Bitcoin Average Dormancy: A Measure of Turnover and Trading Activity: Open Review

Author: Reginald Smith[†*]

Reviewers: Reviewer A, Reviewer B

Abstract. The final version of the review paper "Bitcoin Average Dormancy: A Measure of Turnover and Trading Activity" can be found in Ledger Vol. 3 (2018) 91-99 DOI 10.5915/LEDGER.2018.99. There were two reviewers who responded, neither of whom have requested to waive their anonymity at present, and are thus listed as A and B. After initial review (1A), the author submitted a revised submission and responses (1B). The revised submission was reviewed once again by reviewers A and B, who determined that the author had adequately and substantively addressed their concerns, thus completing the peer-review process.

1A. Review

Reviewer A:

Does this paper represent a novel contribution to cryptocurrency or blockchain scholarship?:
Yes

If you answered "yes" to the previous question, in one sentence, describe in your own words the novel contribution made by this paper::
Analysis of "bitcoin-days destroyed"

Is the research framed within its scholarly context and does the paper cite appropriate prior works?:
Important references are missing

Please assess the article's level of academic rigor.:
Good (not excellent but a long way from poor)

Please assess the article's quality of presentation.:
Good (not excellent but a long way from poor)

How does the quality of this paper compare to other papers in this field?:
Top 10%

Please provide your free-form review for the author in this section.:
Dear Editor:

Thank you for the opportunity to review this paper. Below I make detailed notes, but I'll start with my high-level commentary first.

In "Bitcoin Average Dormancy: A Measure of Turnover and Trading Activity," author Reginald D. Smith argues that we can gain useful insight into monetary-velocity-type measures directly from the blockchain, using a measurement called "bitcoin-days destroyed."

The author motivates the use of this measure, and describes how it came to be known from a historical perspective. It was fascinating to follow the links to bitcointalk where this idea originally came to be, and see even Gavin Andresen commenting on the proposal.

The author then points out that there has been little analysis of this measure (it's hard to find a proper equation). The author attempts to provide a more rigorous derivation of bitcoin-days destroyed in Section 2. I think this is an important task, but the author could improve this section significantly. I've given several suggestions below.

In my opinion, this article will *mostly* be of interest as a sort of reference document to understand bitcoin-days destroyed, so I think it is critical that Section 2 be a very clear, almost tutorial-like explaintion of the math behind it. Right now, this section is too short and too confusing.

In terms of "novelty," I certainly wouldn't say this paper has made a ground-breaking discovery, but I did find the discussion of Little's Law intriguing -- I've never seen an argument that bitcoin-days destroyed could be interpretted as the average size of the pool of actively-traded bitcoins, but I think the interpetation is valid.

My recommendation is to accept this paper for publication, although I suggest that the presentation in Section 2 be significantly improved. This will be the section most people will

read if using this paper as a reference.

DETAILED COMMENTS

Abstract.

Maybe use "bitcoin days destroyed" rather than "days destroyed."

"that can allow you to" --> "that allow you to"

Last sentence: too long and confusing. Re-write.

1. Introduction.

"utimately-fixed supply guaranteed by the Bitcoin algorithm" --> this is a topic of debate. Some argue that the inflation schedule will be adjusted to permit tail issuance. Perhaps it is better to say "given its supply scarcity enforced by the network."

The introduction is reads well and is interesting, but an important job of the introduction is to tell the reader what they are going to learn about and why that is important. I don't think this introduction does that.

2. Bitcoin days destroyed.

"First, transactions between addresss on the Blockchain include transactions where change is returned to the payer's address for all transactions where a transfer is of a lesser value than the total Bitcoin assigned to the payer's address." ---> terrible sentence! It hurts my head to try to parse this.

I like the history the author gives about the idea of "days destroyed!" It was great to read through that old thread.

"The weighting for less frequently" --> "The _heavier_ weighting for less frequently circulting coins..."

"It [days destroyed] has been viewed by many as both a better indicator of ..." --> who are these people? Cite at least one source if you're going to make this claim.

All claims made either need to be defended in the paper, or cited.

