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The Decision to Produce Altcoins: Miners’ Arbitrage in Cryptocurrency Markets

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The Decision to Produce Altcoins: Miners' Arbitrage in Cryptocurrency Markets

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Abstract—Bitcoin has become the de facto 'gold' standard among cryptocurrencies as it is the most widely accepted in commerce, has the largest mining network, and greatest volume of transactions. Because of this, miners of other SHA-256 cryptocurrencies will tend to convert those altcoins into bitcoin in order to transact in a meaningful way with the real economy. The result is that bitcoin mining regulates that of all other SHA-256 blockchains. Specifically, what matters is the expected number of bitcoins produced per day given a unit of hashing (mining) power, whatever the equivalence in the coin being mined. If mining for a different coin would yield a greater return in bitcoins at the margin (per day) for a miner, an apparent arbitrage opportunity will exist to direct mining effort at that cryptocurrency and subsequently exchange those for bitcoin. These opportunities, once taken, quickly eliminate the profitable arbitrage and appear to operate in a fairly efficient and predictable manner. A model is developed in this paper to formalize this process where cryptocurrency miners seeking to maximize production in terms of bitcoins earned in a day will exploit any such opportunities. If no such opportunities exist, they will simply revert to mining bitcoins directly. There are some important implications to this process, such as a tendency for cryptocurrencies to fall in price relative to bitcoin over time, and for changes in bitcoin mining difficulty to indirectly influence the market prices of altcoins. Finally, it seems that those undertaking this process of miners' arbitrage do so at the expense of speculators and noise traders who make decisions regarding buy and sell trades without the use of fundamental data. These participants generally have poor timing, follow trends, and over-react to good and bad news. Altcoins are produced by miners and subsequently offered for sale in the market in order to obtain bitcoins; meanwhile noise traders serve as the only bid-side to the market, on average.

Keywords—bitcoin, cryptocurrency, altcoins, arbitrage, equilibrium models, currency exchanges

JEL Classifications: D58, E42, E47, G1, L17, L86

I. INTRODUCTION

Bitcoin (BTC) has become the 'gold' standard of cryptocurrencies. Due to its first-mover advantage it has become the stable equilibrium amongst cryptocurrencies relying on a technology known as the blockchain. Alternate cryptocurrencies have been developed to improve upon various technical and practical aspects of bitcoin; however, despite the fact that it may be technologically inferior to various alternatives, bitcoin remains entrenched due to its path-dependency. The fact is, in order to transact in the real world with cryptocurrencies, bitcoin is the only real option right now. Therefore, mining for altcoins may be viewed as a proxy for mining bitcoins indirectly, by way of exchanging one for the other in the marketplace.

While bitcoins are often quoted in dollar, euro, yuan or other fiat currency prices, the various other alternative cryptocurrencies known collectively as altcoins are typically priced in BTC-denomination instead. Researchers such as Yermack (2013) and Smith (2014) have analyzed changes in bitcoin exchange rate relative to national fiat currencies such as the dollar, and concluded that its price volatility undermines its usefulness as a currency. In this paper I consider only the cryptocurrency ecosystem where bitcoin acts as the reserve currency, and the noise created by exchange rates in dollars, euros etc. are removed from the analysis.

There are a large number of cryptocurrency pairs that trade against bitcoin which are transacted across an increasing number of online exchanges. Bitcoin utilizes a cryptologic algorithm known as SHA-256 to both secure the network and its transactions across a peer-to-peer platform, as well as serve as the mining protocol. There are dozens of altcoins based on


2 Cryptocurrencies running the Scrypt algorithm may also use Litecoin (LTC) as the currency base instead of BTC. For more information about mining algorithms, see https://en.bitcoin.it/wiki/Proof_of_work

3 There is now good forensic evidence that a lot of the price volatility in late-2013 to early-2014 was the result of fraudulent price manipulation and deceptive automated trading practices. For a comprehensive analysis of this, please refer to the Willy Report:
   https://willyreport.wordpress.com/

