Crypto Mining: Profit Projection and Risk Hedging

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KEY FINDINGS

- A robust profit projection model for crypto mining.
- A hedging strategy that minimizes capital risks.
- Real-world examples demonstrating how to apply the hedging strategy in practice.

ABSTRACT

The author introduces a profit projection model for crypto mining. With the model as the foundation, the author presents a hedging strategy that significantly reduces risks.

Due to the highly volatile nature of cryptocurrencies, crypto mining can be a high risk, high reward venture.

The reward or profit is rather straightforward. It's the mining output or the value of the cryptocurrency mined, minus the cost of electricity used to keep the mining equipment running. However, it's not immediately certain how to estimate profit effectively over a future time period, such as next year, in dollar terms.

There are many mining profit calculators available online. They all use daily profit with flatline projection, taking today's profit figure as a constant value and projecting it into a future time period. While that makes the calculation simple, it's not very realistic or useful.

The risk aspect is reflected in the upfront capital investment in mining equipment, and the time it takes to get the capital back, or the breakeven timeframe. Depending on the time of entry and market conditions that follow, the breakeven can range from three months to three years—to potentially never. Such uncertainty implies substantial risks.

We attempt to reduce or eliminate these uncertainties, taking crypto mining out of gambling territory and making it a more stable and repeatable business venture.

As a side note, this article assumes the "sell at spot" business model, where mining output is immediately sold at the spot market price, so that it pays for the ongoing electricity cost and is self-sustaining. There is also "mine and hold," where the cryptocurrency mined is held in anticipation of price appreciation in the future. This model is out of the scope of this article because of the speculative element as well as the need for additional funds to cover electricity, although the core concepts presented here are still applicable.

PROFIT PROJECTION

Two parameters needed in the calculation of daily profit are subject to daily fluctuations, namely, the global mining hashrate and the cryptocurrency's price.

The global mining hashrate determines the local mining output, and the cryptocurrency's price determines the value of the output in USD.

Historical real-world data indicate that, in the short- to mid-term, for up to one year, the global hashrate generally has much less influence on daily profit than the cryptocurrency's price does. Over the long term or multiple years however, the global hashrate usually increases significantly, reducing the local mining output substantially, and therefore becomes as influential as the price.

To start with a simple profit model, we first assume a constant global hashrate in any given year, in which case daily profit becomes linearly correlated to daily price. We then make the global hashrate a variable in the complete model.

Following Exhibits 1 and 2 are from bitinfocharts.com. They are side-by-side comparisons of Bitcoin's daily profitability (USD per TH/s) vs. daily price, plotted over two time periods, three months and one year respectively, ending on January 31, 2022.

We chose this one-year window for illustration because of the wild price swings and the seismic changes that happened in the crypto mining world in 2021. With China banning mining that accounted for about 75% of the global output, mining equipment first had to shut down and relocate elsewhere, and then power back up, in the span of a few months. This is evident in the apparent "phase shift" in Exhibit 2, starting in July. Despite a chaotic year, a strong correlation can be seen here, allowing the use of price as the sole parameter to estimate profit.

Assuming exponential price increase or decline, we have the following classic equation

$$P_N = P_0 e^{kN} \tag{1}$$

where P_0 is today's daily price, P_N is the projected daily price N days into the future, and k is the exponential growth or decay factor. Conversely, we can trivially find the value of k

$$k = \frac{\ln \frac{P_N}{P_0}}{N} \tag{2}$$

Given today's mining revenue D_0, projected daily mining revenue N days into the future D_N can be calculated as

