the first agent will not accept the fiat money in the last trade meet-up, as he knows that he would be stuck with the fiat money in the end. By backward induction, it can be concluded that no one should accept the fiat money in the first place, because the subsequent person would most probably not accept it.

This problem is solved by Kovenock and De Vries (2002), by expanding the amount of agents to such a degree that the probability of being the last person to hold on to the fiat money is small enough that the reward of choosing to trade is larger than the loss incurred by accepting the fiat money. So, due to uncertainty, it can be concluded that fiat money can be used in finite economies

as long as the reward for using it is relatively higher than the probability of being the last to hold on to the fiat money multiplied by the loss incurred.

Expectations

As can be logically deduced from the facts, the Bitcoin is an example of a type of fiat money existing in a finite economy. In addition, the Bitcoin is neither backed nor constructed by any government or big financial corporation. This would mean that only the theory of Kovenock and De Vries (2002) can logically explain the existence of the Bitcoin (Deck, McCabe, & Porter, 2006). So, it can be stated that the Bitcoin derives its value due to the fact that investors and other buying agents believe that the Bitcoin will retain its value during the time that they own it and that they would not end up with the so-called hot potato. Through incomplete information and uncertainty, agents take this risk because the value of investing in the Bitcoin is higher than the loss incurred. From this it can be inferred that the Bitcoin is only valuable due to the fact that agents expect it to be valuable in the foreseeable future.

These expectations by agents in the market are impossible to measure and quantify, making it very hard to determine what drives the value of the Bitcoin. Therefore, measureable indicators for such expectations should be found and used instead of the actual expectations. These indicators can consist of macroeconomic measures, e.g. GDP per capita, unemployment, Consumer Confidence Index, etc. but also financial indicators, such as oil prices, stock exchanges, and exchange rates. These indicators can never represent the real expectations completely, but they can explain a significant percentage of its impact on the value of the Bitcoin.

3. Data

In the subsequent part of this paper, an empirical analysis will be performed on the value of the Bitcoin. Through this empirical analysis, financial indicators should be found that can explain the effect that expectations about economic performance have on the value of the Bitcoin. The decision to use financial data has been made because it is more frequent and more closely related to the Bitcoin itself.

3.1 Data Description

The dataset that is used in the analysis consists of 8 main variables, which will all be discussed in the following chapter. Additionally, the data transformation done in order to use the data in the empirical analysis will also be described in this chapter.

The first and most important variable is the closing value of the exchange rate of the Bitcoin to U.S. dollars (*bit_close*). This variable is a time series of the value of the Bitcoin at the closing time of the market called Mt. Gox, at 12.00 am. Mt. Gox is the biggest market for trading Bitcoins and is therefore the best estimation of what is the value of the Bitcoin at a particular time. The value of the Mt. Gox is in U.S. dollars in this case. The raw data was downloaded from the website Bitcoin Charts (Bitcoin Charts).

The second variable is a time series of the closing value of the Dow Jones Index (*dj_close*). The Dow Jones Index is an industrial average that follows 30 major corporations on either the NYSE or the NASDAQ. The value of the Dow Jones is in U.S. dollars, price-weighted, and is very closely watched as a financial indicator for the state of the economy. Therefore the Dow Jones Index can be seen as an indicator for economic performance, especially for the U.S. economy. The data has been downloaded from the Datastream database of the EUR Library.

The third variable is the closing value of the FTSE 100 Index (*ftse_close*). The FTSE 100 index is a share index of the 100 largest companies on the London Stock Exchange. This concerns mostly multinational companies that operate all over the world, but have their headquarters in Europe. The FTSE 100 is one of the most closely watched financial indicators in Europe and therefore provides an overview of the state of the economy. The valuation is done in British Pounds. The data has been downloaded from the Datastream database of the EUR Library.

Another variable is the closing value of the Nikkei 225 Index (*nik_close*). The Nikkei 225 Index is an industrial average that takes into account 225 large to very large corporations in Japan on the Tokyo Stock Exchange, measured in Japanese Yen. This internationally recognized index is an indication of economic performance in Japan and several other Eastern Asiatic countries. The data has been downloaded from the Datastream database of the EUR Library.

Furthermore, there are two variables concerning the exchange rates between the U.S. dollar and the Euro and the Yen, (*eur_us, yen_us*). The values are in euros and yens respectively, because this makes the interpretation in the data analysis clearer. The data has been downloaded from the Datastream database of the EUR Library.

