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Concentration of DeFi's liquidity: Evidence from Decentralised Exchanges (DEXs) and Automated Market Makers (AMMs)

By

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Decentralised exchanges (DEXs) are on-chain platforms where traders can exchange one crypto-asset for another. DEXs play an increasingly important role in the decentralised finance (DeFi) market, particularly in the aftermath of the recent downturn in the crypto-asset market. This working paper explores the characteristics of DEXs and identifies areas of possible concentration in decentralised exchanges activity and potential associated risks. To substantiate the analysis, it uses an original on-chain dataset covering the largest DEXs. The paper reveals an increased concentration within DeFi trading in the sample observed, which could exacerbate vulnerabilities already present in DeFi markets.

Authorised for release by Carmine Di Noia, Director, OECD Directorate for Financial and Enterprise Affairs.

Keywords: DeFi, decentralised finance, lending protocols, decentralisation, finance, tokens, liquidity pools, liquidity providers, decentralised exchanges, DEX, automated market makers, AMM.

JEL Codes: D53, G12, G14, G15, G23, O39.

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1 Executive summary

Decentralised Exchanges (DEXs) are on-chain platforms where traders can swap crypto-assets for other crypto-assets - but not for fiat, as in centralised crypto-exchanges (CEXs) (OECD, 2022[1]).[1] Instead of order books, DEXs increasingly rely on liquidity pools (LPs) where liquidity providers lock crypto-assets in exchange for fees or rewards, paid by traders using the pools' liquidity. Automated Market Makers (AMMs) are DEXs that pool liquidity from users and price the assets within a pool using algorithms, replacing order-books.[2]

DEXs are an increasingly important part of the so-called decentralised finance (DeFi) market, with growing market share as compared to CEXs, particularly following the recent failures of several multi-function crypto-asset intermediaries (e.g. FTX)[3] whose functions are typically centred around the operation of a trading platform[4]. This could be attributed to investors' lack of confidence in centralised forms of crypto-intermediaries following the recent domino of failures of such intermediaries and fear of losing access to their crypto-assets (OECD, 2022[2]). Given that DEXs involve direct self-custody of crypto-assets by the investors without third-party custodians, investors may have perceived them as safer and more transparent, driving increased activity following the crypto-asset market downturn.

This working paper examines the characteristics of DEXs and identifies areas of possible concentration in decentralised exchanges activity and potential associated risks, using original on-chain data on some of the largest liquidity pools and AMM-based DEXs to substantiate the analysis. Increased concentration of liquidity in DEXs, as evidenced in the sample examined, could exacerbate vulnerabilities observed in DeFi markets. In particular, it could affect market functioning and price discovery, and give rise to possible anti-competitive behaviour resulting from market dominance of dominant exchanges with possible barriers to entry for new participants, potential for misuse of market power and cost implications for end-users. On the liquidity supply side, concentration in the provision of liquidity by a small number of liquidity providers could give rise to concentration risks and risk of market manipulation (e.g. through initiation of large withdrawals impacting price and potentially destabilising the liquidity pool). Concentration of DEX activity in small number of platforms, coupled with the vast interconnectedness of the crypto-asset system (OECD, 2022[2]) could amplify the risk of disruption of the market in case of failure of a single dominant DEX.

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[2] For a detailed comparison of the various types of decentralised exchange protocols, see (Schär, 2021[8]).

[3] For more examples of similar failed intermediaries see (OECD, 2022[2]).

[4] Multifunction crypto-asset intermediaries (MCIs) combine a broad range of crypto-asset services, products, and functions (including proprietary trading and investment functions, issuing, promoting, and distributing crypto-assets or related products, including stablecoins). Some combinations of functions within a single MCI could exacerbate vulnerabilities associated with leverage, liquidity mismatch, technology and operational vulnerabilities, and interconnections (FSB, 2023[18]).

The working paper provides evidence of increased concentration in DeFi trading, beyond the infrastructure level (blockchains used as settlement layer), and beyond the fact that DEXs liquidity providing is concentrated in a small number of large protocols. The working paper delves deeper into this question of concentration of DeFi trading and showcases a low trade count in liquidity pools where DeFi trading is concentrated, with 20% of the pools of some of the DEXs examined accounting for more than 90% of the trading volume of that DEX. Moreover, concentration is also observed at the supply level of liquidity for DEXs examined: a small number of liquidity providers participating in these pools seem to represent a significant part of the trading activity (at the pool level), as measured by the amount of liquidity pool tokens held by those liquidity providers. The latter is cross-examined through an analysis of the amount of mints and burns[5] by liquidity providers in the examined pools. Even in cases of large absolute numbers of liquidity providers in the examined DEXs, most of them participate in only a minority of liquidity pools, and specifically in the pools with the highest trade size, possibly driven by respective financial incentives those particular pools offer relative to other pools. In approximately 50% of the sample examined, there have been instances where a single liquidity pool token holder controls between 90-100% of the pool's liquidity.

The analysis is based on an original on-chain transaction-level dataset of three of the largest decentralised finance exchange protocols for the period between December 2020 and August 2023: Uniswap v2, Uniswap v3 and Curve. These three DEXs represent the majority of the DeFi trading market, accounting for more than 95% of the total DEX activity as of August 2023.

[5] Liquidity on DEXs is distributed amongst liquidity providers in the form on LP tokens, which are fungible tokens that are issued or 'minted' as a receipts for the provided liquidity and are cancelled or 'burnt' once the liquidity is withdrawn from a liquidity pool.

2 Decentralised Exchanges (DEXs) rising in importance in DeFi

This Section provides background on Decentralised Exchanges (DEXs) and Automated Market Makers (AMMs); highlights the rising importance of such DeFi protocols for trading of crypto-assets in decentralised finance markets and provides an overview of the original dataset used in this working paper.

Decentralised Exchanges (DEXs) and Automated Market Makers (AMMs)

DEXs are on-chain platforms where traders can swap crypto-assets for other crypto-assets - but not for fiat, as in centralised crypto-exchanges (CEXs). DEXs facilitate the exchange of crypto-assets through smart contracts rather than through centralised trading platforms, which require traders to deposit their crypto-assets with the trading platform operator (IOSCO, 2022[3]). DEXs can rely on order books and include off-chain components (order book exchanges, OTC, P2P, reserve aggregators) or can be fully on-chain (e.g. AMMs).

