SIMULATED AMMs

Under Chaotic Scenarios

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SIMULATOR ARCHITECTURE

Uniswap v2 - Constant Product Market Maker

Robust pioneer AMM, but with high slippage on large trades

Formula:

$x \cdot y = k$

Constant Sum Market Maker

A linear model optimized for equal-value assets like stablecoins, but catastrophically unstable for volatile pairs

Formula:

$x + y = k$

Curve StableSwap

A hybrid approach blending both formulas to achieve low slippage near price parity while maintaining stability

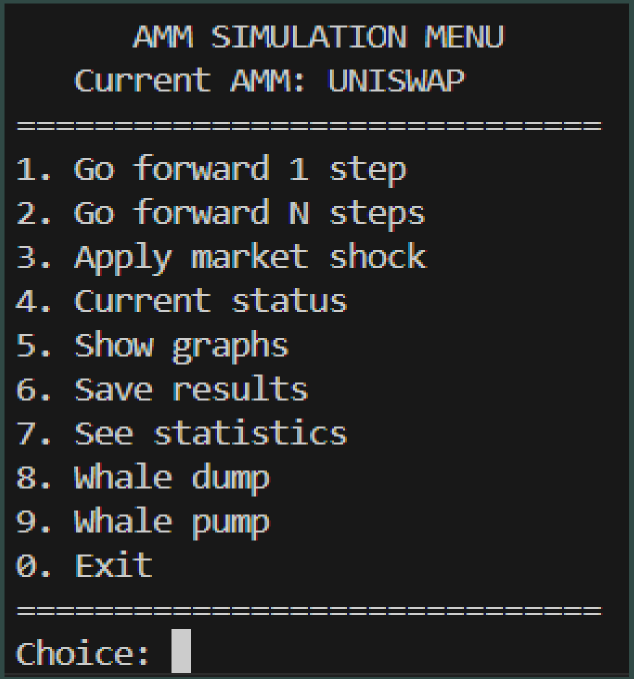
Formula (simplified):

$k = (x \cdot y)^{\alpha} \cdot (x + y)^{1-\alpha}, \ \alpha = \frac{A}{A+1}$

MARKET AGENTS

Retail Trader	Smart Traider	Arbitrageur	Liquidity Provider	Whale Trader
Performs random buy/sell actions based on the available wallet balance	*Avoids trades with excessive slippage*	*Acts as the market’s stabilizer*	*Introduces fragility to the system*	*Capable of moving the market with a single action*

SIMULATION DYNAMICS



Main CLI

The Main Interface (main.py)

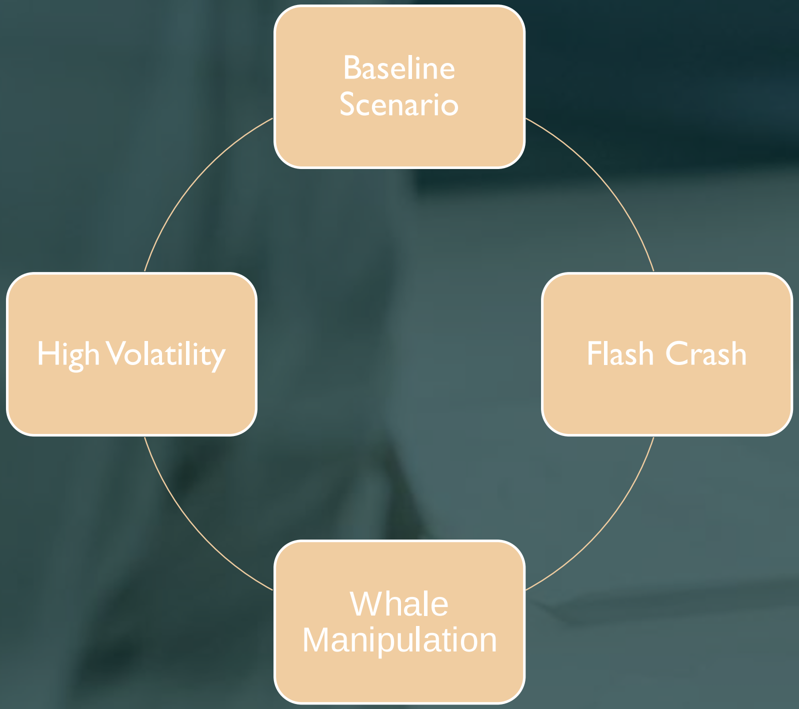
Provides a Command Line Interface (CLI) that gives the user full control on the market via a simple text menu.