*****

Now that I'm about to begin Section 2.1, I think a good idea would be for the author to combine Section 1 with the first part of Section 2, because really Section 2 gives the information that I was looking for in Section 1. It told me why we _care_ about the problem of measuring transactional activity, and some of the challenges of earlier techniques people tried. It then told me that "days destroyed" is a really useful metric that people use, but that no one has really analyzed the metric in and of itself.

So I suggest the author combine that with the intro and I think the paper will be stronger. In fact, the author can probably make the more general discussion of bitcoin in Section 1 briefer. Your reader knows most of that anyways!

2.1 Days destroyed and its relation to Bitcoin transaction volume

I think the author needs to develop these equations more slowly. It is pretty confusing to follow because there are actually two periods of time being considered, the time period over which "B" bitcoins were spent, and the function f(t) that describes the distribution for when those bitcoins were create. I think this could be made more clear.

How about something like this:

Let B(t) be the cumulative amount of bitcoins destroyed (i.e., spent) since the genesis block, up until time t.

The total amount of bitcoins destroyed between time t1 -> t2 (for any t1 and t2) can then be expressed as:

$\Delta B = B(t2) - B(t1)$

Of those bitcoins destroyed between t1 and t2, there was a _distribution_ of times for when they were first created [note 1]. Let this distribtion be ß(t), such that the normallacy condition

Integrate[ß(t), {t, -inf, 0}] = ΔB

holds (i.e., the coins recently destroyed must have been created at _some_ time in the past).

With these definitions in place, bitcoin-days destroyed can be expressed as:

D = integral[t ß(t) , {t, -inf, 0}]

(Since the blockchain began on January 3, 2009, we can of course start our integration here

rather than at -infinity)

We can also write ß(t) = ΔB f(t), and so

D = integral[t ΔB f(t), {t, -inf, 0}]
= ΔB integral[t f(t), {t,-inf, 0}]
= ΔB

where is the average length of time the bitcoins spent during the analysis period lay dormant.

....I think it is easier to understand the above with integrals and continous time, rather than with sums. But obviously the sumation notation is useful for practical calculations, so then perhaps derive that next....

D = Sum[t ß(t) ....

[note 1] here I'm saying that a coin is "created" either when it is mined, of when outputs are spent and new "unspent outputs" are created.

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Now, I still think you need to do more here. How about you give some examples to make these equations more concrete to your reader?

Ex. 1. Alice received 10 BTC, and sent them to Carol 3 days later. How many bitcoin-days were destroyed on the day that Alice sent her coins to Carol? (Assume no other blockchain events occured).

Here we have:

D = Sum[t ß(t) , {t, 0, inf}] = 0*0 + 1*0 + 2*0 + 3*10 + 4*0 + 5*0 + ... = 30 btc-days

Ex.2 Immediately after receiving the coins from Alice, Carol send 5 of them back to Bob. How many bitcoin-days are destroyed on this day now?

D = Sum[t ß(t) , {t, 0, inf}] = 0*5 + 1*0 + 2*0 + 3*10 + 4*0 + 5*0 + ... = 30 btc-days

It is still 30 btc-days, because the transfer to Bob has no "time weight" yet.

3. Average dormancy over time.

"The sources for the data analyzing this paper" -> "analyzed in this paper"

You argue that "average turnover seems more consistent [than average duration]" but this seems like a strange statement since its the same data set, just inverted.

Need a reference to the Good Wife episode.

"Average dormancy's uncanny similarity to USD/BTC price" .... they are clearly correlated, but is this an "uncanny similarity"? I'm not convinced. It might be helpful to do a parametric plot with USD/BTC price on the y axis and average dormancy on the x axis.

Good discussion of the meaning of "average dormancy" - that only the actively-traded coins count towards it.

4. Little's Law.

You say "[days destroyed] is the average size of the pool of actively traded bitcoins" which is really interesting way to look at it, but when I first read this the word "traded" made me think "traded on an exchange." "Spend"?

5. Discussion.

I feel this section needs a different title. You're not really discussing the previous sections, but rather warning about power-law / fat-tail effects. I think the discussion here is really good though, and interesting.

My suggestion would be to integrate the first and last paragraphs of Section 5 to the conclusion (these more general statements seem better at the end of the paper). And then change the name of Section 5 to something more descriptive.

6. Conclusion.

Definitely too short. But I think the changes I suggested above would fix that.