AMMs are smart contracts that allow traders to exchange one crypto-asset (or tokenised asset more broadly) for another, by drawing on a common pool of liquidity, and based on prices that are determined by a pre-specified algorithm (BIS Innovation Hub, 2023[4]). Instead of order books, AMMs rely on liquidity pools where liquidity providers lock one or several crypto-assets in exchange for rewards, paid by traders using the pool's liquidity. Trading volumes in DEXs tend to follow the wider crypto-asset market volume trends, and particularly that of the Bitcoin, knowing that most crypto-asset prices tend to move in sync between themselves (Lahajnar and Rožanec, 2020[5])[6].

The model of DEXs is based on a liquidity pool system that employs smart contracts, where liquidity providers contribute funds to a pool that facilitates trades between different crypto-assets. Transaction fees charged by the pool are proportionally distributed among liquidity providers. AMMs are used to determine prices based on the amount of liquidity available in the pool for each asset, based on different functions (e.g. constant product function). This system, in theory, could promote decentralisation, transparency, privacy and trustlessness, by eliminating the need for a central authority to control the exchange process. In practice, at the current stage of development of this market, most DeFi systems are not truly decentralised[7] and fit on a dynamic multi-level spectrum of decentralisation (OECD, 2022[1]; CFTC, 2024[6]). Various centralised dependencies can be identified both from the technological and legal points of view (Schuler, Cloots and Schär, 2024[7])

DEXs are relying on smart contract functionalities; they can store crypto-assets and assume the role of a custodian with customisable criteria on how, when and to whom the assets can be released (Schär, 2021[8]). Given that DEXs do not hold client assets (non-custodial), they could mitigate the risk of theft via

[6] Prices of the top 10 crypto-assets exhibit a strong positive correlation between themselves, while these mainstream crypto-assets also exhibit medium-high positive, and rising, correlation with traditional asset classes (OECD, 2022[19]).

[7] "Decentralised in Name Only", see (IOSCO, 2023[21]).

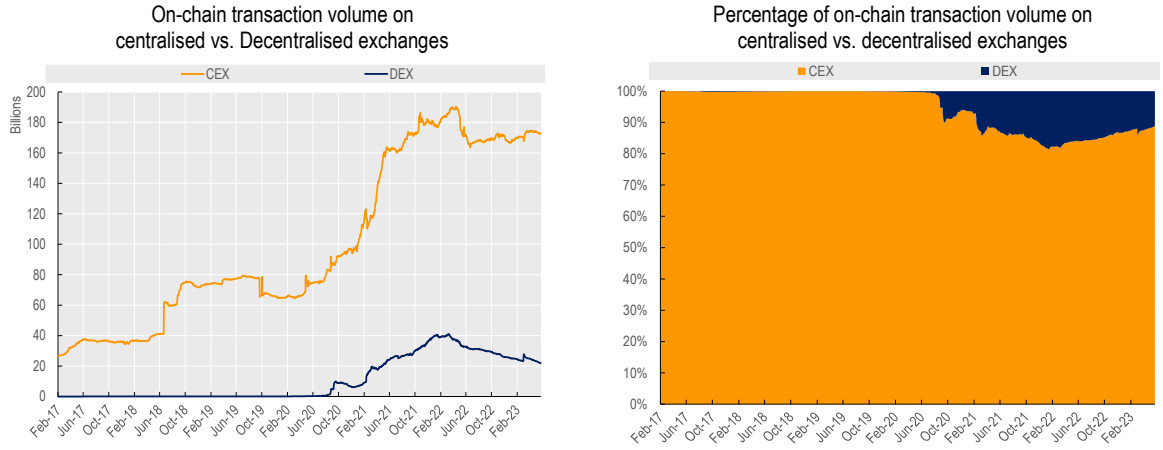
exchange hacking enhancing cyber security, however, they remain vulnerable to exploits (ESMA, 2023[9]).[8] DEXs could also reduce counterparty risk vis-à-vis the exchange operator and the risk of clients' asset misappropriation, since the custody and exchange logic of the assets is processed and guaranteed by smart contracts (ESMA, 2023[9]).

The rising importance of DEXs and AMMs in crypto-asset trading

Over the last few years, there has been a significant increase in trading volume on DEXs. While centralised exchanges have been in existence since the advent of Bitcoin and have evolved to offer a broad range of services to institutional and retail crypto investors, decentralised exchanges are relatively new but have achieved increasingly growing trading volumes. As a result, analysis of their characteristics and associated potential risks may warrant the attention of researchers and policy makers alike, despite their small size relative to traditional trading venues (see Figure 2.2. for relative volume of DEXs to CEXs analysed in this working paper).

DEXs are an increasingly important part of the DeFi market, with growing market share as compared to centralised crypto-asset exchanges (CEXs), particularly following the recent failures of multi-function crypto-asset intermediaries up until February 2022, when DEX trading volumes started to recede (Figure 2.1). Most of the crypto-asset transaction activity has been happening at centralised exchanges for crypto-assets (CEXs) until early 2021, when DEX trading volumes started to become a meaningful part of the total activity, growing to almost 20% of the total trading activity as of H2 2022. Interestingly, DEX activity increased in the aftermath of the FTX failure, with an increase in trading volumes occurring after the Silicon Valley Bank crisis. This could be attributed to investors' lack of confidence and fear of losing access to their crypto-assets, given that DEXs involve self-custody of assets by the investors themselves without a third-party custodian (OECD, 2024[10]) .

Figure 2.1. Increasing part of crypto-asset trading occurring in DEXs

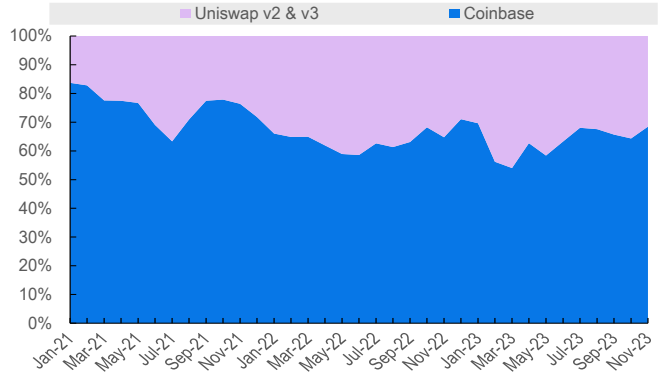


Note: CEX is defined as crypto-to-crypto exchanges and DEX is as decentralised exchanges.
Source: Kaiko exchange volume data.

[8] It should be noted, however, that liquidity providers entrust their assets to the smart contracts that govern the operation of the pool, and therefore liquidity providers still have a risk exposure related to the technology or operational risk. As such, the classic counterparty (or misappropriation) risk (i.e. the operator absconds with the funds) is replaced in DEXs by the exploit / hacking / operational risk (e.g. KyberSwap attack).

