TLDR:

The ERC-7683 standard, presented in Q2 2024 by Uniswap Labs and Across, establishes a unified framework for intent-based systems to define cross-chain actions precisely. Should this standard gain widespread adoption, it could fundamentally alter the dynamics of DEXs, with Uniswap—the DEX with the largest TVL—standing at the epicenter of this seismic shift.

Although studies suggest that our first hypothesis is correct and that the main reason a user refrains from taking action (in this case, bridging and adding liquidity) is due to think time, our findings indicate that the other hypotheses are incorrect. Consequently, the rise of intent-based protocols shows a positive correlation with on-chain liquidity, potentially enhancing it rather than diminishing it. This correlation is stronger on Ethereum than Arbitrum or Base, although the effect varies depending on the asset pairs analyzed.

Introduction

Liquidity remains a critical challenge for many emerging blockchain networks, particularly within DEXs. Despite accumulating significant TVL, these networks often struggle to maintain sufficient liquidity, leading to poor UX, high transaction costs, and ultimately, hampered growth and adoption. This issue is exacerbated by the complexities and costs associated with bridging assets across chains and low APYs that fail to incentivize liquidity providers.

This study explores how Uniswap can play a pivotal role in mitigating these challenges by leveraging atomic cross-chain swaps. These swaps enable seamless asset exchanges across different blockchains without relying on a central intermediary, potentially reducing friction and unlocking new liquidity pools.

Our research will focus on three key hypotheses:

1. Transaction costs and bridging complexities deter liquidity provision on new blockchains.
2. Intent-based atomic cross-chain swaps could reduce liquidity on smaller DEXs.
3. These swaps may impact the on-chain liquidity of high-cap assets more than long-tail assets.

By investigating these aspects, we aim to provide actionable insights and recommendations to enhance liquidity provision in new blockchain networks supported by Uniswap's innovative technology and established platform.

Liquidity Flywheel

Our research builds on the concept of the liquidity flywheel

, which is the essence of every AMM-based DEX and the main incentive why liquidity providers add liquidity. Here's a simple breakdown of how it works:

1. High Liquidity Attracts Traders:

The more liquidity there is, the easier and faster it is for traders to execute large transactions without significantly affecting the price.

1. Trading Volume Generates Fees:

Every trade is charged a fee, which is collected and distributed to the LPs (Liquidity Providers) who have supplied liquidity.

1. Fees Attract Liquidity Providers:

Because liquidity providers earn these trading fees, providing liquidity becomes an attractive way to earn passive income. The more fees generated from trading volume, the more people are incentivized to add liquidity to earn those fees.

1. More Liquidity Attracts More Traders:

The pools grow larger as more people add liquidity. Larger pools mean even better trading conditions for traders, attracting more traders to Uniswap, increasing trading volume, generating more fees, and thus continuing the cycle.

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One strategy new blockchains use to attract liquidity is to increase incentives for liquidity providers through airdrops or tokens, ensuring that the APY they receive for providing liquidity is higher than what other blockchains offer. This is how they attempt to kickstart the liquidity flywheel.

However, these incentives often fall short of starting this flywheel due to two main reasons:

1. Friction (speed, cost, security, etc.) from bridging assets and making the necessary swaps to add liquidity.

2. The security of these new blockchains, which is inferior to the base layer (Ethereum), leads most LPs to prefer staying on Ethereum despite receiving lower APYs.

Cross-chain intent-based protocols address friction by allowing users to bridge and swap assets quickly and securely.

Yet, while solving one problem, they could potentially create another: If the fees generated in an AMM are distributed to solvers instead of liquidity providers, could this impact the liquidity flywheel and, consequently, be detrimental to the liquidity of AMM DEXs like Uniswap?

While it is true that solvers need to get their liquidity somewhere, they typically have access to significant funds and can obtain liquidity from CEXs at a lower cost and with greater ease than on-chain. As a result, they may not generate fees for LPs in these situations. However, this dynamic changes when dealing with long-tail assets that are only available on-chain or listed on a limited number of CEXs with low liquidity. In such cases, market makers would need to acquire these assets on-chain, thereby generating fees for LPs.

