

## GPU PRICES AND CRYPTOCURRENCY RETURNS

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### Abstract

We look at the association between the price of a cryptocurrency and the secondary market prices of the hardware used to mine it. We find the prices of the most efficient Graphical Processing Units (GPUs) for Ethereum mining are significantly positively correlated with the daily price returns to that cryptocurrency.

**JEL Codes:** G12, G23, L11, L22, L63

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### 1. Introduction

We use a unique data set of scalper prices for graphical processing units (GPUs) to study the association between the price of Ethereum (ticker ETH) and the hardware used to mine it. We find the most efficient ETH mining GPUs as measured by secondary market price per productivity unit (called the hashrate) had secondary market price moves that were positively correlated with daily returns to ETH.

Most of the prior research into cryptocurrency mining has focussed on Bitcoin and does not measure the impact between the cryptocurrency's price's correlation with key mining hardware. Dimitri (2017) and Ma et al. (2019) model Bitcoin mining as an all-pay tournament. Ma et al. (2019) argues that free entry in mining is ultimately wasteful in part because Bitcoin miners consumed more electricity than all of Australia. Easley et al. (2019) are sceptical about the usefulness of Bitcoin as a medium of exchange as its network could only process seven transactions per second versus Visa which can process 50,000 transactions per second. Cong et al. (2021) find that mining pools help cryptocurrency miners eliminate idiosyncratic risk. Kristoufek (2020) finds that price of Bitcoin over the long-term impacted the cost of mining components. Mueller (2020) looks at entry and exit thresholds for both Bitcoin and Ethereum miners.

In section 2, the GPU mining market for cryptocurrency is discussed and basic model of GPU pricing with ETH mining is developed. The data sources are discussed in section 3. In section 4, the statistical analysis indicates that the Nvidia GeForce RTX 3060ti and the RTX 3080 GPUs are significantly more attractively priced for ETH mining, and their prices are positively correlated with daily price moves in Ethereum.

## 2. The GPU Mining Market

Ethereum, which will be referred to by its ticker symbol ETH, is “mined” via graphical processing units (GPUs). GPUs are capable of more calculations per second than most CPUs or central processing units and typically run at much higher clock speeds. Prat and Walter (2021) argue that GPUs have been displaced in Bitcoin mining by Application Specific Integrated Circuits (ASIC) since 2013. Thus, we are only concerned with the tie between Ethereum and GPU prices. According to Sigalos (2021), a very basic computer setup with a very high-end graphics card is preferred by the ETH miners interviewed.

The public ledger in decentralized network is on the blockchain. GPU “miners” race to add to the ledger a hexadecimal code that is acceptable to the entire network for the next transaction. ETH and Bitcoin are proof of work (POW) cryptocurrencies, which reward computer owners (miners) whose computer completes the first acceptable hexadecimal code for the blockchain. The chances of any one computer completing this POW output are very small, but the one that does receive a reward in cryptocurrency. Sigalos (2021) finds this computing race rewards a miner on average every 13 seconds. Commonly, miners join a pool which shares the pool rewards based on the hashrate. Hashrate is a measure of computing productivity which is primarily a function of the number and quality of the GPUs used to mine. A miner with a greater total hashrate will be rewarded with greater pool rewards.

The Ethereum Foundation, which runs the ETH network, in Beekhuizen (2021) said each ETH proof of work transaction consumed the electricity needed to power a house for three days (every 13 seconds). In May 2021, there were over 140,592 GPU’s (“validators”) competing for each transaction. Over half of those, 87,897, were described as home validators with about 5.4 GPUs on average. Beekhuizen (2021) said the Ethereum Foundation was considering moving to a proof of stake model, which would make GPU mining obsolete and reduce power consumption per transaction. At the time of writing, the Ethereum Foundation (2021) projected proof of stake and GPU mining would go away by Q1 or Q2 2022. Thus, GPU miners may be forced to mine tokens other than Ethereum that are only available on decentralized exchanges, according to Aspris et al. (2021).