Figure 2.2. Example of relative volume traded in DEX relative to CEX

Relative volume of exchanges analysed in this paper



Source: Kaiko exchange metrics data.

DEX activity and liquidity provision: dataset used

The analysis is based on an original on-chain transaction-level dataset encompassing three Ethereum-based DEXs[9]: Uniswap 2.0, Uniswap 3.0 and Curve. There are three types of data used for this analysis: tick-level trades on DEXs, liquidity events (mints and burns), and liquidity pool tokens holdings[10]. These liquidity events refer to all information on the addition or removal of tokens to/from a liquidity pool by liquidity providers.

The tick-level trades data provides all the information (price, amount, direction, user address) regarding swaps registered on DEXs.

The liquidity events data provides valuable information on the liquidity flows initiated by liquidity providers, which can shed light on possible elements of concentration in DeFi exchange activity. To ensure the accuracy of the analysis, certain events that have no real impact on liquidity have been removed. This includes 'just-in-time liquidity events', which involve liquidity providers minting and burning a concentrated position immediately before and after a crypto-asset swap in order to maximize transaction fees. Such events[11] do not affect the pool's liquidity and are therefore excluded from the dataset used.[12] Additionally, mints and burns with a liquidity amount of zero are also removed from the dataset as they have no impact on liquidity.

Additional data on Uniswap V2 liquidity pool tokens holdings is used in this study. This data is made available at a block granularity and enables us to know the amount of LP tokens held by any user address who has provided liquidity to any Uniswap V2 liquidity pool, at any time. From this dataset, we leverage data from February to December 2020 (as opposed to the rest of the dataset, covering the period between December 2020 and August 2023).

[9] DEXs built on Ethereum-based blockchains represent the majority of DeFi trading activity, with 59% of total TVL being concentrated on Ethereum-based blockchains as of 20 February 2023, see Section 3.1.

[10] It should be noted that liquidity pool tokens holdings data is only available for Uniswap V2 liquidity pools, as of the time of writing of the working paper.

[11] Such events are exclusive to Uniswap V3.

[12] For more on Just-in-Time Liquidity see (Capponi et al., 2023[20]).

3 DEX Characteristics and concentration of DeFi trading

This Section analyses characteristics of DEXs based on an original on-chain dataset, pointing to increased levels of concentration in the DeFi markets examined.

Dominance of the Ethereum blockchain as the DeFi infrastructure

DeFi protocols, including DEXs, exist on various DLTs, such as the Binance Smart Chain or the Avalanche c-chain, as well as on sidechains like Polygon and rollups like Arbitrum and Optimism. However, currently, Ethereum stands out as the dominant blockchain used as the settlement layer[13] where DeFi protocols, including DEXs, run and execute transactions (Table 3.1). Ethereum is also the underlying blockchain with the highest liquidity locked into DEXs liquidity pools and the most trading volume. DEXs deployed on Ethereum clearly represent the majority of activity although such level has dropped from historical levels (see also (CONSOB, 2023[11])).

A possible dependence on a small number of infrastructure providers for the settlement layer underlying DEXs and other DeFi protocols, and over which the DeFi developers may not have direct control, could be considered as an important vulnerability of DeFi. Over-reliance on specific dominant blockchains such as the Ethereum blockchain may raise issues for users in case of congestion and corresponding fees, and increase the level of risk associated with operational reliability of such chains (OECD, 2022[1]; FSB, 2023[12]). Such dependency has led many DeFi protocols to expand their services across multiple chains to process operations in a less costly manner, albeit at the expense of fragmentation (FSB, 2023[12]). According to some studies, the physical infrastructure hosting the blockchain nodes consists of a concentrated ecosystem whereby cloud providers host a majority of Ethereum nodes (Banque de France ACPR, 2023[13]).

Table 3.1. Distribution of DeFi activity based on underlying blockchain

Underlying blockchain	TVL (USD, billion)
Ethereum	26.15
Tron	7.54
BNB Smart Chain (BSC)*	2.95
Arbitrum	2.14
Total	46.70

Note: *Previously Binance. As of 30 November 2023.
Source: Calculated based on DeFi Pulse data.

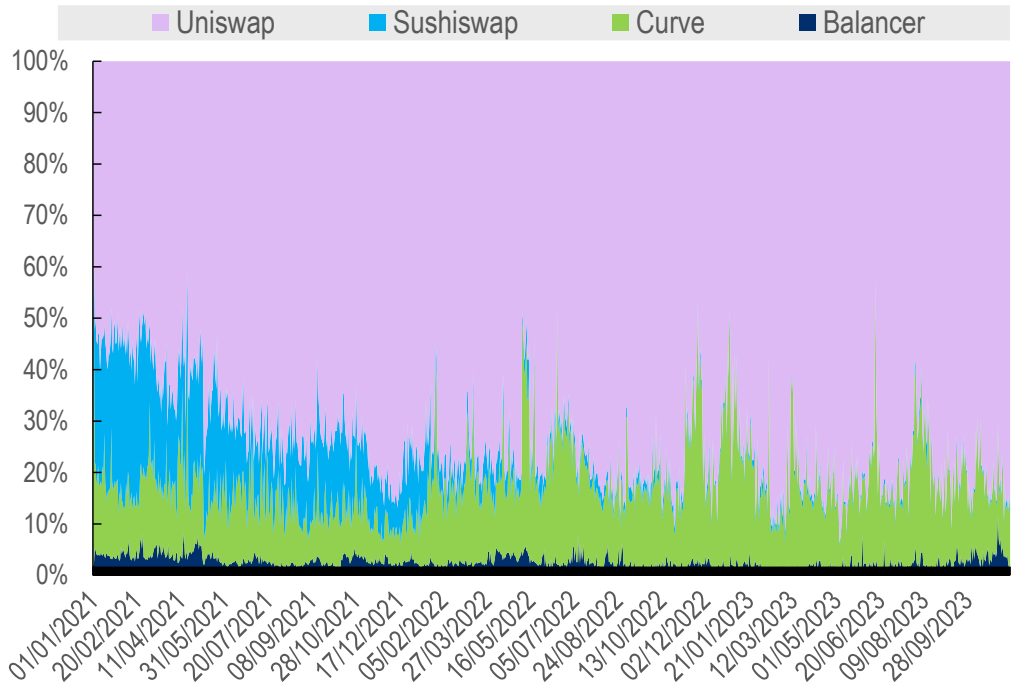
[13] For more on the DeFi architecture stack, see (Schär, 2021[8]).