Reviewer B:

In this manuscript the author describes a new measure of Bitcoin economic activity, average dormancy, and both discusses its various interpretations as well as shows real data.

Among the authors observations, when looking at dormancy vs. other variables, is that dormancy tends to increase with increasing value of bitcoins (as measured by their USD exchange rate).

Overall, I found this article well written and interesting to read and think it would appeal to the readership of Ledger. That being said, I have a few minor suggestions/comments to the author, listed in no particular order:

- B(t) is defined as "bitcoins created, mined, and spent, over all time up to time t" ... inj this definition, it sounds as though there are three separate buckets: bitcoins created, bitcoins mined, and bitcoins spent. However, presumably "created" is just one of either "mined" or, in this context, "spent." As written this if fairly confusing.

- A related point to the above is that it is unclear from the definition and what follows of how we should think about mined bitcoins. For example, if between t2 and t1 there is no activity except for an empty block being mined with a reward of 50 BTC, then B(t2)-B(t1) = 50. According to the definition, this would be "50 bitcoins destroyed", but is that the right way to think about a coinbase transaction? If it takes an entire day for a block to be mined, and the reward is 50 BTC, does that result in 50 bitcoin days destroyed? It would help to clarify this.

- Fig 4 shows an interesting effect of dormancy increasing with BTC value. However, there is a coincidence that after the USD value of BTC went beyond $1500, so did the 1 MB blocks fill up entirely, making it much more frustrating to transact with BTC. This likely would also increase dormancy, and so it is hard to disentangle the effects of the 1 MB blocksize from other possible causes of increased dormancy during this period.

- As depicted, it is a little hard to extract insight from Fig. 5, there may be a better way to show this data.

1B. Author's Response

- First I would like to thank the reviewer for his/her insightful comments and suggestions. My responses are below.

Reviewer A:

DETAILED COMMENTS

Abstract.

Maybe use "bitcoin days destroyed" rather than "days destroyed."

- This has been changed throughout the paper. If the Editor or Reviewer find the entire statement is cumbersome, I can abbreviate subsequent uses with "BDD" though I am wary of filling up the paper with acronyms.

"that can allow you to" --> "that allow you to"

- Fixed

Last sentence: too long and confusing. Re-write.

- Rewritten

1. Introduction.

"utimately-fixed supply guaranteed by the Bitcoin algorithm" --> this is a topic of debate. Some argue that the inflation schedule will be adjusted to permit tail issuance. Perhaps it is better to say "given its supply scarcity enforced by the network."

- This is a good point, but in rewriting and condensing the introduction I eliminated the mention of this since it wasn't of huge value to the paper.

The introduction is reads well and is interesting, but an important job of the introduction is to tell the reader what they are going to learn about and why that is important. I don't think this introduction does that.

- I have totally rewritten the introduction condensing the basic background data on Bitcoin to one paragraph before addressing the main question of the paper: how to measure the usage and/or velocity of Bitcoin from 2009 to present.

2. Bitcoin days destroyed.

"First, transactions between addresss on the Blockchain include transactions where change is returned to the payer's address for all transactions where a transfer is of a lesser value than the total Bitcoin assigned to the payer's address." ---> terrible sentence! It hurts my head to try to parse this.

- Yeah and I simplified this to: "This measure had many drawbacks, however, one of those being that it did not differentiate between transactions that may be trivial, such as users moving bitcoin between several addresses they own, and more substantive transactions reflecting the acceptance of bitcoin and usage in the wider economy."

- The change aspect is mentioned later when describing the data series from Blockchain.info, it is not as necessary in the discussion of why transaction value volume is insufficient alone.

I like the history the author gives about the idea of "days destroyed!" It was great to read through that old thread.

"The weighting for less frequently" --> "The _heavier_ weighting for less frequently circulting coins..."

- Fixed

"It [days destroyed] has been viewed by many as both a better indicator of ..." --> who are these people? Cite at least one source if you're going to make this claim.

All claims made either need to be defended in the paper, or cited.

- Cited a couple of papers that make this claim. Granted, BDD as velocity is usually taken as a given and no one has rigorously tried to show it is analogous to classical monetary velocity.