The last three variables are all measurements concerning oil prices, namely the Brent oil price (*oil_brent*), the West Texas Intermediate (WTI) oil price (*oil_wti*), and the UBS Bloomberg Constant Maturity Commodity Index (CMCI) of Oil (*oil_index*). The Brent oil price is the price of Crude oil in the North Sea and the WTI is the price of Crude oil as measured by the West Texas Intermediate, both measured in U.S. dollars per barrel. The CMCI by Bloomberg measures the collateralized returns from WTI Crude Oil Futures, ranging from 3 months to 3 years in U.S. dollars. The data of the CMCI has been downloaded from the Datastream database of the EUR Library and
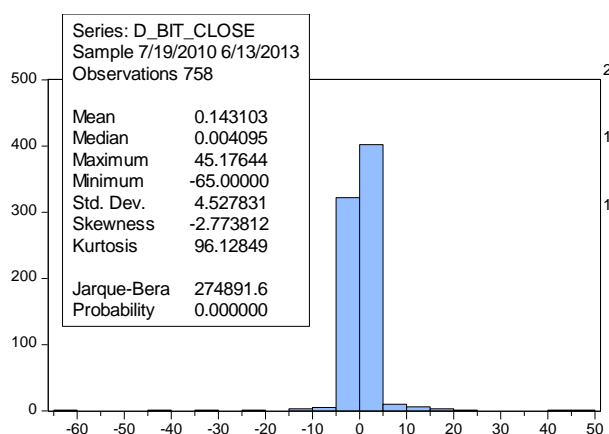
the other data of the oil prices has been downloaded from the website of the U.S. Energy Information Administration (U.S. Energy Information Administration).

The time frame of the data spans from the 19th July 2010 until 13th June 2013, which is almost 3 years worth of data, counting 759 observations. The data is provided in high-frequency daily data divided into five day weeks, from Monday to Friday, because most of the represented stock exchanges close during the weekends, hence no weekend data is available. In several time series, particularly the stock indices there are several gaps in the data, due to holidays in the respective countries, where the stock exchanges would close during those days. The fact that the data is provided in five day weeks can lead to weekly patterns, which should be adjusted accordingly in the data analysis.
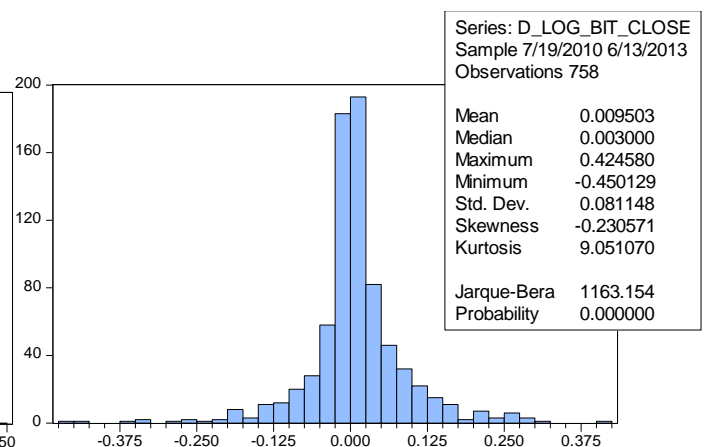
Data Transformation

The entire dataset concerns daily financial data, which, by definition, are mostly positive non-stationary variables. Therefore, the data should be transformed in such a way that it can be used in the data analysis. Firstly, the time series of the value of the Bitcoin shows a trend over time (Graph A.1) and when examining the histogram of the first difference of the time series, it shows much skewness and kurtosis. This histogram, displayed in Graph 3.1, shows many outliers and skewness, which indicates heteroskedasticity and exponentiality. In order to remedy this, the natural log of the variable is taken along with the natural log of all other variables. The new histogram of the first difference time series can be found in Graph 3.2. Additionally, the initial and the final time series of several of the variables after the transformation can be found in the Appendix (Graph A.1 –A.6).

Graph 3.1   **Graph 3.2**

Series: D_BIT_CLOSE	
Sample 7/19/2010 6/13/2013	
Observations 758	
Mean	0.143103
Median	0.004095
Maximum	45.17644
Minimum	-65.00000
Std. Dev.	4.527831
Skewness	-2.773812
Kurtosis	96.12849
Jarque-Bera	274891.6
Probability	0.000000

Series: D_LOG_BIT_CLOSE	
Sample 7/19/2010 6/13/2013	
Observations 758	
Mean	0.009503
Median	0.003000
Maximum	0.424580
Minimum	-0.450129
Std. Dev.	0.081148
Skewness	-0.230571
Kurtosis	9.051070
Jarque-Bera	1163.154
Probability	0.000000

Augmented Dickey-Fuller Test

In order to identify whether a variable is stationary and therefore can be used in the regression analysis, the Augmented Dickey-Fuller (ADF) test will be used. The ADF test examines a single

variable and tests whether this variable show non-stationarity. The equation used for the standard ADF-test is:

$$\Delta y_t = \theta y_{t-1} + v_t$$

where y_t = dependent variable, and v_t = the error term. The null and alternative hypotheses are $H_0: \theta = 0, H_a = \theta < 1$ respectively, the null hypothesis implying non-stationarity and the alternative hypothesis implying stationarity. The basic ADF model can be enhanced in such a way that it also accounts for either constant term or a constant and a trend term. The equations for those two tests are as follows:

$$\Delta y_t = \alpha + \theta y_{t-1} + v_t$$
$$\Delta y_t = \alpha + \theta y_{t-1} + \delta t + v_t$$

The α included in the equation concerns the constant term, meaning that the time series would be stationary around an upward or downward trend. The δt included only in the second equation is a trending term that takes into account the possibility that the change in y_t has a certain change over time, either increasing or decreasing. In both cases the hypotheses and conclusion are the same as in the basic model. The critical values are slightly different from the usual t or F critical values, and are also differing across the three tests. They can be found in any Econometrics textbook (Carter Hill, Griffiths, & Lim, 2012).

