A Bitcoin Valuation Model Assuming Equilibrium Of Miners’ Market -- Based On Derivative Pricing Theory

1st January 2019

Ziang LING, Bitblock Group Founding Partner, Fiat Capital Managing Partner, ZheJiang University Blockchain Association Co-founder

Chengpei LIU, Bitblock Group Regional Executive Director (Singapore), Bdong Research Institute Chief Research Officer

Eric YUAN, Bitblock Group Investment Manager, Bdong Research Institute Research Analyst
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Abstract

The concept of Bitcoin first appeared in the world in 2008 and Bitcoin first appeared in the world in 2019. Now after 10 years, Bitcoin starts to move gradually from the geek world towards the mass capital markets. Especially in the recent two years, the real value of Bitcoin has been the centre of an increasingly vibrant discussion in the market. Even practitioners and academia are debating on how to value Bitcoin appropriately.

With the burst of financial bubbles in 2017 and 2018, the real intrinsic value of Bitcoin is still highly debated. Based on data from July 2016 to December 2018, this research paper aims to explain the relationships between Bitcoin price and its intrinsic value based on the market equilibrium in the mining industry. The model has significantly explanatory power on some recent cryptocurrency events through microeconomics cost analysis method. We concede the needs to consider the endogeneity of the model and will analyse retail trading activities in a subsequent research paper.

Secondary Research

Since its inception, Bitcoin’s nature and function have been highly controversial among academia and usually deemed as a mix of gold, securities, and currencies. As a method of payment, it can facilitate trade and finance. The price of Bitcoin behaves like a highly speculative security (Lee, Changjia, 2014). Nonetheless, Bitcoin is produced like gold, with a maximum supply of 21 million. Currently, the total number of Bitcoin mined is 17 million, and the mining speed halves every four years. From July 24th 2016 until now, 12.5 Bitcoin is produced every 10 minutes.

There are usually three theories on Bitcoin valuation model, and we summarize them below.

I. Currency Model.

Bitcoin was conceptualized as a digital cryptocurrency, with the aim of replacing the fiat currency issued by sovereign entities. As a currency, the value of Bitcoin is directly connected to the users’ expectation, its circulation, and its velocity (Dannis van Wijk, 2013).

We can thus analyze the value of Bitcoin as if it functions like a world currency with no national boundaries. Macroeconomists have worked on the valuation of fiat currencies for decades if not centuries. Among existing theorists, Irving Fisher, an esteemed professor from Yale University, has produced a highly influential equation: MV=PQ. We can adopt this theory and assume that Bitcoin can serve as a fiat currency, just like any national currency. Then the value of Bitcoin can be expressed as:
\[ P = \frac{MV}{Q} \quad (I) \]

Here, \( P \) is the price of goods and services denoted in Bitcoin. \( M \) represents the supply of Bitcoin, \( V \) the circulating velocity of Bitcoin, and \( Q \) the total quantity of goods and services traded via Bitcoin.

With the help of Fisher’s equation, we can establish a valuation method for Bitcoin. There have been many practitioners who attempt to pin down the exact value of Bitcoin or any other cryptocurrency through this quantitative model, unfortunately without much success. Indeed, there are many reasons for this failure, but here we list the two most significant ones.

Firstly, Fisher’s equation proves difficult to explain some macroeconomics phenomena even outside of cryptocurrency field. Especially after the 2008 financial crisis, many central banks, including the Federal Reserve, eased the money supply substantially through the Quantitative Easing (QE) program. As \( M \) increases in the equation above, the price of goods and services, as indicated by global inflation, ought to rise, ceteris paribus. Nonetheless, global deflation pressure did not ease even several years after the crisis. This empirical experiment proved the deficiency in Fisher’s equation’s explanatory power.

Secondly, the value of Bitcoin seems hardly limited as a currency. The vast amount of investments into the cryptocurrency markets together with its extreme volatility illustrates the security characteristics of Bitcoin. Therefore, it is not surprising that the currency model has very limited explanatory power on Bitcoin value.

