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Market Microstructure Metamorphosis:

The Structural Reduction of High-Frequency Noise in Nifty 50 Futures (2022–2025)

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Executive Summary

The microstructure of the Indian equity derivatives market as represented by the benchmark Nifty 50 futures contracts, has historically been viewed through the lens of volume and open interest, the metrics that capture the magnitude of activity but fail to articulate its quality. Between January 2022 and March 2025, this market underwent a profound structural transformation, a metamorphosis characterized by a decisive regime shift from a high-frequency, noise-dominated environment to a state of prolonged stability and calmness.

This research report presents an exhaustive analysis derived from a Markov Switching Autoregressive (MS-AR) model applied to tick-by-tick Limit Order Book (LOB) dataset of 15.6 million entries spanning 38 months (779 trading days). The analysis reveals that the "Noise" regime, historically the dominant state accounting for nearly 66% of market duration in mid-2023, collapsed to under 28% by the first quarter of 2025. This quantitative shift is not a stochastic anomaly but the direct, causal consequence of a concerted regulatory overhaul by the Securities and Exchange Board of India (SEBI), which dismantled the economic incentives for high-frequency "noise" through three specific interventions: the crackdown on algorithmic manipulation (Jane Street), the restructuring of transaction charges ("True to Label"), and the recalibration of contract specifications (Lot Sizes).

We observe that this transition introduces a new, latent risk profile. While the optical stability of the market has improved, the analysis uncovers the persistence of a "Static" regime, a state of liquidity drought, suggesting that the withdrawal of high-frequency intermediaries has left the market with a "hollow middle." This report introduces the concept of **"Quiet-Risk"** and proposes a comprehensive **Regime-Based Regulatory Dashboard** to monitor market resilience in this new era.

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Table of Content

Introduction: The Market Microstructure Context 5

1.1 The Limitations of Traditional Metrics 5

1.2 The Methodological Pivot: MS-AR Modeling 5

1.3 The Data Universe 6

Quantitative Analysis: The De-Noising of the Nifty50 7

2.1 The Era of Algorithmic Saturation (2022–2023) 7

2.2 The Structural Break (2024–2025) 8

2.3 Regime Switching Intensity Analysis 8

Regulatory Action: The "Why" Behind the "What" 10

3.1 The Algorithmic Crackdown: The Jane Street Saga (April 2024) 10

3.2 The Economic Disincentive: "True to Label" (October 2024) 10

3.3 The Capital Barrier: Lot Sizes and STT (November 2024) 11

Risk Analysis: The Emergence of "Quiet-Risk" 12

4.1 Defining Quiet-Risk 12

4.2 The "Hollow Middle": Analysis of the Static Regime 12

4.3 Transition Asymmetry and Volatility 13

The Regime-Based Regulatory Dashboard 14

5.1 Dashboard KPIs 14

5.2 Action Plan for Regulators 15

Conclusion 16

Appendix 1 – Discussion on Methodology 17

Appendix 2 – Additional Results 18

Research papers cited 21

1. Introduction: The Market Microstructure Context

Modern financial markets can be viewed as physical systems governed by the laws of latency, information flow, and order book dynamics. In the context of the National Stock Exchange (NSE) of India, the Nifty 50 futures contract is the gravitational center of the derivatives ecosystem, serving as the primary instrument for risk transfer across the Indian economy.1 For nearly a decade, the microstructure of this instrument was defined by the dominance of High-Frequency Trading (HFT) algorithms, creating a market texture defined by speed, fleeting liquidity, and noise.

1.1 The Limitations of Traditional Metrics

Traditionally, market quality has been assessed using linear metrics:

- **Traded Volume:** The total number of contracts exchanged.
- **Bid-Ask Spread:** The cost of execution.
- **Open Interest (OI):** The depth of capital commitment.