We've analyzed with empirical data what is happening and if our hypotheses are correct.

Analysis

To test our hypotheses, we analyzed the on-chain volume and the volume of intent-based protocols (not just the cross-chain ones, but every relevant intent-based protocol) for three different asset pairs across three blockchains. The objective was to verify whether an increase in the volume of intent-based protocols correlates with a decrease in on-chain volume for the same asset pairs. This decrease would lead to a decrease in the on-chain liquidity because it could break the liquidity flywheel.

Although it could make sense to analyze all the off-chain volume (all transactions conducted off-chain, including those on CEX and intent-based protocols), in this study, we focus exclusively on the volume from intent-based protocols because it reflects transactions only from on-chain users (those who use a DEX, whether intent-based or not) and not from off-chain users (those who only use CEX).

Our analysis was conducted systematically involving four key steps, ensuring a comprehensive evaluation of the blockchain and asset pairs in question.

Step 1: Blockchain Selection

The first step involved identifying the most suitable blockchains for our case study. This was achieved through the following process:

1. Data Collection

: We gathered inflow-outflow data from deBridge (one of the most relevant cross-chain intent-based protocols), focusing on a cumulative 180-day period.

1. Data Analysis

: We compiled a list of the top blockchains by cumulative inflow-outflow volume, to identify blockchains with significant intent-based cross-chain activity.

1. Criteria Matching

: We further refined the selection by ensuring that the chosen blockchain met specific criteria: * Adequate (i.e. among the top 10 volume blockchains) cumulative 180-day off-chain volume.

- The absence of an ongoing airdrop could skew the data.

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- Selection

: We chose 3 different blockchains based on the three steps above: * Base Layer: Ethereum

- Consolidated Alt-layer: Arbitrum
- Alt-layer + new chain: Base
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- Consolidated Alt-layer: Arbitrum
- Alt-layer + new chain: Base

Step 2: Off-chain and On-chain Data Collection (180-day Period)

After defining the sample, the next step focused on collecting and analyzing off-chain and on-chain data, ensuring that we had a detailed understanding of the asset pairs and their volumes.

1. Off-chain Data Extraction

: We obtained the cumulative volumes generated on intent-based protocols for all exchanged asset pairs (e.g., ETH-USDT, ETH-USDC) on the selected blockchains over 180 days.

1. On-chain Data Extraction

: We obtained the cumulative volumes generated on DEXs for all exchanged asset pairs (e.g., ETH-USDT, ETH-USDC) on the selected blockchains over 180 days.

1. Asset Pair Identification

: We chose 3 pairs of assets for each blockchain: the main pair of assets (ETH-USDC or similar), a pair of assets including a high cap with high volume (e.g. PEPE-ETH), and a pair of assets of an on-chain-only token (or at least predominantly on-chain) (e.g. USDC-USD+)

1. Selection

: We chose 3 different pairs of assets for each blockchain: * Ethereum

: USDC-ETH, PEPE-ETH, APU-ETH

- Arbitrum

: USDC-ETH, ARB-ETH, MIM-ETH

- Base

: USDC-ETH, BRETT-ETH, USD±USDC

1. Ethereum

: USDC-ETH, PEPE-ETH, APU-ETH

1. Arbitrum

: USDC-ETH, ARB-ETH, MIM-ETH

1. Base

: USDC-ETH, BRETT-ETH, USD±USDC

Step 3: Market Activity Data Collection (180-day period)

The final step related to data extraction focused on retrieving network activity data to use as a proxy in our analysis.

1. Network Activity Data Collection

: We extracted the daily transaction count for each of the selected blockchains.

1. Data Utilization

: This data was then used as a proxy indicator to better understand and analyze the network activity in relation to the other variables in our study.

Step 4: Data Analysis

In this phase, we looked over the collected data using statistical and graphical methods. The primary objective was to determine whether there was a correlation between the increase in off-chain volume and the decrease in on-chain volume for each asset pair.

The analysis involved the following steps:

1. Data Transformation:

Logarithmic transformations were applied to the on-chain volume, off-chain volume, and active addresses data to address skewness and stabilize variance.