*****

Now that I'm about to begin Section 2.1, I think a good idea would be for the author to combine Section 1 with the first part of Section 2, because really Section 2 gives the information that I was looking for in Section 1. It told me why we _care_ about the problem of measuring transactional activity, and some of the challenges of earlier techniques people tried. It then told me that "days destroyed" is a really useful metric that people use, but that no one has really analyzed the metric in and of itself.

So I suggest the author combine that with the intro and I think the paper will be stronger. In fact, the author can probably make the more general discussion of bitcoin in Section 1 briefer. Your reader knows most of that anyways!

- This was done in Section 1. 1.1 now starts the discussion of BDD and introduces the equation. Section 2 now discusses the average dormancy. We can tweak these breaks if we like.

- ~~2.1~~ 1.1 Days destroyed and its relation to Bitcoin transaction volume

I think the author needs to develop these equations more slowly. It is pretty confusing to follow because there are actually two periods of time being considered, the time period over which "B" bitcoins were spent, and the function f(t) that describes the distribution for when those bitcoins were create. I think this could be made more clear.

- These were some good suggestions. I admit I was skeptical at first and thought they would cause more confusion than clarification but after re-reading several times I see where the Review was coming from. I made a few edits. Most notably using t1 and t2 in parentheses next to volume or BDD variable to remind the reader these are within a time frame and make the indices on the integrals/sums less confusing. I also fully

explained and fleshed out the meaning of 'created' so this would cause less confusion. Finally instead of using -inf as the lower limit of integration, I used t0 which is the date of the Genesis block. Let me know if these equations and their explanation are clear since I definitely don't want to lose anyone at this point in the paper.

- [Equation explanation section by Reviewer removed]

Now, I still think you need to do more here. How about you give some examples to make these equations more concrete to your reader?

- I do give an example tying transaction value, BDD, and average dormancy.

3. Average dormancy over time.

"The sources for the data analyzing this paper" -> "analyzed in this paper"

- Fixed

You argue that "average turnover seems more consistent [than average duration]" but this seems like a strange statement since its the same data set, just inverted.

- I removed this and instead discuss the turnover as the inverse and approximate rate of coin usage. I thought about comparing it to monetary velocity in uses of currency but I need a lot more theoretical and empirical support that is beyond the scope of this paper (maybe another one). I do give a brief discussion of this notion in the conclusion, however.

Need a reference to the Good Wife episode.

- Added as reference 15

"Average dormancy's uncanny similarity to USD/BTC price" .... they are clearly correlated, but is this an "uncanny similarity"? I'm not convinced. It might be helpful to do a parametric plot with USD/BTC price on the y axis and average dormancy on the x axis.

- See new discussion on pages 5 and 6 as well as the new plot of Average Dormancy (30 day aggregated) vs. USD/BTC in Figure 4. The Figure 4 plot shows that the correlation is basically only largely valid above the value of $1000 USD/BTC so it has a fixed regime and isn't fully universal. Above $1000 USD/BTC the correlation coefficient is 0.68 so about 46% of the variance in average dormancy is possibly caused by the variance in the exchange rate over $1000 USD/BTC. Doing a full least-squares linear regression is not advisable in my opinion since I think the relation is fundamentally nonlinear, especially near the lower end and forecasting average dormancy by exchange price is probably both fallacious and useless.

Good discussion of the meaning of "average dormancy" - that only the actively-traded coins count towards it.

- Thanks

4. Little's Law.

You say "[days destroyed] is the average size of the pool of actively traded bitcoins" which is really interesting way to look at it, but when I first read this the word "traded" made me think "traded on an exchange." "Spend"?

- Changed to spent

5. Discussion.

I feel this section needs a different title. You're not really discussing the previous sections, but rather warning about power-law / fat-tail effects. I think the discussion here is really good though, and interesting.

My suggestion would be to integrate the first and last paragraphs of Section 5 to the conclusion (these more general statements seem better at the end of the paper). And then change the name of Section 5 to something more descriptive.

- The first part of section 5 has been changed to the title "Non-normality of bitcoin days destroyed" and discusses primarily the aspect of the fat tail of BDD distribution. The graph (now Figure 5) is also changed to a scatterplot to look less crowded.

6. Conclusion.

Definitely too short. But I think the changes I suggested above would fix that.

- Expanded and discussed in more detail. Hopefully the three paragraphs now is more sufficient.