Emergence of Next Generation AMMs

Jamie E. Young*

JEY Labs

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Abstract

We discuss an emergent path which opens up a design space for next generation Automated Market Makers (AMMs). We discuss a new way to decompose the design space underlying AMM behavior, by identifying 3 independent design components: 1) price, 2) liquidity shape, and 3) pool asset reserves. We then give an example of a next-generation AMM with a mechanism that meets the objective to optimize for trader and LP utility by mitigating theoretical arbitrage ("toxic flow"). This AMM pairs an external price oracle sync, with trade settlement deferral to eliminate easy front-running, while protecting LP reserves which can be leveraged to provide more capital efficient liquidity than before in the face of mitigated impermanent loss.

Finally, we reveal how our work on the equivalence of AMM and order book systems is a bridge for future work, enabling one hybrid class of next generation AMMs we call *order book AMMs*. We anticipate this as combining hybrid characteristics of the granularity of order books and the democratization and transparency of AMMs, which have promise if implemented on L2 solutions (low cost permissionless smart contract environments).

1 The Next Generation Automated Market Maker (AMM)

AMM: a transparent but static market maker system. There are 2 major types of trading venues in crypto assets. First is the traditional order book exchange, in centralized off-chain form such as Binance as or decentralized on-chain form such as 0x; the other type is an invention in DeFi, particular to the on-chain environment, called AMM (Automated Market Maker). AMMs started with Uniswap [3], and many other variants thereafter (such as Balancer [4] and Curve [2]). From a market maker's perspective, these 2 types of exchanges are very different: in the traditional order book system, market makers have full freedom to deploy any kind of market making strategies, i.e. placing and canceling any order at any condition as they like; however in an AMM, generally the market making strategy is designated (hard coded) before hand and completely transparent. This new type of market maker on AMM has no freedom to design their market making strategies but to only choose which AMM (such as Uniswap or Curve) they participate in by depositing their assets, effectively playing the role of a liquidity provider (LP) without idiosyncratic choice of strategy.

On Equivalence of AMM and Limit Order Book Systems. However, from a spot market taker's perspective, order book exchange and AMM are merely underlying mechanisms that achieve the same interface. Under either system, a taker puts in some amount of asset A and takes out some amount of asset B, even though the underlying system is different. Despite the disparity, there is a type of intrinsic equivalence between order book exchange and AMM, at least from a market taker's perspective: both are providing liquidity at various price levels. This motivates the study of the underlying equivalence.

*ENS: professorjey.eth. Contact: @ProfessorJEY.

Next Generation AMM Design Decomposed. There are profound implications from our prior work on the equivalence of AMM and order book systems [5]. One noteworthy observation is that almost all AMMs need to use the total asset reserve amounts to determine the pricing curve, while in general the price-quantity relationship in the order book system does not depend on the total bid amount and ask amount. Once the equivalence is established, the AMM's pricing mechanism can be separated as an independent design feature from its actual quantity of asset reserves. Therefore an AMM design represented as such, would have a larger degree of freedom to exhibit the price-quantity relationship that it otherwise could not due to constraints from its actual reserve quantities. For example, this allows the existence of leveraged Uniswap [1], with a configurable leverage factor depending on the desired liquidity, even if the pool has only limited reserve amounts. This also enables an AMM to adjust its current spot price according to an oracle, while keeping the shape of liquidity, without the intervention of external trades. (This is in contrast to Uniswap, for which the pool price will only change if there are external trades.) This essentially makes the three aspects of 1) price, 2) liquidity shape, and 3) pool reserves both conceptually independent as design controls and modular from one another in functionality. Achieving this concept of modular next-generation AMM design, and decomposition into multiple controls has not yet been realized in the design of AMMs, to the best of our knowledge.

Bye bye "toxic flow" towards a pure trader and LP Experience. This also eliminates arbitrage in theory. However, it requires that both the oracle update itself is timely and the pull of the oracle update is also timely. In practice this is most likely not true because there will be arbitrageurs that front run the oracle update. Therefore we consider introducing a trade deferral mechanism, so that the execution of trades will be deferred by a certain amount of time, to ensure the oracle update is timely and the pull of the oracle is also timely. This way arbitrage shall be eliminated and the only trades that are left are mostly noisy flows with very low toxicity. With this mechanism, systematic loss of liquidity provider is largely reduced, allowing the protocol to charge a lower fee as compensation, benefiting both traders and makers (at the expense of a significantly higher barrier for arbitrageur participation).

Please refer to the series of papers for details.

2 Future Developments

There are a farther reaching implications of the order book equivalence. When L2 solutions arrive, a space of hybrid designs which we will refer to as the *order book AMM* will be feasible, as we suggested in prior work [5]. Such order book AMMs constructed on L2 solutions will face lower gas transaction costs. Thereby it can afford to update its oracle and pricing curve much more frequently, potentially continuously in real time (regardless of its asset reserves thanks to the independence property in our next generation AMM framework).

Another new capability of an order book AMM will be tracking and replication of the liquidity of a liquid exchange (such as Binance) or even any combination of exchanges in real time. In other words, there is potential for mirroring liquidity from an external exchange, onto an order book AMM due to its more granular support of price preference potentially down to even each level of the order book. This is far more expressive regarding price and quantity than previous AMMs' coarse concept of total pool reserves. As a result, the AMM can be more liquid than any single exchange and thus more attractive to takers.

Taking the assumptions that: 1) market makers as a group on centralized exchanges make net profit and 2) the order flow into the AMM is similar to the general order flow in other exchanges, then such replication enables LP of such an order book AMM to make similar profits as the average market maker of a centralized exchanges, without actually knowing or implementing their (sophisticated) market making strategies. This would not be possible in a pure order book system because each order is booked separately (the orders logged and profits accounted for distinctly by the exchange matching process). In contrast, in an AMM system each LP earns a share of total market making profits proportionally to their investment size.

References

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