

# Strategic Hierarchies and Flow Anticipation in Modern Markets:

## A Theoretical Note on the Stackelberg Flow Model

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### Abstract

This note develops a theoretical foundation for the *Stackelberg Flow Model* (SFM), a hierarchical framework describing how anticipatory agents interact with constrained institutional participants under asymmetric information and timing. Departing from simultaneous-move equilibrium models of price competition, the Stackelberg approach captures a sequential dynamic in which a strategically aware trader commits to an action that alters the optimization domain of mechanically constrained institutions. This asymmetry generates state-dependent feedback loops linking market impact, liquidity provision, and volatility. By framing modern flow-driven phenomena, such as dealer gamma feedback and VaR-induced deleveraging, as Stackelberg equilibria, the model clarifies how endogenous predictability and transient alpha can arise in otherwise efficient markets. The paper emphasizes the conceptual architecture rather than the implementation details, providing a complementary theoretical lens to existing flow-based and risk-sensitive asset pricing frameworks.

**Keywords:** Stackelberg equilibrium, market microstructure, institutional constraints, dynamic games, anticipatory trading.

# 1 Introduction

Financial markets have evolved into multi-layered systems of heterogeneous agents operating under distinct mandates, constraints, and information structures. Traditional models of equilibrium pricing, from the rational-expectations paradigm to modern factor models, presume symmetry in information and simultaneity in action. Yet, the increasing algorithmic segmentation of institutional behavior introduces a structural hierarchy: some agents act *reactively* according to formalized constraints (e.g., gamma hedging, VaR limits, benchmark tracking), while others act *strategically* in anticipation of these reactions. The Stackelberg Flow Model (SFM) we proposed formalizes this hierarchy as a sequential optimization problem in which the leader’s action is chosen with foresight into the deterministic or near-deterministic responses of constrained followers.

This approach contrasts with the conventional Bertrand-Nash representation of market interaction, in which all agents move simultaneously and competition drives profits to marginal cost. In reality, institutional constraints, latency differences, and the predictability of flow dynamics create endogenous lags in market response, endowing informed or adaptive participants with an exploitable informational gradient. The Stackelberg framework captures this temporal and structural asymmetry explicitly, offering a mechanism through which predictable price impact, volatility clustering, and transient inefficiencies can emerge even in liquid, high-turnover markets.

## 2 Conceptual Foundation

The core premise of the SFM is that markets can be represented as hierarchically ordered games of flow interaction rather than symmetric contests of price competition. The leader, representing a strategically flexible agent (such as a flow-aware quant or discretionary macro trader), operates under forward-looking expectations, committing to a position or exposure that indirectly determines the feasible response set of institutional followers. The followers, typically large dealers or funds constrained by internal risk controls, regulatory requirements, or hedging mandates, respond optimally given their constraint surfaces and the observed leader action. This sequential ordering produces a class of dynamic equilibria characterized by path-dependence and reflexivity: prices evolve not purely as reflections of information, but as endogenous outcomes of strategic anticipation and constrained adjustment.

Unlike in Bertrand or Nash formulations, where agents interact simultaneously and payoffs are resolved competitively, the Stackelberg hierarchy embeds an element of commitment power. The leader’s choice shapes not only the magnitude of market impact but also the trajectory of subsequent liquidity absorption and volatility propagation. In such a system, predictability does not stem from superior information about fundamentals, but from knowledge of the mechanical rules governing institutional adaptation. This transition—from informational to structural advantage—marks a fundamental shift in how alpha and inefficiency are conceptualized in post-automation market environments.

### 3 Theoretical Implications

Modeling the market as a Stackelberg system reframes several longstanding puzzles in financial economics. First, it provides a tractable explanation for the persistence of short-horizon alpha despite widespread data symmetry: when large portions of flow are constraint-driven, rational anticipation of those flows can yield predictable excess returns without violating informational efficiency. Second, it rationalizes volatility clustering and non-linear price impact as equilibrium features of sequential adjustment rather than exogenous shocks. The reaction elasticity of the follower, regardless if it is a dealer’s gamma sensitivity or a fund’s VaR scaling coefficient, acts as an endogenous amplifier, magnifying or dampening the leader’s initial impulse. Third, it integrates naturally with existing structural and reduced-form frameworks. Within a broader ecosystem, FRiSPe-type models generate the expected regime signals, the Stackelberg layer governs how those regimes translate into flow asymmetries, and MECD-style frontiers determine portfolio selection given the induced risk profile.

The Stackelberg hierarchy also introduces a new interpretation of market power: not as dominance in size or capital, but as dominance in timing and adaptability. Because the leader internalizes the reaction function of the constrained institutions, their optimization problem embeds a higher-order conditionality: an awareness not only of prices, but of the rules that produce those prices. This higher-dimensional rationality gives rise to *strategic liquidity provision*, where the leader effectively co-creates liquidity events by navigating predictable institutional constraints.

### 4 Analytical Distinction from Bertrand and Nash Frameworks

Whereas a Bertrand setting models price competition among symmetric agents and collapses to a binary, zero-profit equilibrium under homogeneity, the Stackelberg setting allows for continuous, state-dependent payoffs. The difference is not merely one of timing but of informational topology: in a Bertrand world, agents face simultaneous decision nodes with mutual uncertainty; in a Stackelberg world, the leader moves on a higher informational plane, optimizing with respect to an anticipated best-response function rather than a probabilistic belief distribution. The existence of a structured reaction function introduces gradients in the payoff landscape, enabling differentiable and hence optimizable expectations. This is what permits equilibrium predictability in the SFM without violating market efficiency in the aggregate sense: predictability arises from mechanical necessity, not informational asymmetry.

In this sense, the SFM extends the classical quantity-setting interpretation of Stackelberg competition into a stochastic flow domain. Where the industrial Stackelberg leader chooses output anticipating the follower’s quantity response, the financial leader in SFM chooses exposure anticipating the follower’s flow or hedge adjustment. The analogy is direct but the dynamics are richer: the “demand curve” is replaced by a nonlinear impact function, and the follower’s reaction is filtered through evolving risk constraints and volatility regimes.

## 5 Research Outlook

The theoretical agenda implied by this framework is broad. Future formalizations can extend the SFM into continuous time as a Stackelberg differential game with stochastic volatility and regime switching, or into mean-field limits to capture aggregate flow reflexivity. Empirical calibration would rely on observable proxies for follower constraint sensitivity—gamma exposure, ETF rebalancing flows, funding spreads—paired with reduced-form estimates of leader impact coefficients. Such empirical implementations, while complex, could bridge microstructural modeling and asset pricing, offering a dynamic foundation for understanding how structural flow asymmetries shape expected returns, liquidity, and systemic risk.

## 6 Conclusion

The Stackelberg Flow Model situates modern markets within a hierarchy of anticipatory and reactive agents, redefining efficiency as a layered, state-dependent equilibrium rather than a simultaneous consensus. By interpreting institutional constraints as endogenous best responses within a sequential game, it illuminates a pathway through which predictability and instability coexist. This structure, subtle but pervasive, may explain why flow-induced feedback effects—gamma squeezes, volatility clustering, and self-exciting liquidity cycles—persist in the age of automation. Ultimately, the SFM reframes alpha as a measure not of informational advantage, but of temporal and structural positioning within the recursive logic of modern market games.

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