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Reconciling Open Interest with Traded Volume in Perpetual Swaps

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Reviewers: Reviewer A, Reviewer B

Abstract. The final version of the paper "Reconciling Open Interest with Traded Volume in Perpetual Swaps" can be found in Ledger Vol. 9 (2024) 1-15, DOI 10.5195/LEDGER.2024.325. There were two reviewers involved in the review process, neither of whom has requested to waive their anonymity at present, and are thus listed as Reviewers A and B. After initial review by Reviewers A and B, the submission was returned to the authors with feedback for revision (1A). The author resubmitted their work and responded to reviewer comments (1B). The paper was returned to the reviewers who recommended the paper be accepted, thus ending the peer review process. Author responses have been bulleted for reader clarity.

1A. Review

Reviewer A

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

Yes, important contribution(s)

Please briefly explain why you think the paper makes or does not make a novel contribution.

Data abnormalities are important.

Is the research framed within its scholarly context and does the paper cite appropriate prior works?

Yes

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Please assess the article's level of academic rigor.

Unsatisfactory (better than poor but a long way from excellent)

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?

The paper ranks highly but it may not be among the most authoritative references in the field.

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

Review of: RECONCILING OPEN INTEREST WITH TRADED VOLUME IN PERPETUAL SWAPS

Interesting topic about accuracy of API data from different exchanges, should become a well-cited work but needs improvement as explained below and results need re-doing. So I stopped after 5 pages and will review it again once the preliminary errors are all corrected:

Page 1

• Small font and single space is difficult to read, almost declined to review because of this. Please use 11pt double-space
• Abstract should not contain definitions, it needs re-writing after looking at various journals guidance about abstract writing.

Page 2

• I do not agree that linear perpetuals cannot be used for hedging. Anything could be used as a hedge, but might not be effective. However linear are only a little less efficient than inverse, see Alexander, C., Deng, J. and B. Zou (2023) Hedging with Automatic Liquidation and Leverage Selection on Bitcoin Futures. European Journal of Operational Research, 306(1), 487 - 493

Page 3

• Typo in second bullet
• Transaction volume counts both sides of the matched trade, hence Eq (1) is missing 0.5 given how you define V immediately below
• Eq (1) is not well-enough explained
• Liquidation is mentioned on page 3 out of the blue! Need to explain what this is and how does liquidation affect open interest. There can be long and short liquidations in same time interval – depending on the time interval you select. Everything depends on this, so first

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define your parameters, the first is that you select a regular partition with t_{i-1} - t_i = \delta, say. What values of \delta are you considering in your results? The larger is \delta, the greater the effect of long+short liquidation on OI
• Define acronym (API)
• Assumptions about timestamps should be justified, e.g. by explaining the two different timestamps on Binance data, i.e. event and transaction
• The matching trades and the matching engine needs explaining before using the terms in the middle paragraph
• Latency often builds up to exceed 500msec. Internal latency may be calculated from the API data by subtracting the event timestamp from the transaction timestamp provided in each message. Recommend a more detailed description of API data, along with examples of event and transaction timestamps. Then examine latency over all samples because this could be the reason for mismatched volume and OI.
• Your 1ms offset in (2) may not be sufficient. Set this as a parameter \tau and see how robust results are to increasing \tau
• Define your partition better. So you have regular partition with t_{i=1}-t_i = \delta and then P = N \delta, yes?

Page 4.

• Note that liquidiations are massively under-reported, e.g. only at most one per millisecond on Binance.

Page 5

• Your results will depend on \delta, \tau and N. How robust are they to different choices of these parameters?
• Note that OI/0.5TV is an approximation to the average holding period of a contract. It would be interesting to see results on these, if the OI and TV results are sensible.
• As previously suggested, the reason for these results could be latency between event and transaction timestamp
• “Considering that the periods are quite lengthy in comparison with the open interest reporting period in all the exchanges under consideration,” …where are these periods defined? Which particular day, or hour, or…… ?
• I am too confused about parameter settings at this point to be able to assess the rest of the paper. Also, the likely distortion from mis-defining trading volumes, and need to explore results for different parameters requires a major revision

Reviewer B:

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

Yes, incremental contribution(s)

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Please briefly explain why you think the paper makes or does not make a novel contribution.

The authors report the inconsistency between the open interest and the trading volume of the Bitcoin perpetual swap. To my knowledge, this is new.

Is the research framed within its scholarly context and does the paper cite appropriate prior works?

Yes

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?

This is a good or average paper.

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

The authors report the inconsistency between the open interest and the trading volume of the Bitcoin perpetual swap. Perpetual swaps in the (unregulated) exchanges mentioned in this paper play an important role in cryptocurrency trading. Given the importance, the inconsistency is quite surprising, and it should be brought to attention. I recommend the publication of this paper.