1. Regression Models:

Ordinary Least Squares (OLS) regression models were employed to analyze the relationship between on-chain volume (dependent variable) and two independent variables: off-chain volume and active addresses. The models were separately applied to each token pair on each blockchain.

1. Statistical Significance:

The significance of off-chain volume's effect on on-chain volume was determined using p-values, with a threshold of $p < 0.05$ to indicate statistical significance.

1. Pearson Correlation Coefficient:

Pearson correlation coefficients were calculated to assess the strength of the linear relationship between on-chain and off-chain volumes.

1. Visualizations:

Regression plots were generated to visually represent the relationship between on-chain and off-chain volumes, including the Pearson correlation coefficient.

1. Time Series Analysis:

Analyzed the relationships between on-chain volume, off-chain volume, and active addresses over time.

1. ADF Test:

Applied the ADF (Augmented Dickey-Fuller) test to ensure the stationarity of the time series data.

1. VAR Model:

Utilized a VAR (Vector AutoRegression) model to explore the interdependencies among the variables.

1. Granger Causality:

Conducted Granger causality tests (normal and inverse) to assess whether off-chain volume can predict on-chain volume and whether on-chain volume can predict off-chain volume, indicating potential causality.

This approach tested the hypothesis

that an increase in off-chain volume was statistically associated with a decrease in on-chain volume for the selected asset pairs and either confirmed or refuted it.

Additionally, we analyzed the solvers' activity and compared their volume to the on-chain volume to assess whether intent-based protocols are a practical alternative solution to AMM-based DEXs.

Results

The numerical results obtained from the first 4 steps of the data analysis are summarized in the following table:

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Pearson coefficient and its p-values

1280×699 205 KB

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To provide further context, we have included the charts for each of the analyzed asset pairs below:

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Daily volumes and regression plot of USDC-WETH on Ethereum

1714×1836 232 KB

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Daily volumes and regression plot of PEPE-WETH on Ethereum

1699×1834 222 KB

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Daily volumes and regression plot of APU-WETH on Ethereum

1709×1816 215 KB

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Daily volumes and regression plot of USDC-WETH on Arbitrum

1707×1839 219 KB

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Daily volumes and regression plot of ARB-WETH on Arbitrum

1682×1819 217 KB

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Daily volumes and regression plot of MIM-WETH on Arbitrum

1687×1799 214 KB

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Daily volumes and regression plot of USDC-WETH on Base

1714×1824 216 KB

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Daily volumes and regression plot of BRETT-WETH on Base

1689×1824 218 KB

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Daily volumes and regression plot of USD+-USDC on Base

1687×1814 223 KB

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It is observed that for all pairs, there is a significant positive correlation, except those that are purely onchain (USD±USDC and MIM-WETH). Additionally, this correlation is significantly stronger on Ethereum than on Arbitrum and Base.

The ADF test results indicate that all variables, except for the log series of active addresses and for USDC-WETH on Arbitrum are stationary, as evidenced by their significantly low p-values. This is summarized in the table below:

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ADF Tests

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The numerical results from the Granger Test indicate that the outcomes vary across different asset pairs, depending on the lags analyzed. This data is summarized in the following tables:

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Granger Test Results for Ethereum

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Granger Test Results for Arbitrum

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Granger Test Results for Base

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The optimal lag selection for the VAR model was determined based on the AIC coefficient, with the number of lags chosen according to the lag showing the lowest coefficient among the 15 lags analyzed. This approach provides a robust framework to explore the interdependencies among the variables. Additionally, the Granger causality tests reveal a significant predictive relationship between off-chain volume and on-chain volume, and vice versa for some assets, with p-values indicating potential strong causality. This suggests that movements in one volume type can reliably predict movements in the other, highlighting a dynamic interaction between on-chain and off-chain activities.

For other assets, the relationship only implies correlation in one direction—either from off-chain to on-chain or from on-chain to off-chain. For less liquid asset pairs, the correlation is confirmed to be insignificant.

Lastly, we also analyzed the solvers' typical working hours and compared their volume with on-chain volume to assess whether, in practice, the solution based on them is effective and whether they are active at all times of the day.