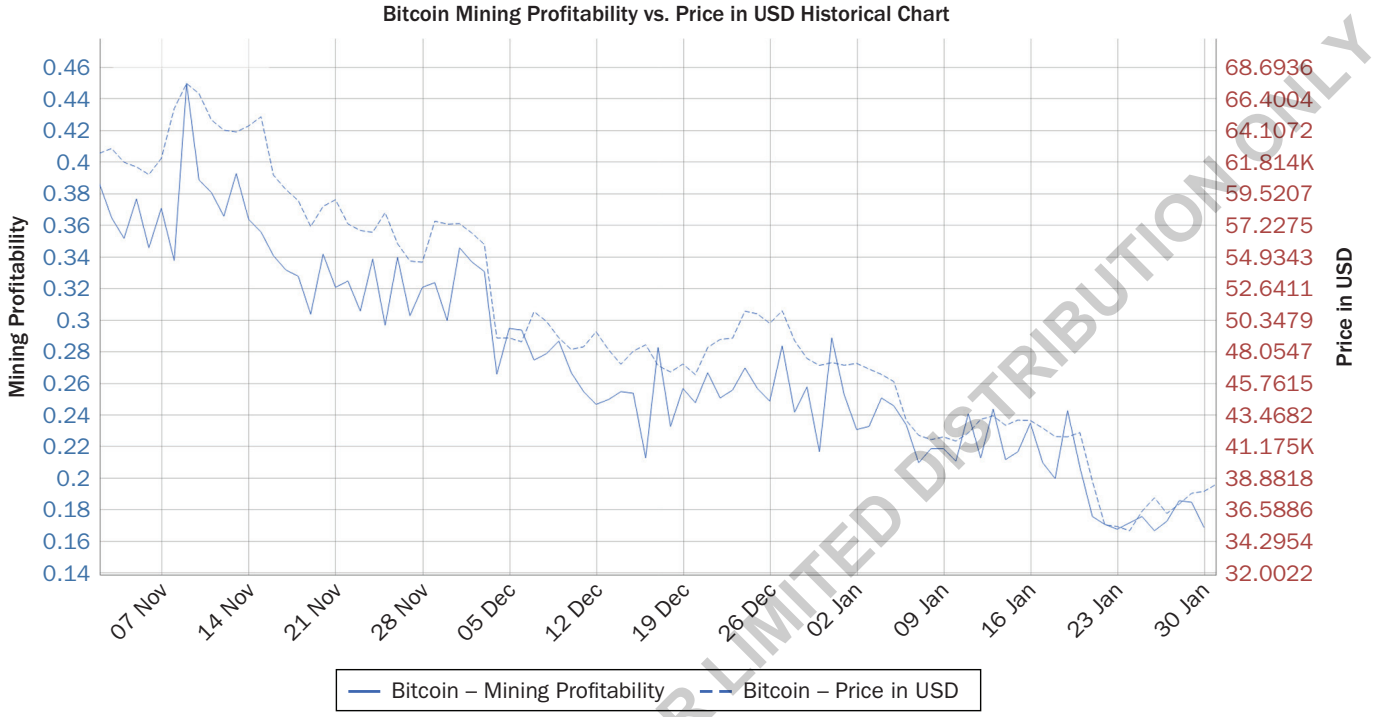
$$D_N = D_0 e^{kN} \tag{3}$$

For multiple years, we further introduce a hashrate factor h, bringing the global hashrate into the equation. For our initial assumption of a constant global hashrate, we have $h = 1$ in the first year. For every subsequent year, we increase h by a certain empirical value, e.g., 0.25, which can be fitted from historical data. The inverse of this factor can be considered the obsolescence factor, by which existing mining hardware becomes increasingly obsolete due to new hardware iterations from OEMs and the ever-rising global hashrate. Since h is a function of N, we modify Equation 2 as