II. Supply And Demand.

Supply and demand are the basic explanatory tools for economic studies. The price of Bitcoin is only determined by the equilibrium between supply and demand. From a macroeconomic perspective, Bitcoin can be viewed as a good with perfect inelastic supply at any one point of time. Its price is thus determined by the equilibrium of supply and demand, while the price volatility is decided by the velocity of change of demand and supply curves. As time changes, the demand curve may shift towards the right. While in the foreseeable future, as more people join the Bitcoin market, the demand curve shifts up with a higher speed than that of change of supply curve. Hence, the price will rise.
As shown in Figure 1.1 and Figure 1.2, $P_{t2} > P_{t1}$.

From a microeconomic perspective, the supply and demand curves of every individual market (mutually exclusive Bitcoin trading exchanges) have their unique elasticities. Therefore, the change of price of Bitcoin depends not only on the speed of change of supply and demand curve at the collective market but also the direction of change and the elasticity at a micro level. The graphs below discuss two cases in the microeconomic markets.

As shown in Figure 2.3 and Figure 2.4, $P_{t2} > P_{t1}$. The demand curve has a higher elasticity than the supply curve. When both curves move outwards at the same speed, $P_{t2} > P_{t1}$.

As shown in Figure 2.3 and Figure 2.4, $P_{t2} > P_{t1}$. The demand curve has a lower elasticity than the supply curve. When both curves move outwards at the same speed, $P_{t2} < P_{t1}$.

Demand and supply model utilizes the theory of equilibrium pricing. Without additional price factors, it is able to analyse the equilibrium price of Bitcoin.

However, the demand and supply theory has its setbacks. Even in the field of financial economics, it is extremely challenging to measure the position and elasticity of demand and supply curve accurately. Very few real-world cases obey the condition of ceteris paribus. At any point in time, any price or quantity movement might come from multiple factors. The observers measure the current price and quantity without observing the causal relationships. As a result, the equilibrium pricing model has very limited practical usage. In the case of Bitcoin pricing, any cryptocurrency researcher can hardly use the equilibrium model to predict the price movement.
III. Mining Model

Bitcoin is produced through the process of ‘mining.’ The commercial activity of mining starts with the purchase of a ‘mining machine,’ i.e. a computer with high computational power. Then miners pay a substantial amount of electricity cost every day. The cost of Bitcoin mining is thus the opportunity cost of obtaining Bitcoin and subsequently deemed as the approximated intrinsic value of Bitcoin. Research has shown that this intrinsic value can serve as a fundamental support position in the Black Swan event (Emily M. Little, 2014).

According to Cox.Ross derivative pricing model, the price of a derivative is equal to the expected discounted value at a risk-neutral position. The pricing formula is as follows:

\[ P = E_{X_0} [e^{\int_0^T -r(t)dt} \times \Pi(X_T)] \]  

\[ P = E_{X_0} [e^{\int_0^T -r(t)dt} \times (\Pi(X_T) - C \times \text{hash rate})] \]  

\( P \) is the price of the derivative, \( \Pi(X_T) \) the revenue function, \( r(t) \) the current discount rate, \( E_{X_0} \) the risk-neutral expected value at the initial condition of \( X_0 = x_0 \) (Cox.Ross, 1976). According to Cox. Ross pricing model, we can solve for Bitcoin’s fair market value. We deem the mining machine as a financial derivative, the price of which is the difference after discount between the expected value of Bitcoin mined and the electricity cost during the lifetime of the machine. Subsequently, we utilize the arbitrage pricing model through expected risk and return. Then, we obtain the equation below:

\[ P = E_{X_0} [e^{\int_0^T -r(t)dt} \times (\Pi(X_T) - C \times \text{hash rate})] \]  

\( P \) is the mining machine, a fixed value at any point in time. \( T \) is the lifetime of the mining machine, \( r(t) \) the riskless interest rate, \( \Pi(X_T) \) is Bitcoin’s revenue function, i.e. the intrinsic value of Bitcoin times the expected Bitcoin mined in a day. \( C \) denotes the daily cost (24 hours) of electricity needed to maintain 1 TH/s of hash rate. \( \text{hash rate} \) is the total computational power of the entire Bitcoin network. We simplify the growth of computational power, in the unit of Th/s, using a compounded growth model.

Fundamentally, the mining model is based on the non-arbitrage pricing or risk-neutral pricing model in financial economics. The theory states that any riskless arbitrage opportunity is quickly taken up by well-capitalized market players, and thus the price is maintained at the arbitrage-free price level. This paper focuses on valuing Bitcoin through the mining model and subsequently utilizes the valuation method to explain events and trends in the cryptocurrency markets since 2016.