The Simulation Class (run simulation.py)

Initialize the markets and execute the full simulation lifecycle, while recording data for analysis.

EXPERIMENTAL DESIGN

We designed four distinct stress-testing scenarios to evaluate our AMMs



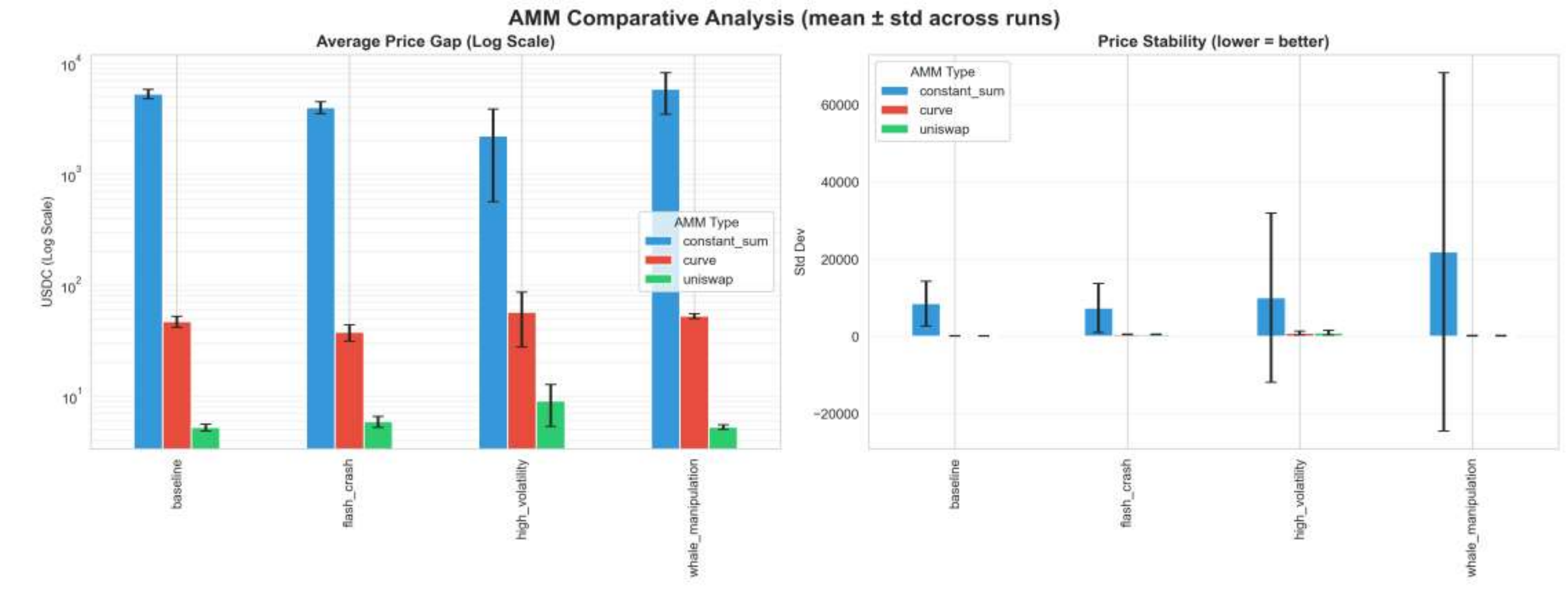
Baseline Scenario	Flash Crash	Whale Manipulation	High Volatility
Simulates normal market condition	Simulates a sudden 50% price drop	Executes large-scale pump-and-dump trades	Simulates prolonged market chaos by applying sustained extreme volatility

