

Ph.D. DISSERTATION DEFENSE

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Degree:	Doctor of Philosophy
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Title:	Price Dynamics and Convergence to Market Equilibrium in the Mean–Deviation Portfolio Framework
Chairperson:	Dr. Michael Zabaranin, Department of Mathematical Sciences, School of Engineering & Sciences
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ABSTRACT

Market equilibrium is a fundamental concept in mathematical economics and finance. It corresponds to a market state in which aggregate demand for assets or goods equals aggregate supply. The first theoretical analysis of market equilibrium dates back at least to Walras' *Elements of Pure Economics* (1874). Since then, the vast majority of theoretical and empirical studies have focused on the existence of market equilibrium and the characterization of equilibrium prices, often omitting the questions of whether such an equilibrium can be reached, under what price adjustment mechanisms, and how fast. This dissertation addresses these questions by studying price-adjustment dynamics for agents whose risk–reward preferences are modeled using the mean–deviation framework of Rockafellar et al.

The first part of the dissertation analyzes centralized markets, or Walrasian auctions, in which an auctioneer iteratively adjusts prices in response to excess demand, and trade occurs only after equilibrium prices are reached. Such a price-adjustment process is called *tâtonnement*. The dissertation establishes convergence conditions and obtains convergence rates for various versions of *tâtonnement*.

The analysis is then extended to decentralized markets, where trading is bilateral, clearing is local, and no global price is available. The dissertation proposes a distributed price-adjustment mechanism on a communication graph modeling information exchange among agents. It shows that, despite the absence of centralized coordination, the mechanism converges to the same equilibrium as in the centralized market, with a convergence rate determined by the topology of the underlying graph. From a control-theoretic perspective, the equilibrium corresponds to consensus, and the mechanism can be interpreted as being executed by a virtual auctioneer.

Finally, the dissertation studies the inverse problem of recovering agents' risk–reward preferences from observed price dynamics. While price trajectories identify only aggregate demand, a multi-stage inverse problem combines observations across sequential market equilibria to recover individual portfolios and deviation measures. This analysis offers to quantify market efficiency, as the half-life of price discovery, which links price adjustment rate to the agents' deviation measures. The theoretical results are demonstrated and validated by numerical experiments using synthetic factor models and empirical financial data.