1B. Author Response

Reviewer A

Page 1

Small font and single space is difficult to read, almost declined to review because of this. Please use 11pt double-space.

- We have now adjusted the font size to 11pt and use double-space.

Abstract should not contain definitions, it needs re-writing after looking at various journals guidance about abstract writing.

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- Our intention with this abstract is to help potential readers evaluate whether this work would be of interest, without making too many assumptions about their expertise and background. To that end we felt it appropriate to add very short definitions of the key elements important to this work. In our view the abstract as written accomplishes that goal.

Page 2

I do not agree that linear perpetuals cannot be used for hedging. Anything could be used as a hedge, but might not be effective. However linear are only a little less efficient than inverse, see Alexander, C., Deng, J. and B. Zou (2023) Hedging with Automatic Liquidation and Leverage Selection on Bitcoin Futures.
European Journal of Operational Research, 306(1), 487 - 493.

- Given that the margin in linear perpetual contracts is most commonly a stablecoin (e.g. USDT), this means that a liquidation point exists when using these contracts as a hedge. Putting aside for a moment the fact that this is capital inefficient, the existence of a liquidation point exposes the hedger to additional risk. If the price gradually appreciates more than 100% during the period the hedge is open if no additional collateral is posted the hedger risks losing their entire position so in that case the efficiency of the hedge drops even further as additional collateral must be posted. This matter is made worse on some exchanges that have a limit on the position size, namely if a position reaches a certain size (at the time of writing for example on ByBit that is $20M for the BTC USDT P pair) it can no longer be increased so the hedger is left with no choice but to close and re-open the position with additional capital incurring costs in the form of market impact and exchange fees. Additionally, although liquidity is improving there still exist certain periods (e.g. US after-market and weekends) during which liquidity is significantly lower than average. During such periods of low liquidity a transient spike in prices of more than 100% can take place (and it too often does, see BitFinex) which will lead to an immediate liquidation. Given these facts the linear perpetual swap can at best be described as a very short term, low capacity, low efficiency high risk proxy to a hedge. Using it as a hedge in any other setting would serve only to invite losses. We updated the text to reflect this insight.

Page 3

Typo in second bullet.

- We were not able to identify any typo in the second bullet. If the reviewer can be more specific we'll be happy to amend the text appropriately.

Transaction volume counts both sides of the matched trade, hence Eq (1) is missing 0.5 given how you define V immediately below.

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- We can confirm that the definition of volume used in this study is the standard definition of volume reported by exchanges for every trade. We refer the reviewer to the following definition Binance/Glossary/Volume.

Eq (1) is not well-enough explained.

- We have added examples to explicate Equation (1).

Liquidation is mentioned on page 3 out of the blue! Need to explain what this is and how does liquidation affect open interest. There can be long and short liquidations in same time interval - depending on the time interval you select. Everything depends on this, so first define your parameters, the first is that you select a regular partition with $t_{i+1} - t_i = \delta$, say. What values of δ are you considering in your results? The larger is δ, the greater the effect of long + short liquidation on OI.

- We have added a footnote to define liquidations. As we mention, liquidations are simply trades, it's just that these are initiated forcefully by the exchange, their impact to open interest is the same as regular trades.

Define acronym (API).

- We have added a footnote to define what the acronym API stands for.

Assumptions about timestamps should be justified, e.g. by explaining the two different timestamps on Binance data, i.e. event and transaction.

- There is an inherent uncertainty on timestamps as no exchange provides publicly available information on how exactly they timestamp API messages. Therefore we have to make the assumption that this takes place at a reasonable point in the messaging life-cycle. Regarding the timestamp resolution that we mention in the text, this is not an assumption, it is simply documented in the respective APIs (e.g. see Binance API/General Info).

The matching trades and the matching engine needs explaining before using the terms in the middle paragraph.

- We have added a footnote where the matching and risk engines were mentioned.

Latency often builds up to exceed 500msec. Internal latency may be calculated from the API data by subtracting the event timestamp from the transaction timestamp provided in each message. Recommend a more detailed description of API data, along with examples of event and transaction timestamps. Then examine latency over all samples because this could be the rea- son for mismatched volume and OI.