$$k = \frac{\ln \frac{P_N}{P_0 h(N)}}{N} \tag{4}$$

EXHIBIT 1

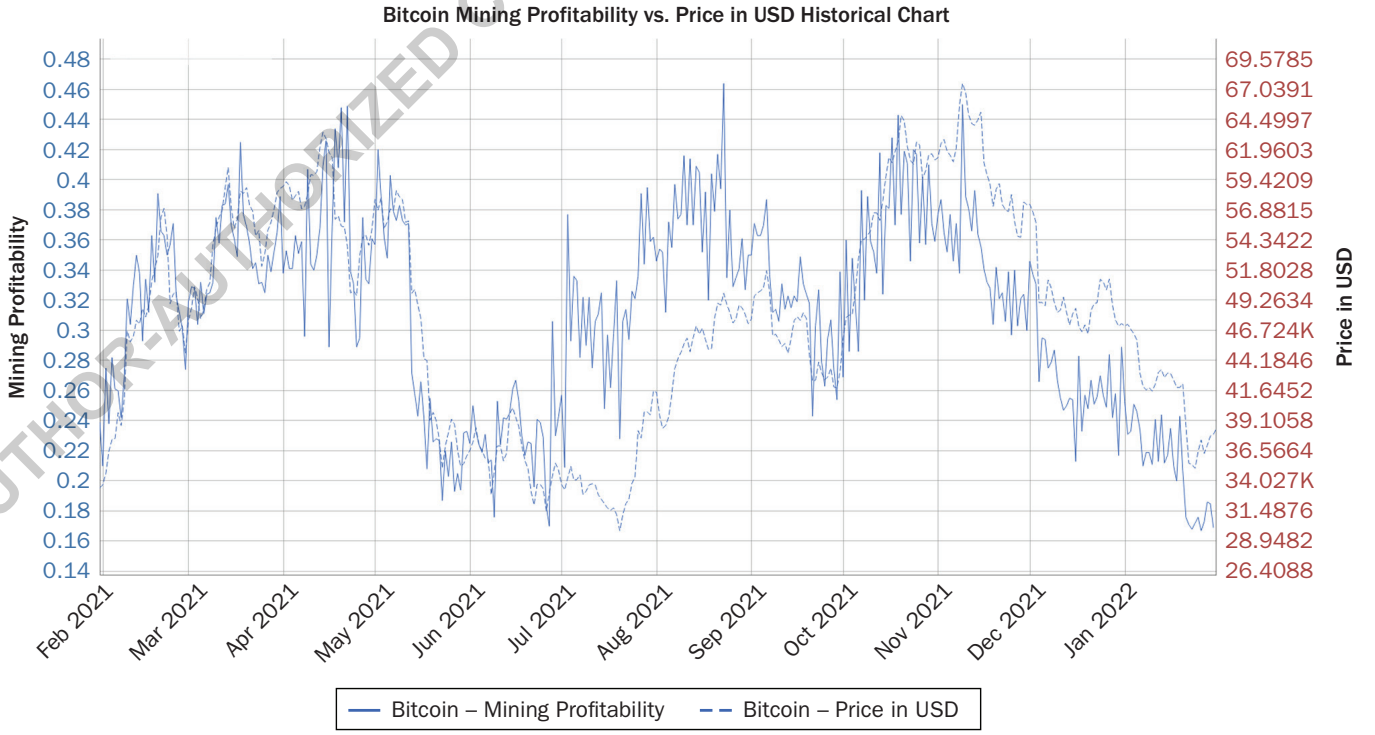
Bitcoin Mining Profitability vs. Price, Three Months



SOURCE: bitinfocharts.com.

EXHIBIT 2

Bitcoin Mining Profitability vs. Price, One Year



SOURCE: bitinfocharts.com.

Finally, taking electricity into account, total profit or reward R over the next N days is

$$R = \sum_{n=0}^{N} (D_0 e^{kn} - Q_{kW} \cdot \$_{kWh} \cdot 24) \quad (5)$$

where Q_{kW} is the power consumption of mining equipment in *kW* (traditionally denoted by P in physics), and $\$_{kWh}$ is the per *kWH* cost of electricity.

We now have an equation that projects profit into the future. However, a skeptical mind certainly will question the equation's usefulness in the real world, since it still involves the future price P_N which is unknown and essentially unknowable. We will show that, with proper hedging, it is possible to have a guaranteed return of capital within a certain time period, without the need to know or predict P_N.

RISK HEDGING

How long does it take to break even? It's usually one of the first questions an investor asks when evaluating crypto mining as a business, before committing capital.

Almost all capex goes into purchasing mining machines, aka ASIC miners. According to historical pricing data from miner OEMs, prices of these miners are very elastic, and generally follow the underlying cryptocurrency's market price, with a slightly lagging time period. A new miner is usually priced so that it takes roughly one year of 24/7 mining to break even, using the flatline profit projection model. It's ECON 101 at play and intuitively it makes sense. Obviously, the higher the price point, the more profit a miner sale generates for the OEM; the lower the price point, the more appealing a miner is to a customer. OEMs naturally want to maximize profit per miner, and at the same time also maximize sales volume. The one-year timeframe is most likely optimized based on both economical and psychological factors.