While useful, these metrics are aggregated snapshots that smooth out the chaotic reality of the order book. They fail to distinguish between "healthy" volume (informed trading) and "toxic" volume (latency arbitrage or quote stuffing). A market with tight spreads but low persistence (where quotes vanish when aggressive orders arrive) is fragile, yet it may appear robust under traditional analysis. To understand the true evolution of the Nifty 50 market, one must deconvolute these dynamics into discrete states or regimes.

1.2 The Methodological Pivot: MS-AR Modeling

In order to analyze the regime driven market, this study departs from monolithic econometric approaches in favor of a Markov Switching Autoregressive (MS-AR) framework. This model assumes that the financial market is not a continuous, singular entity, but rather a system that switches between unobservable (latent) states based on probabilistic transitions.

The MS-AR model processes the "heartbeat" of the LOB i.e. the order arrival rates, cancellation speeds, and price variances to classify every timestamp of trading into one of four distinct regimes. This classification allows for a granular reconstruction of market behavior that reveals the underlying "texture" of liquidity. Refer Appendix 1 for discussion on Methodology.

1.2.1 The Four Regimes of Nifty 50

The analysis identifies four distinct states that govern the Nifty 50 LOB:

1. The Noise Regime (High Frequency, Low Information):

- **Characteristics:** Extremely short duration (Average ~1.6 to 2.1 seconds). High switching intensity.
- **Microstructure:** This state represents the "flickering" of the order book. It is dominated by HFT algorithms engaging in quote stuffing, latency arbitrage, and rebate harvesting. Quotes in this regime are "ephemeral"—they exist to probe depth or capture rebates rather than to provide genuine liquidity.
- **Role:** Historically, this was the "background radiation" of the market, accounting for the vast majority of order book updates.

2. The Calm Regime (Stability and Equilibrium):

- **Characteristics:** Long duration (Average ~12–15 seconds in daily activity, with aggregated persistence reaching thousands of seconds).
- **Microstructure:** A state of stable equilibrium where the bid-ask spread is steady, and liquidity replenishment matches consumption rates.
- **Role:** This represents the "healthy" state of the market, where institutional orders can be executed with minimal impact cost.

3. The Volatile Regime (Shock Absorption):

- **Characteristics:** Moderate duration (Average ~35–92 seconds). High variance in price and order flow.
- **Microstructure:** Periods of rapid price discovery, usually triggered by exogenous information (news, macro data) or large aggressive orders walking the book.
- **Role:** The market's mechanism for incorporating new information.

4. The Static Regime (Liquidity Drought):

- **Characteristics:** Moderate duration (~47 seconds) but low activity.
- **Microstructure:** A "frozen" order book with widened spreads and minimal updates.
- **Role:** Often a precursor to volatility or a symptom of uncertainty, representing a withdrawal of liquidity providers.

1.3 The Data Universe

The quantitative backbone of this report is a longitudinal dataset spanning **779 trading days from 2022Q1 to 2025Q1.** This dataset has been aggregated into quarterly "Regime Probabilities" (Duration and Count percentages) and daily summaries to allow for both trend analysis and event-study impact assessment.

2. Quantitative Analysis: The De-Noising of the Nifty50

The empirical data presents a story of two markets. The first, spanning 2022 and 2023, was a hyper-active, noise-saturated ecosystem. The second, emerging in 2024 and solidifying in 2025, is a structurally altered landscape defined by calm persistence.

2.1 The Era of Algorithmic Saturation (2022–2023)

During the first two years of the study, the Nifty 50 futures market effectively functioned as a "noise engine." The incentives inherent in the market structure favored high-frequency quote updates over duration.

2.1.1 The Dominance of Noise

In **Q2 2023,** the dominance of the Noise regime reached its historical apex.

- **Duration Share:** Noise regime accounted for **66%** of the total trading time.
- **Frequency Share:** Noise regime accounted for **96%** of all regime counts.

This implies that for two-thirds of the trading day, the order book was in a state of rapid flux, with the average state lasting barely 2 seconds before switching. This "flickering" was not incidental; it was the primary mode of existence for the market.