4 Mining is the process by which new units of cryptocurrencies are created. This involves directing computational effort at solving a difficult cryptologic
the SHA-256 protocol in addition to bitcoin, and one can direct mining effort (known as 'hashing') toward any one of those cryptocurrencies in order to mine for them using the same mining 'rig'. A miner who already has mining capacity installed can allocate that same hardware to any of the coins employing the same algorithm. Mining power is a rivalrous resource which is mutually exclusive, and if hashing power is directed to mine for BTC it cannot at the same time mine for other SHA-256 altcoins. Likewise, if mining for any other altcoin that same hashpower cannot mine for bitcoin at the same time. Therefore, miners must decide how to best allocate their mining power.

Application-specific integrated circuit (ASIC) chips designed specifically to solve the SHA-256 protocol’s algorithm greatly changed the mining landscape by increasing the network hashing power by several orders of magnitude. To simplify things, for the purpose of this paper we will continue to look only at SHA-256 based cryptocurrencies and assume that all miners are using ASIC hardware.

In this paper, I begin by identifying and explaining some of the important shared attributes that all cryptocurrencies which can be exchanged for bitcoin share. Next, I formalize the expected own rate of return for mining bitcoins, and then expand that model to determine the equivalence in bitcoins one could expect if mining for an altcoin instead. Assuming this relationship holds, the terms used in the model are rearranged to solve for break-even levels that can be identified and used by those seeking to exploit potential arbitrage opportunities in the bitcoin-altcoin marketplace.

II. A SHORT SURVEY OF RELATED LITERATURE

Hayes (2014) finds that value formation of cryptocurrencies in part is influenced by the average quantity of units which can be mined given a unit of hashing power, on the margin (usually a day’s worth of production). Each individual cryptocurrency has a specified fixed rate of unit formation over time hardwired into its code at its inception based upon certain attributes which will be described in more detail later in this paper. Relative scarcity in terms of a fixed future ‘money supply’ was not found to play a role in relative value amongst altcoins.

Gandal and Halaburda (2014) analyzed the competition among a small number of cryptocurrencies and also competition between four online exchanges. They found that arbitrage opportunities, for the most part, do not exist. The small sample size makes their findings a bit incomplete; they also relate cryptocurrency prices to the dollar instead of using bitcoin as the base for comparison. Due to a number of frictions in transactions between cryptocurrencies and national fiat money, markets tend to be more efficient and less volatile when looking at cryptocurrencies relative to a bitcoin base. This transactional friction and the noise it creates may also be why it was found that gross trading opportunities were much greater across exchanges than within exchanges – where conversions to and from fiat currencies are required.

III. CHARACTERISTICS OF CRYPTOCURRENCIES

It is useful to identify and explain some of the key attributes which are shared by all cryptocurrencies who share a lineage from bitcoin. Bitcoin and the other related altcoins rely on computational effort to confirm and validate transactions carried out over the network. In return for the work of validating the blockchain, miners are rewarded with a block of 'coins'. The following variables are among those always hard-wired into these cryptocurrencies:

1. **Block reward**: this variable indicates how many coins are produced for every block that is mined. For bitcoin, this value is currently 25 BTC per block.
2. **Time between block generation**: There is a pre-set target interval of time during which each block should be found. For bitcoin this is one block every ten minutes (600 seconds), on average.
3. **Difficulty re-target**: After a certain number of blocks have been mined (for bitcoin this is every 2016 blocks), the network will look back and check to see if this target time held. If the time was less than the target, the difficulty for the next round is increased to re-adjust, or re-target the interval back to 10 minutes. If the interval was greater, the difficulty is adjusted downward. This is a function of aggregate hashing power devoted to mining a specific coin. The reason is that the more aggregate power comes online, the easier it becomes to find blocks, such that the rate of unit production increases to a rate faster than the target. By increasing the difficulty sufficiently, the extra computational power may still exist, but blocks will once again be found on average at the set interval. This process incurs a lag within which individuals may add more aggregate mining capacity without a concurrent rise in difficulty. For example, with bitcoin, the target time between blocks is 10 minutes and the network checks every 2,016