In contrast to the flatline model, if a mining business starts operating near the beginning or middle of an uptrend market, it may take less than one year to break even; if it starts near the beginning or middle of a crash, it may take much longer than one year, essentially trapping the capital. Since market cycles are difficult to predict, a mining business carries significant risks.

To reduce or potentially eliminate such risks, we present a simple hedging strategy: buying put options on the crypto futures market to protect against potential market downturns.

With this strategy, we aim to achieve guaranteed return of capital within one year. For simplicity, we only look at put options that expire in one year, which is also the longest contract time period available on Deribit. (Deribit is currently the dominant futures market worldwide for Bitcoin and Ethereum, commanding ~90% and ~95% of the two respective cryptocurrencies' options open interest market shares.)

In order to cover all capex, the number of put option contracts O that need to be purchased can be calculated as

$$O = \frac{C - R(P_N)}{P_s - P_a - P_N} \quad (6)$$

where C is the capital to be invested in miners, P_N is the future price of the underlying cryptocurrency at contract expiration, i.e., in one year, $R(P_N)$ is from Equation 5, which is the mining profit during the one-year period and a function of P_N, P_s is the option's strike price, and P_a is the option's ask or purchase price.

The equation can be rearranged as

$$C + P_a O = R(P_N) + (P_s - P_N)O \tag{7}$$

where it shows that total capex equal total returns. The two terms on the left are the cost of miners plus the cost of options, and the two terms on the right are the return from mining plus the return from exercising options. For $P_N \geq P_s$, where the cryptocurrency's price at expiration is at or above the strike price, the options will expire ATM or OTM and will not generate any return.

Obviously, it only makes sense to consider scenarios where $P_N < P_s - P_a$. For $P_N \geq P_s - P_a$, Equation 6 encounters a singularity and crosses into negative territory. This is where options generate zero or below-cost returns and therefore offer no protection, in which case we simply do not buy any. Equation 6 can be modified as

$$O = \begin{cases} \dfrac{C - R(P_N)}{P_s - P_a - P_N} & \text{if } P_N < P_s - P_a \\ 0 & \text{if } P_N \geq P_s - P_a \end{cases} \tag{8}$$

In practice, it's a good idea to keep a healthy distance between P_N and $P_s - P_a$ in order to avoid high costs near the singularity.

Finally, we introduce a hedge ratio (related to but not the same as the traditionally defined term)

$$Hr = \frac{P_a O}{C} \tag{9}$$

It is simply the cost of hedging as a fraction of the cost of miners. We now have all the pieces needed for proper hedging. For illustration purpose, let's look at some real-world examples.

REAL WORLD SCENARIOS

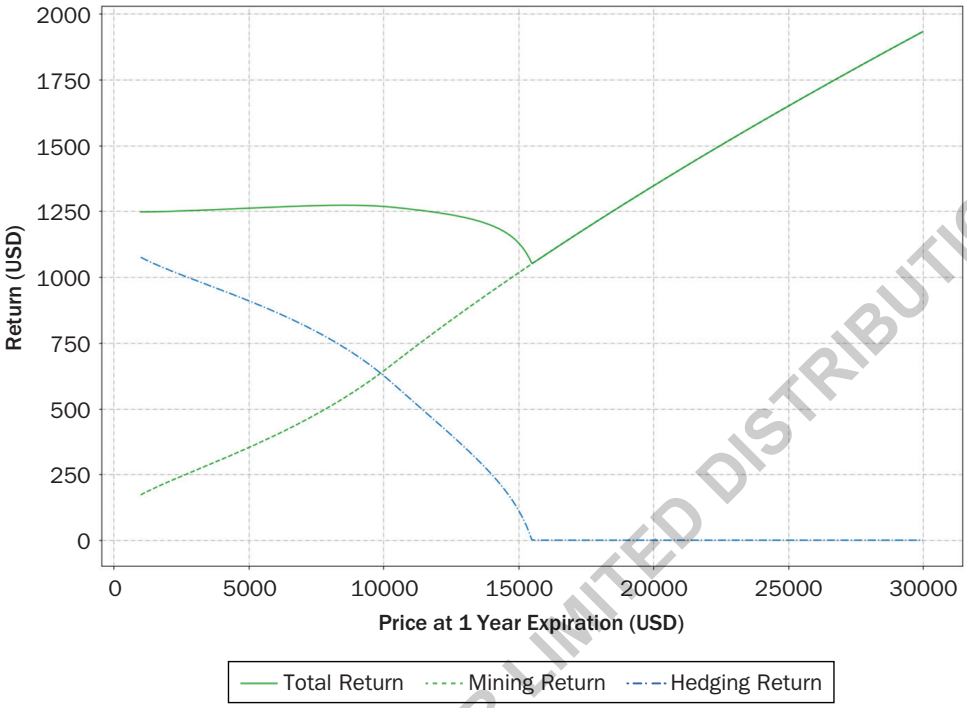
As of this writing, on January 21, 2023, the market price of one BTC is around $23,000. From bitinfocharts.com, Bitcoin mining profitability is $0.0806 per TH/s for the day. On deribit.com, the ask price for one contract of put option with $20,000 strike and December 29, 2023, expiration is $3,482.