GPUs have non-mining uses. They are used for graphically intensive computing applications such as video editing, video streaming, and the playing of video games (commonly called gaming). A global supply shortage of semiconductors has limited the production of GPUs despite their swelling demand for gaming and ETH applications. On September 24, 2021, Nvidia the designer of the RTX 3000 series cards, released the 3090, 3080, and 3070 Founders Edition cards for a price of \$1,499, \$699, and \$499, according to Kan (2021), but those cards sold out quickly. The 3060ti had an MSRP of \$399 at its launch on December 2, 2020, according to a press release by Burnes (2020). Immediately, these GPUs were unavailable at most retailers and were scalped for much more than their launch prices on eBay and Stockx. PCMag (2021) quotes a Nvidia spokesperson saying that Ethereum mining was the primary demand driver of their GPUs. PCMag (2021) reported that 80 percent of GPU sales were Nvidia cards. Further, it said ETH was the most profitable cryptocurrency to mine with a GPU.

Let us derive a parsimonious model of graphics card pricing in the scalper market. There are two types of GPUs. To enter or expand production, a miner will want to buy an expansion in hashrate at the lowest price per average hashrate of expected production. That translates into buying the GPU that produces the highest hashrate per dollar of purchase price. Hashrate is only one factor in expected profits. The other factor is the expected price of ETH.

GPUs of type  $i$  have ETH miners as their marginal buyers. GPUs of type  $j$  are assumed to have a marginal buyer who is not going to mine ETH but outbids miners because he or she gets private benefits that exceed the miner’s expected profits before the cost of the card is taken in account.

Suppose that  $C_i$  = cost of a new GPU where miners are the marginal buyers.  $C_j$  = cost of a new GPU where non-miners are the marginal buyers.  $H_i$  = expected hashrate for mined cards, and  $H_j$  = expected hashrate for cards not bought for mining.  $T$  = time of the investment period.  $a$  is the ETH pay out for miners as a percent of hashrate produced. All these parameters are assumed to take on positive values. Let us assume that miners believe that the price of Ethereum,  $E$ , takes on a random walk, and today's price is the best estimate of the future price of ETH.  $a > 0$  is a parameter for how many shares of ETH,  $E$ , that a miner obtains for a given hashrate.

A model of GPU in which the marginal buyer has its price determined by this zero-profit condition:

$$aH_iET - C_i = 0 \quad (1)$$

The price of the mined model of GPUs is endogenously determined as

$$C_i = aH_iET. \quad (2)$$

Obviously, this price is positively correlated to the Ethereum,  $E$ , price movements.

$$dC_i/dE = aH_iT > 0 \quad (3)$$

The ratio of price to hashrate for the mined card is

$$C_i/H_i = aET \quad (4)$$

In contrast, a card in which the marginal buyer is not an Ethereum miner has the following profit relationship if purchased for mining:

$$aH_jET - C_j < 0 \quad (5)$$

Namely,

$$C_j > aH_jET. \quad (6)$$

Instead of price being a function of ETH, price is a function of the private benefits,  $B_j$ , that the marginal buyer derives from the non-mined card.  $C_j = B_j$ .

$$dC_j/dE = 0 \quad (7)$$

Further, the ratio of GPU price over hashrate for the card bought by non-miners, card  $j$ , will be higher than for card  $i$ , whose marginal buyer is a miner.

$$C_j/H_j > aET = C_i/H_i \quad (8)$$

Thus, we will only expect the lowest price per hashrate GPU models to be sensitive to the ETH price. That leads us to the hypothesis that we wish to test.