DEX market activity concentrated in a handful of protocols

Currently, the Ethereum-based DEX landscape is heavily concentrated, with Uniswap dominating the market share of volume capturing around 80-90% of total market activity. Curve follows as a distant second with approximately 5-10% of the total volume.

Interestingly, the historical trend of the short history of these markets has been following a trend of concentration in market activity, rather than expansion. Indicatively, SushiSwap was one of the top three DEXs in 2021 and now ranks only 10th in terms of trading volume. This could be attributed not only to the impact of the crypto-asset market downturn (OECD, 2022[2]) but also to the business economic models ('tokenomics') of the specific DEX model (Sushiswap forum, 2022[14]).

Figure 3.1. Few players dominating the market



Note: Measured in percentage of total trading volume, for the period 1 January 2021 – 16 November 2023. Uniswap refers to Uniswap v2 and v3.
Source: Kaiko exchange metrics data.

To some extent, the liquidity concentration observed can be considered as an expected phenomenon in these markets. Trading activity can be expected to gravitate towards markets with the highest liquidity, given lowest price slippage when executing orders. A flow of trading activity then induces liquidity providers to switch their liquidity provision to the most active pools, in a positive feedback loop. Also, according to economic theory, DeFi activity can be thought of as a space of increasing returns which can lead to situations of concentration of power (Banque de France ACPR, 2023[13]).

Additionally, liquidity providers may choose to participate in fewer liquidity pools out of caution with different trading strategies across pool categories, given that the returns and losses in different pools varies a lot (Heimbach et al., 2021[15]). Liquidity providers activity may also be motivated by external market factors (e.g. liquidity mining activities) (Heimbach et al., 2021[15]).

Box 3.1. Uniswap v2 vs. Uniswap v3

It is worth noting that all versions of the Uniswap protocol are still live. Two of them, Uniswap V2, launched in May 2020, and Uniswap V3, launched in March 2021, gather most of the activity. The lack of existence of an admin key makes it impossible to overhaul or shut down the previous version of the protocol, and the transition was based on the migration of liquidity providers (and subsequent liquidity) towards the new version, instead of shutting down or upgrading the previous version.

The primary difference between the two versions lies in their price determination mechanism and liquidity pool structure. In the second version of Uniswap, liquidity providers provide an equivalent amount of both tokens on the overall price curve of a liquidity pool. In return, they receive a share of the transaction fees (0.3% of each swap amount) generated by traders using the liquidity to make swaps. This share is proportional to the liquidity provider's contribution relative to the other liquidity providers in the pool.

Uniswap V3 allows liquidity providers to optimize their capital efficiency and fee-based rewards by letting them choose which price levels they want to provide liquidity at. The smaller the price range a liquidity provider operates in, the higher the likelihood that they will capture a significant share of liquidity and fees over the covered price ranges.

Uniswap recently released the code for V4 (still not deployed/live), which differs from V2 and V3 in that it allows for customisation by users and liquidity providers with the introduction of tools such as "hooks" and "singleton contracts". These tools allow users to integrate liquidity pools into their smart contracts and aim at providing architecture that reduces costs (gas fees) and improving capital efficiency by allowing liquidity providers to focus their funds on a smaller price range (i.e. users can provide liquidity for a specific price range, reducing the amount of capital needed to maintain a pool).

High concentration of trading volume in a tiny fraction of liquidity pools of DEXs

The number of liquidity pools (LP) available at each DEX protocol varies widely, noting that users with technical knowledge can create new LPs in many of these protocols. There have been 159,252 liquidity pools deployed on Uniswap V2 since its genesis, while Uniswap V3 has only 11 031 deployed liquidity pools to date. Curve has 208 liquidity pools deployed since its inception, combining both official and factory pools[14] from Curve V1 and Curve V2.

The level of activity of the abovementioned DEX LPs varies considerably, and the majority of LPs on both Uniswap V2 and V3, as well as Curve, remain very small in size. When using USD 100 m of total traded volume as the threshold, the vast majority of the examined DEX LPs have activity that does not surpass that mark for the period August 2020 to April 2023 on an aggregated basis. Specifically, on Uniswap V2, only 582 out of 159 252 pools, which corresponds to 0.36% of the total pools, have surpassed USD 100 m of volume for that period. On Uniswap V3, 262 out of 11 031 pools, which corresponds to 2.37% of the total liquidity pools, have achieved the same level of trading volume. In the case of Curve, given that both Curve V1 and V2 coexist under the Curve Finance protocol, both versions are considered together at the protocol level for the purposes of this analysis. Among the total of 208 LPs identified at Curve, only 72 have surpassed the USD 100 m trading volume mark since August 2020, which corresponds to 34.6% of total number of active pools.

[14] Factory pools are permissionless meta-pools that can be deployed by any user with the relevant technical skills.

Low trade count in liquidity pools where trading is concentrated

When analysing LP activity levels, it is important to consider the number of trades performed in a particular LP on top of the total trading volume in that pool. Indeed, upon closer examination of the subset of pools exceeding USD 100 m in total traded volume, it becomes apparent that some exhibit an unusual trading pattern characterised by a low number of trades but a high overall trading volume. This suggests the possible dominant role of large professional users (e.g. centralised crypto-asset service providers) or individual large crypto-asset investors (e.g. institutional investors such as hedge funds or large accounts, so-called 'crypto-whales'). It could also relate to the possibility of market manipulation techniques, such as wash trading, which involves a small number of large actors artificially inflating the trading volume.

A healthy, diversified trading activity would be characterised by both a high trading volume and a sufficient number of trades from a diverse user base. On the contrary, liquidity pools with too low trade count, as pointed in the DEXs examined in this paper, may point to increased concentration and possible centralised elements of activity despite a high volume of trading activity overall (Table 3.2).

Table 3.2. Volume and trade count relationship

Volume	Trade Count	Possible underlying drivers
Large	Large	A liquidity pool that has a large number of users over an extended period and a high trading volume is considered a good indicator of a healthy and representative market. However, the average trade size (volume divided by trade count) should be relatively low, as this suggests a diverse range of users with varying trade sizes.
Large	Small	A liquidity pool that has a high likelihood of the presence of whales, and so a small number of traders.
Small	Large	A liquidity pool with a high probability of market manipulation (e,g, wash trading) is typically characterised by an abnormally high number of micro trades. These pools often have a small number of users who engage in frequent trading at low volumes, which can artificially inflate the pool's trading volume and give the appearance of high activity.
Small	Small	A pool that is not significant may either be recently created or may contain tokens that are not of great interest to the users of the platform.