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In the heatmap, it can be observed that despite solvers being primarily institutions or market makers, their activity does not decrease significantly at any time during the week and is even higher during periods of reduced volume, such as weekend nights.

Discussion

Based on the analysis, the relationship between off-chain volume and on-chain volume varies depending on the specific blockchain, token pairs, and the type of pair of assets (traded on CEX+DEX vs traded only on DEX):

Ethereum

- USDC-WETH

: The analysis shows a significant positive correlation between off-chain and on-chain volumes (coefficient = 0.698, p-value < 0.001). This suggests that an increase in off-chain trading volume is associated with a notable increase in on-chain volume. VAR model results indicate a strong predictive relationship from off-chain to on-chain volume, with Granger causality tests confirming this bidirectional influence. This pair's high liquidity across CEX and DEX platforms underscores the robustness of this relationship, suggesting that off-chain activity might drive or reflect similar trends in on-chain transactions.

- PEPE-WETH and APU-WETH

: Both pairs exhibit strong positive correlations, with coefficients of 0.828 and 0.756, respectively, and very low p-values. The VAR analysis for these pairs also indicates a significant influence of off-chain volume on on-chain activity, particularly for PEPE-WETH, where Granger causality tests suggest that off-chain volume significantly predicts on-chain volume. These findings imply that even for less prominent pairs, off-chain volume is a strong predictor of on-chain activity.

Base

- USDC-WETH

: The positive but smaller coefficient (0.186, p-value < 0.001) suggests a weaker yet significant relationship between off-chain and on-chain volumes. VAR analysis for this pair shows that while there is a positive correlation, the predictive power is weaker compared to Ethereum. The differences might stem from variations in market maturity, liquidity, or infrastructure. Granger causality tests did not find a strong causal relationship, indicating that the interaction between these volumes might be more complex on Base.

- USD±USDC

: This pair shows an insignificant and slightly negative relationship between off-chain and on-chain volumes (coefficient = -0.011, p-value = 0.433). The results suggest that for USD±USDC, off-chain activity may not be a reliable predictor of on-chain volume and vice versa.

- BRETT-WETH

: Although less traded than USDC-WETH, BRETT-WETH still shows a positive correlation (coefficient = 0.152, p-value < 0.001). The VAR analysis suggests that off-chain volumes can moderately predict on-chain activity even for smaller pairs on Base, although the relationship is not as robust as in more liquid pairs.

Arbitrum

- USDC-WETH

: The relationship between off-chain and on-chain volumes is moderate but significant (coefficient = 0.404, p-value < 0.001). However, the ADF tests indicate that the time series for on-chain volume, off-chain volume, and active addresses are not stationary, which raises concerns about the validity of the VAR model and Granger causality tests applied in this context. Although the VAR model suggests that off-chain volume influences on-chain volume, this relationship may be less robust due to the non-stationarity of the data. The Granger causality tests confirm some degree of influence, highlighting the interconnectedness of off-chain and on-chain activities even in less mature ecosystems like Arbitrum. However, these results should be interpreted with caution, given the potential for spurious relationships caused by the underlying trends in the non-stationary data. Further preprocessing or alternative modeling approaches may be necessary to obtain more reliable insights.

- ARB-WETH

: The effect is weaker (coefficient = 0.173, p-value < 0.001) but still significant, indicating that off-chain activity influences on-chain volume, though the impact is smaller compared to more liquid pairs. The VAR analysis also supports this finding, showing a moderate influence of off-chain volume on on-chain activity.

- MIM-WETH

: This pair shows the weakest relationship (coefficient = 0.022, p-value = 0.337), with the VAR model and Granger causality tests indicating a lack of significant interaction between off-chain and on-chain volumes. The results suggest that for MIM-WETH, off-chain activity may not be a reliable predictor of on-chain volume and vice versa.

Comparative Insights Across Blockchains

- Ethereum as a Benchmark

: Ethereum remains the blockchain where off-chain volume most strongly affects on-chain activity. The robustness of these relationships, particularly for USDC-WETH, makes Ethereum an essential benchmark for understanding the dynamics between off-chain and on-chain trading. These insights could inform strategies as other blockchains evolve and develop their market structures.

