Distinguishing Between Transient and Information-Driven Liquidity Reactions in Foreign Exchange Markets: An Integrated Microstructure Approach

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Abstract:

The $9.6T foreign exchange market [1] struggles with transient liquidity shocks that mask genuine information-driven economic signals, complicating the process of price discovery and liquidity provision worldwide—a cornerstone of today's financial world. The research paper investigates whether limit order book imbalances, combined with dynamic ACD-TVP modeling, can classify sustained information shocks versus transient liquidity noise in FX markets. The approach first identifies high-activity periods through trade timing patterns, then measures if price impacts persist or revert. The objective is to advance information asymmetry theory while providing institutional traders and regulators with a practical tool for real-time shock classification in global FX markets.

Introduction:

The foreign exchange market powers global capital allocation through efficient price discovery [1]. At high-frequencies, however, price formation becomes increasingly unreliable due to the inability to distinguish transient liquidity shocks from persistent information-driven price movements. This distinction is not simply theoretical. Misclassifying noise as information can lead institutional traders to allocate capital based on noise-induced signals and cause regulators to overestimate volatility and systemic risk, with empirical evidence proving microstructure noise can bias volatility estimates by up to 30–50% [2]. This leads to price failing to perform its role in efficient global resource allocation. Moreover, inflated volatility from microstructure noise distorts risk assessment and regulation, causing imbalances in financial stability and the reliability of price discovery [8][2].

The challenge of distinguishing liquidity-driven activity from information-based price changes lies at the core of market microstructure theory. Early dealer-based bid-ask models emphasized inventory costs and asymmetric information but didn't account for high-frequency dynamics [3][5]. Subsequent advances introduced more granular approaches. Duration-based models, particularly the Autoregressive Conditional Duration (ACD) framework, captured clustering in trade arrivals and provided deeper insights into heightened periods of information flow [10]. Occurring in parallel, order flow based research demonstrated that imbalances in market volume contain predictive power for short-term price movements, reflecting shifts in supply and demand at the limit order book level [6][8][9]. More recently, time-varying parameter (TVP) models have extended these insights by allowing price impact to evolve across different market regimes [7]—periods characterized by distinct liquidity and volatility states in which identical order flow can have different impacts on price movement.

Despite these developments, existing approaches are carried out in isolation. Order flow imbalance captures directional pressure but not persistence, duration models identify clustering without measuring price impact, and time-varying frameworks track dynamic market conditions without classifying the nature of shocks. Because of this, high-frequency systems often misinterpret transient liquidity shocks as meaningful information [2]. This research addresses this gap by proposing a unified framework that integrates these dynamics to classify foreign exchange shocks as either transient or information-driven.

Literature Review:

Current exchange rate microstructure centers on order flow imbalance. Evans-Lyons (2002) [8] shows that order flow explains 30-60% of returns, while Cont et al. (2014) [9] demonstrates that OFI (net signed volume at best levels) linearly predicts price impact. However, these approaches focus on immediate price response and do not classify whether such impacts persist over time. Duration models complement this by offering trade timing: Engle-Russell's ACD [10] captures trade arrival clustering which signals information intensity, but does not directly measure resulting price dynamics.

Time-varying parameter models extend this analysis by showing the effect of order flow on price changes depending on market conditions. Primiceri (2005) introduced TVP frameworks for non-static dynamics, while Ait-Sahalia and Yu (2009) show how microstructure noise can significantly bias volatility estimates. These developments build on the Glosten-Milgrom framework of asymmetric information, where informed trading is what drives significant price formation. Recent research extends high-frequency microstructure modeling through improved order flow prediction [12][13], but remains focused on forecasting rather than explicitly distinguishing informative price mechanics from transient ones.

Methodology:

1. **Data and Preprocessing**: This study utilizes DukaScopy tick data for EUR/USD from January 2024 to March 2026. Data preprocessing proceeds in three stages. First, extreme returns are filtered using a rolling 1-hour standard deviation threshold $[(|r_t| \geq 3\sigma)]$ to remove tail data. Second, duplicate and irregular ticks should be identified and removed. Third, the dataset is restricted to the top 1% of hourly trading sessions by volume to focus on periods of meaningful market activity, ensuring that the proceeding analysis can capture genuine microstructure dynamics rather than illiquid noise.
2. **Event Triggers**: Candidate shocks identified via two criteria designed to isolate periods of both directional pressure and information intensity. Only observations satisfying both conditions are classified as candidate shocks.
    - **a.** Order Flow Imbalance: Events where OFI exceeds the 95th percentile, built with the formal definition of Cont et al. (2014) [9]. This captures the periods of significant directional supply-demand imbalances
    - **b.** Trade Clustering: Events where inter-trade duration falls below the sample median based on the ACD framework of Engle and Russell (1998) [10]
3. **Persistence estimation**: For each event window (approx. 60 seconds to allow analysis of short-term price adjustments) fit the post-shock mid-price path with an exponential decay specification measured by: $e^{-\lambda_t}$ [11]. This measures whether the shock dissipates quickly or persists
4. **Classification Metric:** To formally create a distinction between transient and informational shocks, a weighted persistence metric is constructed:
    - a. Each post-event price change (ΔP□) is weighted by the exponential decay factor. This assigns greater importance to sustained movements.
    - b. The weighted sum of price changes is normalized by total absolute price movement to only capture growth of the movement. This yields the classification statistic below, where $p_t \in [0, 1]$ and a higher value suggests an information-driven shock:

$$p_t = \frac{\sum_{k=1}^{60} |\Delta P_k \times e^{-\lambda_t k}|}{\sum_{k=1}^{60} \left|\Delta P_k\right|}$$

Limitations:

This framework depends on a threshold-based event definitions and a fixed post-shock window, which may introduce sensitivity to parameter choices and fail to capture longer-term impacts. Moreover, it is insensitive to external macroeconomic factors that play a role in sudden volatility changes. To address this, as an extension identified shocks can be cross-checked with macroeconomic announcements.

Conclusion:

This study addresses a central problem in FX microstructure: distinguishing permanent, information-driven price movements from temporary liquidity shocks. The proposed methodology offers a unified way to classify market events that earlier were approached separately. Using Dukascopy tick data to reconstruct limit order book features for feasibility, and combining order flow imbalance, trade arrival intensity, and quantifying post-shock price persistence, the method is designed to capture both the immediate pressure of the liquidity interaction along with the extent to which the stock shapes further price action. The resulting metric not only advances the understanding of information asymmetry in modern FX markets but also improves the level at which high-frequency price dynamics can be interpreted.

Work Cited

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