We consider a Bitcoin miner with a 100 TH/s hashrate and 3 kW power consumption, which is more or less middle-of-the-road mainstream. For simplicity, all calculations here are focused on this one miner but can be trivially applied to a large number of miners, since mining operations are linearly scalable.

Based on real-world information above, we have P_0 = $23,000, D_0 = $0.0806 × 100 = $8.06, Q_{kW} = 3 kW, P_s = $20,000, P_a = $3,482, and N = 342 in this case instead of 365, since December 29, 2023, is 342 days into the future. We assume a bulk industrial electricity rate of $\$_{kWh}$ = $0.05, and analyze two miner cost scenarios, with C = $1,050, which would be a volume discount bargain price, and C = $1,350, which resembles a brand-new retail price.

EXHIBIT 3

Mining and Hedging Returns in One Year



NOTE: $P_s = 20000$, $C = 1050$.

First Case Scenario

Plugging these numbers into Equation 7 and using the brutal force approach, we calculate the options cost, mining return, and hedging return at every future price point of P_N, ranging from \$1,000 to \$30,000. For C = \$1,050, Exhibit 3 above shows plots of the results.

We can see from the plots that in the event of a market crash, return from mining will take a nose dive. With proper hedging, however, return from options will compensate for the drop in mining profit, so that total return consistently stays above our total initial investment, no matter the future price P_N in one year.

Between P_N = \$1,000 and \$12,000, the cost of options P_aO is around \$200, and the hedge ratio Hr is around 20%. It gets much lower when P_N further increases. At P_N = \$15,000, P_aO is around \$80 and Hr around 7.5%. Since the future price is the price against which we are hedging, a mining business needs to determine an optimal P_N value based on their internal analysis and risk tolerance, for example, whether to spend the \$200 for a full coverage down to P_N = \$1,000, or \$80 to save on the hedging cost but accept the risk of the future price falling below \$15,000.