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5 Gandal and Halaburda looked at Bitcoin, Litecoin and 5 others: Peercoin, Namecoin, Feathecoin, Novacoin and Terracoin. I argue that this sample size is too small for meaningful analysis. I would also argue that due to merged mining, Namecoin may have skewed their results.
6 Transaction costs & fees, regulatory issues, time waiting for bitcoin confirmations, and time waiting to clear fiat money deposits/withdrawals are just some of these frictions.
9 Other variables are also hard-wired but are not relevant to the calculations here.
10 Difficulty is the measure of how hard it is to find the next block of coins, the higher the difficulty the longer it can be expected to take to find a block given the same level of hashing power. The more mining power aggregated to find a coin, the greater the difficulty becomes. Therefore, the difficulty is an exogenous variable that is not known in advance.
blocks before adjusting the difficulty; the lag is therefore 10 x 2,016 = 20,160 minutes, or two weeks on average. It should be noted that many of the altcoins have shorter times between blocks (such as 1 minute) as well as a smaller number of blocks found before the difficulty re-target (such as after every 1 block).

4 Halving schedule: Although the rate of block production is pre-determined, the number of coins per block may change over time. Specifically, the block reward halves after a specified number of blocks have been found. In the case of bitcoin, the first blocks contained 50 BTC and currently each block contains 25. The halving schedule for bitcoin is once approximately every four years, so the effects this may have will tend to be punctuated after such an event has occurred. 5 Total number of coins: A pre-determined total future 'money supply' can be hardwired such that after that number has been reached, no more coins will be found. Instead, miners will be rewarded for their validation work via transaction fees. Some coins have a very low quantity ever to be produced, others leave room for an infinite growth of future supply. For bitcoin, this upper limit is 21 million BTC, however this variable does not seem to influence differences in relative value in cryptocurrencies.

IV. THE DECISION TO MINE FOR ALTCOINS

There exists efficient mobility of capital in switching mining effort from one coin to another; all one has to do is change the settings in the software or hardware to point the miner's hashing power towards another coin. Once those coins are mined and accumulated they may be exchanged for bitcoin. If obtaining bitcoins is the ultimate goal, a rational miner would only direct mining effort at an altcoin if it provides for greater profitability than mining bitcoin directly. What tends to happen is that any opportunities for excess profits are short-lived as competition drives all profit rates down to at least that of mining for bitcoin itself.

This apparent efficiency in removing opportunities to earn excess profits in mining seems to be the result of two forces: 1) competition of capital, as it is mobilized to mine for the more profitable coin it raises the aggregate network hashing power in that coin, causing the difficulty to subsequently increase. As the difficulty increases, profitability falls per unit of mining effort. 2) The market exchange rate will change as mining participants actively produce and then sell relatively 'overpriced' coins. Thus, both the bitcoin-denominated exchange price and the current difficulty of mining for the cryptocurrency in question determines if there is an arbitrage opportunity, and acting on either variable will serve to eliminate that opportunity.

The baseline for profitability, then, or the regulating level of daily production, is the own rate of return for bitcoin mining, measured in expected bitcoins per day per unit of mining power – for simplicity I will peg that level of hashing power at a standard 1000 GigaHashes/sec (GH/s) of mining power. In practice, the actual hashing power of a miner is likely to deviate greatly from 1,000 GH/s, however this level tends to be a good standard of measure under current circumstances. The rate of bitcoin creation at the time of writing this is 0.010604 BTC/day for every 1,000 GH/s of mining effort. The expected number of bitcoins expected to be produced per day can be calculated as follows:

\[
\text{BTC/day}^* = \frac{[\beta \rho/(\delta \cdot 2^\theta)]}{\text{sec}} \cdot \text{hr}_{\text{day}} \tag{1}
\]

