Decentralized and Centralized Options Trading: A Risk Premia Perspective

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MOTIVATION

- Growing interest in cryptocurrency options contracts.
  - In July 2023, crypto options trading exceeded $3 trillion in notional value, comprising 69% of total crypto volume.
- Options are traded on:
  - **Centralized Exchanges (CEX):** Limit order-based market.
  - **Decentralized Exchanges (DEX):** Peer-to-peer trading platforms using **Automated Market Making (AMM)** mechanisms.

→ What are the implications of trading options on **DEX vs. CEX**?

KEY FINDINGS

1. **Larger Implied Volatilities** (IVs) **On-Chain:**
   - which increase with maturity and being ATM.
2. Explanation for **Larger On-Chain IVs**:
   - **Trading volume** and **net demand pressure**:
     - Retail investors prefer calls (aligned with Eaton et al., 2023).
   - Multilayered On-Chain fee structure.
3. **Strategy to Exploit IV Differences**:
   - **Profitable net of fees** in some cases.
   - **Linked to investor sentiment** and the price of the LYRA token.
4. Theoretical Justification:
   - **Stoll** (1978) **model rationalized results:**
     - Monopolist AMM vs. multiple risk-averse dealers (CEX).

AMM

- **Trading** through an (options) **AMM**, using a **liquidity pool**,

$$IV_{new,j} \begin{cases} IV_{old,j} + 1\% \text{ pool sells 1 SS} \\ IV_{old,j} - 1\% \text{ pool buys 1 SS} \end{cases}$$

- **Risk Management** of the AMM,
  - **hedges delta** and **vega** exposure by charging **fees** based on trade's impact on overall risk.
  - The final price of the option is then given by:

$$f_t = \underbrace{A \times W}_{BS(IV_{i,j})\text{ option price}} + \underbrace{B \times H \times VU_t + C \times S_t}_{\text{fees from risk management}}$$

DATA

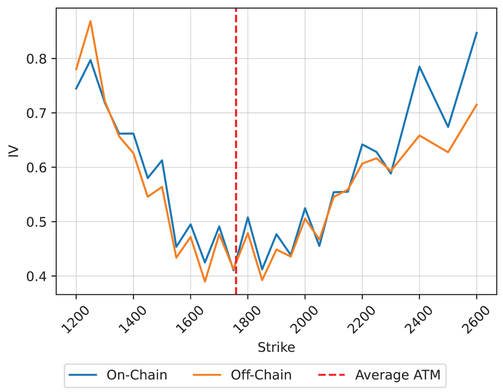
- Analyze a **cross-section of trades** (tick level) and **quotes** (hourly):
  - **European** out-of-the-money (OTM) options,
  - BTC and ETH,
  - **maturities** (7-30 days),
  - **On-Chain** (Lyra V2), **Off-Chain** (Deribit).

RESULTS

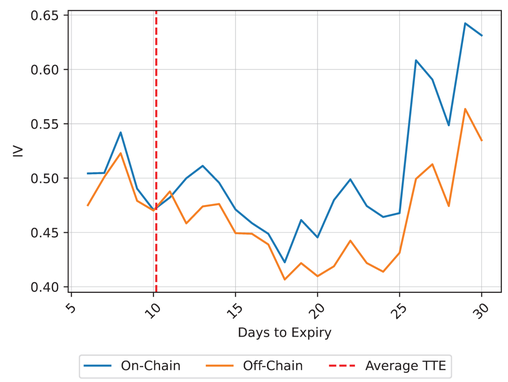
Differences between On-Chain and Off-Chain IVs using key characteristics

- IV begins to **diverge for low and high strike prices** and is widening for **longer maturity** options.

(a) ETH Trades: IV-Strike



(b) ETH Trades: IV-Maturity



On-Chain and Off-Chain vs. option characteristics

$$\text{Diff IV}_{i,t} = \beta_0 + \beta_1 \text{Call}_i + \beta_2 \text{Maturity}_{i,t} + \beta_3 \text{Mness}_{i,t} + \epsilon$$
$$\text{Diff IV}_{i,t} = \beta_0 + \beta_1 \text{Abs. Delta}_{i,t} + \beta_2 \text{Vega}_{i,t} + \epsilon$$

Variable	Diff IV	Diff IV
Intercept	-0.35380	-0.04622
	(0.00000)	(0.00000)
Call	0.01167	
	(0.00000)	
Maturity	0.00194	
	(0.00000)	
Mness	0.36788	
	(0.00000)	
Abs. Delta		0.13586
		(0.00000)
Vega		0.00031
		(0.00000)
Adj. R-squared	0.0843	0.1910
Observations	146438	146438

→ **Difference in IV** tends to increase for **calls, longer-dated** options, and options closer to **ATM**.