All variables are tested for stationarity using the Augmented Dickey-Fuller test. From the test it can be concluded that all variables except the oil price according to the WTI standard are non-stationary. There are several ways to deal with non-stationarity, e.g. taking the first difference, or introducing a trend term in the model. In this case the first difference of all non-stationary variables has been taken. As a result, all variables are now stationary and it is possible to use them in the final analysis.

3.2 Methodology

The statistical program that is used is called Eviews. The version that is employed in the statistical analysis is Eviews 7, which is provided by the Erasmus University Rotterdam. This particular statistics program is chosen, because it generally works well with time series, as well as regressions over a time period.

Ordinary Least Squares

Ordinary Least Squares (OLS) is the type of regression used in this paper, because it is the best estimator for linear relations between variables. OLS estimates the best possible linear relationship between the dependent and independent variables, thereby minimizing the sum of squared

residuals, meaning that a linear regression with lower sum of squared residuals explains the relation better.

It is possible that deleting terms from the regression equation will significantly decrease the explanatory power of the model, in which case we should keep the deleted variables in the regression equation. This can be tested by using an F-test, which checks whether the restricted model, i.e. the model without the specific variables, has a significantly higher sum of the squared residuals. The following formula is used in the estimation of this difference:

$$F = \frac{(SSE_R - SSE_U)/J}{SSE_U/(N - K)}$$

Where J = number of restrictions, N = number of observations, K = number of coefficients in the unrestricted model, and SSE_R, SSE_U = sum of squared residuals of the restricted model and unrestricted model, respectively (Carter Hill, Griffiths, & Lim, 2012).

There are several assumptions that have to be tested in order to check the validity of OLS, especially heteroskedasticity, serial correlation and cointegration. Heteroskedasticity in this case is solved due to the fact that the natural log is taken of all variables and the kurtosis that still ensues after this transformation is negligible.

Serial correlation concerns the correlation between the error terms of subsequent time periods. This correlation should be zero and can be tested by looking at the correlogram of the residuals of a regression analysis. Additionally, the Breusch-Godfrey LM test for serial correlation can be used to double check this assumption.

The last assumption to test concerns cointegration. When the residuals of a regression with all non-stationary variables are stationary, then it can be assumed that there is cointegration between the dependent and independent variables. In order to test this assumption, the residuals of the regression that includes all non-stationary variables, will be tested for stationarity using the ADF test. The resulting F-statistic of -5.28 and the corresponding p-value 0.0000 show that the residual series is stationary, thus this indicates cointegration (Carter Hill, Griffiths, & Lim, 2012).

Error Correction Model

Due to the fact that almost all variables have been transformed and are currently in the state of first difference, it can be stated that a lot of information is lost if only OLS is used. Taking the first difference of all variables will result in the loss of long run effects in the outcome of the analysis. Luckily, there is a technique called the Error Correction Model (ECM), which allows for dynamic effects, both short run and long run effects. Additionally, ECM also solves problems with cointegration, because it includes both the stationary variables as well as the non-stationary. The

ECM is constructed starting from the autoregressive distributed lag (ARDL) model by using a linear transformation. The ARDL model is as follows:

(3.1)
$$y_t = \alpha + \theta_1 y_{t-1} + \beta_0 x_t + \beta_1 x_{t-1} + v_t$$

The following linear transformation is called the Bårdsen (1989) transformation and is depicted below in steps:

$$y_t - y_{t-1} = \alpha + (\theta_1 - 1)y_{t-1} + \beta_0 x_t + \beta_1 x_{t-1} + v_t$$
$$\Delta y_t = \alpha + (\theta_1 - 1)y_{t-1} + \beta_0(x_t - x_{t-1}) + (\beta_0 + \beta_1)x_{t-1} + v_t$$

(3.2)
$$\Delta y_t = \alpha + (\theta_1 - 1)y_{t-1} + \beta_0 \Delta x_t + (\beta_0 + \beta_1)x_{t-1} + v_t$$

where $\Delta y_t = y_t - y_{t-1}$, and $\Delta x_t = x_t - x_{t-1}$. It is easily noticeable that by adding y_{t-1} on both sides, the new equation with y_t as the dependent variable is obtained. This equation is presented below:

(3.3)
$$y_t = \alpha + \theta_1 y_{t-1} + \beta_0 \Delta x_t + (\beta_0 + \beta_1)x_{t-1} + v_t$$

Ordinary Least Squares can be used to estimate equation (3.2) and (3.3) easily.

Dynamic effects

From equation (3.2), the long run and short run effects can be distinguished. In order to find the long run effect we have to start from the ARDL model:

(3.1)
$$y_t = \alpha + \theta_1 y_{t-1} + \beta_0 x_t + \beta_1 x_{t-1} + v_t$$

In the long run it can be assumed that $y_t = y_{t-1} = y$, $x_t = x_{t-1} = x$, and $v_t = 0$. After implementing this assumption, the following equation can be derived:

(3.4)
$$y(1 - \theta_1) = \alpha + (\beta_0 + \beta_1)x$$

Rewriting this equation leads to the long run trend, as depicted below:

(3.5)
$$y = \frac{\alpha}{1 - \theta_1} + \frac{(\beta_0 + \beta_1)}{1 - \theta_1}x$$

The last equation shows the long run effect of the ECM model, leaving the remaining part of the equation as the short run effect, consisting of $\beta_0 \Delta x_t$ and v_t (Carter Hill, Griffiths, & Lim, 2012).

