

Market Report: Ecosystem Integration and Emergent Behavior

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Section 1 — Experimental Setup

All experiments were conducted under **identical market structure and simulation parameters**. Only the **agent composition** was varied across scenarios.

Common Parameters

- **Simulation length:** 500 time units
- **Random seed:** 42
- **Tick size:** 1
- **Snapshot interval:** 1.0
- **Latency model:** Exponential (mean = 1.0)
- **Matching engine:** Price-time priority
- **Reference price:** Mid-price from L1 book
- **Fair value process:** Random walk ($\sigma = 0.5$)

Agent Types

Agent Type	Description
Noise Trader	Zero-intelligence trader using market and aggressive limit orders
Market Maker	Posts bid and ask quotes with inventory-dependent skew
Momentum Trader	Trend-following agent using SMA crossover

Scenario Definitions

Scenario A — Noise Traders Only

- 3 Noise Traders
- Arrival rate: 1.2 each

Scenario B — Noise + Market Maker

- 3 Noise Traders (arrival rate 1.2)
- 1 Market Maker (arrival rate 0.5)

Scenario C — Noise + Momentum

- 2 Noise Traders (arrival rate 1.2)
- 2 Momentum Traders (arrival rate 1.0)

Section 2 — Scenario Results

For each scenario, the following were plotted over the **same time horizon and price scale**:

- **Top panel:** Mid-price time series
- **Bottom panel:** Bid–ask spread

(See `market_report.pdf`)

Scenario A — Noise Traders Only

Observed dynamics

- Price follows a near-random walk
- Spread is wide and highly unstable
- Frequent temporary liquidity gaps
- No persistent anchoring of price

Key observation

There is **activity but no structure**. Liquidity exists only when random orders coincide.

Scenario B — Noise + Market Maker

Observed dynamics

- Spread is consistently tighter
- Price fluctuations are damped
- Book remains resilient to order flow
- No large discontinuities

Key observation

Liquidity provision stabilizes both **price** and **execution cost**.

Scenario C — Noise + Momentum

Observed dynamics

- Clear trend formation
- Volatility clustering
- Spread widens during strong trends
- Sharp reversals occasionally occur

Key observation

Positive feedback loops dominate when liquidity is not adaptive.

Section 3 — Comparative Analysis

Summary Statistics

Scenario	Avg Spread	Volatility
Noise Only	High	Moderate
Noise + MM	Lowest	Lowest
Noise + Momentum	Elevated	Highest

(Exact values printed by `market_report.py`)

Key Comparisons

- **Spread:** Scenario B < Scenario A < Scenario C
- **Volatility:** Scenario C > Scenario A > Scenario B
- **Liquidity resilience:** Present only when market makers are active

Section 4 — Interpretation

Liquidity Provision

Market makers continuously supply **both sides of the book**, converting random order flow into predictable execution prices. This compresses spreads and dampens volatility without predicting price direction.

Feedback Loops

- Momentum traders amplify trends by reinforcing recent price moves
- This creates **endogenous volatility**, not noise
- When combined with insufficient liquidity, this leads to instability

Inventory Risk & Stability

Market makers absorb order flow **at the cost of inventory risk**. Inventory-based quote skew prevents runaway exposure and enables continuous participation.

Without this mechanism:

- Liquidity vanishes
- Spreads explode
- Price becomes discontinuous

Final Conclusion

- Noise traders provide activity
- Market makers provide stability
- Momentum traders provide amplification