- Divergence in Lower Liquidity Networks

: The results from Base and Arbitrum highlight that the relationship between off-chain and on-chain volumes can vary significantly depending on each blockchain's liquidity and trading environment. On these blockchains, off-chain activity's influence on on-chain volumes is less pronounced, possibly due to differences in market infrastructure or liquidity provision strategies.

Although our initial hypotheses suggested that intent-based protocols might negatively impact on-chain liquidity, our findings indicate a positive correlation across most pairs and blockchains. A key reason could be that this off-chain volume (generated by solvers) remains very low—about 4.63% of on-chain volume—failing to reach the critical threshold needed to significantly affect APY in liquidity pools.

Furthermore, the strength of this relationship varies significantly. The effect is more pronounced in highly liquid pairs (such as USDC-WETH on Ethereum) and diminishes in pairs primarily traded on DEXs or with lower liquidity. This could suggest that solvers are not interested in filling orders from DEX-only tokens. Our main hypothesis suggests that this is because these tokens can't be arbitraged through CEXs, making it difficult to offer better quotes than the price provided by an AMM LP. However, this is just a hypothesis and should be investigated further to obtain conclusive data.

Regarding the time series of all the aggregated data, its analysis, supported by the ADF tests, confirms that most key variables are stationary, ensuring that the relationships observed are reliable and not driven by underlying trends.

The VAR model analysis, considering the most significant lags (ranging from 1 to 10 across different pairs), reveals that past values of on-chain and off-chain volumes do indeed influence current volumes over time. However, the complexity and interaction within these markets are highly dependent on the specific asset pair and blockchain, with varying degrees of impact observed across different lags.

Granger causality tests show a mixed picture of the relationships between off-chain and on-chain volumes. For some pairs, there is a strong bidirectional relationship, indicating that off-chain and on-chain activities are closely interlinked, each influencing the other. However, for other pairs, the relationship is weaker or even insignificant, suggesting that the dynamics between off-chain and on-chain activities can vary widely depending on the specific context.

Regarding solver activity, although they fill less volume on weekends, a comparison with on-chain volume shows that they fill orders every day at every hour, indicating that intent-based protocols are currently a good alternative to AMM-based DEXs.

Conclusions

We formulated three hypotheses before conducting this research:

1. Transaction costs and bridging complexities deter liquidity provision on new blockchains.

True:

Studies suggest that trader behavior is predominantly influenced by "think time" (in this case, the time a user spends thinking about how to bridge funds), one of the most critical predictors of user satisfaction. In addition, the task completion rate and "click time" (or offset time) also play significant roles. Transaction costs and bridging complexities compel users to deliberate on the fastest, safest, and cheapest way to bridge funds for adding liquidity, leading to longer thinking times and decreased user satisfaction. This results in fewer users choosing to bridge funds to new blockchains.

These are not the only factors driving this behavior; incentives and lower security on new blockchains are also relevant reasons users may avoid bridging funds and providing liquidity.

1. Intent-based atomic cross-chain swaps could reduce liquidity on smaller DEXs.

Partially False:

The data analysis suggests that while intent-based atomic cross-chain swaps were hypothesized to reduce liquidity on smaller DEXs, this is not entirely the case. Instead, there is a positive correlation between off-chain and on-chain volumes, indicating that off-chain activity can enhance on-chain liquidity because of the liquidity flywheel (more volume leads to more fees, leading to more liquidity). This suggests that rather than diminishing liquidity on DEXs, the off-chain volume may complement and support on-chain trading activity across different assets and blockchains.

1. These swaps may negatively impact the on-chain liquidity of high-cap assets more than that of long-tail assets.

Partially False:

The data analysis shows that intent-based swaps do not negatively impact the on-chain liquidity of high-cap assets as hypothesized. Instead, a stronger positive correlation exists between off-chain and on-chain volumes for high-cap assets, which enhances on-chain liquidity. This positive correlation is particularly evident in blockchains with higher liquidity and more mature ecosystems, where off-chain activity complements and bolsters on-chain trading. In contrast, long-tail assets exhibit a weaker correlation, suggesting that the impact of these swaps on on-chain liquidity is less pronounced for less liquid assets.