The ECM is implemented as a dynamic model, because it corrects the short run changes with a long run trend in such a way that errors do not deviate far from the long run trend. This indicates that ECM is a better estimator than Ordinary Least Squares and should rather be used, especially when working with time-series data.

3.3 Results

OLS with the first difference variables

In order to examine the impact of expectations on the value of the Bitcoin, a regression will be estimated with the value of the Bitcoin as the dependent variable and the variables for the value of the Dow Jones, the value of the FTSE 100, the value of the Nikkei 225, the euro-dollar exchange rate, the yen-dollar exchange rate, the Brent oil price, the WTI oil price and the CMCI oil price index as the independent variables. The output can be observed in Table 3.1:

Table 3.1

Dependent Variable: D_LOG_BIT_CLOSE
Method: Least Squares
Date: 06/26/13   Time: 13:59
Sample (adjusted): 7/21/2010 5/30/2013
Included observations: 603 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.158634	0.170211	-0.931979	0.3517
D_LOG_DJ	1.162738	0.491782	2.364337	0.0184
D_LOG_EUR_US	-0.358594	0.597428	-0.600230	0.5486
D_LOG_FTSE	-0.506164	0.469668	-1.077707	0.2816
D_LOG_NIK	-0.113574	0.296836	-0.382616	0.7021
D_LOG_OIL_BRENT	-0.120033	0.231434	-0.518650	0.6042
D_LOG_OIL_INDEX	-0.002525	0.302045	-0.008360	0.9933
LOG_OIL_WTI	0.036927	0.037650	0.980797	0.3271
D_LOG_YEN_US	0.960973	0.638149	1.505876	0.1326

R-squared	0.018708	Mean dependent var		0.008824
Adjusted R-squared	0.005492	S.D. dependent var		0.084851
S.E. of regression	0.084618	Akaike info criterion		-2.086532
Sum squared resid	4.253139	Schwarz criterion		-2.020832
Log likelihood	638.0894	Hannan-Quinn criter.		-2.060962
F-statistic	1.415546	Durbin-Watson stat		1.844875
Prob(F-statistic)	0.186638			

As can be observed, the only variable that is significantly influencing the independent variable is the value of the Dow Jones Index, which has a significant positive effect on the independent variable. This means that the other insignificant variables could be deleted from the regression.

In order to see whether the insignificant variables should be deleted, an F-test can be performed on the sum squared residuals of both the restricted and the unrestricted model, to see whether the full model explains more than the restricted model with the deleted coefficients. As can be seen from the output, the sum of squared residuals of the full model is 4.25 and that of the restricted model is 4.67. Therefore the result of the F-test on model significance is as follows: an F-statistic of $F_{(7, 595)} = 8.44$, which is bigger than the critical value of 2.02. This would indicate that it is not appropriate to delete the variables from the regression equation.

So, proceeding with the full model, where all variables are included. However, before drawing any conclusions the validity of this linear regression analysis will be checked by testing several assumptions of a regression model.

To test for serial correlation, the correlogram of the residuals is observed (Table A.7), which shows serial correlation up to the 31st lag. Additionally, the Breusch-Godfrey LM test with five lags is performed in order to give another indication of serial correlation. The result that is obtained rejects the null hypothesis that says that there is no serial correlation of the error term. With an F-statistic of 5.88 and a p-value of 0.00, we can conclude that there is serial correlation in the error terms. Especially the first and fifth lags are significantly correlated with the current period residual. This problem will be addressed later.

From this regression the conclusion can be drawn that the change in the value of the Bitcoin depends on the change in the value of the Dow Jones (1.16) minus a constant. The rest of the variables are insignificantly different from zero, but by looking at the size of the coefficients, it can be observed that especially the change in the exchange rate between the yen and the dollar has a large impact on the change of the closing value of the Bitcoin.

Error Correction Model

However, in order to remedy the problem with cointegration and to distinguish between the long-run and the short-run effects of the dependent variables on the independent variable, the Error Correction Model (ECM) will be used. The ECM regression is run taking into account all variables and their first order autoregressive term plus the first-order autoregressive term of the value of the Bitcoin.

Also for this regression, validity will be checked, in particular serial correlation. Again, heteroskedasticity is solved due to the fact that the natural log of all variables has been taken at the start of the analysis.

The assumption of autocorrelation will be tested by first looking at the correlogram, which can be found in Table A.8 in the Appendix. The correlogram indicates autocorrelation in the first lag and from the fifth lag up to the 23rd lag. When using the Breusch-Godfrey LM-test, which results in an F-statistic of 5.88 and a p-value of 0.00, it can be concluded that the regression contains autocorrelation. Especially the first and fifth lags correlate clearly with the residual of the current period. This autocorrelation can be explained by showing that the variables are divided in data of five day weeks, which are most probably the cause of this autocorrelation.