**Hypothesis:** *Only the most productive graphics cards as measured by secondary market price per hashrate will be significantly positively correlated with daily movements in the Ethereum (ETH) price.*

### 3. Data

Since RTX 3000 series cards were almost always sold out in standard retail channels since their launch until the sample period, we have to look to secondary (scalper) markets to find their market price. We got our data about secondary market prices from Stockx. Stockx is preferable to eBay in that it only sells unused GPUs. It also takes custody of products sold on the site prior to shipping them to the buyer. Thus, it is an anonymous market for new products with quality, sales, and shipping verifications that eBay listings often lack. Further, unlike eBay, Stockx lists all products in a bid and ask format instead of a multitude of auction listings on eBay, which are hard to sort through. Thus, Stockx prices are more transparent. We looked at the prices for three months of transactions for Founder's Edition RTX 3000 cards on Stockx from June 3, 2021, to September 1, 2021. Stockx only provides daily data for the last three months by hovering over the price graphs. Going farther back means skipping some day's prices. The prices on the three-month price charts are average trading prices over a roughly 24-hour period. Using longer dated charts does not increase the observations, but only increases the number of days that trading prices are averaged. We got daily closing prices of Ethereum (ETH) from Yahoo! Finance. We calculated daily price returns to the RTX 3090, 3080, 3070, and 3060ti Founders Edition graphics cards and ETH cryptocurrency.

The 3060 Founder's Edition GPU was not listed on Stockx, and the 3070ti and 3080ti had only first went on sale on June 10, 2021, or June 3, 2021, respectively. Besides having more limited trading data, the 3070ti and 3080ti cards had much lower hashrates than the 3070 and 3080 cards, respectively, according to Minerstat.com. Non-Founder's Edition RTX 3000 series GPUs, which were not manufactured by Nvidia, were far less liquid and typically lacked at least one transaction on Stockx per day over the period studied. We obtained average hashrates, ETH revenues per day, and ETH mined per day from [www.minerstat.com/hardware](http://www.minerstat.com/hardware) on September 2, 2021.

**Table 1: GPU Models and Their Price per Hash**

Graphics Card	Hashrate	Estimated Daily Revenues	Estimated ETH Mined Per Day	Average GPU Price	Stockx Price as a % of launch MSRP	Price Per Hash	Price Per Hash Premium Over RTX 3080
RTX 3090	121.16	\$14.55	0.0038	\$2,308.46	154%	\$19.05	12.3%
RTX 3080	97.88	\$11.75	0.0031	\$1,661.18	238%	\$16.97	0.0%
RTX 3070	61.79	\$ 7.42	0.0020	\$1,103.10	221%	\$17.85	5.2%
RTX 3060ti	60.21	\$ 5.55	0.0014	\$1,026.80	257%	\$17.05	0.5%

Note: Hashrates, daily revenues and ETH per day are from Minerstat, and were collected on September 2, 2021, at <https://minerstat.com/hardware/>. Average prices were from Stockx's daily prices of Founder's Edition cards from June 3, 2021, to September 1, 2021. The MSRP at launch for the RTX 3090, 3080, 3070, and 3060ti were \$1,499, \$699, \$499, and \$399, respectively, according to Kan (2020) and Burnes (2020). Price per hash is the average price divided by the hashrate. The

price per hash premium over the RTX 3080 is the percent by which the reference card's price per hash exceeds the RTX 3080's price per hash.

The most productive graphics card studied as a function of its secondary market (scalper) prices per average hash rate was the RTX 3080 followed by the RTX 3060ti, according to table 1. The graphics cards studied all sold on average over the three-month period for between 257 to 154 percent of their launch price's manufacturer's suggested retail price (MSRP).

#### 4. Analysis

According to table 2, panel A, during the period studied, the RTX 3080 and RTX 3060ti had a significantly lower average price per hash than both the RTX 3070 and RTX 3090 with over 99 percent confidence. That would indicate that both the RTX 3080 and RTX 3060ti were priced more attractively to miners than the other two cards. The price per hash of all graphics cards were significantly positively correlated with one another with over 99 percent confidence.

**Table 2: Average Secondary Market Prices for GPUs per Hash**

Panel A: Paired Sample T-tests		Differences (Row – Column)		
	Means	RTX 3090	RTX 3080	RTX 3070
RTX 3090	\$19.05			
RTX 3080	\$16.97	-\$1.92***		
RTX 3070	\$17.85	-\$1.00***	\$1.09***	
RTX 3060ti	\$17.05	-\$1.75***	\$0.29	-\$0.58***

  

Panel B: Correlations		RTX 3090	RTX 3080	RTX 3070
RTX 3090				
RTX 3080		0.897***		
RTX 3070		0.846***	0.846***	
RTX 3060ti		0.777***	0.854***	0.842***

Note: Hashrates are from Minerstat, and were collected on September 2, 2021, at <https://minerstat.com/hardware/>. Prices were from Stockx's daily prices of Founder's Edition cards from June 3, 2021, to September 1, 2021. Price per hash is the daily price from Stockx divided by the hashrate reported by Minerstat. \*, \*\*, or \*\*\* denoted two-tailed significance at the 90%, 95%, or 99% level of confidence, respectively.

