Transaction fee extrapolation

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1 Overview

Olivier Janssens put up a reward of up to 10 BTC[1] for producing an extrapolation of transaction income for miners. This is an entry to this contest.

This context is held in the wider context of convincing Bitcoin miners to switch their mining hardware to alternative Bitcoin implementations that support on-chain scaling, such as Bitcoin Unlimited.

On-chain is believed by its proponents (such as the author of this document) to be a key element for Bitcoin's continued success.

Disclaimer: It should be noted that -as all predictions are- they can be wildly inaccurate and the author takes no responsibility for using the data and predictions shown herein. Predictions including exponentials even more so![2] There are also no guarantees that the calculations and estimates done here are even correct. However, the code and data is all out in the open, and anyone is invited to check it all.

2 Assumptions and method

All data that is used for creating this document has been taken from the charts page of `http://blockchain.info/en/charts`. The contained script `get.sh` shows all commands to fetch an up-to-date set of data, as comma-separated-value (CSV) files.

For this analysis, data ranging from March, 1st 2009 to Oct, 15th 2016 is used. This corresponds to the `.csv` files included in the repository.

Data analysis is done using `python` (version 2) and its most common data analysis packages: `numpy`, `scipy` and `pandas`.

The overall method to reach a graph of transaction income first looks at the historically close relation between transaction rate and market cap(italization) (MCAP). From this, a fit is used to estimate market cap from transaction rate. The author claims in no way novel insights on this relation. It has been prominently been demonstrated by Peter Rizun before.

[1] `https://www.reddit.com/r/btc/comments/57anod/can_someone_create_a_transaction_fee_income_graph/`

[2] The author does not question the fact that exponentials can *not* go on forever for physical reasons; however the author also assumes that we still have lots of *potential* exponential growth ahead!

It should be noted that, although, so far, the famous x^2 relation holds to a high degree, the correlation (that is presumed to be an indication of Metcalfe's law about the value of scaling networks) is expected to break down at some unknown point in the future.

This analysis and extrapolation further assumes that miners will think in dollars instead of BTC for the foreseeable future, and that the prices of equipment etc. are stable, when denominated in $ (no inflation).

It is a common complaint of those intending to scale Bitcoin onchain that onchain transaction volume is being crippled by the 1MB block size limit in place. This crippling can also be clearly seen in the graphs below. For the sake of this analysis, Bitcoin's history so far is divided into three periods:

Initial stage The early stage of growth, until Jan 2013

Early stage The time range from Jan 2013 to Dec 2015

Saturation stage The time from Dec 2015 till now, where it is assumed that the 1MB has an effect upon maximum transaction rate, and more importantly, also the actions of market participants.

Blockchain.info supplies a data set called the *number of transactions excluding popular addresses* (NTEP). The excellent correlation between market cap and transaction rate is especially visible when relating to NTEP.

As NTEP and total number of transactions seem to converge over time, it is assumed that NTEP is as good as regular total transaction rate for all analyses below, while avoiding the singular cases of Satoshi Dice and similar to influence the MCAP/TXN relation. NTEP excludes the 100 most popular addresses (measured by their number of outputs) from the total transaction rate.