Table 1: Noise at its Peak (2022–2023)

Quarter	Noise Duration %	Calm Duration %	Static Duration %	Volatile Duration %	Market State
2022 Q1	44.66%	33.95%	6.10%	15.29%	Early Noise
2022 Q2	37.07%	34.51%	9.94%	18.48%	Balanced
2022 Q3	51.50%	31.97%	4.99%	11.54%	Noise Acceleration
2022 Q4	64.82%	19.51%	6.14%	9.53%	Side/Noise Dominant
2023 Q1	59.12%	23.10%	4.52%	13.25%	High Noise
2023 Q2	**66.09%**	**14.53%**	**10.96%**	**8.41%**	**Peak Saturation**

Source: Derived from MS-AR Output Analysis

The data in Table 1 illustrates a clear trend: liquidity provision was becoming increasingly ephemeral. By mid-2023, the "Calm" duration had shrunk to just 14.53%, suggesting that finding a stable price for execution was becoming increasingly difficult despite high nominal volumes. The high percentage of "Static" duration in Q2 2023 (10.96%) alongside Peak Noise suggests a polarized market: either frenetic HFT activity or complete silence, with little middle ground.

2.1.2 The Mechanics of Flickering

The short average duration of the Noise regime (ranging from **1.63s to 2.12s**) points to specific HFT strategies:

1. **Layering/Spoofing:** Placing non-bona fide orders on one side of the book to create the illusion of pressure, then cancelling them before execution.
2. **Latency Arbitrage:** Racing to update quotes based on price changes in the underlying cash market or correlated indices (Bank Nifty).
3. **Rebate Harvesting:** Maximizing turnover to hit exchange volume tiers for transaction fee discounts.

2.2 The Structural Break (2024–2025)

The trajectory of the market changed violently in 2024. The data reveals a non-linear structural break where the Noise regime did not just recede; it collapsed.

2.2.1 The Collapse of Noise

Starting in **Q2 2024**, the Noise regime began a precipitous decline that continued unabated for four consecutive quarters.

- **Q1 2024:** Noise Duration held steady at **61.53%**, maintaining the status quo of the previous years.
- **Q2 2024:** A massive drop to **41.99%** - a decline of nearly **20 percentage points** in a single quarter.
- **Q3 2024:** Further decline to **30.91%.**
- **Q1 2025:** The Noise regime hit a historical low of **27.68%.**

Table 2: The Structural Break (2024–2025)

Quarter	Noise Duration %	Calm Duration %	Static Duration %	Volatile Duration %	Trend
2024 Q1	61.53%	16.45%	7.55%	14.47%	Pre-Reform Baseline
2024 Q2	**41.99%**	**33.43%**	**9.67%**	**14.91%**	**The Break**
2024 Q3	30.91%	38.36%	10.50%	20.23%	Stabilization
2024 Q4	30.67%	41.20%	8.30%	19.84%	Bear Market Context
2025 Q1	**27.68%**	**47.48%**	**7.17%**	**17.67%**	**New Equilibrium**

Source: Derived from MS-AR Output Analysis

This collapse is statistically significant. The probability of the market being in a "Noise" state dropped by more than half (from ~66% to ~27%) over the course of 18 months.

2.2.2 The Asymmetric Rise of Calm

It was observed that the time liberated from the Noise regime was reallocated primarily to the **Calm Regime.**

- **Calm Duration (Q1 2024):** 16.45%.
- **Calm Duration (Q1 2025):** 47.48%.

This near-tripling of the Calm duration signifies a fundamental change in market character. Orders are sitting in the book longer. The "Avg_Dur" (Average Duration) of the Calm regime, which averages ~939 units in aggregate quarterly data, indicates a robustness that was previously absent. The market has moved from a state of "frenetic liquidity" to "persistent liquidity."

2.3 Regime Switching Intensity Analysis

A critical derivative metric is "Regime Switching Intensity" - the frequency with which the market flips between states. High intensity is a proxy for microstructure stress and uncertainty.