Analysis of LPs with trading volume greater than USD 100m shows that most of the trading volume in DEX protocols examined was concentrated in a small number of pools for all DEXs examined[15]. Uniswap V3 showed the highest concentration of protocol's volume by pool, with only 20% of the pools on Uniswap V3 accounting for 92.46% of the trading volume, corresponding to 53 out of the 265 pre-selected pools (period from March 2021 to April 2023).

A mere 10% of the pools which have a total trading volume above USD 100m cumulate 88.21% of the traded volume on Uniswap V3 for the same period (Table 3.3). The respective figure for Uniswap V2 is 59.02% of the pools, and the difference is attributed to the fact that Uniswap V2 registers almost twice more liquidity pool than V3, given the large number of pools with small cap tokens. For Curve, only seven pools of examined pools cumulate 59.01% of the traded volume on the DEX (and correspond to 10% of all pools with total trading volume above USD 100 m).

Results are a bit less concentrated when looking into the trade count of pools with more than USD 100 m of trading volume. Around 50% of the pools, which correspond to 132 pools, represent 90.54% of the trading count of the DEX in Uniswap V3. In the case of Uniswap V2 and Curve, 90% of the trading volume and trade count over their entire existence was concentrated in 40-60% of the liquidity pools.

[15] Uniswap V2, Uniswap V3, and Curve.

Table 3.3. Volume and Trade Count Distribution over Uniswap V2, V3 and Curve Liquidity Pools (LPs with a volume greater than USD 100M)

Quantiles	Pools are ranked by Volume (Cumulative)			Pools are ranked by Trade Count (Cumulative)			Number of pools		
	Uniswap V3	Uniswap V2	Curve	Uniswap V3	Uniswap V2	Curve	Uniswap V3	Uniswap V2	Curve
10%	**88.21%**	**59.02%**	**59.01%**	**65.14%**	**50.39%**	**50.25%**	**27**	**58**	**7**
20%	92.46%	70.09%	74.86%	75.39%	62.80%	71.20%	53	116	14
30%	94.80%	77.61%	85.38%	81.78%	71.95%	83.28%	79	175	22
40%	96.33%	83.02%	91.35%	86.74%	79.04%	90.14%	106	233	29
50%	97.40%	87.21%	95.05%	90.54%	85.08%	93.64%	132	291	36
60%	98.22%	90.57%	97.14%	93.79%	90.15%	96.09%	159	350	43
70%	98.84%	93.50%	98.27%	96.40%	94.26%	98.00%	186	407	50
80%	99.31%	96.06%	99.10%	98.34%	97.40%	99.18%	212	466	58
90%	99.68%	98.17%	99.66%	99.55%	99.52%	99.67%	239	524	65
100%	100.00%	100.00%	100.00%	100.00%	100.00%	100.00%	265	582	72

Notes: Based on analysis of the the period March 2021 – April 2023.
Source: Authors calculations based on Kaiko.

Concentration of liquidity provision in liquidity pools[16]

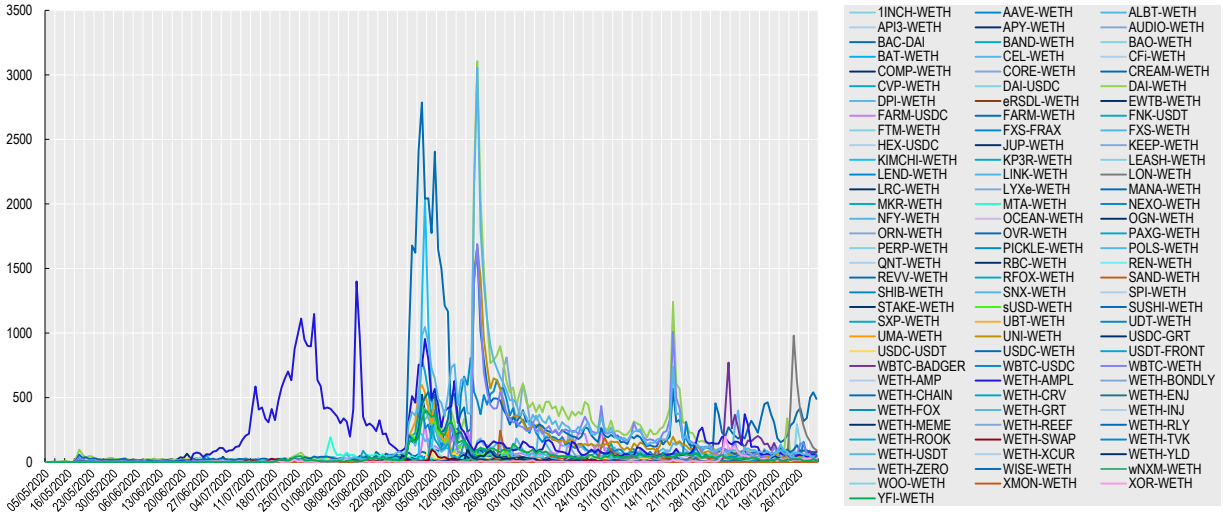
Liquidity on Uniswap V2 is distributed amongst liquidity providers in the form on LP tokens, which are fungible tokens that function as receipts for the provided liquidity and are burnt once the liquidity is withdrawn from a liquidity pool. Using the Uniswap V2 protocol as an example, analysing the number of LP token holders by pool over time in Uniswap V2 provides an indication of the overall level of liquidity decentralisation on this particular DEX. The greater the number of LP token holders at the protocol level, the more diluted the liquidity can be considered. Conversely, the smaller the number of LP token holders, the greater the centralisation of power in the protocol. It should be noted, however, that in practice one liquidity provider can hold LP tokens with multiple addresses.

Similar analysis has been applied to token ownership distribution and dynamics of governance token-holdings in DeFi protocols. Such analyses suggest elements of centralisation in token distribution in DeFi markets, although the level of such ownership concentration varies from one study to another. There is, however, consensus by researchers around the fact that in the vast majority of DeFi, the majority of the tokens are held by a handful of individuals, raising important questions regarding protocol decentralisation (Nadler and Schär, 2020[16]; Barbereau et al., 2022[17]).

When examining the ownership of Uniswap V2 liquidity among users who hold LP tokens throughout 2020, and so the total number of liquidity providers at each point in time (as illustrated in Figure 3.2), it becomes evident that the majority of liquidity pools had less than 500 liquidity providers, with some of the larger pools seeing more than 2 000 liquidity providers during peak periods.

[16] Includes analysis of liquidity pools with over USD 100m of traded volume.