3 Transaction rate and market cap

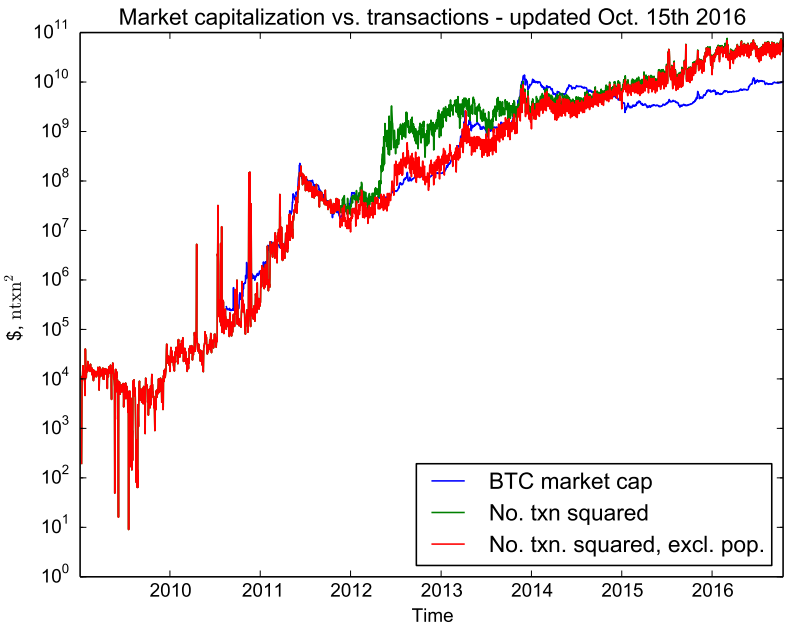

Figure 1: MCAP, NTEP and total transaction rate.

It has prominently been demonstrated by Peter Rizun before that MCAP and NTEP align if $\mathrm{NTEP} \times \mathrm{NTEP}$ is plotted on top of MCAP (in dollars). In Fig. 1, this figure is recreated once more, using recent data. It also includes the NTEP as well as the total number of transactions.

It can be seen that, as stated above, NTEP and total transaction count converge. Also visible is that in the *Saturation stage*, the MCAP seems to be suppressed compared to transaction count, presumably due to market actors factoring in the apparent unwillingness of many Bitcoin miners to scale Bitcoin.

The relation of

$$\mathrm{MCAP}/\$ = \mathrm{NTEP}^2 \tag{1}$$

seems to be a close fit already. In Fig. 2, this relation is displayed once more, but in a different way. Here the data from the *Initial* and *Early* stage is plotted as green dots, and that of the *Saturation* stage in red.

The blue line is a linear fit of the green data, of the form

$$\log(\mathrm{MCAP}/\$) = x \log \mathrm{NTEP} \tag{2}$$

yielding $x = 2.03$.

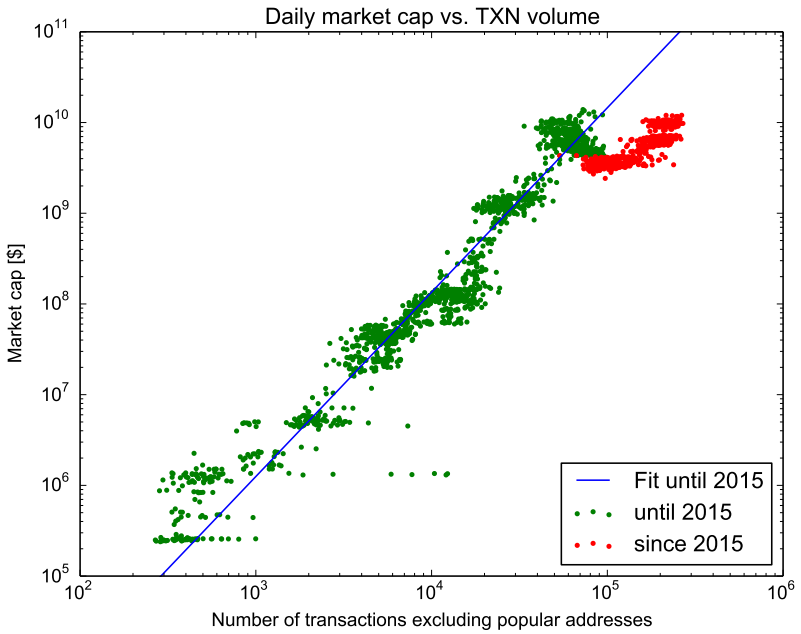

Figure 2: MCAP vs. NTEP and fit.

Clearly visible is the saturation and divergence from the squared behavior for the latest *Saturation* period, where the blocksize limit has a profound effect upon Bitcoin.