It is important to remember that correlation does not imply causation. While the results analyzed through the Granger causality tests suggest that these correlations might reflect a causal relationship, this evidence alone is insufficient to confirm causality. The Granger test indicates potential predictability between variables, but it cannot account for all possible external factors or underlying mechanisms driving these relationships. Therefore, while the findings provide strong indications of a causal link, further investigation, and additional methods would be necessary to establish causality.

Recommendations

The findings of this study indicate that the rise of intent-based protocols, while potentially beneficial for certain aspects of cross-chain functionality, could pose significant challenges to the liquidity dynamics of AMM-based decentralized exchanges like Uniswap. To address these potential challenges and ensure sustained growth and resilience, Uniswap could consider the following strategic recommendations:

- Enhancing Liquidity on Smaller Blockchains

: Based on our analysis, Uniswap should consider strengthening the infrastructure for intent-based protocols on smaller blockchains, primarily by deploying UniswapX on more blockchains. The positive correlation between off-chain and on-chain volumes indicates that improving on-chain volume could lead to increased fees and, consequently, more incentives for liquidity providers to contribute to these networks. Uniswap is already paving the way for this by implementing the ERC-7683 standard and deploying UniswapX cross-chain, which leverages this framework. To maximize the impact of these initiatives, Uniswap should also enhance support for solvers and simplify their onboarding process, attracting more participants and further boosting liquidity on smaller blockchains. The practical steps should be as follows: 1. Deploy UniswapX on Target Blockchains

: The governance should vote on and allocate resources towards expanding UniswapX to smaller blockchains such as Base or Optimism. Prioritize blockchains with active user bases and liquidity needs, ensuring that deployment is efficient and aligns with market demand.

1. Create Incentive Programs for Solvers

: Uniswap could introduce temporary incentives to encourage filling on smaller blockchains (e.g. protocol fee sharing, grants, etc).

1. Improve Solver Onboarding

: To attract more solvers and market makers, Uniswap could allocate resources to streamline the onboarding process. This might include providing grants or subsidies for solver infrastructure, offering developer tools, and simplifying documentation, making it easier for new solvers to participate.

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- Continuous Monitoring:

Uniswap should regularly monitor the evolving landscape of intent-based protocols and their impact on on-chain liquidity. By staying informed and adapting its strategies accordingly, Uniswap can ensure it remains competitive and responsive to the dynamic changes in the decentralized finance ecosystem. This could involve periodic reviews of data, user behavior, and market developments to make adjustments as needed.

- Tailoring Strategies

: Uniswap should consider these dynamics when implementing new features. For Ethereum, where off-chain volume significantly impacts on-chain behavior, strategies that closely integrate off-chain and on-chain data could be crucial. On Base and Arbitrum, however, more tailored approaches that focus on strengthening on-chain liquidity or optimizing cross-chain interactions might be needed to ensure that the off-chain innovations translate effectively into these ecosystems.

- Consider Alternative Cross-Chain Solutions

: If off-chain volume is found to impact on-chain liquidity negatively, Uniswap should explore the implementation of alternative cross-chain solutions proposed in the CAKE framework (see references) that do not rely on intent-based mechanisms. By diversifying its approach to cross-chain functionality, Uniswap can mitigate potential risks to on-chain liquidity and maintain a robust and balanced ecosystem.

Future work

While this research provides insights into the potential impact of intent-based protocols on on-chain liquidity, several ways for future research remain open. Expanding the scope of the analysis to include a broader range of blockchains and token pairs would help validate and generalize the findings.

Comparative analyses between the different solutions proposed in the CAKE models and their impact on the Defi landscape would be another valuable area of research. These comparisons could highlight different chain abstraction solutions' relative strengths and vulnerabilities.

Finally, simulations that model the potential impact of full adoption of the ERC-7683 standard across various ecosystems could help anticipate risks and inform the development of mitigation strategies. By pursuing these lines of inquiry, future research can provide a more comprehensive understanding of the challenges and opportunities presented by intent-based protocols in decentralized finance.

(references and acknowledgements below)