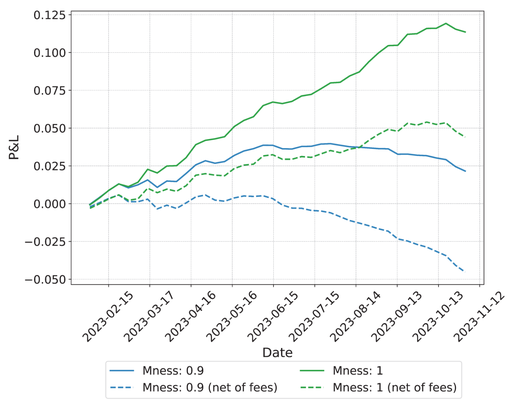
Net buying pressure (NBP) and the option's IV

$$\text{Diff IV}_t = \beta_0 + \beta_1 \text{Underlying Return}_t + \\ + \beta_2 \text{Underlying Volume}_t + \beta_3 \text{NBP}_t + \beta_4 \text{Delta IV}_{t-1} + \epsilon$$

	On-Chain			Off-Chain		
	Call_{q1}	Call_{q2}	Call_{q3}	Call_{q1}	Call_{q2}	Call_{q3}
Variable	Delta IV	Delta IV	Delta IV	Delta IV	Delta IV	Delta IV
Intercept	-0.00000	0.00000	0.00000	0.00000	0.00000	-0.00000
	(1.00000)	(1.00000)	(1.00000)	(1.00000)	(1.00000)	(1.00000)
Underlying Return	0.20923	0.10629	-0.01384	0.18794	0.14044	0.10529
	(0.00062)	(0.12235)	(0.85556)	(0.01728)	(0.05408)	(0.16253)
Underlying Volume	0.14831	0.20361	0.20261	0.18251	0.23946	0.27212
	(0.03731)	(0.00106)	(0.00155)	0.01279)	(0.00028)	(0.00003)
Net Buying Pressure	0.20254	0.17446	0.11149	0.11686	0.07664	0.02076
	(0.00103)	(0.00896)	(0.10900)	(0.01430)	(0.21876)	(0.65818)
Delta IV L1	-0.21543	-0.14118	-0.19513	-0.03295	-0.01458	-0.03800
	(0.00246)	(0.15091)	(0.03951)	(0.56779)	(0.77410)	(0.48544)
Rsquared	0.15	0.10	0.09	0.10	0.10	0.09
Rsquared Adj	0.14	0.08	0.07	0.09	0.09	0.08
Nobs	218	231	217	280	314	314

→ **Changes in IV** are directly linked to **NBP from public order flow**.

Trading strategy - Buy 1 Off-Chain option and sell 1 On-Chain Option



→ Without fees ≈ 0.01 ETH/month profit,
→ With fees profit at least halves.

	Call		Put	
Variable/Days	7	15	7	15
LYRA	537.1840	-1304.7638	361.9476	2098.1037
	(0.010)	(0.259)	(0.000)	(0.012)
TxGrowth	-0.0000	0.0001	0.0000	-0.0001
	(0.136)	(0.146)	(0.353)	(0.205)
# Contracts	-0.0494	0.3492	-0.0443	-0.4930
	(0.557)	(0.255)	(0.200)	(0.040)
FearGreed	-0.2818	-0.8912	-0.1999	0.2921
	(0.041)	(0.152)	(0.010)	(0.538)
Rsquared	0.48	0.21	0.66	0.54
Rsquared Adj	0.42	0.12	0.62	0.48
Nobs	39.00	39.00	38.00	39.00

→ **Profitability rises** with **LYRA price**, reflecting future protocol profits.
→ **Profitability increases** with negative **cryptocurrency sentiment** (fear), higher On-Chain trading compensation.

THEORETICAL EXPLANATION

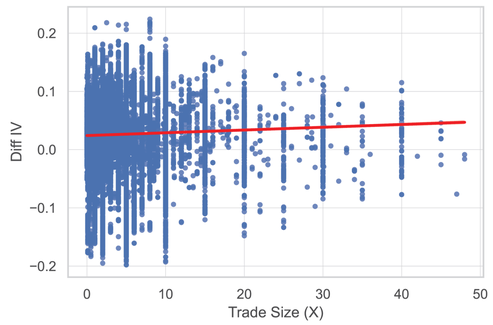
- **Adapting Stoll** (1978) **model with inventory**.
- **DEX/AMM: Monopolistic dealer** offers immediate liquidity.
- **CEX:** LOB with M **risk-averse dealers**.
- We show that the price On-Chain excess the price Off-chain if:

$$p_{DEX} \geq p_{CEX} \Leftrightarrow x \geq \left(W_0 + \frac{1}{2} I - \bar{I}\right) \frac{2M}{M-2} \coloneqq \text{Lower Bound}$$

Empirical Investigation:

set $x = x_{AMM} = x_{CEX}$, select trades at the same time with similar size to conduct empirical investigation.

- **Larger difference in IV** for larger **trade size** (Lower Bound).
- Regression confirms visual evidence:



CONCLUSIONS

1. **On-Chain options** provide a decentralized way to trade options.
2. On-Chain options have **higher IVs**,
   - which increase with **maturity** and proximity to being **ATM**.
   - A profitable trading strategy that captures this difference (profitable net of fees only in some cases).
3. We explain the **difference between On-Chain and Off-Chain IVs**:
   - fee structure, **trading volume**, and **net buying pressure**.
   - NBP is more relevant for On-Chain calls (as compared to Off-Chain).
4. **Theoretical explanation** rationalizes the results
   - larger difference in IV for larger trade size.

Many more results in the paper!

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