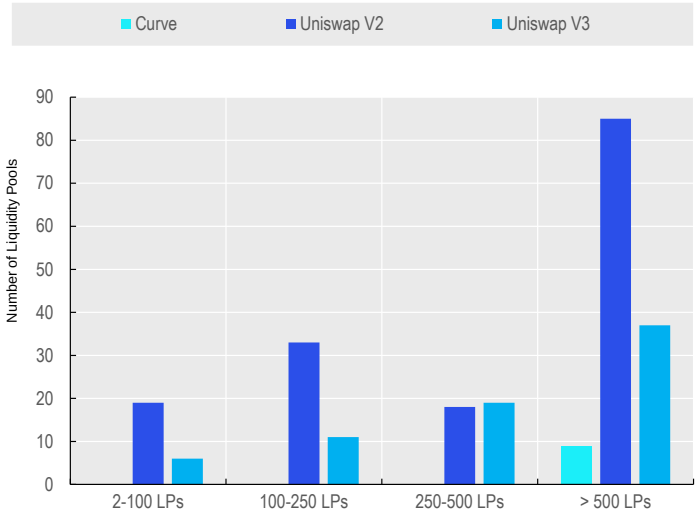
Figure 3.2. Uniswap V2 pools register a large number of liquidity providers



Note: All liquidity providers are holding LP tokens by definition.
Source: Authors based on Kaiko wallet data.

Zooming in on the largest liquidity pools of other DEXs over a three-year period (January 2020 to August 2023) as depicted in Figure 3.3, we observe that the findings outlined in Figure 3.2 for Uniswap V2 also hold true for Uniswap V3 and Curve. In general, most liquidity pools have a substantial number of liquidity providers, often exceeding 500, implying a relatively low concentration of liquidity within DEX liquidity pools at first glance.

Figure 3.3. Most DEXs Liquidity Pools encounter a large number of liquidity providers



Source: Authors calculations based on Kaiko liquidity events (mints & burns) data.

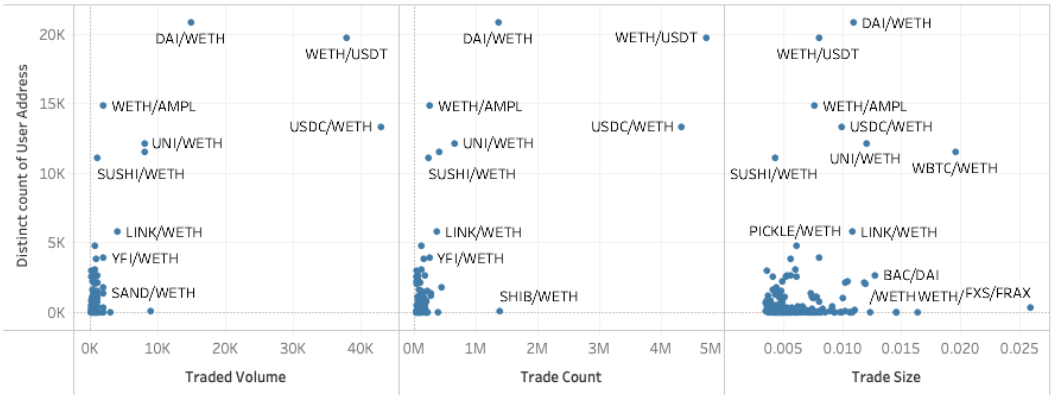
However, when cross-examining the number of liquidity providers for all Uniswap V2 liquidity pools which are part of this analysis, with their traded volume, trade count, and average trade size (Figure 3.4), it appears that the pools with the highest average trade size also encounter the largest number of liquidity

providers. This observation is also verified when the analysis is extended to other exchanges, including Curve and Uniswap v3. Comparing the total minted amount by liquidity providers over a three-year period with the trade volume, trade count, and trade size on those pools (Figure 3.5), shows that there is a positive relation between the amount minted by liquidity providers during this period, and the average trade size.

This analysis suggests that even if there are numerous liquidity providers (in absolute number) holding the pools' liquidity, most of those liquidity providers participate in only a minority of liquidity pools, and specifically in the pools with the highest trade size. This suggests a concentration of liquidity in those pools, which could possibly be attributed (among other things) to financial incentives those pools offer to liquidity providers relative to other pools.

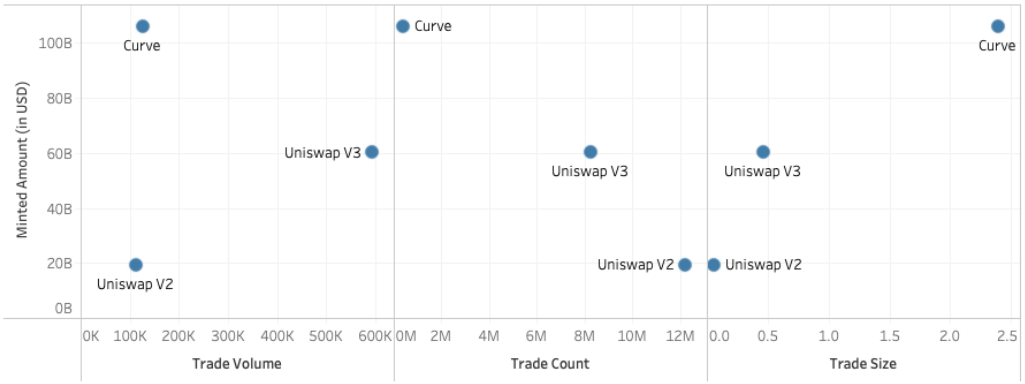
Economic incentives of liquidity providers could partly explain the observed high concentration levels in DEXs liquidity. Liquidity providers rewards directly depend on the transaction fees paid by traders which in turn are proportional to the trades size. If we expect that liquidity providers are rational economic beings, making decisions that maximise their personal utility, then they should be attracted by liquidity pools used for relatively large trades.

Figure 3.4. The largest Uniswap V2 liquidity pools by volume, trade count, and trade size, draw the most liquidity providers



Note: Distinct count of user addresses corresponds to number of liquidity providers.
Source: Authors based on Kaiko wallet data.

