Under the hood of the Ethereum blockchain

Article

Accepted Version

Urquhart, A. ORCID: https://orcid.org/0000-0001-8834-4243 (2022) Under the hood of the Ethereum blockchain. Finance Research Letters, 47 (Part A). 102628. ISSN 1544-6123 doi: https://doi.org/10.1016/j.frl.2021.102628 Available at https://centaur.reading.ac.uk/101841/

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Abstract

Since the creation of Bitcoin, there has been an explosion in the number of cryptocurrencies developed and although Ethereum is the second largest cryptocurrency in terms of market capitalization, there is very little research on this cryptocurrency and in this paper, we provide an overview of this cryptocurrency. We examine the addresses, transactions and fees as well as users holding patterns to the Ethereum blockchain. Therefore this paper offers the first detailed overview of the Ethereum blockchain.

Keywords: Ethereum; Blockchain; Cryptocurrencies; Network

1. Introduction

Ethereum is a platform based on a peer-to-peer network that supports an immutable transaction record on a public shared ledger, known as blockchain. Ethereum has long been the largest smart-contract blockchain and the second largest cryptocurrency behind Bitcoin in terms of market capitalization of its native coin, Ether. The advantage that Ethereum has over the Bitcoin blockchain is that it is more than just a peer-to-peer transaction network. Ethereum allows users to set up and execute smart contracts, and now many cryptocurrencies use the Ethereum blockchain.[1] Further, Ethereum is the premier blockchain for non-fungible tokens (NFTs) which are growing in size and popularity at an incredible rate with a growing academic literature examining the nature of these new forms of art (for example see Dowling 2021a; Dowling 2021b; Aharon and Demir 2021).[2] Given the importance and increasing size of the Ethereum network, not to mention the explosion in the price of Ether, it is surprising that the literature has largely ignored this cryptocurrency.

The majority of prior literature studies solely Bitcoin (such as Dwyer 2015; Urquhart 2016; Shen et al 2021), or studies the relationship between Bitcoin and other cryptocurrencies (such as Corbet et al 2018; Ji et al 2019; Katsiampa et al 2019), or conduct asset pricing studies on cryptocurrencies (such as Shen et al 2020; Liu and Tsyvinski 2021; Liu et al 2021). In terms of the main findings for Ethereum, Cretarola and Figà-Talamanca (2020) identify bubbles in Bitcoin and Ethereum while Alvarez-Ramirez and Rodriguez (2021) study the efficiency of Bitcoin and Ethereum.[3] Alexander et al (2021) examine the price discovery and microstructure in the ether spot and derivative markets while Kim et al (2021) show that generic blockchain information can be used with machine learning techniques to predict future Ethereum prices. However the literature is sparse on Ethereum and given its growing size and importance to the cryptocurrency ecosystem, an overview of the Ethereum blockchain is well overdue. In this paper, we fill this gap and provide a thorough overview of the Ethereum blockchain by studying the addresses, transactions and fees of the Ethereum blockchain. Therefore, we significantly advance the literature in this area and provide avenues for future research within Ethereum.

The rest of this paper is organised as follows. Section 2 presents the data used in this study, while Section 3 provides an overview of the addresses and user within the blockchain. Section 4 provides details of the transactions and fees, while Section 5 presents details on the holding periods of users. Section 6 summarizes the paper and provides future avenues of research.

2. Data

We collect data from Glassnode.com as well as Coinmetrics.io. Glassnode provides details of the Ethereum blockchain while Coinmetrics supplements the data and is a reliable source of cryptocurrency data that has been sued in previous studies such as Bhambhwani et al (2021), Tsang and Yang (2021), Chen and Irresberger (2021) and Liu and Tsyvinski (2021). Coinmetrics only provides data based on reputable exchanges and uses 35 criteria to filter out illiquid and unreliable exchanges. For example, Coinbase, Kraken and Bittrex are included by Coinmetrics.io, but exchanges such as CoinBene, OkEX and BitForex are excluded as they have been found to report suspicious volume data. We collect Ethereum data from 30th July 2015 to 25th October 2021

[1] As of 28th October, Coinmarketcap reports that 124 cryptocurrencies use the Ethereum blockchain.
[2] See https://medium.datadriveninvestor.com/nft-ecosystems-101-currencies-wallets-and-marketplaces-e30457a6ca11 for more information.
[3] Bubbles are prevalent in Bitcoin and Ethereum and the cited literature finds that Ethereum bubbles coincide with Bitcoin bubbles, indicating the strong spillovers and correlation between these two leading cryptocurrencies. Further, Alvarez-Ramirez and Rodriguez (2021) find that the level of market efficiency is very similar in Bitcoin and Ethereum.

thereby capturing 2,280 trading days. Although Ethereum was conceived in 2013, the network went live on 30th July 2015 therefore we capture the complete history of Ethereum.

