Valuation of Crypto Currency Mining Farms

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Traditionally, the Net Present Value method was used to compare diverging investment strategies. However, valuating crypto-projects with fiat-based currency is confusing due to extreme coin appreciation rates as compared to fiat interest rates. Here, we provide a net present value method based crypto-coin as the underlying asset. Profitability benchmarks for different strategies (HODL, mining) are provided. We also provide a sensitivity analysis of profitability impact of electricity price, mining difficulty growth and initial investment.

Keywords—Crypto-Economics; Bitcoin; Valuation.

I. INTRODUCTION

In the current crypto mining boom [1-2], two opposed views exist on profitability of mining operations. One view states that mining is profitable, the other states that HODLing the coin is more profitable [3-4]. However, given any economic choice there is only one optimal strategy [5]. A traditional way to find out what is optimal is to use the net present value (NPV) of the future cash flows that the miner will produce during its lifetime [6-7]. However, the NPV method is not straight forward to interpret because it depends on the interest rate of the fiat money chosen to measure the cash flow. For example, given a miner that produces coins, assessing its NPV by aggregating future discounted cash flows at a given interest (aka discount rate) is complex because it is not clear what interest rate should be used. The FED interest rate? The "official" inflation rate? The compounded growth of the mined coin in Euro? The Ethereum[8]/USD growth rate? Moreover, (unlike fiat) the mined asset, does not depreciate with time. This poses questions on whether is apropriate to discount cash flows (coins) that are basically inflation free.

An alternative, is to use the Net Coin Value (NCV). The NCV is the sum of the coin's flow that a mining operation will produce minus all the capital and operating expenses valued at the price of the coin on the day of the purchase of the mining machine.

$$NCV_{Miner} = C1 + C2 \ldots + Cn \qquad (1)$$

where Ci is the amount of mined coin per day minus expenses, n is the last day of mining, and,

$$Ci = (1-k)Mi/(1+r)^i - e/p \qquad (2)$$

where k is the mining fee (pool fee + claymore fee + hosting and admin fee); M is amount of the coin mined per day, and r is the daily growth of hashing power of all miners mining the coin. e is the daily electricity bill divided by the price p of the coin on day 1. From this follows that the payback time happens on the first day of mining that verifies:

$$P_{Miner}/P_{coin} < Sum(C1 + \ldots + Ci) \qquad (3)$$

The time to double the initial investment first day i that verifies:

$$2P_{Miner}/P_{coin} < Sum(C1 + \ldots + Ci) \qquad (4)$$

II. EXAMPLES & DISCUSSION

A. GPU Mining

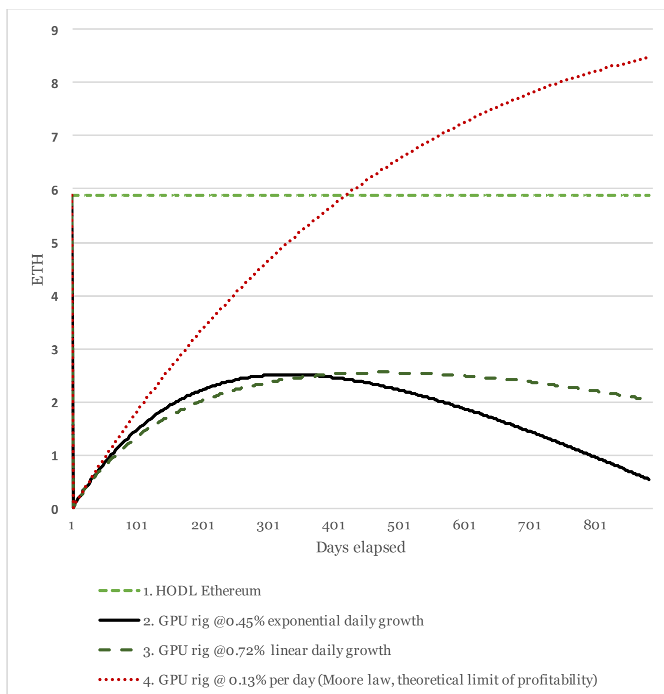

Fig.1 Accumulated daily cash flow for four scenarios at EUR 0.19kwh. The max NCV for mining occurs after 1 year and underperforms HODL by more than 50%