IV. Summary

Cryptocurrency market has seen drastic changes in the past few years. Since 2013, competitors of Bitcoin, led by Litecoin and Ethereum, have flourished. Their increased
dominance and a rise in market value especially in 2017 brought prosperity to the cryptocurrency market.

Bitcoin, as the first cryptocurrency, has a block speed of around 6 to 7 transactions per second. For most of the time, the entire Bitcoin network was too crowded to perform a meaningful function of liquid transactions. As a result, Bitcoin failed to serve as a valid currency in any future commercial setting. In the last ten years, Bitcoin community has proposed multiple solutions to expand Bitcoin’s transaction capacity, which all failed because of various reasons, such as conflicting mining interests. In comparison, other competitor coins have transaction speeds over 100 times that of Bitcoin. As payment tokens, they can perform liquid transactions at a more superior level.

Therefore, this paper defines the key property of Bitcoin as a storage of value. Bitcoin stores equivalent values from the “work of machines.” This paper values Bitcoin through revenue-cost model from the point of view of miners.

Model Construction

The central theme of the model is: (1) Bitcoin’s development and value appreciation are driven by miners, and thus the price equilibrium is established through the equilibrium in the mining market; (2) Bitcoin market is global, and for the entire market to reach equilibrium, the entire global average cost and average revenue must balance; (3) whether potential miners should enter the market is based on the current expected revenue and costs discounted to the present.

We assume that a rational mining investor does not rely on the appreciation of Bitcoin price to profit – otherwise a rational mining investor will simply opt for the purchase of Bitcoin directly. Hence, the expected value of Bitcoin relies solely on considerations of mining power and electricity. We here disregard the irrational volatility and speculation in the Bitcoin markets which may lead to the issue of endogeneity. In the actual trading, there are a large number of retail investors, who behave mostly irrationally and chase for noise trades. These noise traders will be the focus of discussions of our next paper – “Irrational Trading In The Bitcoin Market: How Noise Traders Affect The Formation Of Market Bubbles.”

Based on our assumptions, the two key factors that determine Bitcoin values are electricity costs and mining machine costs. Electricity is a variable cost and mining machine is a fixed cost. Based on microeconomic analysis, mining operators continue to operate while the revenue is higher than the total cost. They continue to operate in the short run if the revenue is lower than the total cost but higher than the variable cost. If the revenue is lower than variable cost, the operators cease production immediately. As a result, the paper constructs a model based on the electricity cost, i.e. variable cost, in addition to the mining machine cost, i.e. the fixed cost. Subsequently, we analyze the Bitcoin price movements with the help of the constructed value trend.
Note that we are only concerned with the period after 2016 July, because the nature of the mining business was vastly different before that. GPU mining (in contrast to ASIC) still represented a significant share of the computational power, and mining pool was not dominant. As a result, we cannot determine the equilibrium in the mining market just based on mining pool and mining machine information. Therefore, we decided to focus on the most representative period for analysis.

Before moving to the model, we explain the variables in the model below.