3. Addresses

Initially, we study the users of the Ethereum blockchain. Figure 1 shows the number of new addresses, active addresses and total addresses on the Ethereum blockchain, where we define active addresses as addresses that have participated in a transaction. We can see a sharp uptake in the number of addresses in late 2017, coinciding with the cryptocurrency bubble of 2017 which is followed by a steady rise from then on. The number of active and new addresses follow a similar pattern with a sharp increase during late 2020 and early 2021, again coinciding with a strong bull market for cryptocurrencies. Since Ethereum went live on 30th July 2015, there has been over 132 million addresses partaking in transactions on the network.

However, studying only addresses can be misleading as many of these addresses my hold very little, or no Ethereum. In fact, there are lots of addresses with zero balances that increases over time and reaches a figure of 51% at the end of sample indicating the number of dormant addresses and the turnover of addresses by users. Figure 2 reports the percentage of Ethereum addresses that hold a certain amount of Ethereum. Specifically, we report the percentage of addresses holding between 0 and 0.1 ETH, 0.1 to 1 ETF, 1 to 10 ETH, 10 to 100 ETH, 100 ETH to 1,000 ETH 1,000 ETH to 10,000 ETH and over 10,000 ETH, respectively. We have plotted the percentage of addresses between 0 and 0.1 ETH on the secondary y-axis where we can see a steady increase over time and peaks around 91% towards the end of our sample, indicating that the vast majority of addresses hold a very little amount of ETH. This could be due to users leaving small amounts of ETH in addresses they have forgotten about or are old addresses with such a little amount of ETH in, that moving it would cost more in transaction fees to move the ETH than the actual value of the ETH. Also, it could be due to users leaving small proportions in their addresses to hold for future transaction fees.[4] The next most popular balance of addresses is between 0.1 to 1 ETH and generally throughout our sample, there are less users holding larger amounts of ETH. This suggests that Ethereum is widely distributed amongst addresses. If we were to compare these figures to Bitcoin, we find that Bitcoin has less diluted supply with more addresses holding larger proportions of Bitcoin.[5]

4. Transactions and Fees

Next we study the transactions on the Ethereum network where we report the daily number of transactions on the blockchain and we can see in Figure 3 the total number of transactions on the network as well as the transaction volume. We can see that the number of transactions on the network increased steadily over time and peaked around the end of 2017, again coinciding with the huge price appreciation. Since then, although there was an initial drop in the number of transactions, there has been a steady increase in the number of transactions on the Ethereum blockchain since late 2019. In terms of transaction volume, this also peaked late-2017 and subsequently fell, but since then, there has been a levelling off in the volume of transactions, indicating that the size of the transactions has reached an acceptable level of the blockchain.

[4] Unfortunately, we do not have access to the value of these addresses thereby we are unable to calculate the value of these addresses with such a. small values.

[5] The Bitcoin comparison results are not reported to conserve space but are available upon request from the corresponding author.

One big concern about the Ethereum blockchain is the size of the transaction fees, called gas.[6] Gas fees have fluctuated dramatically, and many commentators have argued that the rising gas fees are a serious drawback of using the Ethereum blockchain. Figure 4 reports the daily average gas per transaction and although we see a number of spikes throughout our sample, there is a small positive gradient indicating a slight increase in the mean amount of gas required for each transaction. This doesn't look a big issue however on the secondary y-axis, we report the average dollar value of the gas used per transaction. Up until 2020, we can hardly see the dollar value per transaction but since then, we have seen large spikes in the amount a user needs to spend in order to transact on the Ethereum blockchain. The value fluctuates dramatically but reaches two peaks of $66 and $65 respectively indicating the cost of transacting on the Ethereum blockchain. This could be a big problem for Ethereum and no doubt will be examined in future research.