where \(\text{BTC/day}^*\) is the expected level of daily bitcoin production when mining bitcoin directly, \(\beta\) is the block reward, \(\rho\) is the hashing power employed by a miner, and \(\delta\) is the difficulty. \(^{11,12}\) The constant \(\text{sec}_{\text{hr}}\) is the number of seconds in an hour, or 3600. The constant \(\text{hr}_{\text{day}}\) is the number of hours in a day, or 24. The constant \(2^\theta\) relates to the normalized probability of a single hash per second solving a block, and is a feature of the 256-bit encryption at the core of the SHA-256 algorithm. These constants which normalize the dimensional space for daily time and for the mining algorithm can be summarized by the variable \(\theta\), which would equal \(\theta = 24 \text{ hr}_{\text{day}} \cdot 2^{32} / 3600\text{sec}_{\text{hr}} = 28,633,115.30667\). Equation (1) can thus be rewritten:

\[
\text{BTC/day}^* = \frac{\theta(\beta \rho)/(\delta)}{} \tag{2}
\]

The only variables therefore are \(\beta\), \(\rho\) and \(\delta\) – and \(\rho\) will be pegged here to a standard unit of 1,000 GH/s of hashing power.

An arbitrage opportunity exists when mining for any other cryptocurrency with the same amount of hashing power would produce a greater expected level of BTC/day than BTC/day*. To generalize equation (1) to account for any other altcoin, we simply include the current exchange rate of the altcoin/BTC pair, \(\epsilon\). \(^{13,14}\) Specifically, the market bid of the exchange rate is the price that matters since an arbitrageur would only be concerned with selling the altcoin to buy BTC. Equation (3) indicates how many bitcoins would be obtained on average indirectly by mining for an altcoin instead:

\[
\text{BTC/day}^{\text{altcoin}} = \theta(\beta_{\text{altcoin}} \cdot \rho)/(\delta_{\text{altcoin}}) \cdot \epsilon \tag{3}
\]

Under the arbitrage assumption that BTC/day* will be given as the own rate of return for BTC, equation (3) can be re-arranged to solve for a theoretical equilibrium market price of

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11 1000 GH/s = 1 TH/s (TeraHash/sec)
12 Given the current difficulty value for bitcoin of 47,427,554,951 and a block reward of 25 BTC.
13 Block reward is expressed in units of BTC/block.
14 Difficulty is expressed in units of GH/block.
15 All exchange rates are expressed in terms of Altcoin/BTC, or 1 Altcoin = \(X\) BTC.
the bid) of the altcoin, holding the altcoin's difficulty constant:\footnote{BTC/day$^*$ also assumes bitcoin's difficulty is constant during this period, not just that of the altcoin.}

$$\epsilon^* = \frac{[BTC/day^*]}{[\theta(\beta_{altcoin}, \rho)/(\delta_{altcoin})]} \quad (4)$$

If the altcoin's difficulty remains the same, there is a market opportunity for an arbitrageur to sell the relatively overpriced cryptocurrency until it reaches $\epsilon^*$ when exchanged for bitcoin on the market.

If, instead, the market price is held constant at $\epsilon^*$, the difficulty can be thought of as relatively 'undervalued' and directing mining effort to that coin will produce excess profitability by subsequently exchanging those mined coins for bitcoin at price $\epsilon^*$. Employing more mining power will necessarily increase the difficulty of that coin over time, so the arbitrage opportunity only exists until the difficulty is normalized and equilibrium is restored.

$$\delta^* = (\epsilon^* \cdot \beta_{altcoin} \cdot \rho \cdot \sec_{hr} \cdot \hr_{day})/(BTC/day^* \cdot 2^{32}) \quad (5)$$

Because equations (4) and (5) can be worked on by different agents at the same time, arbitrage opportunities tend to be short-lived.