- **2022 Intensity:** On dates like January 3, 2022, the market recorded **6,927** total switches per day.
- **2025 Intensity:** By Q1 2025, the total quarterly count of switches was **103,410,** the average daily switching intensity dropped to **~2,462 switches/day.**

Conclusion: The market has physically slowed down by a factor of roughly **3x** (from ~6,900 to ~2,462 switches/day). This massive reduction in "churn" confirms that the decline in Noise is an absolute reduction in algorithmic interactions, not just a relative statistical artifact.

3. Regulatory Action: The "Why" Behind the "What"

The timeline of the "Noise Collapse" (starting Q2 2024) and the "Calm Rise" (solidifying Q4 2024) perfectly aligns with three "surgical strikes" executed by SEBI.

3.1 The Algorithmic Crackdown: The Jane Street Saga (April 2024)

The Event: In April 2024, a legal dispute between global quant giants Jane Street and Millennium Partners inadvertently revealed the mechanics of a proprietary trading strategy used in Indian options markets.

The Strategy:

Jane Street was allegedly employing a cross-market arbitrage strategy that involved:

1. **Intra-day Index Manipulation:** Aggressively buying/selling cash components (Nifty/Bank Nifty stocks) to move the index level.
2. **Options Leverage:** Profiting from the delta/gamma movements in the massive options market (where their turnover was sometimes 353x their cash turnover) caused by the cash market moves.
3. **Marking the Close:** Aggressive selling in the final hour to depress settlement prices.

The Regulatory Impact (Q2 2024 Break):

SEBI's subsequent investigation and interim order (barring Jane Street and disgorging ₹4,800 Crores) sent a shockwave through the HFT community.

- **Data Correlation:** This event coincides exactly with the **Q2 2024** drop in Noise Duration from **61.53% to 41.99%.**
- **Mechanism:** The strategy described relies on massive, high-frequency order placement in the cash and futures market to align indices with options. This creates "Noise." SEBI's crackdown likely forced not just Jane Street, but all firms employing similar "grey zone" arb strategies, to withdraw or drastically dial down their algorithms. The "flickering" associated with these massive arbitrage flows evaporated.

3.2 The Economic Disincentive: "True to Label" (October 2024)

The Event:

SEBI issued the "True to Label" circular, effective **October 1, 2024.**

The Pre-Reform Economics:

Prior to this, Market Infrastructure Institutions (MIIs) utilized a "slab-wise" fee structure. Brokers and HFT firms generating massive volumes paid significantly lower transaction fees than the amounts they charged clients or the standard rates. This difference (rebate) was a massive revenue stream.

- **Incentive:** It created a perverse incentive to "churn" to trade simply for the sake of generating volume to hit a lower fee slab. A noise-generating algorithm could break even on trading P&L but be highly profitable due to rebates.

The Post-Reform Reality (Q4 2024 Impact):

The circular mandated that MII charges be uniform and "true to label" - brokers could only charge what they paid, and volume slabs were rationalized.

- **Data Correlation:** The trend cemented in **Q4 2024.** The Noise Count % dropped to **82.77%**, and Duration % stabilized at **30.67%**.
- **Mechanism:** The "Rebate Subsidy" for noise was removed. Algorithms that relied on rebate harvesting became mathematically unviable overnight. The "hum" of churning for fees was silenced.

3.3 The Capital Barrier: Lot Sizes and STT (November 2024)

The Event:

NSE revised the lot sizes for index derivatives (Nifty 50 from 25 to 75, later 65) effective November 20, 2024. Simultaneously, SEBI mandated a minimum contract value of ₹15 Lakhs.

The Mechanism:

- **Entry Barrier:** Increasing the lot size effectively tripled the capital required to enter a trade.
- **Retail/Small Algo Filter:** High-frequency strategies often rely on interacting with "uninformed" retail flow or small-lot orders. By pricing out the smallest participants and increasing the margin burden for market makers, the ecosystem was purified of its most speculative elements.

Impact on 2025 Data:

This final pillar set the stage for the Q1 2025 "New Equilibrium," where the Calm regime reached nearly 50% dominance. With higher stakes per trade, order placement became more deliberate, and "flickering" became too capital-intensive and risky.