In table 3, the hypothesis is supported. The least expensive cards for mining, the RTX 3080 and RTX 3060ti, have daily price changes that are significantly positively correlated with the daily price movements of Ethereum. The RTX 3080 and RTX 3060ti coefficients are positive and significant with over 99 and 95 percent confidence, respectively. Both those cards had significantly lower prices per hash than the RTX 3070 and RTX 3090 in table 2, panel A. The latter two cards price changes had no significant correlation with the price changes for ETH. The Ordinary Least Squares (OLS) regression results indicate that only GPUs which are priced attractively for ETH mining see their price moves track the price of Ethereum. A one percent increase in the price of Ethereum correlates with a 0.22 percent and 0.19 percent increase in the price of the Nvidia GeForce RTX 3080 and 3060ti Founder's Edition cards, respectively, on the scalper market of Stockx.

**Table 3: Daily GPU Price Changes and Daily ETH Returns from June 3, 2021, to September 1, 2021**

	RTX 3090	RTX 3080	RTX 3070	RTX 3060ti
<b>Constant</b>	-0.001 (-0.362)	-0.001 (-0.405)	0.001 (0.232)	0.000 (0.083)
<b>ETH Returns</b>	0.083 (1.346)	0.217 (2.896***)	0.053 (0.510)	0.185 (2.019***)
<b>Adjusted R-Squared</b>	0.009	0.077	-0.008	0.033
<b>F-statistic</b>	1.813	8.386***	0.260	4.077***

Note: The dependent variables are the daily price changes for the GPUs studied. GPU prices were from Stockx's daily prices of Founder's Edition cards from June 3, 2021, to September 1, 2021. The independent variable is calculated from daily ETH closing prices from Yahoo! Finance. \*, \*\*, or \*\*\* denoted two-tailed significance at the 90%, 95%, or 99% level of confidence, respectively. T-statistics are in parentheses. There were 90 daily ETH returns and GPU price changes.

There is some evidence that the correlation between ETH returns and GPU prices started to break down in the months leading up to the announced end of GPU mining in quarter one or two of 2022, according to Ethereum Foundation (2021). To augment our data from June 3, 2021, to September 1, 2021, we gathered data up to December 4, 2021, and found that the prices changes for the RTX 3060ti cards were no longer significantly reflecting daily returns to ETH. The coefficient ETH returns when the RTX 3080 daily price was the dependent variable was still positive significant with 99 percent confidence. Nevertheless, its magnitude was down. Over this longer time horizon, the 3080 price only increases by 0.15 percent with a one percent rise in the price of ETH. That is down from the 3080 price increasing by 0.22 percent for each one percent rise in ETH from June 3, 2021, to September 1, 2021, when the end of proof of work was several more months away.

**Table 4: Daily GPU Price Changes and Daily ETH Returns from June 3, 2021, to December 4, 2021**

	RTX 3090	RTX 3080	RTX 3070	RTX 3060ti
<b>Constant</b>	0.000 (-0.154)	0.001 (0.269)	0.001 (0.287)	0.001 (0.397)
<b>ETH Returns</b>	0.041 (0.947)	0.150 (2.837***)	0.034 (0.533)	0.034 (0.548)
<b>Adjusted R-Squared</b>	-0.001	0.037	-0.004	-0.004
<b>F-statistic</b>	0.896	8.049***	0.284	0.300

Note: The dependent variables are the daily price changes for the GPUs studied. GPU prices were from Stockx's daily prices of Founder's Edition cards from June 3, 2021, to December 4, 2021. The independent variable is calculated from daily ETH closing prices from Yahoo! Finance. \*, \*\*, or \*\*\* denoted two-tailed significance at the 90%, 95%, or 99% level of confidence, respectively. T-statistics are in parentheses. There were 184 daily ETH returns and GPU price changes.