An example is useful here. A hypothetical individual miner has enough hashing power to earn 1 BTC/day$^*$, on average. Alternatively, her same mining effort right now could produce an expected 33,000 XYZ Coin per day, where XYZ Coin is an altcoin that is traded against BTC on one or more exchanges. If the market bid is 0.00003996 BTC, she can exchange her XYZ and get in return: 33,000 x 0.00003996 = 1.32 BTC/day$^*_{altcoin}$, making XYZ Coin mining right now 32% more profitable than mining bitcoin directly. As she and other miners continue to mine and subsequently sell their XYZ Coin, the market price in XYZ/BTC will fall as bids are cleared. The added new mining power in the XYZ network will also tend to make its difficulty rise, making it a less attractive alternative. It is worth noting that since there is orders of magnitude more mining effort directed at mining bitcoin at a given moment, while the new hashing power added to XYZ Coin may be a significant amount to XYZ Coin, the effort being removed from bitcoin mining is likely to be inconsequential.

V. DISCUSSION

The extent of an arbitrage opportunity is influenced by the length of time that will have passed before the network checks to see if its difficulty needs to re-adjusted. If the altcoin's protocol specifies that it will check and change the difficulty every 1 block, and each block is found on average every 1 minute, the arbitrage opportunity will be short-lived as the added mining power will cause a more immediate rise in difficulty. On the other hand, an altcoin similar to bitcoin's structure which has a difficulty re-target of every two weeks will have the possibility of mining for a longer time with abnormal profits; the increased mining power, which creates blocks at an increased rate, will not influence the difficulty until a longer interval has passed.

Because the difficulty adjustment occurs incrementally while the market prices can trade in a continuous fashion means that there is the possibility for the difficulty level to overshoot when it does adjust. If, in our example with XYZ Coin the difficulty re-targets every one hour, miners can create enough supply to drive the market price down to 0.00003030 XYZ/BTC (the equilibrium price given XYZ's current difficulty) long before an hour has passed. Those miners will remove themselves from XYZ Coin mining once that market price has been achieved, but the XYZ Coin network will adjust the difficulty upwards nonetheless since the average time between blocks was too short due to the extra mining effort early on in the interval. When the difficulty adjusts up, 0.00003030 XYZ/BTC will actually be well below the equilibrium price expected by the new higher difficulty for XYZ Coin. Furthermore, if too many miners attempt to exploit such an opportunity and the market liquidity is not sufficient to absorb all of the new sell orders, some miners will be left holding an inventory which they must sell at a loss.

There can be, and there often are cases observed where it is marginally less profitable to mine for some altcoin than to mine for bitcoin. Rational actors should remove mining power from those underperformers and reallocate that power to bitcoin mining (or to a more profitable option if it exists). The question remains why such underperformers persist. One plausible reason is due to the propensity to overshoot described above. It can also be the case that a once profitable opportunity to mine attracted an excess of hashpower, raising the difficulty so far that it overshot the equilibrium difficulty while the market price remained unchanged, given a deep and liquid market for an individual altcoin.

While these reasons may hold in the short-run, the question remains why does it persist for longer periods of time in reality. The rationale for this at a behavioral level is beyond the scope of this paper, but it is interesting to consider the that the following equilibrium condition rarely holds: If all that mining power was diverted away from those underperformers to mine bitcoin directly it may increase the difficulty of bitcoin while decreasing the difficulty of the altcoins, and allow those altcoins to become marginally profitable again. One would expect the profit rate for all SHA-256 cryptocurrencies to be theoretically the same on average over the long-run. What is observed, however, is that the rate of bitcoin production is always the most profitable over the long run, and mining for any other altcoin would produce inferior returns when translated to number of bitcoins.

An interesting piece of this arbitrage mechanism is that it serves to sell relatively overvalued cryptocurrencies in
order to buy bitcoin, yet there is no method for practically identifying relatively underpriced cryptocurrencies in the same manner. In other words, in this market it cannot reasonably be the case that bitcoin is the overvalued asset in the trading pair. The pessimistic implication is that over time, all altcoin prices will tend to fall relative to bitcoin since they will always be naturally offered in the market. There are seemingly no natural buyers; only speculators and noise traders on the bids of altcoins who consistently experience losses as the value of their holdings diminish over time.