To illustrate NCV, let's use a real example based on a rig composed of 8 GPU RX580 and the Claymore miner. In this case, an investor would be interested in finding out whether to invest in the rig or to HODL coins. Fig. 1 shows a daily cash flow for a scenario where electricity costs 0.19EUR/kwh (Amsterdam rate); the rig costs $6,756 of which approximately $4,000 is the cost of the GPU and the rest belongs to PSU and motherboard, etc… A 10% admin fee on the mined coins is levied to account for pool fees (1%), Claymore miner fee (1%), rig hosting fee (typically 5 to 30%). In the chart, four cash flows lines are shown: (1) HODL: consists in spending the same amount the rig costs into buying coins and holding them. (2) is the cash flow corresponding to buying a rig on day 0 with coins (price rig / coin price) and then accruing the subsequent coins produced. Coin production declines as more mining power is added to the (Ethereum) network. In this case, we show a growth estimation based on exponential growth (Eq. 2). (3) shows the NCV for the same rig, but assuming linear growth that corresponds to a linear interpolation of the past 12 months of the Ethereum network provided by [9]. In the case of the exponential growth, we assume a 0.45% daily growth rate (same as the BTC network). Finally, the dotted red line (4) shows the daily cash flows if the Ethereum network hash power was to grow at the same rate as Moore's Law (the most optimistic scenario for miners).

As we can see from Fig. 1, the rig recovers the initial investment fast at the beginning and slower later. At current estimated network growth rate, it never recoups the cost when we measure value in NCV. Then, about a year since operation start, the rig will cost more to operate than what the electricity costs in coin produced. In this case the maximum amount of coin produced by the rig never surpasses the strategy of buying the coins directly. We assume price of coin constant, and this assumption overestimates the electricity cost measured in coins, if the coin appreciates. However, as we will see later in Fig. 3 this effect is weaker than the dilution of mining power due to the network growth.

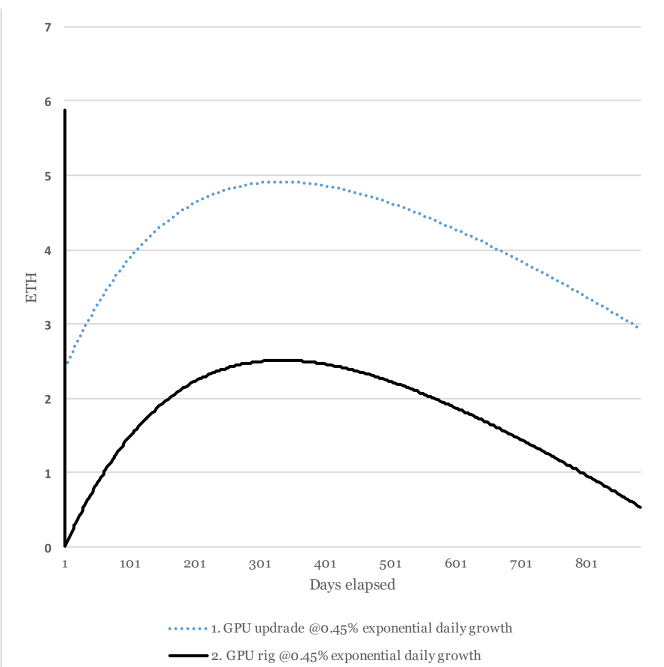

Fig. 2 Miners that can reuse existing infrastructure can achieve better NCV than miners that start from scratch.