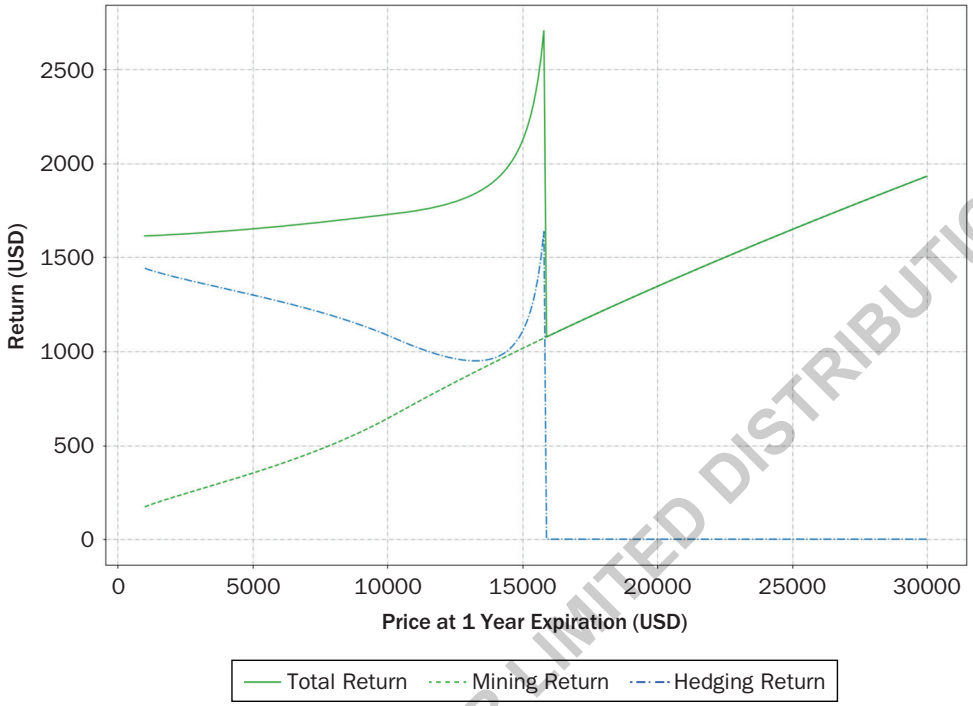
Second Case Scenario

Repeating the calculations and plots with the same numbers except for C = \$1,350, we have Exhibit 4. It's clearly a different picture from Exhibit 3. Due to the much higher miner cost C, the return from options needs to be much higher in order to compensate, while the return from mining remains the same.

As a result, the cost of options P_aO is also much higher, increases when P_N increases, and approaches infinity near P_N = \$16,500.

EXHIBIT 4

Mining and Hedging Returns in One Year



NOTE: $P_s = 20000$, $C = 1350$.

Following are some hedging cost data points in this scenario.

$P_N = \$1{,}000$, $O = 0.0759$, $P_aO = \$264.27$, $Hr = 19.58\%$

$P_N = \$10{,}000$, $O = 0.1086$, $P_aO = \$378.14$, $Hr = 28.01\%$

$P_N = \$15{,}000$, $O = 0.2207$, $P_aO = \$768.57$, $Hr = 56.93\%$

After $P_N = \$16{,}000$, we stop the calculation and O becomes zero in Equation 8. There is a range of P_N here against which we are not hedging, leaving open risk exposure. For those data points covered by hedging, the cost and hedge ratio seem too high. If we decide to hedge against $P_N = \$1{,}000$ and the future price lands above \$1,000, there will be a shortfall between our total return and total initial investment. It may be better not to enter the business in this case, and wait while searching for more favorable opportunities.

Generally speaking, in a downtrend market, the costs of put options are high, and prices of miners lag behind the market from the upside, resulting in fewer "hedgeable" scenarios. An uptrend market on the other hand has the opposite effect.

Risk Consideration

Once a certain number of put option contracts O is decided and purchased, the worst case scenario at expiration is when the price lands at the strike price, which is the lowest point of mining return without protection from options. In case of $C = \$1{,}050$, this is also the point of maximum risk. We have the added cost of options but do not receive any benefit.

EXHIBIT 5

Worst Case Scenarios, Mining Returns at Strike Prices

Strike	Ask	Size	Open	Contract Size	Hedging Cost	Hedging Return	Total Cost	Mining Return	Hr%	ROI%
5000	140.70	0.0	54.3	0.2274	32.00	0	1082.00	351.50	3.05	–67.51
10000	527.61	7.3	363.0	0.1036	54.66	0	1104.66	642.15	5.21	–41.87
11000	668.30	0.0	41.3	0.0941	62.86	0	1112.86	720.98	5.99	–35.21
12000	832.45	4.6	129.0	0.0863	71.87	0	1121.87	797.71	6.84	–28.89
13000	1031.77	2.0	44.6	0.0800	82.57	0	1132.57	872.11	7.86	–23.00
14000	1266.26	0.0	121.0	0.0748	94.73	0	1144.73	944.44	9.02	–17.50
15000	1535.93	2.0	176.3	0.0704	108.17	0	1158.17	1014.93	10.30	–12.37
16000	1852.31	3.1	94.3	0.0668	123.67	0	1173.67	1083.77	11.78	–7.66
17000	2192.51	0.0	3.9	0.0636	139.38	0	1189.38	1151.10	13.27	–3.22
18000	2579.42	2.0	9.4	0.0609	157.01	0	1207.01	1217.05	14.95	0.83
19000	3013.23	1.0	22.9	0.0586	176.49	0	1226.49	1281.75	16.81	4.51
20000	3482.22	4.0	33.3	0.0566	196.97	0	1246.97	1345.30	18.76	7.89
21000	3986.38	0.4	15.7	0.0548	218.51	0	1268.51	1407.76	20.81	10.98
22000	4525.71	0.0	1.0	0.0533	241.14	0	1291.14	1469.24	22.97	13.79
23000	5100.22	1.0	2.0	0.0519	264.91	0	1314.91	1529.78	25.23	16.34

SOURCE: deribit.com snapshot.