4. Risk Analysis: The Emergence of "Quiet-Risk"

The persistence of "Regulatory Success" is evident. Noise is down, Calm is up. However, a deeper interrogation of the MS-AR data suggests that the market has not just become stable; in periods, it has become rigid or hollow. We term this phenomenon **"Quiet-Risk."**

4.1 Defining Quiet-Risk

Quiet-Risk is defined as a market state characterized by high optical stability (Calm) but low structural resilience, manifesting as episodic liquidity droughts (Static) and asymmetric responses to volatility.

It challenges the assumption that **Stability = Liquidity.** A market can be calm simply because no one is trading (liquidity withdrawal), rather than because liquidity is robust.

4.2 The "Hollow Middle": Analysis of the Static Regime

The most concerning signal in the post-reform data is the persistence and occasional spiking of the **Static Regime.**

- **Definition:** The Static regime represents a "liquidity drought"—periods where the order book is frozen, spreads widen, and participation drops to near zero.
- **The Anomaly:** Logic suggests that as the market becomes "Calmer," the "Static" (illiquid) periods should vanish. However, the data shows the opposite.
    - **Q1 2024 (Pre-Reform):** Static Duration % was **7.55%.**
    - **Q3 2024 (Post-Jane Street):** Static Duration % **spiked to 10.50%**.
    - **Q1 2025 (Current):** Static Duration % remains at **7.17%,** despite the massive rise in Calm.

The "Static Ratio" Warning:

The ratio of Static duration to Calm duration has shifted unfavorably in specific quarters. In Q3 2024, the Static duration was nearly 27% of the Calm duration. This indicates that for every 4 minutes of stability, the market suffers 1 minute of complete inactivity.

Implication: The HFTs that were removed were "noisy," but they provided a baseline of continuous (albeit shallow) liquidity. Their removal has left "gaps" in the order book. When the remaining institutional liquidity providers withdraw, there are no HFTs left to fill the void, leading to these "Static" pockets.

4.3 Transition Asymmetry and Volatility

The resilience of a market is defined by how quickly it recovers from a shock. This is measured by the transition probability from **Volatile to Calm.**

- **Pre-Reform (2022):** Shocks (Volatile) were typically absorbed by Noise. A spike in volatility would trigger a swarm of HFTs fighting for position, creating a "cushion" of activity.
- **Post-Reform (2025):** The data suggests a shift. With **Noise** removed, the market must transition directly from Volatile to Calm.
- **The Danger:** If the "Calm" state is fragile (i.e., thinly populated by a few large players), a volatility shock might not revert to Calm but could instead cascade into **Static** (a liquidity withdrawal).

The **Volatile Duration** % has actually increased in the post-reform era:

- **Q1 2022:** 15.29%
- **Q1 2025:** 17.67%.

This suggests that while the market is quieter on average, it struggles more to digest shocks when they do occur. The "dampening" effect of HFT noise is gone, leaving the market more exposed to raw price dislocations. For Additional tables on transition probabilities refer Appendix 2.

5. The Regime-Based Regulatory Dashboard

Given the failure of traditional metrics to capture "Quiet-Risk," this report proposes a new surveillance architecture for SEBI and NSE: the **Regime-Based Regulatory Dashboard.** This dashboard utilizes the MS-AR model outputs to monitor the quality of the market state in real-time.

5.1 Dashboard KPIs

The dashboard consists of five primary Key Performance Indicators (KPIs):

KPI 1: Noise Duration Percentage

- **Definition:** The percentage of the trading session classified as "Noise."
- **Purpose:** Tracks the efficacy of anti-manipulation measures.
- **Threshold:** Target < 30%. A rise above 40% signals a resurgence of toxic HFT or new arbitrage loopholes.
- **Status (Q1 2025):** Green (27.68%).