Figure 5 shows the miner revenues, where we report the daily total miner revenue (in USD) and the percentage of miner revenue from fees since Ethereum miners gain revenue from minted coins, as well as collecting transaction fees. We can see that total miner revenue generally decreased over time until mid-2020 when there was a general increase in the total miner revenue. This value will obviously fluctuate dramatically with the price of ETH. However more interesting is the percentage of miner revenue that comes from transaction fees, as opposed a block reward of newly minted coins. We can see an increase in the importance of transaction fees for miners revenue over time, with a sharp increase from early 2020. The percentage of revenue from fees varies dramatically from early 2020, topping out at 76% and generally above the 30% region. This indicates the importance of transaction fees to miners in terms of their total revenue which is consistent with our findings in Figure 4.

5. HODL Waves

A common term within the cryptocurrency space is HODL, which stands for "hold on for dear life", is a term for investors who hold their cryptocurrency for a long time in the expectations of a large price appreciation. Given the nature of public blockchains, we can study how long coins are held be specific users, which gives a flavour of the sentiment in the market. Figure 6 reports the HODL waves, where we report the percentage of Ethereum that has been held in an address for a certain period of time. We split the time periods into eight different time spans to determine how long users are holding their Ethereum for. We can see that overtime, users are holding Ethereum for longer with the initial largest holding period being between 1 month and 6 months and then switching to 1 to 3 years from 2018. This suggests that Ethereum users are holding the coin for fairly large periods of time. Obviously this metric will be biased towards longer periods as the sample period increases but it clearly shows that Ethereum holders generally do not hold the coin for short periods of time indicating that holders of Ethereum are optimistic about the future price movements of the coin.[7]

6. Summary and Future Research

In this paper, we provide the first overview of the Ethereum blockchain. We report the distribution of addresses on the Ethereum blockchain, as well as the balances of these addresses. We show the number and value of the transactions, as well as the growing gas fees. We also document the miner revenue on the blockchain as well as the growing importance of transaction

[6] Gas refers to the cost necessary to perform a transaction on the Ethereum network where gas prices are denoted in gwei, which is equal to 0.000000001 ETH (10^{-9} ETH).

[7] Interesting, the HODL waves of Bitcoin are very similar to that of Ethereum, indicating that investors are treating Bitcoin and Ethereum in a similar fashion within their cryptocurrency holdings.

fees in terms of the miner revenue. Finally, we report the HODL waves showing that the majority of Ethereum users hold Ethereum for fairly long periods of time rather than holding them for short periods, which indicates that holders are confident about future price appreciation.

We believe that future research within cryptocurrencies need to study Ethereum, and other cryptocurrencies in more detail. Ethereum is the second largest cryptocurrency in terms of market capitalization and trading volume however very little is known in the academic literature of this importance blockchain. Ethereum arguably has more innovative features and a stronger use case than Bitcoin

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Figures

Figure 1: The number of new addresses, active addresses and total addresses on the Ethereum blockchain. The total number of addresses is on the secondary y-axis, while new addresses and active addresses are on the primary y-axis.