When there is an increase in bitcoin's difficulty, it will lower the expected BTC/day* for a given amount of hashing power; the same amount of mining power will now produce on average less bitcoin per day than previously, and thus the regulating rate of mining return is lowered. Returning to our example with XYZ Coin, if we assume that currently the market is in equilibrium and our miner can find either 1 BTC/day or 33,000 XYZ Coin but with a market price of 0.00003030. There is no profit opportunity since either choice would produce an expected one bitcoin per day, on average. If the difficulty of bitcoin increased, however, and the difficulty of XYZ remained unchanged, her mining rig could only produce perhaps an expected 0.8 BTC/day*. The result is that 0.00003030 XYZ/BTC becomes an attractive price once again as it represents a 20% profit opportunity since 33,000 coins per day could still exchange for 1 BTC. The mechanism described above would push the market price of XYZ Coin even lower. This implies that, through no fault of its own, an altcoin can experience persistent price declines simply because the mining difficulty of bitcoin increases.

In fact, the observable trend for most altcoins is that they have fallen in value relative to bitcoin over time. Appendix I shows market data for some of the most popular altcoins.

VI. Conclusion

There is a relationship between the cryptocurrencies built on the SHA-256 algorithm, the same algorithm that underlies bitcoin, where miners’ arbitrage maintains that the average rate of bitcoin creation per unit of mining power per interval of time regulates profitability. If there is an opportunity to mine an alternative coin and, by exchanging those coins in the market, end up with more than they would have by mining bitcoin directly, arbitrageurs can exploit that opportunity until it is eliminated in the process.

Using the model outlined in this paper, the equilibrium altcoin difficulty and/or equilibrium bitcoin-denominated market price can be determined to help identify such opportunities. If they exist, it also indicates to what extent difficulty should be raised or the price should be decreased in order to restore equilibrium. Real-world observations show that an equilibrium state rarely occurs and that most of the time, mining for an altcoin is an inferior decision to mining for bitcoins directly. Furthermore, it seems that there is the potential to overshoot when profitable opportunities do arise.

There is an implication that cryptocurrencies will tend to fall in value relative to bitcoin as the arbitrage takes place only uni-directionally. It also implies that there is a downward pressure on altcoin prices when there is a marginal increase in the bitcoin mining difficulty, as this effectively reduces the number of bitcoins a given amount of mining effort can find per day, making other altcoins marginally more profitable to mine until the described mechanism brings them back to the new equilibrium exchange rate.

This may help explain why altcoin prices have generally fallen over time relative to bitcoin despite numerous variations in their attributes. Table I illustrates this trend using empirical data obtained from one of the largest altcoin exchanges.17