KPI 2: Calm Persistence (Structural Resilience)

- **Definition:** The average continuous duration (in seconds) of the "Calm" regime.
- **Purpose:** Distinguishes between "transient calm" (lucky silence) and "structural calm" (robust depth).
- **Threshold:** Target > 15 seconds (intraday average).
- **Status (Q1 2025):** Green. The quarterly aggregated persistence is extremely high.

KPI 3: Volatile Recovery Time (VRT)

- **Definition:** The median time required for the market to transition from Volatile $\to$ Calm.
- **Purpose:** Measures the "elasticity" of liquidity.
- **Risk Signal**: An increasing VRT implies that market makers are slow to return after a shock.
- **Status:** Amber. The increase in Volatile duration % (17.67%) suggests shocks are lingering longer than before.

KPI 4: The Hollow Ratio (Static / Calm)

- **Definition:** The ratio of Static Duration to Calm Duration.
- **Purpose:** A direct measure of "Quiet-Risk."

- **Risk Signal:** A rising ratio indicates that stability is being replaced by inactivity.
- **Status (Q1 2025):** 15.09%. While improved from the 27.36% high in Q3 2024, it requires monitoring.

KPI 5: Regime Switch Intensity (RSI)

- **Definition:** Total daily regime counts divided by trading minutes.
- **Purpose:** Measures microstructure stress/churn.
- **Status (Q1 2025):** Green. Intensity has dropped ~4x since 2022, indicating a less chaotic market.

5.2 Action Plan for Regulators

Based on the dashboard and the analysis of the "Post-Reform" equilibrium, the following actions are recommended:

1. Address the "Hollow Middle": Conditional Incentives

The "Static" regime persists because there is no economic incentive to quote during low-activity periods now that rebates are gone.

- Action: Introduce **Conditional Liquidity Obligations.** Market Makers should receive fee waivers only if they provide depth during "Static" or "Volatile" regimes. "Fair weather" liquidity provision (during Calm regimes) should not be subsidized.

2. Stress-Test the "Calm"

- Action: Conduct "Flash Crash" simulations. With HFTs gone, does the current order book have enough diversity to absorb a 5% flash move? The rise in Volatile duration suggests it might not. SEBI should analyze **Impact Cost** specifically during the transition from Calm to Volatile.

3. Basis Risk Monitoring

- Action: Correlate "Calm" regimes with the **Futures-Spot Basis.** If the Basis widens during Calm periods compared to the old Noise periods, it implies that while the market is quieter, pricing efficiency (the tether to the spot market) has degraded due to the lack of arbitrageurs.

6. Conclusion

The transformation of the Nifty 50 futures market from 2022 to 2025 is a textbook case of regulatory effectiveness. Through the "Jane Street" intervention, "True to Label" reforms, and capital barrier adjustments, SEBI successfully excised the "tumor" of toxic noise. The collapse of the Noise regime from nearly 66% to 27% is a monumental achievement in market hygiene.

However, the market has traded "Noise" for "Silence," and silence can be deceptive. The persistent footprint of the "Static" regime and the elongation of "Volatile" periods signal the onset of **Quiet-Risk.** The ecosystem has lost its "noise makers," but it has also lost its most active (albeit mercenary) liquidity providers.

The path forward is not to revert to the noise of the past, but to fortify the calm of the present. By adopting a Regime-Based Dashboard and targeting incentives toward the "Static" and "Volatile" gaps, regulators can ensure that the Nifty 50 remains not just a quiet market, but a deep and resilient one.

Data Sources & References

- LOB Data for Nifty50 from LSEG
- MS-AR Model Output Data (Daily & Quarterly metrics).
- Jane Street Case details and analysis.
- SEBI "True to Label" Circular details.
- NSE Lot Size Revision Circulars.

Appendix 1 – Discussion on Methodology

A Markov Switching Autoregressive (MS-AR) model with regime-dependent mean and variance was applied to the micro-price return series. The model assumes that the return series is governed by an unobserved state variable .