Table 3.1: all variables setup

<table>
<thead>
<tr>
<th>Factors</th>
<th>Explanations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ψ</td>
<td>Average variable cost, or electricity cost. We commonly associate this with the Bitcoin machine shut down price.</td>
</tr>
<tr>
<td>Φ</td>
<td>Average total cost, i.e. the discounted sum of electricity cost and mining machine cost. The price of Bitcoin needs to be equal to this cost to reach equilibrium.</td>
</tr>
<tr>
<td>B₀</td>
<td>The daily available Bitcoin for mining in the entire Bitcoin network. Approximately, the Bitcoin network releases 12.5 new Bitcoins every 10 minutes from August 2016 until April 2020.</td>
</tr>
<tr>
<td>Πₜ</td>
<td>The number of Bitcoins that can be mined theoretically on a day by one unit (TH/s) of hash power.</td>
</tr>
<tr>
<td>p₀</td>
<td>The average electricity cost in December 2018, denoted in dollars per kWh.</td>
</tr>
<tr>
<td>cₜ</td>
<td>The average daily electricity cost consumed by one unit (TH/s) of hash power weighted by mining machine market share.</td>
</tr>
<tr>
<td>c₀</td>
<td>cₜ in December 2018.</td>
</tr>
<tr>
<td>ε</td>
<td>Electricity cost gradient: according to our interviews with miners and mining pools as well as information collected online, we obtain some weighted average electricity costs at different points of time from 2016 to 2018. We then construct a piece-wise linear function to represent the historic electricity costs. The gradient of electricity cost here is that of the piece-wise linear function.</td>
</tr>
<tr>
<td>W</td>
<td>Average power of the mining machine on a per hash unit (TH/s) basis weighted according to the mining machine market share.</td>
</tr>
<tr>
<td>Wᵢ</td>
<td>The power of four different mining machines on a per hash unit (TH/s) basis: Antminer, Dragonmint, Avalon, Pangolin. These four mining machines occupy more than 90% of the computational power on the Bitcoin network.</td>
</tr>
<tr>
<td>ω</td>
<td>The weight of the above four mining machines according to their respective computational/hash market share.</td>
</tr>
<tr>
<td>τ</td>
<td>Efficiency discrepancy, i.e. the difference between the actual power efficiency of the mining machines and the stated ones by the machine producers.</td>
</tr>
<tr>
<td>p</td>
<td>The daily price of the mining machine, according to websites, Amazon, and other tracking sources.</td>
</tr>
<tr>
<td>T</td>
<td>The average lifetime of a mining machine, according to discussions with miners and references to mining news.</td>
</tr>
<tr>
<td>r</td>
<td>The discount rate or expected return rate.</td>
</tr>
<tr>
<td>hₜ</td>
<td>The moving seven-day average of the entire Bitcoin network’s hash rate. h₀ represents the most recent data point.</td>
</tr>
</tbody>
</table>
Firstly, we construct a function to represent the average electricity cost, i.e. the average shut down price of mining machines.

\[ c_0 = \bar{W} p_0 (1 + \tau) \quad (4) \]

\[ c_t = c_0 + \varepsilon t \quad (5) \]

\[ \bar{W} = \sum \omega W_i \quad (6) \]

\[ \Psi = \Psi(c_t, h_t, \bar{W}, B_0) = \frac{h_t c_t}{g_0} \quad (7) \]

Here, we take \( p_0 \) as 0.35 RMB per kWh, i.e. 0.051 USD per kWh. The electricity cost in December 2018 serves as a basis, which is 0.31 RMB per kWh. We then add a 15% margin by the mining pools, i.e. 0.051 USD per kWh. Therefore, the actual electricity cost is calculated to be 0.35 RMB per kWh\(^1\).

According to our interviews with miners and mining pools as well as information collected online, with the increasing size of the mining industry, the electricity cost is also climbing up. We then construct a function with a fixed point at present and a positive gradient \( \varepsilon \) to represent the historic electricity costs.

The daily available Bitcoin for mining in the entire Bitcoin network is 1800: \( B_0 = 12.5 \times 60 \times \frac{24}{10} = 1800 \).

According to our interview with miners, there is a difference between the stated power efficiency and the actual one during mining. The difference may be caused by overstated efficiency, extra heat losses, and so on. We estimate the average efficiency discrepancy ranges from 20 to 30 percent and thus take 25 percent as a benchmark in the model.

We are then able to construct the average shut down price of Bitcoin mining machine since July 2016. The graph is shown below.

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\(^1\) We hereby express our sincere gratitude to by Liyun Finance, who provided excellent resources for our research.
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Figure 3.1: Bitcoin shut down price trend

Moving on, we construct a model for the average total cost. Here we adopt the logic of the Cox.Ross pricing model (as explained in Equation 2 above and restated below).

\[
P = e^{\int_{0}^{T} -r(t)dt} \cdot (\Pi - C \cdot \text{hash}_{t})
\]

Our equation assumes zero arbitrage profit in economic terms, i.e. the average total revenue equal to the average total cost. The average total revenue comes directly from the sale of Bitcoin on the secondary markets, while the average total cost consists of the average electricity cost plus the fixed cost of mining machines. Hence, our paper models the Bitcoin equilibrium value to be as follows:

\[
\Pi_{t} = \frac{\phi}{h_{o}e^{t_{o}}}
\]

\[
P = \int_{T}^{r(t)dt} e^{-r(t)(\Pi_{t} - c_{t}) dt}
\]