In order to remedy the problem with autocorrelation, the error terms will be allowed to correlate with the residuals of the past periods through an AR(5) coefficient. The decision has been made for such a coefficient, because the AR(1) through AR(4) are not significantly reducing serial

correlation. Additionally, it can be stated that the AR(5) coefficient changes the error term in such a way that it takes into account the variation of the past 5 lags, resulting in a new uncorrelated error term. This AR(5) coefficient also takes into account the weekly effect that is created due to the construction of the data in 5 day weeks. The output of the entire regression can be found in Table 3.3:

Table 3.3
Dependent Variable: D_LOG_BIT_CLOSE
Method: Least Squares
Date: 07/02/13   Time: 15:19
Sample (adjusted): 8/06/2010 5/24/2013
Included observations: 368 after adjustments
Convergence achieved after 9 iterations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.781630	1.189284	-3.179754	0.0016
LOG_BIT_CLOSE(-1)	-0.021864	0.005675	-3.852766	0.0001
D_LOG_DJ	1.249792	0.568446	2.198611	0.0286
D_LOG_EUR_US	0.388256	0.733598	0.529249	0.5970
D_LOG_FTSE	0.061005	0.543333	0.112279	0.9107
D_LOG_NIK	-0.438453	0.334684	-1.310052	0.1910
D_LOG_OIL_BRENT	0.113007	0.262000	0.431322	0.6665
D_LOG_OIL_INDEX	-0.180018	0.493493	-0.364784	0.7155
D_LOG_OIL_WTI	0.089959	0.375233	0.239741	0.8107
D_LOG_YEN_US	0.489915	0.707740	0.692224	0.4893
LOG_DJ(-1)	0.536843	0.203416	2.639139	0.0087
LOG_EUR_US(-1)	-0.342415	0.150003	-2.282715	0.0230
LOG_FTSE(-1)	-0.022672	0.202176	-0.112139	0.9108
LOG_NIK(-1)	-0.013812	0.103113	-0.133948	0.8935
LOG_OIL_BRENT(-1)	0.073220	0.080589	0.908559	0.3642
LOG_OIL_INDEX(-1)	-0.006572	0.146884	-0.044744	0.9643
LOG_OIL_WTI(-1)	-0.247003	0.100332	-2.461859	0.0143
LOG_YEN_US(-1)	-0.044623	0.167079	-0.267077	0.7896
AR(5)	-0.235096	0.047388	-4.961111	0.0000

R-squared	0.157078	Mean dependent var		0.005117
Adjusted R-squared	0.113604	S.D. dependent var		0.081905
S.E. of regression	0.077113	Akaike info criterion		-2.236851
Sum squared resid	2.075276	Schwarz criterion		-2.035075
Log likelihood	430.5806	Hannan-Quinn criter.		-2.156687
F-statistic	3.613108	Durbin-Watson stat		1.787624
Prob(F-statistic)	0.000001			

Inverted AR Roots	.61-.44i	.61+.44i	-.23+.71i	-.23-.71i
	-.75			

After introducing the AR(5) coefficient it can be shown that the regression contains no more significant autocorrelation, as the correlogram (Table A.9) shows no autocorrelation and the Breusch-Godfrey LM test does not reject the null hypothesis of no autocorrelation with an F-statistic of 1.42 and a p-value of 0.22.

Long run

The long run shows a trend with the following significant variables: the value of the Dow Jones, the euro-dollar exchange rate, and the WTI oil price. The remaining variables have a very low coefficient indicating that they cause little variation in the dependent variable. The value of the Dow Jones (0.525) has a positive effect on the value of the Bitcoin in the long run. If the assumption is made that the Dow Jones Index is in indication of economic performance, this would be an indication that the value of the Bitcoin is positively correlated with a well performing U.S. economy.

The other two variables are both negatively influencing the value of the Bitcoin in the long run. Examining the variables in more detail can explain why. The variable for the euro-dollar exchange rate (-0.335) indicates the price of a euro in U.S. dollars, which means that the dollar appreciates if the value of this variable increases. If the dollar appreciates against the euro, it is most likely the case that it will also appreciate against the Bitcoin. Consequently, an increase in euro-dollar exchange rate would lead to a decrease in the amount of dollars that have to be paid for one Bitcoin, which decreases its value.

The coefficient for the WTI oil price (-0.242) indicates the price of a barrel of Crude Oil as measured by the WTI. An increase in this variable leads to a decrease in the budget of consumers, meaning that less money will be spent on other goods, possibly the Bitcoin. Consequently, this would lead to a decrease in demand for Bitcoin, decreasing its value.

It can be noticed that all variables which are significantly influencing the value of the Bitcoin in the long run are directly related to the U.S. Economy. This can be explained by the fact that in the U.S. the Bitcoin is currently more popular than anywhere else in the world.

Short run

In the short run, the coefficients that represent change in the independent variables are considered together with the autoregressive coefficient that represents the value of the Bitcoin in the previous period.