Exhibit 5 is a snapshot (gray area) from deribit.com, on January 21, 2023. It lists all available BTC put options with December 29, 2023, expiration and different strike prices.

We want to see worst case scenarios by hedging against P_N = $1,000 for every entry on the list, with C = $1,050, while calculating mining return where the future price is at the strike price. This gives us an understanding of risks, and helps us determine the best strike price at which to hedge.

Following Exhibit 6 shows plots of the results.

Obviously, we want our hedging cost or Hr% as low as possible, and mining return or ROI% as high as possible. Judging by Hr% and ROI% from Exhibit 5, strike prices between $17,000 and $22,000 appear to be good candidates at which to consider hedging. On Exhibit 6, we want to focus on the area where the mining return curve approaches the total cost curve from below with the smallest distance; ideally, if parts of the two curves intersect, the strike prices in the vicinity of the intersection are potential candidates.

Empirically, strike prices that are good for our hedging strategy usually are near the current market price or near the money.

Altcoin Hedging

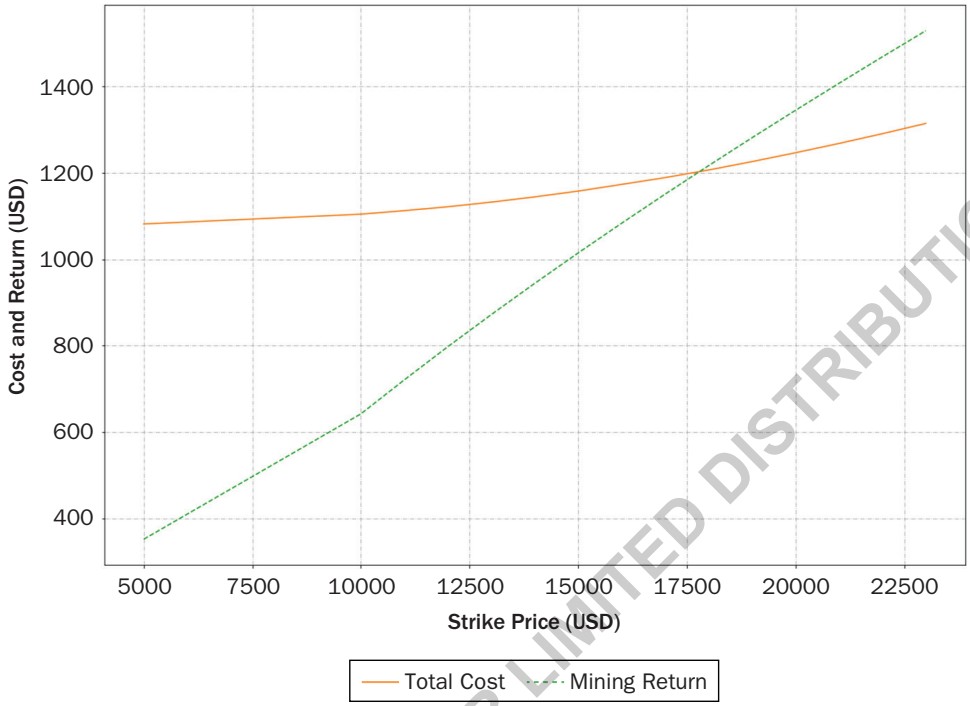
Besides Bitcoin, there are many other proof-of-work based cryptocurrencies that require mining, but most of them do not have an options market. Those can be cross hedged with Bitcoin, assuming an altcoin's price closely tracks that of Bitcoin. There are two simple approaches of cross hedging.