Here, \(T = 730\) (days). According to discussions with miners, the lifetime duration of the mining machine is around 2 years, i.e. 730 days. Admittedly, the depreciation of mining machines can vary greatly. Nonetheless, there are mainly two reasons why a mining machine is declared ‘dead’ completely. Firstly, as the total hash rate of the entire network increases, the old and less efficient machine produces insufficient Bitcoin to warrant the continued productions, i.e. the shut down price of the machine is hit. Nonetheless, since we are calculating the necessary Bitcoin price to balance the revenue and the cost of Bitcoin mining machine and the electricity, the case that the machine hits its shut down price prematurely shall not be considered. Secondly, after ages of mining, the mining machine performance will decrease substantially, deviating significantly from the stated computation efficiency. We here consider only the second case, and based on our in-depth discussions with machine
producers, miners, and pools, we believe that it takes around two years for the machine’s performance to plunge and be abandoned.

Because the risk of holding Bitcoin is significantly higher than that of the fiat or any traditional financial assets, the discount rate r should also be adjusted to justify the risk premium. We researched on foreign mainstream cryptocurrency lending websites as well as reputable domestic cryptocurrency wallets with lending functions. We also take into account the relatively poor performances in cryptocurrency lending in the second half of 2018 and estimate that the required return of Bitcoin lending is around 2%. The annualized discount rate used in the model is thus 24%.

We set the price of Antminer S9 as the basis of the mining machine price P since for the most part between 2016 and 2017, Antminer S9 is the most dominant mining machine in the market. Because of the lack of real-time records of mining machine transactions, we construct a simplified piece-wise function to model the price change of Antminer S9. We collected data in the past few years on sporadic Antminer machine transaction prices, and use these data points as a basis. We then use a piece-wise linear function to construct a continuous function throughout mid-year 2016 to 2018.

Therefore, by solving the simultaneous multi-variable equations, we obtain the Bitcoin mining equilibrium price $\Phi$. The graph of shut down price and revenue-cost equilibrium price from July 2016 are shown below.

Figure 3.2. Bitcoin Mining Shut Down Price and Revenue-cost Equilibrium Price Trends

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2 We hereby express our sincere gratitude to “Mining Old Friends’ Gatherings” organized by Liyun Finance, which provided excellent resources for our research.

3 Foreign online sources include but not limited to Lendingblock, Bitbond, and Saltlending. Domestic functions include unibank, Sobee, and so on.

4 We collected in total 18 data points. The sources include but not limited to machine producer websites and Amazon.
Model Result, Analysis, and Application

Through the results of this model, we analyse the Bitcoin price trends from mid-year 2016 until now. If the Bitcoin price is lower than variable cost line (indicated by the orange line), the mining machines will shut down immediately. If the Bitcoin price is below the total cost (grey line), although no mining machines will shut down immediately, the market price encourages the miners to store Bitcoin in the hope of price appreciating. Thus, the market price is pushed higher. At the same time, miners decline to replace worn out mining machines, thus lowering mining machine price and hash rate difficulty. Therefore, the grey line is pulled down. If the Bitcoin price is higher than the total cost line, then there exist arbitrage opportunities, motivating miners to dump all mined Bitcoin. Hence, because the market price changes rapidly and the Bitcoin value is determined by miners’ costs, a rational market dominated by miners will produce a Bitcoin price movement (i.e. the blue line) fluctuating closely around the revenue-cost equilibrium price.

I. Until 1H2017, price and value remains balanced.

As shown in Figure 4.1, Bitcoin price fluctuates around the grey line until mid-year 2017. During this period, miners continuously enter the mining markets, leading to rising hash rate as well as gradually increasing Bitcoin price. We conclude that the market price of Bitcoin and the intrinsic value of Bitcoin remain balanced. One of the successful strategies at that time was to long Bitcoin when it was undervalued or below the grey line, and to short Bitcoin when it was overvalued or above the grey line. Such strategy resembles the fundamental value funds in the traditional equity markets.

Figure 4.1. Bitcoin Price and Value Trend July 2016 to May 2017

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II. Price deviated from value starting from November 2017.

The fundamental value strategy did not work well from November 2017, as price deviated from value significantly. Although the hash rate of the network was climbing steadily, the price of Bitcoin skyrocketed during the last few months in 2017. After a slight correction in November which brought the price to the value position, the Bitcoin price jumped and the bubble formed officially. Value and price became detached. The historic peak appeared at around 19,000 USD, and finally, the bubble burst in early 2018.