It should be observed from the equation that the value of the Bitcoin (-0.022) in the previous period has a negative, significant effect on the change in the value of the Bitcoin in the current period. To be more exact, the change in the value of the Bitcoin is equal to -2.2% of the value of the Bitcoin in the last period, ceteris paribus. This indicates a downward trend in the value of the Bitcoin when looking at the autoregressive coefficient. When implementing the transformation from equation (3.2) to (3.3), it can be shown that the value of the Bitcoin is equal to 97.8% of the previous value, ceteris paribus.

However, there are other variables that also impact the value of the Bitcoin. The change in the value of the Dow Jones is the only variable that is significantly influencing the value of the Bitcoin

in the short run. This coefficient (1.25) is positive and quite large, showing a clear correlation between the value of the Bitcoin and the change in the value of the Dow Jones. Most probably, this is due to the fact that the Dow Jones Index is one of the most closely watched indicators of the U.S. economy. If the value of the Dow Jones suddenly changes in several days, this usually indicates a large scale event that also influenced the demand for Bitcoins. Therefore, it would be appropriate to say that the Dow Jones and Bitcoin are closely linked, in the short run as well as in the long run.

There are several other variables, which show a coefficient insignificantly deviating from zero, but still show a large coefficient that would explain some of the variation in the dependent variable. The coefficients of the euro-dollar exchange rate, value of the Nikkei 225, and the yen-dollar exchange rate are large enough to be considered as an explanatory variable in the regression analysis. For the variables concerning the exchange rates, they are similarly positively correlated with the dependent variable (0.388, 0.490), which indicates the opposite of what could be observed in the long run. It can be observed that increase in either variable, indicates an appreciation of the U.S. dollar and would increase the value of the Bitcoin. This observation can only be explained by showing that an appreciation is an indication of economic growth and prosperity. As this happens in the short run, people expect the economy to grow when short run indicators point in that direction. This would again show that the value of the Bitcoin is positively correlated with good expectations of economic performance.

The correlation with the variable of the value of the Nikkei 225 is negative (-0.438), showing that the value of the Bitcoin is more closely correlated with the U.S. economy. An explanation can be found by looking at the buyers of Bitcoins. These are mostly investors who believe that the Bitcoin is a profitable investment, and a positive change in the value of the Nikkei 225, would create other investment opportunities for them. Consequently, there will be less demand for the Bitcoin and the value of the Bitcoin drops.

Conclusion

In this paper, the value of the Bitcoin has been examined. The Bitcoin is an example of fiat money, more precisely of fiat money in a finite real world economy. As the Bitcoin is not supported by any government or financial institution, it is hard to explain why agents and investors in the real world would purchase this coin. However, Kovenock and De Vries (2002) have developed a solution, which solves this problem due to the uncertainty among agents of when the coin will finally end up with no value. Due to this uncertainty and the recent popularity of the Bitcoin, the value of the Bitcoin has a significantly high value.

Using financial data, the value of the Bitcoin is examined. The financial data consists of several stock exchange indices, exchange rates, and oil prices measures. This financial data serves as good economical indicators of the world economy, especially for the U.S., Europe, and Japan. They indicate economic performance and economic growth, which might influence the value of the Bitcoin.

Finally, due to the ECM model, the analysis could be performed with the most information as a result. It can be concluded that several financial indicators, including the value of the Dow Jones, the euro-dollar exchange rate, and the WTI oil price have a significant effect on the value of the Bitcoin in the long run. The value of the Dow Jones Index also significantly affects the value of the Bitcoin in the short run. In conclusion it can be said that most of the influencing variables are related to the U.S. economy and therefore the economic performance and growth should be watched most closely when investing in the Bitcoin.

Discussion

There are some restrictions to the analysis done in this paper. Firstly, there is a very limited time frame in which the analysis is done due to the fact that the Bitcoin is very new, which might render many conclusions made in this paper unsatisfying. Secondly, the independent variables used in this case may not effectively reflect the expectations of agents in the market and the financial indicators used here are not complete. Only several have been selected due to limited time for the research. Therefore a suggestion would be to reanalyze the effect of expectations on the value of the Bitcoin in a few years, while using more variables or while using different kinds of variables, like for example macroeconomic variables.

Additionally, a better estimator than ECM could be used in the final analysis. For example, (G)ARCH is a highly suggested technique for analyzing data with serial correlation. However, this requires a continuous dataset, which would mean a change in the way that the dataset is constructed.

In the end it is very hard to estimate and predict the value of the Bitcoin due to the nature of this currency. There is very little certainty in the market of the Bitcoin, making an investment here very risky. It is also unclear how much longer the Bitcoin will continue to exist. It is known that the Bitcoin will exist as long as people trust it, but due to a lack of regulation and governmental support there is no say whether this trust is long-lasting.