All altcoins are commonly priced in both USD and BTC. Given an altcoin's price b in BTC, we simply replace P_N in Equation 4 with $P_N b$, so that P_N becomes Bitcoin's future price in USD, while P_0 remains the altcoin's current price in USD.

Another, and perhaps conceptually better, approach is to simply treat an altcoin miner as a Bitcoin equivalent. For example, a state-of-the-art Kadena miner currently

EXHIBIT 6

Total Cost and Mining Return at Strike Price



NOTE: $P_N = 1000$, $C = 1050$.

generates roughly $45 a day, which is effectively a Bitcoin miner operating at 560 TH/s. Unsurprisingly, such a machine retails at $10,000+.

Caution needs to be taken here, however, if an altcoin is relatively new with a small market cap and low mining participation. Its global hashrate may change rapidly in the one-year timeframe, requiring additional examination of $h(N)$ in Equation 4. And its price may be more volatile than Bitcoin's.

FURTHER COMMENTS

With proper hedging, the biggest uncertainty in mining—the underlying cryptocurrency's future price—becomes secondary.

For a mining business, returns and risks are instead determined by two external factors: cost of miners and cost of put options, that are essentially derivatives of the current market conditions and therefore easier to plan for.

There are also internal factors that a mining business needs to decide: acceptable ranges of hedge ratio and capital return ratio in the hedging period. Most businesses probably are comfortable with a hedge ratio below 20% and a return of 80% capital or above in one year. Actual mileage and preference may vary of course.

The cost of miners fluctuates daily, while the cost of options can change drastically on an hourly or even minutely basis. In practice, a business should scan the market in real time and search for opportunities that fall within the predetermined "hedgeable" range, using the strategy outlined here, with assisting software that integrates with APIs from options exchanges as well as price updates from miner OEMs and distributors. Further details are out of the scope of this article.

NOTES AND CAVEATS

A fully functional profit calculator that implements Equation 5 is available at http://mobius.fund/cmp. We've made this calculator open source. Full source code is available at https://github.com/mobiusfund/cmp.

We also have software that implements Equation 8 with real-time market data integration. Due to its more advanced nature and computing resources required, such as API access, it's available only upon request. Please contact the author for further information.

For Exhibits 1 and 2, there are interactive comparision plots with live data available at https://bitinfocharts.com/comparison/mining_profitability-price-btc.html#1y.

In Equation 1, we use an exponential function to model price. Obviously the market is not going to conform to a simple exponential curve. However, over the course of one year, market ups and downs tend to average out and total profit from Equation 5 is generally a good approximation.

For simplicity, Equation 5 does not account for halving. With Bitcoin, mining rewards are reduced by half roughly every four years. To calculate total profit across halving, simply apply a factor of 1/2 to all revenue after the event. However, beware that halving events historically have been followed by a surge in price. The next Bitcoin halving will happen around March 2024.

Deribit only offers European style options, which can only be exercised at expiration. Since the crypto market is highly volatile, the price of put options can jump hundreds of percentage points in a short time period. When that happens, it's often advisable to sell the options immediately, if the goal is to break even as soon as possible.

Deribit does not accept American customers. This is currently the policy norm from most globally dominant crypto exchanges, including Binance. A US-based mining business needs to go through an offshore entity in order to set up an account. There are US-based crypto options exchanges such as CME and LedgerX, but they have low volume and liquidity at the moment. Hopefully things will improve in the near future.

CONCLUSION

This article has offered a robust profit projection model for crypto mining, a hedging strategy that minimizes capital risks, and real-world examples demonstrating how to apply the hedging strategy in practice.

With our profit projection model and risk hedging strategy, the biggest uncertainty and risk factor in mining—a cryptocurrency's future price—becomes a non-issue. Armed with the concepts and practices outlined here, anyone can enter the mining business with confidence, knowing that upfront capital investment will be returned within a certain time period.

As a closing note, decentralized mining is essential to the integrity of Bitcoin and all other proof-of-work based cryptocurrencies. As a side effect of taking uncertainty and risks out of crypto mining, we can expect broader participation, especially from small-scale players and hobbyists who do not have the benefit of deeply discounted mining hardware and electricity. This ultimately strengthens decentralization and enhances the resilience of crypto networks.