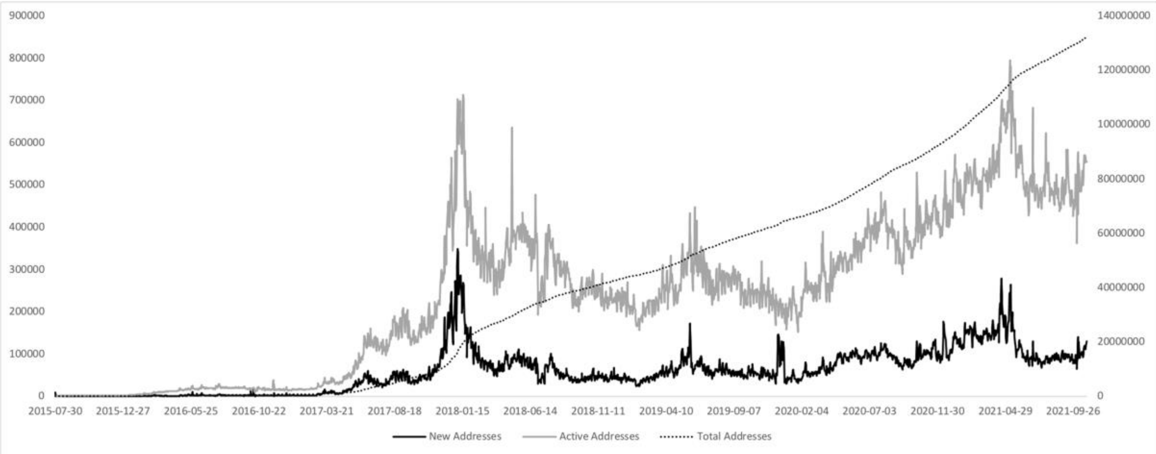

Figure 2: The percentage of overall Ethereum balance of addresses on the Ethereum blockchain, where more than 0 but less than 0.1 is on the secondary y-axis but all other values are on the primary y-axis.

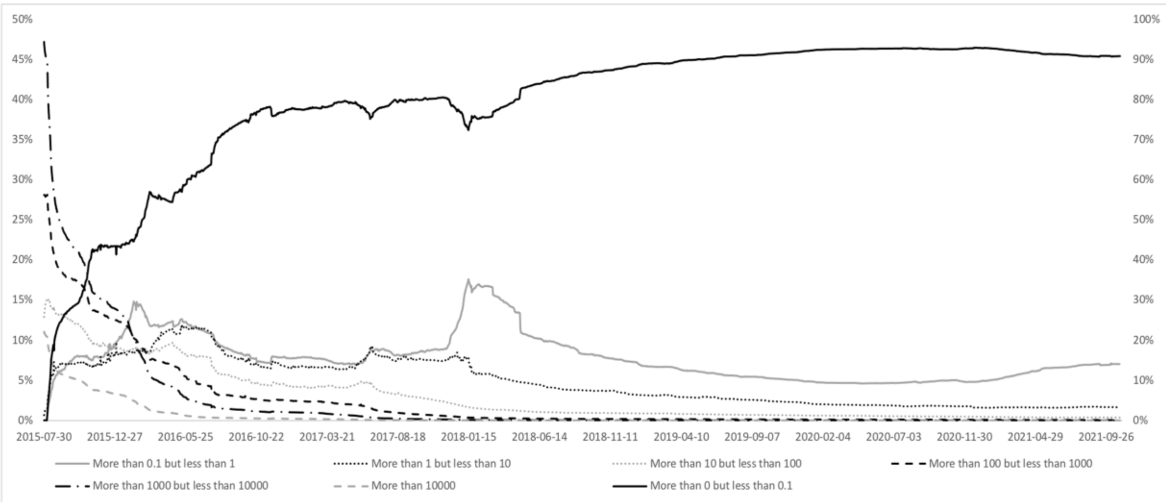

Figure 3: The number of transactions (primary y-axis) as well as the transaction volume (secondary y-axis) on the Ethereum blockchain.

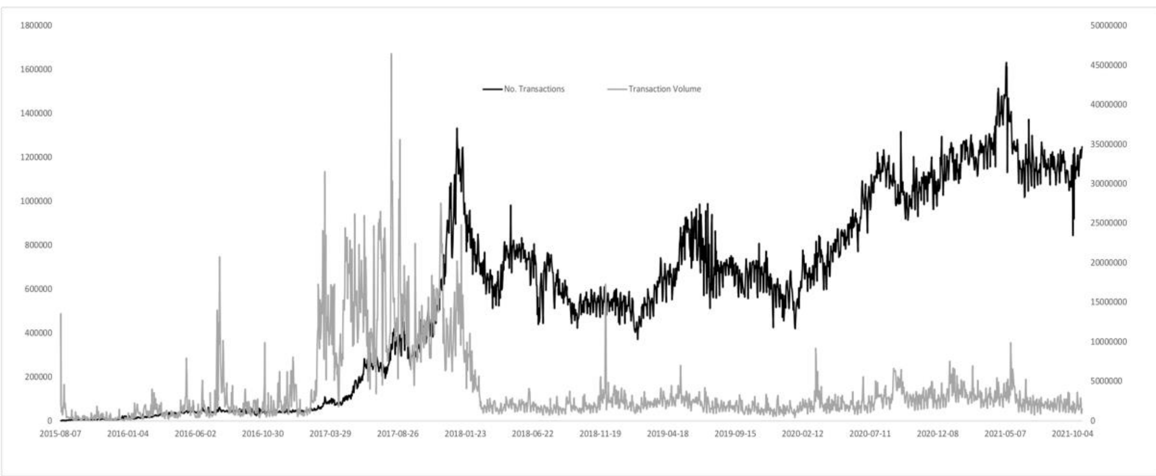

Figure 4: The gas per transaction (primary y-axis) and the gas value per transaction (secondary y-axis) in US dollars on the Ethereum blockchain.