4 Transaction rate models

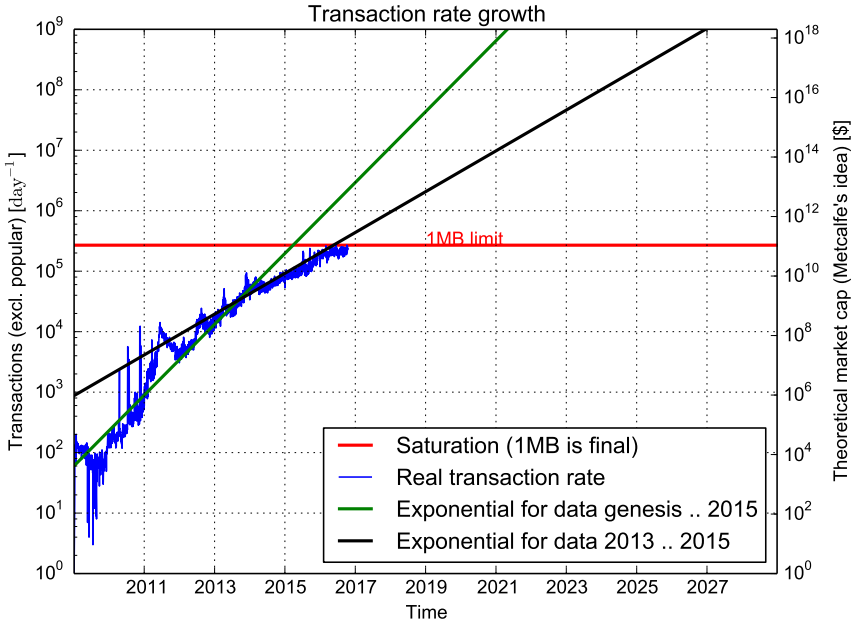

Figure 3: Transaction rate modeling.

The next step to get an estimate of future transaction rates is to look at past behavior and try to extrapolate from it. In Fig. 3, the daily number of transactions (blue curve) is plotted, plus three scenarios for further growth of this rate.

Green is a very optimistic scenario, and is a linear fit of Bitcoin's transaction rate over the *Initial stage* as well as the *Early Stage* (thus yielding an exponential curve for transaction rate growth). It is highly unlikely that Bitcoin's growth will ever exceed this growth again. This curve would those be the most optimistic miner's expectation, should an open-ended blocksize be implemented soon.

Red is the saturation scenario, keeping transaction rate at 1MB, as the indicated direction by several members of the Bitcoin Core team. This red line assumes that the maximum number of transactions per day that have ever been seen is also going to be a good approximation of the future number of transactions for all times.

Black is a (in the near term) optimistic scenario that assumes that Bitcoin's transaction rate with will continue to grow for the near future with the same rate as it did in the *Early*, but not the faster *Initial* stage.

It should be noted that these exponentials can not go on forever, or even a long time - world GDP is currently (Oct 2016) [3] approximately $\$10^{14}$. Bitcoin taking over

[3] https://en.wikipedia.org/wiki/Gross_world_product

the world would thus happen in the middle of next year, or 2021 in the slightly less optimstic scenario. Both cases deemed highly unlikely by the author.