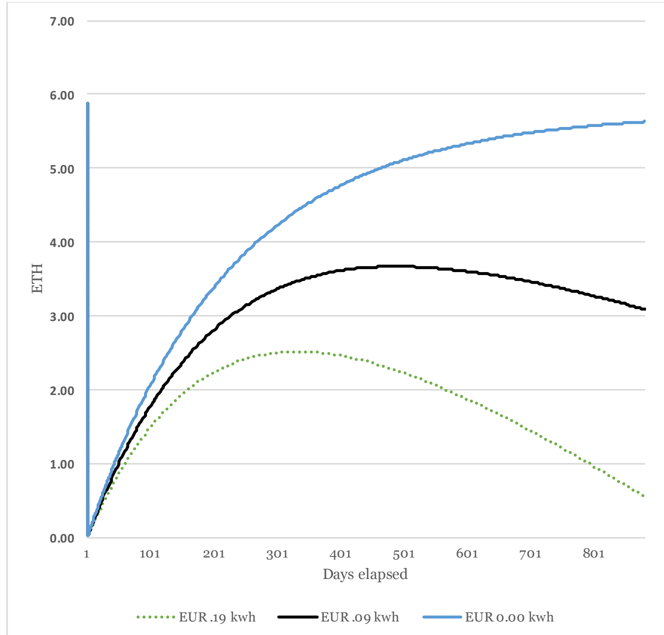

Fig. 3 NCV for three different electricity prices. Even with free electricity, the NCV value of the rig is lower than HODL within 3 years due to the strong growth of the network (@0.45% daily.)

Fig.2 Compares the NCV for a full rig (2) versus just accounting for the cost of the GPU cards (marginal cost of upgrading) (1). We can see that the savings on capital expenditure are passed directly to the NCV. However, while the savings in costs are about 30% of the rig price, the max NCV doubles. Never the less, all else equal mining is still less profitable than HODL. From Fig.3 we can also see that the NCV @ free electricity provides a **hard cap** on how much value a rig can produce. We can also see that network growth and price of rig, rather than electricity cost, is the driving factor impacting the NCV of a mining operation. For example, halving the electricity cost from 0.19 to 0.10 will increase the (max) NCV from 2.5 to 3.5 coins. However, halving the cost of the rig would rise the NCV to 5.5 and 7.5 coins respectively.

B. Bit Coin Cash Mining

In this example, we will address the profitability of an S9 Miner. Fig. 4 shows the evolution of NCV. Fig. 5 and Table 2 illustrate the dramatic effect that delays in delivery of S9 mining machines have on profitability. Source delays: Bitmain [10]. Table 3 offers a qualitative sensitivity analysis of impact on profitability. From it we see that delays in delivery and price of the mining equipment are far more important than the daily rate of difficulty increase or the price of the electricity (given typical price ranges, see also fig. 3). In other words, if an equipment is purchased in coin and in advance [10], the delivery time has an important impact in the total coins mined because it shortens the useful life of the mining equipment exactly when it was most productive: at the beginning. From table

3 we can see that a mere 140 days of delivery delay results in a loss of 1.6 coins, or more than half of the potential coins, as compared to a machine that starts mining immediately after payment.

Table 1 Bitmain Antminer S9 parameters

Item	**miner S9**
Price S9 in $	$2800.00
Price S9 in coins	1.19149
Difficulty increase per day exponential growth model	0.00450
BCH mined per day per miner*	0.01702
Cost kwh EUR*	0.03000
Electricity cost in BCH / day	0.00045
kw per miner	1.6
Admin fee	0.10000
BCH price	$2350
Max NCV	BCH 2.92

*source: various, Dubai

Table 2 Effect of delays in profitability

Item	**No delay**	**140 days' delay**
Max NCV	BCH 2.925	BCH 1.253
Max NCV in USD	$6875	$2946
Max ROI	2.45	1.05

Table 3 Sensitivity analysis

NCV factor	**Sensitivity**
1st Delay to start to mining from purchase date	s>1
2nd Initial cost of rig	s>1
3rd Network growth rate in %daily	s~1
4th Electricity price (impact decreases if coin appreciates)	s~1