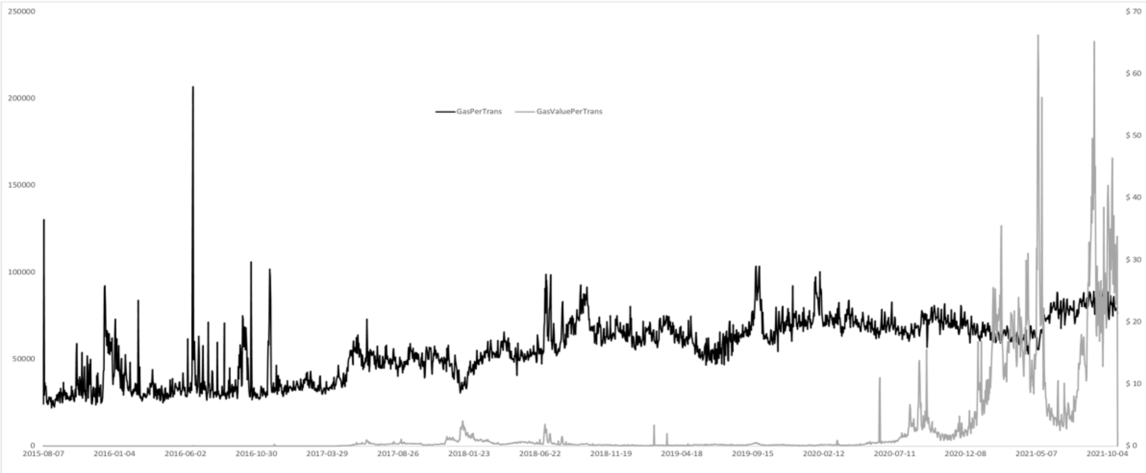

Figure 5: The total miner revenue (primary y-axis) and percentage of miner revenue from transaction fees (secondary y-axis) in US dollars on the Ethereum blockchain.

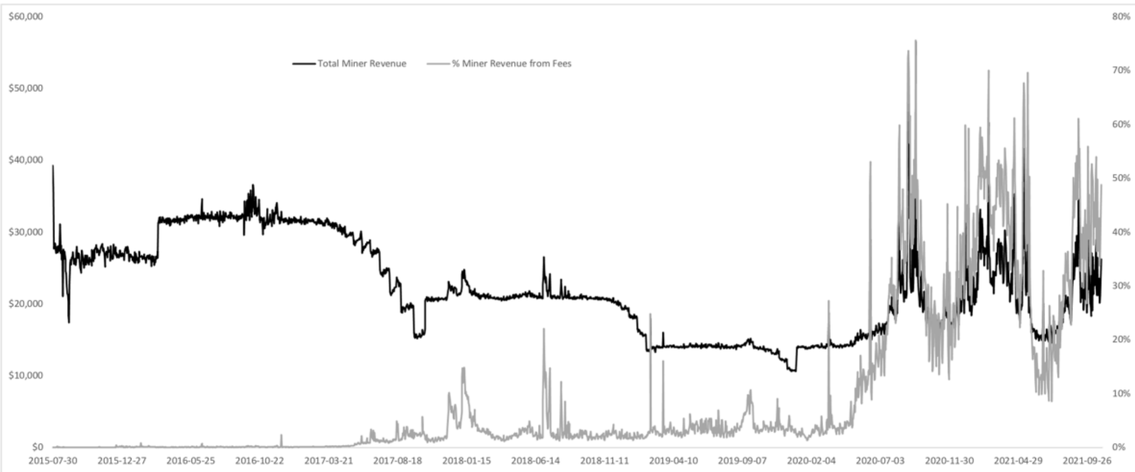

Figure 6: The HODL waves for a variety of time spans on the Ethereum blockchain.