The model specification is:

$$y_t = \mu_{s_t} + \phi_{s_t} y_{t-1} + \epsilon_t, \quad \epsilon_t \sim N(0, \sigma^2_{s_t})$$

where $s_t \in \{1, 2, 3\}$. The three regimes were semantically labeled based on their estimated volatility (σ^2) and persistence parameters (Hamilton, 1989):

Static: Characterized by very low volatility and high mean reversion.
Calm: Baseline market operation, moderate volatility.
Volatile: High volatility, rapid price displacements.

To ensure computational stability and isolate volatility as the primary discriminator of market states, the autoregressive parameter was constrained to be regime-invariant (common across all states) for a given day. The regimes are thus distinguished exclusively by their distinct variance levels and transition probabilities, characterizing the market as switching between 'modes of volatility' rather than 'modes of predictability' at the linear level.

Noise Filtering Protocol: An innovation in our methodology is the filtering of regimes based on duration. We posit that regimes lasting less than 10 seconds constitute "microstructure noise"—transient states driven by algorithmic flickering that do not represent a genuine shift in the macroeconomic or supply/demand equilibrium (Dahlström et al., 2024). High-frequency arrival time analysis supports the distinction between informative trading and noise (Hautsch & Herrera, 2020). If Duration < 10 seconds, the transient state is classified as Noise. If Duration >= 10 seconds, the original classification (Static/Calm/Volatile) is retained. (Hagströmer, 2021). This filtering step is essential to avoid contaminating the analysis with high-frequency flicker and to avoid the problem of dimensionality in subsequent modeling (Nagler & Czado, 2016).

Appendix 2 – Additional Results

Table 3A: Regime Count and Duration across Quarters
(2022 Q1 through 2025 Q1)

QUARTER	REGIME COUNT				REGIME DURATION			
	Noise	Static	Calm	Volatile	Noise	Static	Calm	Volatile
2022Q1	92%	1%	6%	2%	45%	6%	34%	15%
2022Q2	89%	1%	8%	2%	37%	10%	35%	18%
2022Q3	92%	1%	6%	1%	51%	5%	32%	12%
2022Q4	95%	1%	3%	1%	65%	6%	20%	10%
2023Q1	94%	1%	4%	1%	59%	5%	23%	13%
2023Q2	96%	2%	1%	1%	66%	11%	15%	8%
2023Q3	95%	2%	1%	1%	65%	14%	12%	10%
2023Q4	94%	3%	1%	2%	61%	17%	9%	13%
2024Q1	95%	1%	2%	2%	62%	8%	16%	14%
2024Q2	92%	2%	4%	2%	42%	10%	33%	15%
2024Q3	83%	4%	9%	4%	31%	10%	38%	20%
2024Q4	83%	3%	10%	4%	31%	8%	41%	20%
2025Q1	81%	3%	12%	5%	28%	7%	47%	18%
For Overall Data								
Average	92%	2%	4%	2%	49%	9%	27%	14%
Min	89%	1%	1%	1%	37%	5%	9%	8%
Max	96%	3%	8%	2%	66%	17%	35%	18%
Average Regime Duration in seconds					2.11s	47.87s	939.9s	92.98s

Table 3B: Distribution of days across Regimes

Quarter	Only One	Only Two	Only Three	All Four	Remarks
Q1	3	1	12	45	Calm 3
Q2	1	0	18	43	Static 1
Q3	1	1	18	43	Calm 1
Q4	1	0	13	47	Calm 1
Q5	1	0	13	48	Calm 1
Q6	4	0	14	42	Calm 4
Q7	2	0	16	45	Calm 2
Q8	2	0	14	44	Calm 1, Volatile 1
Q9	2	0	16	42	Calm 2
Q10	6	0	13	41	Calm 5, Volatile 1
Q11	2	0	16	46	Calm 2
Q12	3	0	11	47	Calm 3
Q13	4	0	3	35	Calm 4

How to interpret: For Q1, the total period of 61 trading days was distributed as follows: Based on the MS-AR classification, 45 days had all four regimes, 12 days had only three out of four regimes, 1 day had only two regimes while 3 days had only one regime for the entire day. The Remarks column indicates the identity of the regimes on the special case of Single-regime days. For Q1, all three days happened to be in the Calm regime.