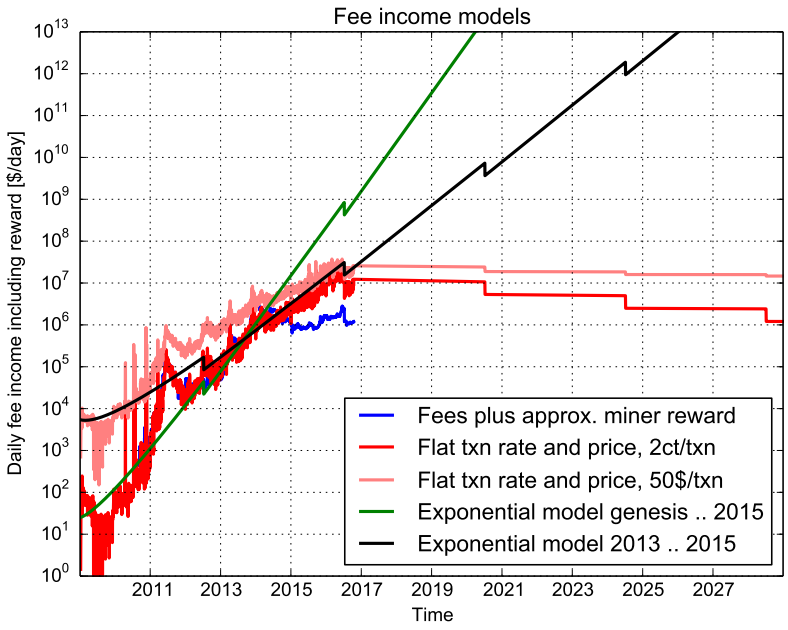

Figure 4: Fee modeling.

5 Fee models

Using another leap of faith, the above transaction growth model can be extended into a model for the miner's income. The result of this can be seen in Fig. 4.

Using the flat transaction rate of the 1MB case and the two exponential models from the preceding section, and further using the MCAP - NTEP relation from above, total miner income can be estimated.

Transaction cost. To create this extrapolation, is assumed that, for high on-chain volume scaling, a transaction will cost $\$0.02$ for all times. For the saturated case, both an assumed $\$0.02$ as well as a high price of $\$50$ per transaction is plotted.

The MCAP and thus coin price is assumed to follow $\mathrm{MCAP} = \mathrm{NTEP}^{2.03}$ with transaction rate of for the respective model.

As the above Fig. 1 shows, the market likely factored the unwillingness of many Bitcoiners to scale Bitcoin into the price. This means that the transaction rate growth until saturation, as observed in the *Saturation stage* would reflect in a higher expected Bitcoin price even when being stuck with an 1MB limit forever. This higher price amounts to ≈ 5200 \$/BTC, and an $\mathrm{MCAP} \approx 110 \cdot \$10^9$. For both the red and light red curve, this higher, constant MCAP is assumed.

A further, minor point is that it is further assumed that the coin schedule is aligned

to the last halving with exactly 4 years of halving time, in both directions of time. As this will not fit the past issuance schedule (which was sped up due to strong hash rate growth), an initial number of coins is set so that the number of coins at the first halving matches what is expected according to schedule. This should not impact later estimates at all. It is visible as a slight bend of the extrapolated green and black lines on the left side in this last plot.

That the lines appear jagged is due to the dropping block reward.

In this plot, the dark red line is assuming 1MB saturation and corresponding market cap, with a cost of $\$0.02$ per transaction. The light red line assumes an 1MB cap and a much higher cost of $\$50$ per transaction, in case Bitcoin is used primarily as a settlement layer.

The green and black line are the exponential models for the *Initial* and *Initial and Early* stage growth of transaction volume, with corresponding market cap growth. Both lines assume a low, constatnt cost of $\$0.02$ per transaction on chain.

The more optimistic, green line exceeded both red cases a while ago. Approximately today, also the $\$50$ high fee, but satured Bitcoin case is exceeded by an assumed NTEP and MCAP growth.

6 Conclusions

In Fig. 1, the black curve exceeds the light red curve at about this time.

This means that even with an assumption of very high transaction prices in the forced saturation scenario of $\$50/\mathrm{txn}$ (settlement layer) and even further assuming that the growth as indicated by the black line continues only until 2018, it would, according to this model, still be much better for miners to allow on-chain growth beyond 1MB.

The future is uncertain. The author makes no claim that exponential growth will continue forever, but is certain that intentional crippling of Bitcoin's scapability to scale onchain is *not* going to help Bitcoin get any more widespread adoption.

Furthermore, it should be noted that one of the main arguments of the *small blockist* is that higher level scaling solutions on top of Bitcoin will increase Bitcoin's market cap as well, which might bend the red curve upwards by an unknown amount. The time is now, though, and reliable, usable and widely accepted solutions have not been implemented yet.

There is also no reason that higher level solutions on top of Bitcoin can not work synergistically with a lifted maximum block size limit.