Figure 3.5. Trading volume, count and size are positively related to liquidity



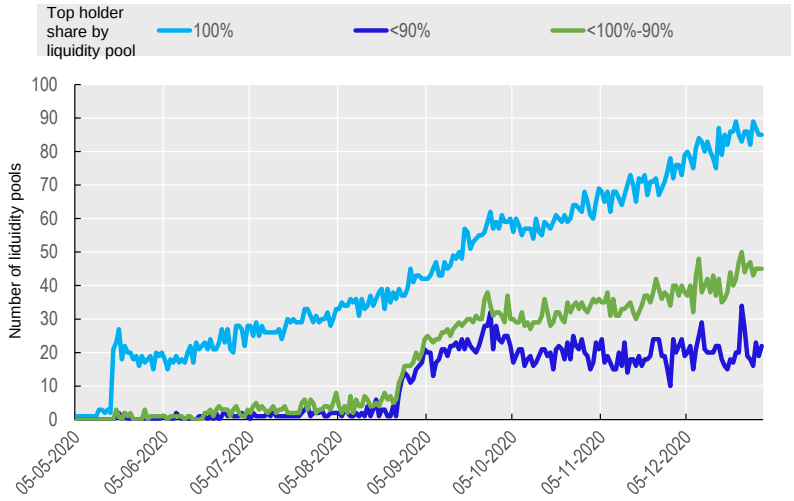
Note: Each exchange represented by its top five pools by trading volume. Minted amounts correspond to liquidity provision.
Source: Authors based on Kaiko liquidity events (mints & burns) data.

High concentration of liquidity provision in one's hands

Despite the numerous user addresses holding Uniswap V2 pools liquidity, when looking at the balance of liquidity pool tokens held by each (Figure 3.6), a whole a completely different story emerges. For about half of the pools chosen for this analysis, from May to December 2020, the largest liquidity pool token holder holds between 90 - 100% of the liquidity of the pool, in amount, while for more than half of the pools, there is only one holder having power over the entire pool's liquidity.

The trend of rising concentration has become more pronounced over time, with the gap between the number of pools with a top holder who holds less than 90% of the pool's liquidity and the number of pools with a top holder who possesses more than 90% of the pool's liquidity becoming more significant over time. This could constitute evidence of a trend of increase in the concentration of liquidity across Uniswap V2 pools.

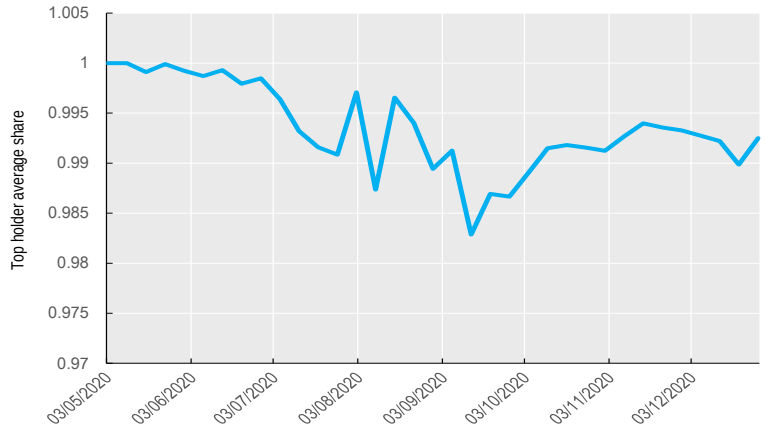
Figure 3.6. Uniswap V2 liquidity pool tokens are mostly held by a single liquidity provider



Source: Kaiko wallet data.

When taking the average share of LP tokens held by the top holder of each of the largest Uniswap V2 liquidity pools across 2020, our analysis shows that 98% to 100% of a pool's liquidity is held by a single liquidity provider (Figure 3.7).

Figure 3.7. On average, 98-100% of a pool's liquidity is held by one liquidity provider

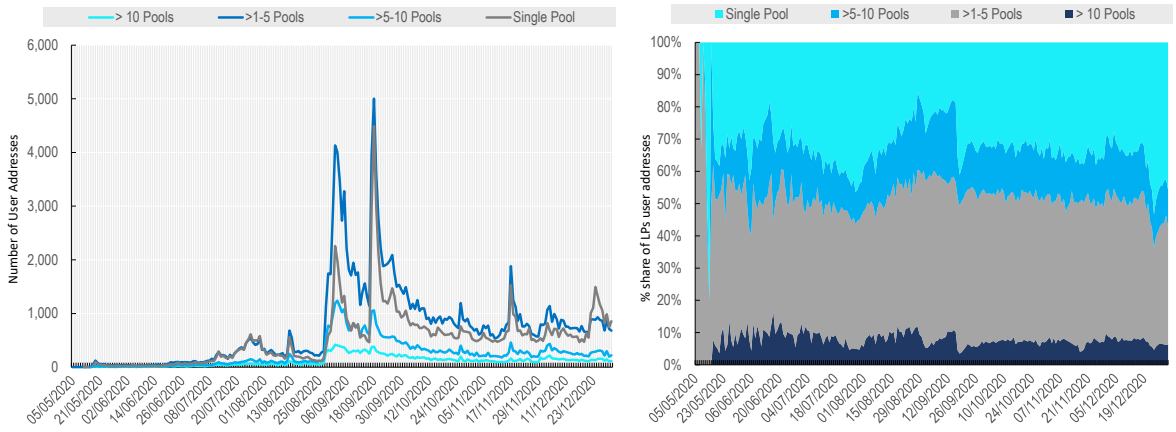


Source: Authors based on Kaiko wallet data.

Liquidity Providers strategies and liquidity provision behaviour

A question one might ask is whether the liquidity providers across the liquidity pools are consistently the same. Given the pseudonymous nature of DeFi market activity, the identity behind user addresses identified as liquidity providers is unknown (OECD, 2022[1]). However, for the purposes of the analysis, we consider that there is only one entity or individual behind each distinct user address. Based on this hypothesis, during 2020, most of Uniswap V2 pools liquidity providers were providing liquidity to up to five liquidity pools (about 80% of the total user addresses), and only a monitory of them (less than 10%) provided liquidity to more than 10 pools (Figure 3.8).