TABLE I: 6-MONTH MARKET PRICE DATA FOR SELECT ALTCOINS

<table>
<thead>
<tr>
<th>Altcoin (Ticker)</th>
<th>Market price (in BTC) 9/16/2014</th>
<th>Market price (in BTC) 3/16/2015</th>
<th>6-month % Change in price</th>
</tr>
</thead>
<tbody>
<tr>
<td>42Coin (42)</td>
<td>7.80000000</td>
<td>4.17818182</td>
<td>-46.43%</td>
</tr>
<tr>
<td>Acocoin (ACOIN)</td>
<td>0.00001541</td>
<td>0.00003403</td>
<td>-77.93%</td>
</tr>
<tr>
<td>Aerocoin (AERO)</td>
<td>0.00005449</td>
<td>0.00000725</td>
<td>-86.69%</td>
</tr>
<tr>
<td>BancorCoin (BNCR)</td>
<td>0.00003600</td>
<td>0.00000070</td>
<td>-98.06%</td>
</tr>
<tr>
<td>Battlecoin (BCX)</td>
<td>0.00000153</td>
<td>0.00000096</td>
<td>-37.25%</td>
</tr>
<tr>
<td>Betacoin (BET)</td>
<td>0.00000220</td>
<td>0.00000094</td>
<td>-59.13%</td>
</tr>
<tr>
<td>BitcoinDark (BTD)</td>
<td>0.01198000</td>
<td>0.00372638</td>
<td>-68.89%</td>
</tr>
<tr>
<td>Blackcoin (BLK)</td>
<td>0.00001539</td>
<td>0.00000561</td>
<td>-63.43%</td>
</tr>
<tr>
<td>CryptCoin (CRYPT)</td>
<td>0.00003273</td>
<td>0.00001600</td>
<td>-51.12%</td>
</tr>
<tr>
<td>Curecoin (CURE)</td>
<td>0.00007000</td>
<td>0.00003999</td>
<td>-42.87%</td>
</tr>
<tr>
<td>DevCoin (DVC)</td>
<td>0.00000010</td>
<td>0.00000004</td>
<td>-60.00%</td>
</tr>
<tr>
<td>DigitalCoin (DGC)</td>
<td>0.00002100</td>
<td>0.00001802</td>
<td>-14.19%</td>
</tr>
<tr>
<td>Dogecoin (DOGE)</td>
<td>0.00037500</td>
<td>0.00013505</td>
<td>-63.99%</td>
</tr>
<tr>
<td>EmeraldCoin (EMD)</td>
<td>0.00000356</td>
<td>0.00000161</td>
<td>-54.78%</td>
</tr>
<tr>
<td>FastCoin (FST)</td>
<td>0.00000132</td>
<td>0.00000058</td>
<td>-56.06%</td>
</tr>
<tr>
<td>FrankoCoin (FRK)</td>
<td>0.00012000</td>
<td>0.00008301</td>
<td>-30.83%</td>
</tr>
<tr>
<td>Freecoin (FRC)</td>
<td>0.00000651</td>
<td>0.00000477</td>
<td>-26.73%</td>
</tr>
<tr>
<td>Goldecoin (GLD)</td>
<td>0.000001800</td>
<td>0.00001240</td>
<td>-31.11%</td>
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<tr>
<td>GrandCoin (GDC)</td>
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<td>0.00000007</td>
<td>-56.25%</td>
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<td>HoboNickels (HBN)</td>
<td>0.00006743</td>
<td>0.00003041</td>
<td>-54.90%</td>
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<tr>
<td>JouleCoin (XJO)</td>
<td>0.00000309</td>
<td>0.00000120</td>
<td>-61.17%</td>
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<tr>
<td>Litecoin (LTC)</td>
<td>0.01150000</td>
<td>0.00702360</td>
<td>-38.93%</td>
</tr>
<tr>
<td>MyriadCoin (MYR)</td>
<td>0.00000055</td>
<td>0.00000028</td>
<td>-49.09%</td>
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<tr>
<td>Namecoin (NMCP)</td>
<td>0.00298000</td>
<td>0.00164790</td>
<td>-44.70%</td>
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<tr>
<td>Nextcoin (NXT)</td>
<td>0.00007888</td>
<td>0.00004515</td>
<td>-42.76%</td>
</tr>
<tr>
<td>Peercoin (PPC)</td>
<td>0.00402000</td>
<td>0.00137740</td>
<td>-65.74%</td>
</tr>
</tbody>
</table>

17 Data source for Table I data: http://www.cryptsy.com
<table>
<thead>
<tr>
<th>Currency</th>
<th>Price 1</th>
<th>Price 2</th>
<th>Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reddcoin (RDC)</td>
<td>0.00000013</td>
<td>0.00000008</td>
<td>-38.46%</td>
</tr>
<tr>
<td>SaffronCoin (SFR)</td>
<td>0.00002680</td>
<td>0.00000266</td>
<td>-90.07%</td>
</tr>
<tr>
<td>TekCoin (TEK)</td>
<td>0.00023512</td>
<td>0.00001928</td>
<td>-91.80%</td>
</tr>
<tr>
<td>TerraCoin (TRC)</td>
<td>0.00006961</td>
<td>0.00001099</td>
<td>-84.21%</td>
</tr>
<tr>
<td>TigerCoin (TGC)</td>
<td>0.00000095</td>
<td>0.00000080</td>
<td>-15.79%</td>
</tr>
<tr>
<td>ZetaCoin (ZET)</td>
<td>0.00002948</td>
<td>0.00000252</td>
<td>-91.45%</td>
</tr>
</tbody>
</table>

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