Clearly, we can see that thanks to the deviation, the explanatory power of the model remained low from November 2017 to the first few months in 2018. We then have to turn to the theory of traders, which will be explained more in detail in our next research paper.

Figure 4.2. Bitcoin Price and Value Trend July 2016 to December 2018

III. After mid-year 2018, mining machine sales dropped significantly.

Our model correctly predicted the decline in sales of mining machines during mid-year 2018.

Despite the plummeting price, the first quarter in 2018 still saw significant sales of mining machines across the world. One evidence is Bitmain’s 1.1 billion USD profits in Q1 2018. Our model explains the successful sale figures because the Bitcoin price was still significantly over the intrinsic value of Bitcoin or the mining cost of Bitcoin. The miners were incentivized to enter the market to reap the supernormal profits.
However, the sales plummeted shortly afterwards. The blue line fell below the grey line in Figure 4.2 above and the shortfall widened significantly. Based on our analysis of a few big mining machine producers’ financial statements, mining machine sellers performed poorly in the past half a year or so. For instance, Bitmain lost 400 million USD in Q2 2018 and also saw significant losses in Q3. As miners expected negative profits through the purchase of mining machines, the price deterred miners from making new purchases. The lag between the Bitcoin market price and the mining machine price can thus be explained.

IV. An irrational sell out appeared in July this year.

According to our model’s prediction, it is irrational for price to remain significantly below the equilibrium price for a long period of time. As can be seen in the graph above, a healthy rise of Bitcoin price appeared in early July this year from over 6,000 USD to over 8,000 USD. That was the last time when the markets moved sufficiently close to the revenue-cost equilibrium price line. Based on our analysis, after half a year’s correction, the Bitcoin bubble since the end of 2017 had largely been digested. Nonetheless, an sell out happened in the market which we deemed highly irrational from a value point of view. The sell out pushed the markets further away towards the undervalued range, despite rising hash rate.

V. Touching the unhealthy shut down price, Bitcoin price awaits a long-needed rebound.

As shown in Figure 4.2 above, Bitcoin price (blue line) has been moving towards the orange line (shut down price) over the past weeks. With mining power continues to climb up, a long-awaited price rebound seems imminent, given the strong supporting position. Value buyers, including miners, are likely to enter the markets gradually through the purchase of Bitcoin. Fluctuations in the down time may be the best time to build portfolios.

VI. Mining Markets Face Reshuffle

In the past two years, the average newly purchased mining machine may not recoup any profits assuming an average electricity cost. As a result, with Bitcoin price remains low, many mining machines that were purchased in 2017, were facing challenges in continued productions thanks to its low production efficiency.

Nonetheless, if certain miners or mining pools can source for competitive electricity costs, the market timing can be great for market share expansion. We have already seen a gradual increase in interest for innovative electricity cost reduction strategy, and we expect such move to intensify in the near future. With the next generation of mining machines, like S15, appearing in the market, low efficiency mining machines may not have much time left.
In the near future, high efficiency machines can thwart the space of other machines, leading to higher efficiency in the market as a whole.

**Potential Improvements**

I. **Endogeneity.**

Any economic or financial model contains exogenous factors and endogenous factors. The goal of the model is to explain or to predict endogenous factors by exogenous factors.

In this model, we hope to explain Bitcoin price (endogenous) by the mining machine, hash rate, electricity, and many other exogenous factors. However, the problem of endogeneity surfaces if some of the exogenous factors in the model can be influenced by the price of Bitcoin. The problem of endogeneity may decrease significantly this model’s power of forward prediction in the real world.

We understand the importance of endogeneity. We intend to address this issue in our coupled research paper about noise traders (i.e. the retail investors) with the help of market evidence. Their irrational trading can have significant swings in the market.

II. **Uncertainty over Mining Machine Prices**

The price of the mining machine is one of the most important exogenous factors in our model. Nonetheless, without any real tracker of mining machine transactions, we are less confident on the function of mining machine pricing. Meanwhile, when Bitcoin mining was extremely popular, mining machines were very hard to come by, let alone through direct purchase from official channels. While the black market price of machines could exceed the public price by several times. Lastly, according to our research, mining pools can potentially obtain mining machines at a much lower price than the retail one, and can even pay by instalment. Before mining machine has a transparent exchange, we are unable to confirm the mining machine price through the current over-the-counter system.