Table 4: Transition Probabilities (Summary results from MS-AR outputs)

Part A [For periods 2022Q1 through 2024Q1] – Nine Quarters			
	From Calm	From Static	From Volatile
To Calm	0.709	0.144	0.140
To Static	0.142	0.701	0.161
To Volatile	0.149	0.155	0.699
Part B [Quarter 2024Q2] – The Structural Break			
	From Calm	From Static	From Volatile
To Calm	0.713	0.143	0.140
To Static	0.139	0.699	0.164
To Volatile	0.148	0.158	0.696
Part C [For period 2024Q3 through 2025Q10] – Three Quarters			
	From Calm	From Static	From Volatile
To Calm	0.730	0.109	0.115
To Static	0.120	0.714	0.152
To Volatile	0.150	0.177	0.732
Part D [Difference between Part C (after) and Part A (before)]			
	From Calm	From Static	From Volatile
To Calm	0.021	-0.036	-0.025
To Static	-0.022	0.013	-0.009
To Volatile	0.001	0.022	0.034

Research papers cited

1. Hamilton, J. D. (1989). A new approach to the economic analysis of nonstationary time-series and the business cycle. Econometrica, 57(2), 357-384.

2. Dahlström, P., Hagströmer, B., & Norden, L. (2024). The determinants of limit order cancellations. The Financial Review, 59(1), 181-201.

3. Hautsch, N., & Herrera, R. (2020). Multivariate dynamic intensity peaks-over-threshold models. Journal of Applied Econometrics, 35(2), 248-272.

4. Nagler, T., & Czado, C. (2016). Evading the curse of dimensionality in nonparametric vine copula modeling. Journal of Multivariate Analysis, 151, 69-89.

5. Hagströmer, B. (2021). Bias in the effective bid-ask spread. Journal of Financial Economics, 142(1), 314-337.

Other works cited

6. The Saga of the Jane Street Trading Scandal - Capitalmind, accessed January 21, 2026, https://www.capitalmind.in/insights/the-saga-of-the-jane-street-trading-scandal

7. SEBI'S 'TRUE TO LABEL' CIRCULAR: TRANSPARENCY OR TROUBLE?, accessed January 21, 2026, https://www.tcclr.com/post/sebi-s-true-to-label-circular-transparency-or-trouble

8. NSE and BSE Increase Lot Sizes for Index Derivative Contracts - Groww, accessed January 21, 2026, https://groww.in/blog/nse-increases-lot-sizes-for-index-derivatives

9. Jane Street: The line between market manipulation and arbitrage - NLS Forum, accessed January 21, 2026, https://forum.nls.ac.in/nlsblr-blog-post/jane-street-the-line-between-market-manipulation-and-arbitrage/

10. Jane Street & SEBI: Formulating A Structured Approach To Regulatory Governance of Financial Markets - Law School Policy Review, accessed January 21, 2026, https://lawschoolpolicyreview.com/2025/12/13/jane-street sebi-formulating-a-structured-approach-to-regulatory-governance-of-financial-markets/

11. SEBI Circular on 'Charges levied by Market Infrastructure Institutions – True to Label' - NSDL, accessed January 21, 2026, https://nsdl.co.in/downloadables pdf/2024-0094-_Policy-_SEBI_Circular_on_Charges_levied_by_Market Infrastructure_Institutions__True_to_Label.pdf

12. Revision in lot size of Index derivative contracts from November 20, 2024 - Zerodha, accessed January 21, 2026, https://zerodha.com/marketintel/bulletin/393605/revision-in-lot-size-of-index-derivative-contracts-from-november-20-2024

13. What is Nifty Lot Size? Current Limits & New Rules (Nov 2025) - PL India, accessed January 21, 2026, https://www.plindia.com/blogs/what-is-nifty-lot-size/

Citation guideline

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