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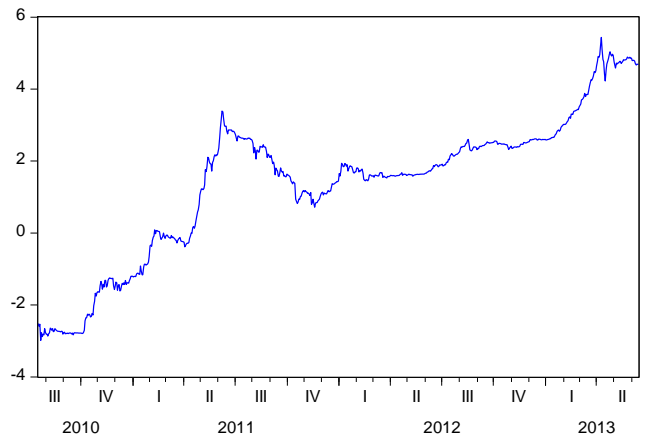Smith, A. (1776). *An Inquiry into the Nature and Causes of the Wealth of Nations.* W. Strahan and T. Cadell, London.
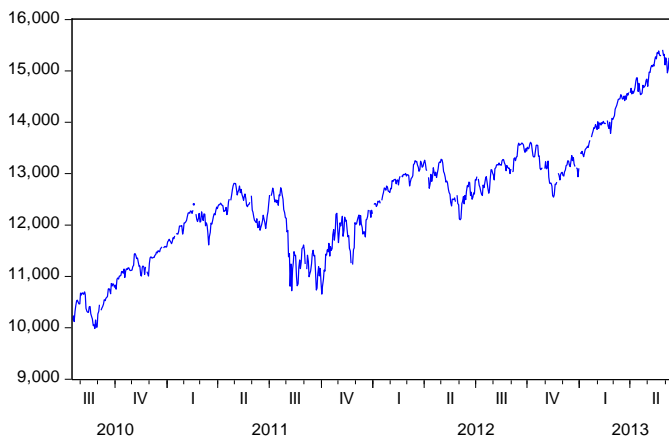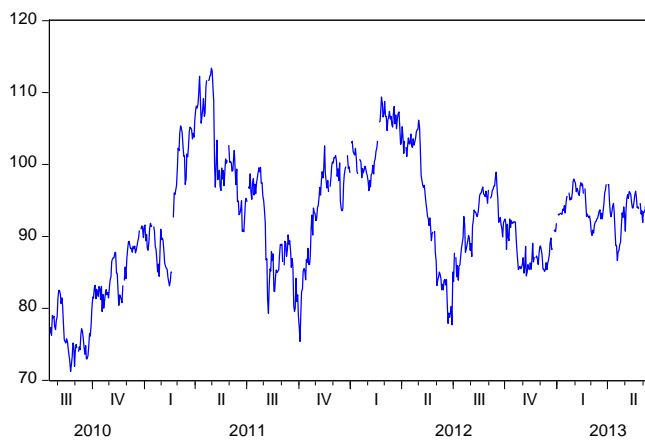
Appendix

Graph A.1 – A.6
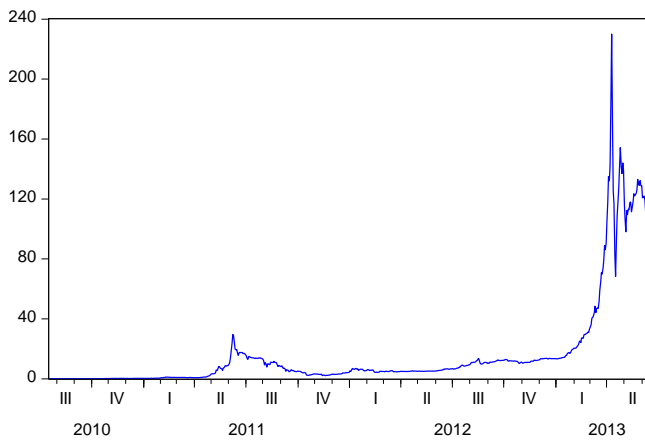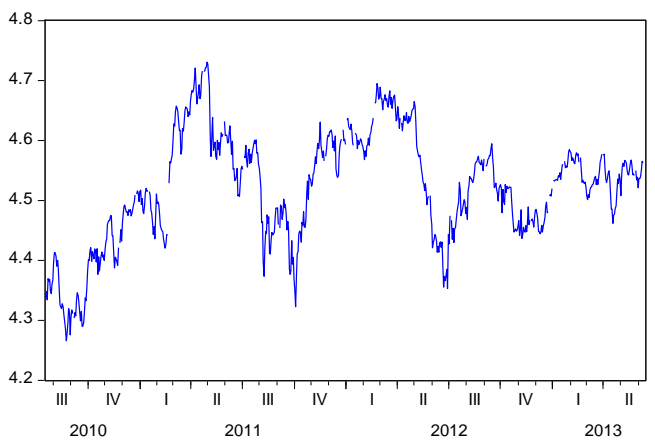
Table A.7

Date: 07/11/13   Time: 14:39
Sample: 7/21/2010 5/30/2013
Included observations: 603