Figure 3.8. Number and share of Uniswap V2 Liquidity Providers which provide liquidity to one or more pools

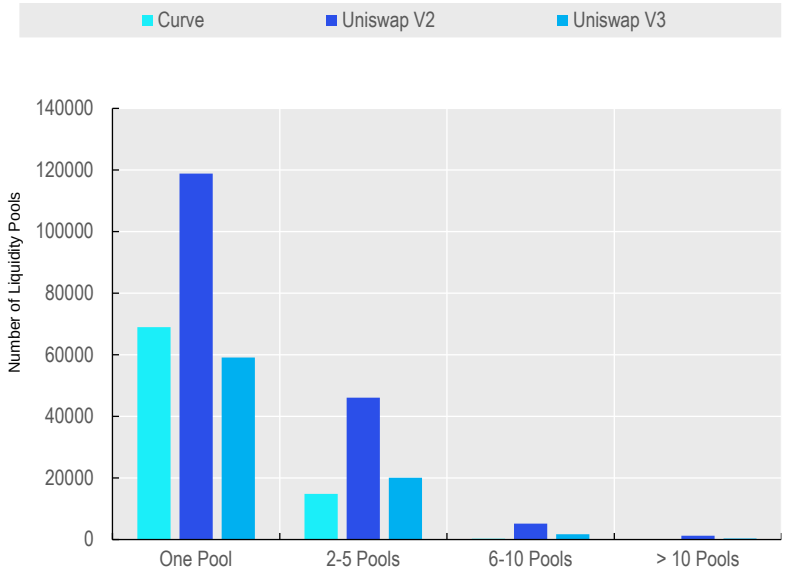


Source: Kaiko wallet data.

This observation is even more pronounced when looking over a larger time period than previously ranging from 2020 to 2023, and when looking to other DEXs as Uniswap V3 and Curve. Barely any liquidity provider provides liquidity to more than 6 pools on those three DEXs, and most liquidity providers provide liquidity to only one liquidity pool. This points to liquidity being scattered across users, under the hypothesis that

each distinct user address corresponds to one identity. In reality, however, the same user can use different accounts which means that one identity can correspond to multiple distinct addresses.

Figure 3.9. Number of Uniswap V2, Curve and Uniswap V3 Liquidity Providers providing liquidity to one or more pools



Source: Authors based on Kaiko liquidity events (mints & burns) data.

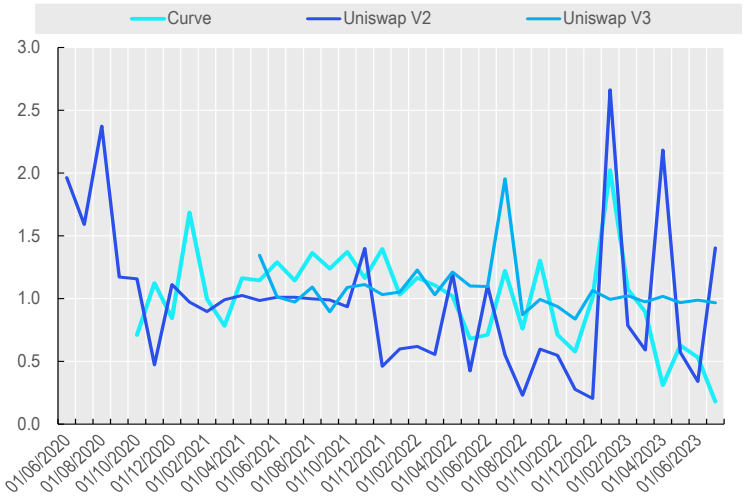
Concentration levels in liquidity pools, measured in amount of mints and burns by liquidity providers per pool in examined DEXs and mint/burn ratio

Liquidity providers are central to the functioning of DEXs as they provide, and could indirectly control, the exchanges' liquidity. Liquidity providers deposit tokens into a liquidity pool and receive liquidity pool tokens that represent their pool share in exchange. This process is referred to as a "mint", as the user is minting a liquidity pool token by adding tokens to a pool. In the reverse, when a liquidity provider wants to withdraw their liquidity, they will "burn" their liquidity pool token and receive the underlying tokens in return, plus any transaction fees that they accrued.

By monitoring the mint/burn ratio per pool over time, we can observe whether liquidity providers at the exchange level are primarily withdrawing or minting liquidity. When the average mint/burn ratio across an exchange's pools falls below one, it indicates that liquidity providers are exiting liquidity pools, resulting in a decrease in the level of liquidity dispersion and an increase in centralisation at the pool.

Liquidity provision and the mint/burn ratio of liquidity providers in DEXs could be used as a proxy to examine whether DEX trading activity is procyclical relative to the wider crypto-asset markets. If pool prices differed from market prices, there would be arbitrage opportunities, therefore pool prices and market prices are expected to be in line. Based on the analysis of the DEXs included in the scope of this working paper, there seems to be no direct connection between liquidity providers activity and the crypto-asset market cycle. Considering Curve, Uniswap V2 and Uniswap V3 mint over burn amount ratio over time, no significant results suggesting that liquidity providers take out liquidity during bear market and bring liquidity to the pools during bull market appears (Figure 3.10).

Figure 3.10. Number of Uniswap V2, Curve, and Uniswap V3 Liquidity Providers providing liquidity to one or more pools



Note: For the period 1 June 2020 – 1 June 2023.
Source: Authors based on Kaiko liquidity events (mints & burns) data.

Areas of possible further analysis

This paper provides evidence of increased concentration of DeFi liquidity provision in a sample of DEXs examined and based on an original on-chain dataset to substantiate the analysis. A low trade count is observed in liquidity pools where DeFi liquidity provision is concentrated, with 20% of the pools of some of the DEXs examined accounting for more than 90% of the trading volume of DEXs examined. In addition, a small number of liquidity providers participating in the examined DEX pools represent a significant part of the trading activity as measured by the amount of liquidity pool tokens held by those liquidity providers, which is also evidenced through an analysis of the amount of mints and burns by liquidity providers in the examined pools.

Increased concentration of liquidity in DEXs, as evidenced in the sample examined, could exacerbate vulnerabilities observed in DeFi markets, possibly affecting market functioning and price discovery, and giving rise to possible anti-competitive behaviour resulting from market dominance (e.g. barriers to entry and misuse/abuse of market power with potential implications on pricing for the end-users). Concentration in the provision of liquidity by a small number of liquidity providers could give rise to concentration risks and risk of market manipulation as is the case with wash trading, for example (e.g. provision or withdrawal of liquidity in a way that affects prices at least within the liquidity pool). Dominant liquidity providers can affect price volatility through the initiation of large withdrawals of liquidity with potential spill-overs to the wider crypto-asset markets given concentration of DEX activity in small number of platforms and vast interconnectedness of the crypto-asset system (OECD, 2022[2]). The latter also translates into possible amplification of the risk of disruption of the crypto-asset market in case of failure of a single dominant DEX. Dominant liquidity providers could be connected to centralised crypto-asset intermediaries, and could indeed be market-makers, and more research is needed to identify the character of such DEX actors.

Further areas of possible interest for analysis could also include empirical analysis of the levels of concentration of DeFi DEXs in periods of important market events and the possible links between liquidity concentration levels and price evolution of mainstream crypto-assets.

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