METRICS

Price Gap	Price Stability	Arbitrageur Profit	LP Panic Events	k Growth
• Divergence between AMM and market price	• Standard deviation of AMM price	• Total gains from price corrections	• Frequency of liquidity withdrawals	• Fee accumulation rate (pool health)

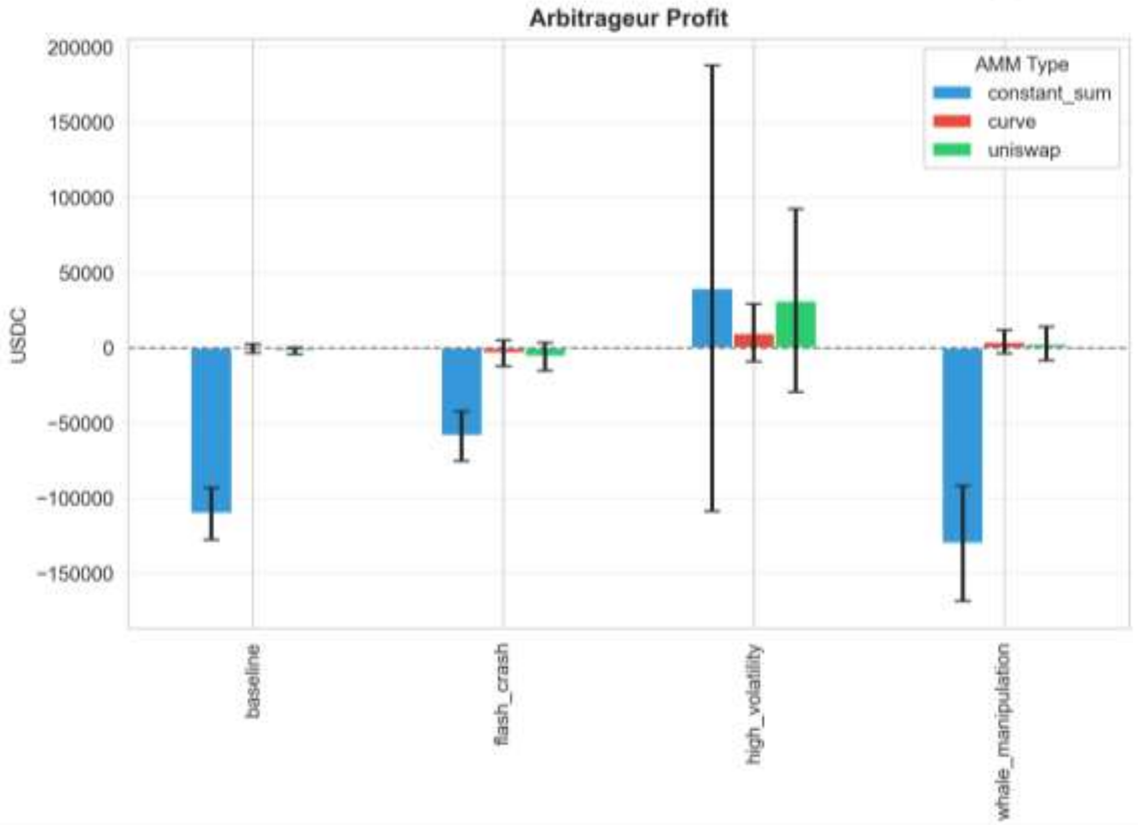
RESULTS

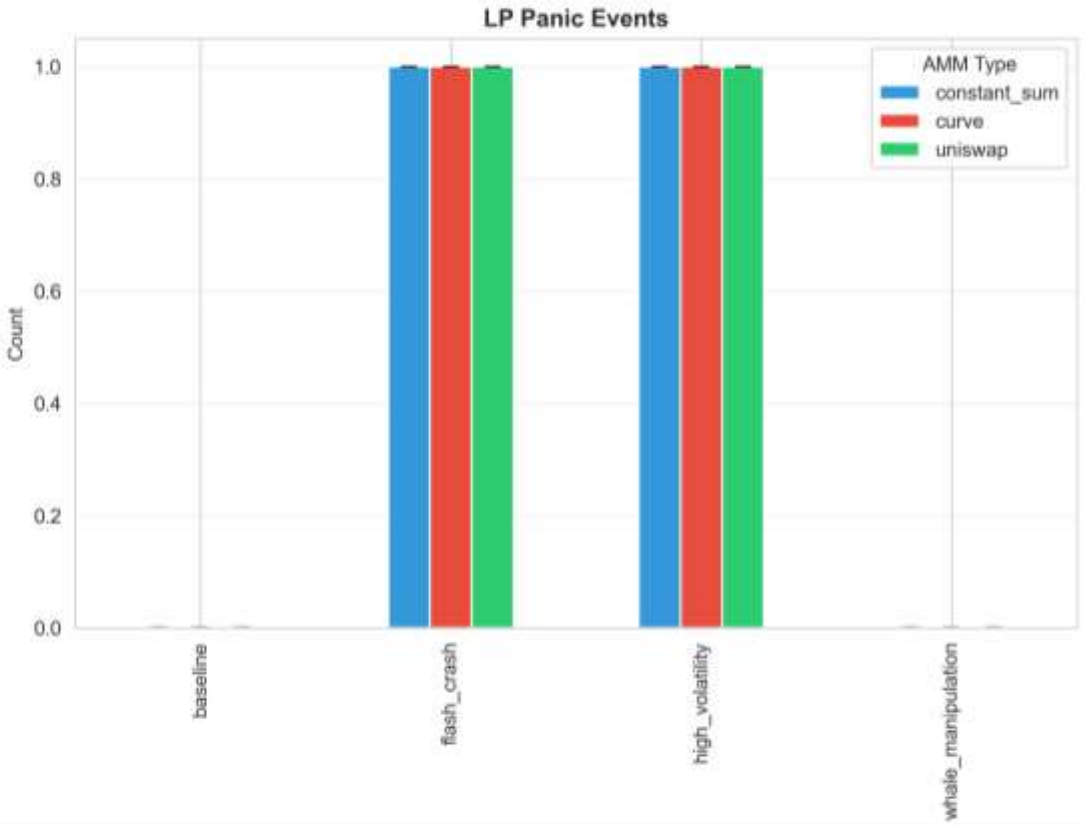