III. **Cyclical Electricity Cost**

The location of the Bitcoin mines determines the electricity cost. Normally, most Bitcoin mines are positioned near hydropower or wind power stations. In China, Sichuan and Xinjiang provinces contain most mines. For instance, in Sichuan, May to September sees ample water flow, while December to February sees low flow. Different time periods and their respective water level will affect the electricity costs significantly. The gap between electricity costs during high and low water level is around 15 to 20 percent. Wind power plants also face similar issues. Unable to breakdown the global mining electricity costs into different sources, we do not discuss the exact electricity cost changes during different seasons.
IV. Uncertainty Over Discount Rate

As the price of Bitcoin fluctuates, Bitcoin lending and borrowing rate vary greatly. When the market price improves, the lenders dominate and the average interest rate rises. During November and December 2017, we observed a significant growth of lending rate. In this paper, we believe that in a rational market, because miners do not have preferences over future Bitcoin prices, the discount rate does not change drastically.

Conclusion

For long, cryptocurrency pricing model has been a challenging topic among academia. Many academia or practitioners have done extensive research in exploring a valid valuation method, but so far no consensus has emerged. On one hand, this is because cryptocurrency’s property is more complex than traditional financial products or other currency products. On the other hand, its recent appearance means that data availability is limited and scattered.

As a result, we believe that this lack of the sense of fundamental value contributed significantly to the extreme volatility of the Bitcoin market in the past two to three years. Market traders perceive the real value of Bitcoin so differently that no fundamental value buyers are willing to buy low and sell high to maintain the market price in a reasonable range. With short-term profit-chasing traders flooding the market, bubbles appear easily and burst easily.

This paper uses Bitcoin as its point of entry. Through relatively consistent and stable mining data, we first invented a continuous quantitative valuation model. Although many thinkers have argued for the pricing of Bitcoin through mining cost, few research papers have done in-depth analysis. This paper may be the pioneer in this field.

The central conclusions in the paper include:

1. In most time period, Bitcoin price aligns with its fundamentals. During November 2017 to mid-January 2018, Bitcoin saw an irrational bubble, while since early June 2018, there has been an oversold in the market. When Bitcoin price exceeds the total cost, because of the arbitrage possibility, short position is favored; when the Bitcoin price falls below the total cost, long position is recommended.
2. In early December 2018, Bitcoin price almost touched the variable cost line, and immediately rebounded. Most miners have incentives to maintain a Bitcoin price above the variable cost position. They then can ensure mining profits. Therefore, the time when Bitcoin price broke the variable cost is an excellent opportunity for a decisive buy-in strategy if we do not observe a significant loss in computational power of the entire network.
3. However, the reshuffling and rebalancing of the mining industry lags behind the secondary market price movement. The fall in Bitcoin price recently destroyed many small-and-medium mining machine producers. Hence, even if Bitcoin price climbed somewhat in the near future, in the medium run (one year horizon), the mining capacity might not see significant rises. Before the production line of the new...
generation machines becomes stable, we believe that Bitcoin market performance will remain in the down beat.

(4) In the short run, the technological improvements in the mining industry, including computational power improvement and unit cost reduction, weaken the markets, because of decreased expected costs. In the long run, the significantly expanded market capacity brings positive news to the markets because new miners can be attracted and thus increase the network computation power.

(5) Without considering future reduced unit hash cost thanks to technological advancement, according to the estimated maximum capacity of global mining industry, we believe that the total cost line can still be lifted by 10 or even 30 times. Furthermore, around every 45 months the Bitcoin production rate halves, further depressing the return over electricity cost. The Bitcoin mining cost will increase further. If we take a long time horizon, Bitcoin still has high upside.

For sure, our ultimate goal is to seek for a universal valuation standard for all other competitor coins, such as ETH and EOS. In this aspect, we have done many meaningful researches, including how to distinguish the different characteristics among utility, security, and payment tokens. We can then use sum-of-parts valuation of the different functions of the token separately. These related findings will be published soon as a continuity of this research paper.

Reference


Atzori, M. (2015). Blockchain technology and decentralized governance: Is the state still necessary?


