

# Computer-Implemented Systems for Dynamic Equilibrium Detection in Algorithmic Markets: A Ljungqvist-Sargent Recursive Framework

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## Abstract

Disclosed are methods and systems for identifying, quantifying, and stabilizing recursive equilibrium states within algorithmically mediated financial markets, such as cryptocurrencies or equities. The framework implements Ljungqvist-Sargent recursive equilibrium (LSRE) logic in conjunction with volatility damping routines and high-frequency liquidity diagnostics to dynamically detect self-reinforcing price thresholds. Applications include stock exchange systems for real-time order entry, equilibrium detection, and hedge adjustment, as well as cryptocurrency exchanges requiring equilibrium detection systems compatible with recursive macroeconomic theories.

## 1 Technical Field

The present disclosure relates to systems and methods for managing financial order flows. Specifically, it relates to dynamic equilibrium identification and stability assessment using recursive macroeconomic logic applied to cryptocurrency markets and analogous digital asset infrastructures.

## 2 System Overview

A computer-implemented system comprising:

- One or more modules for real-time price monitoring within a bounded range,
- An LSRE computation engine leveraging volatility and margin ratio inputs,
- A liquidity clustering detector identifying resistance and support levels,
- Gamma exposure module quantifying dealer hedging saturation points,
- Bayesian adjustment module for evaluating informed versus noise trading ratios.

This architecture facilitates a dynamic recursive trap between 104,200 and 104,500 in the presence of suppressed implied volatility.

### 3 Order Flow Toxicity and Algorithmic Liquidity Provision

The system is configured to:

- Detect toxic orders based on skewed bid/ask replenishment patterns.
- Calculate microprice gradients based on real-time book imbalance.
- Adjust hedge positions in response to gamma compression zones and realized volatility decay.

Mathematically, equilibrium detection is based on:

$$\text{Microprice} = \frac{\text{Bid} \cdot \text{AskSize} + \text{Ask} \cdot \text{BidSize}}{\text{BidSize} + \text{AskSize}} \quad (1)$$

## 4 Rigorous Mathematical Analysis

In this section, we present a theoretical framework to analyze the Ljungqvist-Sargent Recursive Equilibrium (LSRE) pegged at a lower bound equilibrium of 104,200 and 104,500 on 2025-06-06. The goal is to help others in similar market conditions analyze what phenomena to expect numerically given these oscillations.

### 4.1 Theoretical Framework

We define the recursive equilibrium as follows:

$$F(x'(t), x(t), u(t)) = 0 \quad (2)$$

where  $x(t)$  is the state variable and  $u(t)$  is the control variable.

The lower bound equilibrium is given by:

$$P_t \geq 104,200 \quad \text{if} \quad \sigma_t \leq 0.38 \quad \text{and} \quad \frac{\partial y_t}{\partial t} < 0 \quad (3)$$

The upper bound equilibrium is defined as:

$$P_t \leq 104,500 \quad (4)$$

The system is expected to stabilize within the recursive band  $[104,200, 104,500]$  under the condition of suppressed volatility and dynamic hedge adjustment mechanisms.

## 4.2 Projection of Asset Movement

Given a drop from a 105,200 commodity price high earlier on 2025-06-06, the system predicts the following:

- Stabilization within the band as

$$P_t \in [104,200, 104,500]$$

- Anticipated volatility suppression with  $\sigma_t \leq 0.38$ .

**\*\*Proof of Expected Price Movement:\*\***

Assume an initial price drop from a high  $P_0 = 105,200$  to  $P_t = 104,200$ . The price movement can be modeled by the differential equation:

$$\frac{dP_t}{dt} = -k(P_t - P_{\min}) \quad (5)$$

where  $k > 0$  is a damping constant representing the market's resilience to volatility.

Solve the differential equation:

$$P_t = P_{\min} + (P_0 - P_{\min})e^{-kt} \quad (6)$$

Given  $P_0 = 105,200$  and  $P_{\min} = 104,200$ , the equilibrium will be maintained as long as  $P_t$  remains in the interval  $[104,200, 104,500]$ .

## 5 Trading Infrastructure Applications

Applications span:

- Stock exchange systems for real-time order entry, equilibrium detection, and hedge adjustment.
- Cryptocurrency exchanges requiring equilibrium detection systems compatible with recursive macroeconomic theories.
- Derivative exchanges modeling gamma risk clusters and stability zones.