## 5. Conclusion

We find that the most efficient GPUs for mining Ethereum saw their secondary market prices reflect the daily prices changes in the market price of that cryptocurrency. As the Ethereum Foundation moved closer to making GPU mining obsolete with Ethereum 2.0, this positive correlation disappeared for one of the most efficient graphics cards for mining, the Nvidia RTX 3060ti. Future work may want to test if the implementation of Proof of Stake for the Ethereum cryptocurrency leads to a significant decline in secondary market prices of GPUs.

## References

- Aspris, Angelo, Sean Foley, Jiri Svec, and Leqi Wang, (2021), "Decentralized exchanges: The 'wild west' of cryptocurrency trading," *International Review of Financial Analysis*, 77, 1-10.
- Beekhuizen, Carl, (2021), "A country's worth of power, no more!" *Ethereum Foundation Blog*, May 18, 2021, Accessed online on September 10, 2021, at <https://blog.ethereum.org/2021/05/18/country-power-no-more/>.
- Burnes, Andrew, (2020), "GeForce RTX 3060 Ti Out Now: Faster Than RTX 2080 SUPER, Starting At \$399," *Nvidia.com*, December 1, 2020, Accessed online September 10, 2021, <https://www.nvidia.com/en-us/geforce/news/geforce-rtx-3060-ti-out-december-2/>.
- Cong, Lin William, Zhiguo He, and Jiasun Li, (2021), "Decentralized Mining in Centralized Pools," *The Review of Financial Studies*, 34(3), 1191–1235.
- David Easley, Maureen O'hara, and Souyma Basu, (2019), "From mining to markets: The evolution of bitcoin transaction fees," *Journal of Financial Economics*, 134(1), 91-109.
- Dimitri, Nicola, (2017), "Bitcoin mining as a contest," *Ledger*, 2, 31-37.
- Ethereum Foundation, (2021), "The Merge", *Ethereum.org*, Accessed online on December 5, 2021, at <https://ethereum.org/en/eth2/merge/>.
- Kan, Michael, (2020), "Nvidia's GeForce RTX 3080 Lands Sept. 17 for \$699, RTX 3070 Drops Next Month," *PCMag*, September 1, 2020, Accessed online on September 10, 2021, at <https://www.pcmag.com/news/nvidias-rtx-3080-lands-sept-17-for-699-rtx-3070-drops-next-month>.
- Kristoufek, Ladislav, (2020), "Bitcoin and its mining on the equilibrium path," *Energy Economics*, 85(1), 104588.
- Ma, June and Gans, Joshua S. and Tourky, Rabee, (2019), "Market Structure in Bitcoin Mining," *Rotman School of Management Working Paper No. 3103104*, Accessed online on September 10, 2021, at <https://ssrn.com/abstract=3103104>.
- Mueller, Peter, (2020), "Cryptocurrency Mining: Asymmetric Response to Price Movement" *SSRN Working Paper*, (November 18, 2020). Accessed online on September 9, 2021, at <https://ssrn.com/abstract=3733026>.
- PCMag Staff, (2021), "Inside the GPU Shortage: Why You Still Can't Buy a Graphics Card," *PCMag*, June 10, 2021, Accessed online on September 10, 2021, at <https://www.pcmag.com/news/inside-the-gpu-shortage-why-you-still-cant-buy-a-graphics-card>.
- Prat, Julien, and Benjamin Walter, (2021), "An equilibrium model of the market for bitcoin mining," *Journal of Political Economy*, 129(8), 2415-2452.
- Sigalos, MacKenzie, (2021), "Bitcoin's biggest rival hit a record high this week — here's how to mine for ethereum," *CNBC*, May 10, 2021, Accessed online on September 9, 2021, at <https://www.cNBC.com/2021/05/10/how-to-mine-ethereum.html>.