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- It is a rare event that latency on major cryptocurrency ex- changes reaches or exceeds 500ms, even during exceptionally high volatility periods. In our experience we have never seen latency spikes above ≈ 120ms. This assumes a collocated con- figuration (namely our servers are as close as possible to those of the exchange). We cannot comment on what latency will be experienced by users that are not collocated in the Amazon Web Services locations indicated by each exchange as this will add network latency that is outside the control of the exchange (e.g. overall network traffic between the user's location and the ex- change servers). Furthermore, messages communicated by the exchange come in streams. These streams are subscribed to bymarket participants and after that the exchange pushes new in- formation as it arrives. Therefore there are no two timestamps to compare and infer the internal latency. The only exchange for which we are aware of the internal latency, defined as the time it takes for the matching and risk engine to process an order, is on Deribit and this is only because they report it in their response. This latency is on the order of 100μs.
- Regarding the API data, every exchange has its own individual format and we have provided links to every exchange see Table 1. It is beyond the scope of this work, and of little added value to readers, to comment on the messages and their format for every one of these exchanges whilst these exchanges provide authoritative documentation on their websites.
- Lastly, we do not share the view that latency could explain the discrepancies between the reported volume and open interest for the simple reason that those mismatches manifest even for long time periods: one minute, one hour, one day (cf. Tables 4 and 5), one month and three months (cf. Tables 2 and 3). As an example let us go through the first line of Table 2 in the market (ByBit, BTC USDT P). For the entire period (January of 2023) the traded volume was $30.32B and the absolute value of the difference of the open interest for the entire month was equal to $15.34B. The reason we included these larger intervals is exactly because we share the concern with the reviewer that these discrepancies could be due to some timing or other issue (see Section 5 - Discussion). That said, even considering this longer time intervals discrepancies persist. It's a mathematical impossibility that Equation (1) is violated if there is complete reporting of transactions.

Your 1ms offset in (2) may not be sufficient. Set this as a parameter τ and see how robust results are to increasing τ.

- As described in the previous point, the latency mentioned of 1ms (say even 1s) in the paper cannot explain the incongruities observed for a several months period. Also we decided to remove τ and Equation (2) from the paper as they do not really impact the results presented in this and can add confusion.

Define your partition better. So you have regular partition with $t_{i+1} - t_i = \delta$ and then $P = N\delta$, yes?

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- We have added in the paper more details about the partition and effectively we have always $P = N\delta$ with for all i, $\delta := t_{i+1} - t_i = \text{constant}$.

Page 4

Note that liquidations are massively under-reported, e.g. only at most one per millisecond on Binance.

- Firstly, the timestamp resolution offered by Binance and all other exchanges is 1 millisecond, so by extension their reporting will be once per millisecond. Even if the websocket API pushes data at a higher rate, which it does, the time resolution is the same. Since they don't offer finer granularity timestamps, at least not according to their API documentation (see Binance API/General Info) we cannot know with certainty where these discrepancies are coming from: it can be miss-reporting of the traded volume (liquidations being part of the trading volume), the open interest or both. What we can say with confidence is that there is a mismatch and on some exchanges a glaring one, however, we cannot make the assertion that Binance is massively under-reporting liquidations. In addition, taking into account the results in Tables 2, 3, 4 and 5, although there are discrepancies on Binance, they are far behind ByBit and OKX in that respect. Please see Section 5 and 6 on further comments and discussion as to what may be the source of the observed discrepancies.

Page 5

Your results will depend on δ, τ and N. How robust are they to different choices of these parameters?

- Absolutely, in this paper we have considered the following choices for δ and P (N being determined by those two parameters).
- In table 2, we have taken $P = \delta = 1\text{month}$ and therefore $N = 1$ as we considered the entire first period (January 2023).
- In table 3, we have taken $P = \delta = 3\text{months}$ and therefore $N = 1$ as we considered the entire second period (July - September 2023).
- In table 4, we have considered inside the first period $\delta = 1D$ (one day), $\delta = 1H$ (one hour) and finally $\delta = 1\text{min}$ (one minute).
- In table 5, we have considered inside the second period $\delta = 1D$ (one day), $\delta = 1H$ (one hour) and finally $\delta = 1\text{min}$ (one minute).
- Those incongruities between the traded volume and open interest are visible at all of these different timescales. As an example, in the case of ByBit with $\delta = 1D$ (one day), 100% of the time it was not possible to reconcile the traded volume and the open interest. With $\delta = 1H$ (one hour) it is more than 98.5% of the time and with $\delta = 1\text{min}$ (one minute) more than 70%.

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Note that OI/0.5TV is an approximation to the average holding period of a contract. It would be interesting to see results on these, if the OI and TV results are sensible.

- There are several studies that can be performed considering open interest and traded volume and what the reviewer suggests is one of them. However, given that we cannot reconcile open interest with traded volume such studies will inadvertently produce misleading results. We hope exchanges take our suggestions in section 6 into consideration and reconcile these two important quantities. If they do we would be more than happy to produce follow up studies.

Reviewer B

We thank the reviewer for his recommendation.

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