** s~ 1 means proportional.*

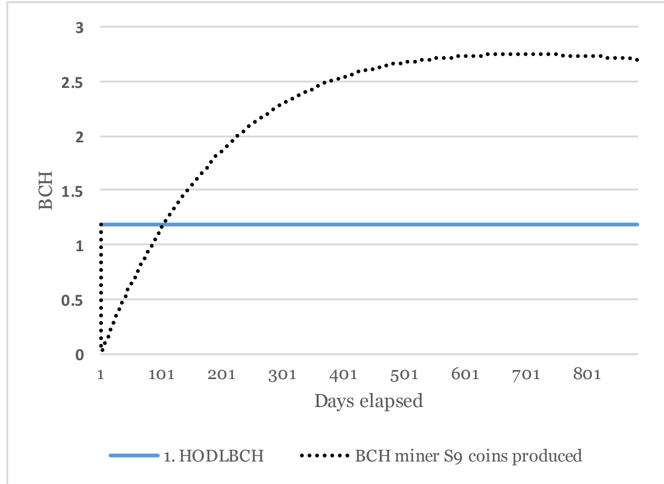

Fig. 4 NCV for S9 miner @ Dubai electricity prices. Assumes network growth exponential @0.45% daily. Payback time 3 months. Time to ROI = 2x 1.3 years. See. Eq.2

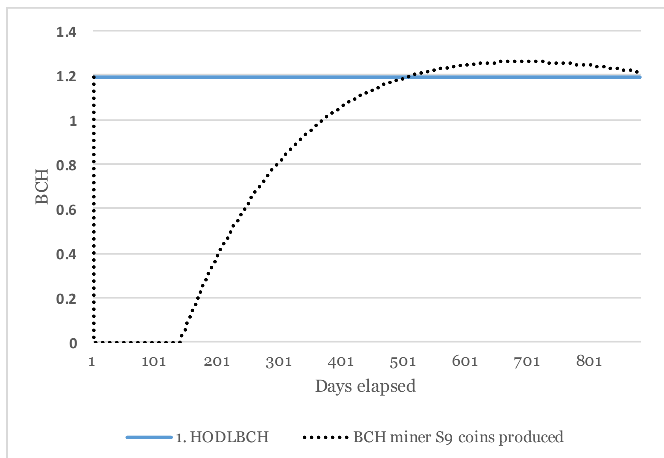

Fig. 5 NCV for S9 miner with a delivery delay of 140 days. Assumes network growth exponential @0.45% daily.

C. *NPV vs. NCV*

Here we will compare NPV vs. an NCV analysis and we show how using NPV can lead to suboptimal investment decisions. Let's assume the case in Fig. 1, a GPU rig to mine Ethereum. Clearly the NCV value of the rig is much less than the cost of the machine in coins at the time of purchase. However, if Ethereum was to triple in price since the purchase of the rig and we measure the cash flows in USD rather than in ETH an investor could be fooled into believing that the rig was a good investment decision because the value of the total mined coin after a few months was higher than the cost of the rig in USD. Not realizing that HODL was twice as profitable.

D. AC cost of a mining farm

Another factor often overlooked in mining farm investments is the cost of AC, the overheads, fire insurance, and so on. In countries such as Germany, a mining license is required to mine Ethereum even at one's home. AC cooling is a problem in hot weather places such as Dubai. In summer outside temperatures can reach up to 55C and cards must not opperate at high temperatures. This cost cannot be overlooked in a profitability analysis. Moreover, AC and heat pumps have Coefficients of Performance (COP) that thermodinamically cannot exceed 2 to 4 depending on the design. This means that for a CoP =2 for every 2 kw of GPU heat that we want to dissipate, at least 1kw of power must be used by the heat pump or AC just to maintain the temperature stable inside the mining farm. Therefore Eq. 2 becomes:

$$Ci = (1-k)Mi/(1+r)^\wedge i - (1+1/CoP)e/p \qquad (5)$$

Where a CoP calue is typically 2 to 4, and the cost of the AC equipment would be added to rig cost on a pro rata basis.