AMM Comparative Analysis



RESULTS

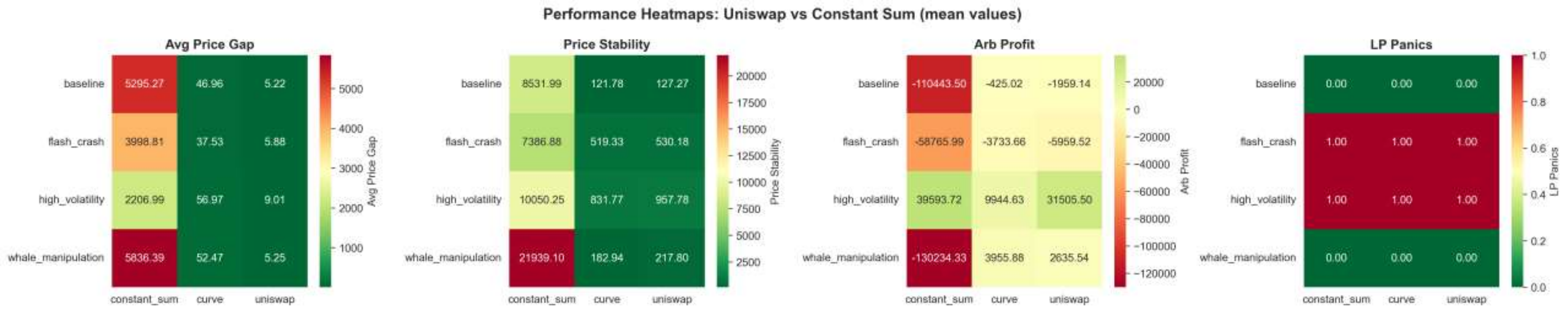
AMM Comparative Analysis





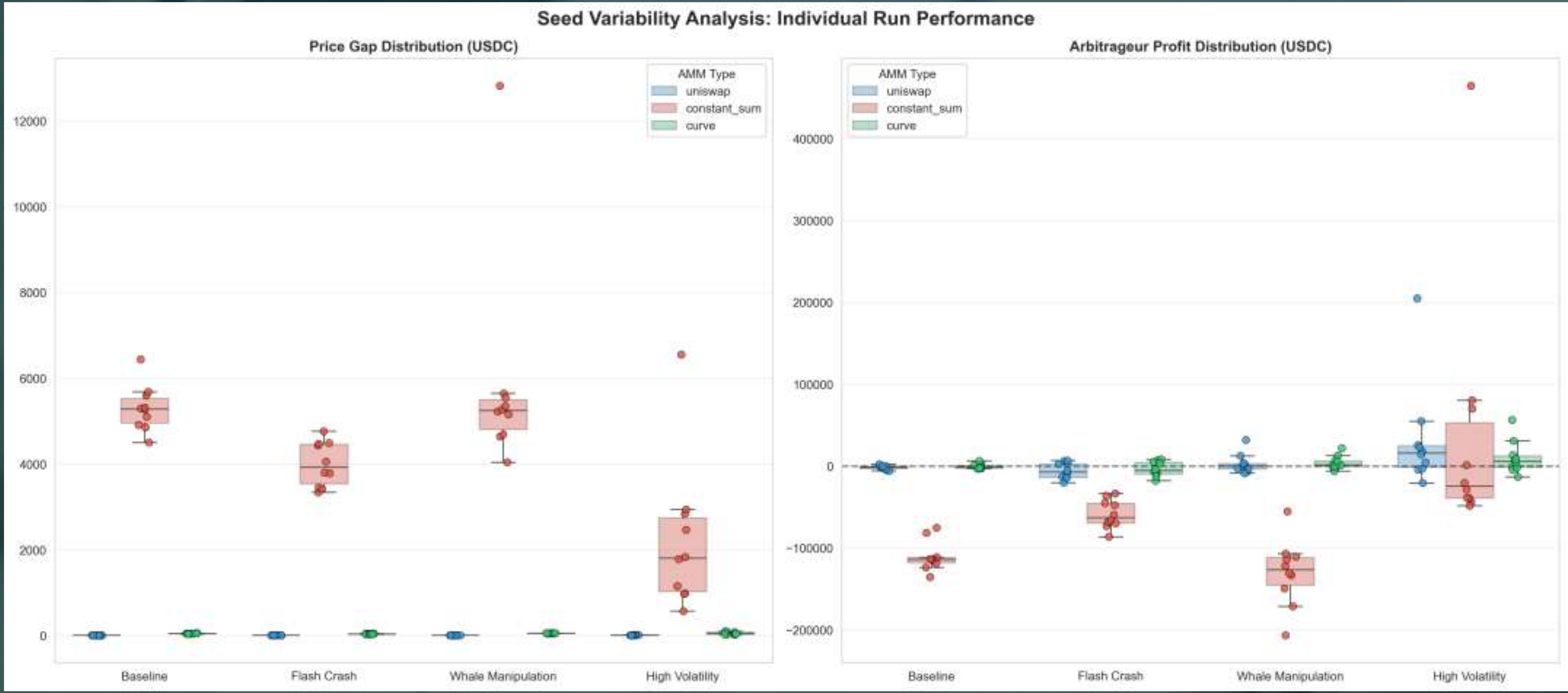
RESULTS

Performance Heatmap



RESULTS

Variability Analysis



CONCLUSIONS

Uniswap v2

- Best for Volatile Pairs
- Lowest price gaps across all scenarios
- Consistent arbitrage opportunities

Curve Stableswap

- Moderate Efficiency
- Price gaps 9× worse than Uniswap, but 113× better than CSMM
- Consistent arbitrage opportunities

Constant Sum

- Catastrophic Failure
- Price gaps 1014× worse than Uniswap
- High instability
- Inconsistent arbitrage opportunities

Thank you!

- *Alessandro Tricca*
- *Jonathan Cerullo Uyi*