	AC	PAC	Q-Stat	Prob
1	0.101	0.101	6.1761	0.013
2	0.010	-0.001	6.2312	0.044
3	0.081	0.081	10.204	0.017
4	0.020	0.004	10.448	0.034
5	-0.139	-0.144	22.300	0.000
6	-0.075	-0.055	25.757	0.000
7	0.026	0.039	26.182	0.000
8	0.010	0.028	26.242	0.001
9	0.065	0.080	28.837	0.001
10	0.027	-0.010	29.277	0.001
11	0.037	0.011	30.113	0.002
12	0.014	0.001	30.241	0.003
13	-0.001	0.001	30.242	0.004
14	0.037	0.057	31.082	0.005
15	0.050	0.053	32.625	0.005
16	0.047	0.041	33.981	0.005
17	0.056	0.044	35.915	0.005
18	0.044	0.017	37.145	0.005
19	0.026	0.020	37.568	0.007
20	0.076	0.083	41.224	0.003
21	0.037	0.034	42.096	0.004
22	0.008	0.013	42.136	0.006
23	-0.004	-0.016	42.148	0.009
24	0.016	0.005	42.299	0.012
25	-0.033	-0.027	43.007	0.014
26	-0.035	-0.022	43.800	0.016
27	0.018	0.019	44.000	0.021
28	-0.028	-0.041	44.496	0.025
29	-0.014	-0.022	44.624	0.032
30	-0.028	-0.052	45.136	0.037
31	-0.019	-0.039	45.359	0.046
32	-0.011	-0.012	45.437	0.058
33	0.006	-0.001	45.457	0.073
34	0.008	-0.005	45.498	0.090
35	0.019	-0.001	45.741	0.106
36	0.052	0.024	47.511	0.095

Table A.8

Date: 07/11/13   Time: 15:52
Sample: 7/21/2010 5/30/2013
Included observations: 603

	AC	PAC	Q-Stat	Prob
1	0.087	0.087	4.5643	0.033
2	-0.004	-0.011	4.5718	0.102
3	0.061	0.062	6.7987	0.079
4	0.003	-0.008	6.8044	0.147
5	-0.160	-0.161	22.481	0.000
6	-0.091	-0.069	27.507	0.000
7	0.012	0.024	27.599	0.000
8	-0.011	0.006	27.670	0.001

	AC	PAC	Q-Stat	Prob
9	0.047	0.061	29.013	0.001
10	0.009	-0.027	29.062	0.001
11	0.019	-0.006	29.273	0.002
12	-0.005	-0.015	29.290	0.004
13	-0.011	-0.007	29.360	0.006
14	0.030	0.049	29.913	0.008
15	0.037	0.041	30.763	0.009
16	0.032	0.027	31.381	0.012
17	0.036	0.027	32.205	0.014
18	0.023	0.004	32.549	0.019
19	0.006	0.010	32.568	0.027
20	0.062	0.078	34.945	0.020
21	0.033	0.038	35.631	0.024
22	-0.005	0.004	35.649	0.033
23	-0.018	-0.024	35.862	0.043
24	0.009	0.004	35.910	0.056
25	-0.047	-0.033	37.322	0.054
26	-0.054	-0.028	39.175	0.047
27	0.003	0.013	39.181	0.061
28	-0.033	-0.039	39.866	0.068
29	-0.029	-0.031	40.407	0.077
30	-0.046	-0.064	41.755	0.075
31	-0.025	-0.042	42.162	0.087
32	-0.020	-0.017	42.411	0.103
33	-0.006	-0.007	42.434	0.126
34	0.002	-0.008	42.437	0.152
35	0.014	-0.009	42.564	0.178
36	0.049	0.023	44.123	0.166

Table A.9

Date: 07/18/13   Time: 12:33
Sample: 8/06/2010 5/24/2013
Included observations: 368
        Q-statistic
probabilities adjusted
 for 1 ARMA term(s)

	AC	PAC	Q-Stat	Prob
1	0.054	0.054	1.0834	
2	-0.054	-0.057	2.1673	0.141
3	0.091	0.098	5.2735	0.072
4	0.037	0.023	5.7780	0.123
5	-0.004	0.004	5.7827	0.216
6	-0.045	-0.051	6.5318	0.258
7	-0.018	-0.019	6.6588	0.354
8	-0.021	-0.026	6.8227	0.448
9	-0.012	-0.002	6.8774	0.550
10	-0.019	-0.015	7.0110	0.636
11	0.031	0.038	7.3733	0.690
12	0.011	0.006	7.4225	0.764
13	0.014	0.019	7.4940	0.823
14	0.042	0.034	8.1816	0.832
15	-0.005	-0.013	8.1925	0.879
16	-0.057	-0.059	9.4585	0.852
17	0.007	0.006	9.4762	0.893
18	-0.001	-0.008	9.4767	0.924
19	-0.028	-0.013	9.7926	0.938
20	-0.050	-0.042	10.770	0.931
21	0.008	0.015	10.794	0.951

22	0.010	0.003	10.830	0.966
23	-0.033	-0.024	11.263	0.971
24	-0.032	-0.031	11.659	0.975
25	0.016	0.009	11.756	0.983
26	-0.060	-0.070	13.187	0.974
27	-0.040	-0.023	13.826	0.975
28	-0.073	-0.082	15.940	0.954
29	-0.024	-0.008	16.180	0.963
30	-0.036	-0.036	16.705	0.967
31	0.024	0.047	16.942	0.973
32	-0.023	-0.034	17.149	0.979
33	-0.021	-0.007	17.324	0.984
34	0.058	0.044	18.713	0.978
35	-0.046	-0.059	19.573	0.977
36	0.034	0.035	20.037	0.980