E. Mining with cards without warranty

Overcloking cards increases hashing power between 10 to 20%. For exaple, from 27MHz/s to 32 in the case of a AMD Rx580). This is not despreciable. On the other hand, because overcloking abuses the hardware card manufacturers do not issue warranty on susch cards. Therefore, many farms prefer to use comercial 2-year warranty GPU cards sucha as the nvidia 1060. With overloking Eq.5 becomes,

$$Ci = q(1-k)Mi/(1+r)^\wedge i - (1+1/CoP)e/p \qquad (6)$$

Where a q is the overclock factor. While the benefits of overcloking with warratny are subtantial, we must note that overclocking increase the rate of failure of cards and errors. Therefore, a tradeoff exists between increased mining power GPU downtime and a shortened life of the card. However, we have no data on such tradeoff.

F. Cycle life time

The NCV peak provides an estimate of when a card becomes unprofitable to operate. Assuming all else contant, we can see that a card useful mining lifetime is very limited (between 18 months and 12 months). Therefore, it should be treated as fungible cost, not a capital expenditure in NPV calculations. The 18 month deadline is particularly accurate, for example mining ethereum with an nvidia GEFORCE 1060 (launched on May 2016, hashing power 10Mh/s), does not produce the $10/27^{ths}$ of coin produced by an nvidia 1070 card of (27Mh/s). It produces close to zero due to the way minign pools work and timeouts work (nanopool).

If from experience, we consider that the card value for mining drops to zero in 18 months (N=540 days) and consider it as a fungible (not CAPEX) then Eq.6 becomes:

$$C_{7i} = C_{6i} - P_{card}/N \qquad (7)$$

Where C_7 is Eq. 7, P_{card} is the price of the card in coin at purchase time, and the number of coin used to compare with HODL would include all CAPEX in mother boards, PSU, AC and cabling and exclude the cost of GPU cards. Eq. 7 is apropriate because P_{card} is correlated with the price of coins that the card can mine at purchase time while the rest of the equipment is not, and because the life time of the rest of the rig is greater than 18 months.

G. Marginal cost of mining

From Eq. 7 we can now estimate pairs of CAPEX (ex-card) and electricity that makes mining unprofitable.

$$C_{6N}(e) = P_{card}/N \qquad (8)$$

As coin returns diminish, and substituting $i=N$, we can now forecast if a card will reach its end of lifetime due to Moore's Law or because a high price of electricity in which case N should be adjusted accordingly.

III. Conclusions

We have shown how to use Net Coin Value method to value mining operations using Ethereum and Bitcoin Cash as the underlying asset. This method, offers a simpler alternative to the discounted cash flow method which is not suited for underlying assets that do not depreciate in time. From a qualitative sensitivity analysis, we conclude that there are four main factors that impact profitability (NCV) but that delivery delay (the time from purchase to switch on) has a disproportionate effect on the NCV of the miner. Hence, for mining equipment sellers, the easiest way to adjust the profitability of a mining machine or GPU card is not its price but the delivery date on pre-orders (this delay is currently between 3 and 9 months for an S9). This offers mining equipment manufacturers great leeway to adjust the actual profitability of the machines sold without altering the USD prices of the machines on sale.

A. Miner's paradox

Finally, we can now address the *miner's unprofitability paradox*: Mining seems never profitable for new entrants because existing miners that can simply upgrade GPU in their data centres have an *unfair* capital advantage compared to new entrants, who must invest in full rigs and overheads such as AC, cabling and admin personnel from scratch. However, as shown in Fig. 4 when there is no delay, mining offers ROIs close to 3x per year and with underlying assets denominated in inflation free coin. We hope this analysis helps to clarify profitability analysis of mining farms.

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