INTRODUCTION

Since the advent of the Efficient Market Hypothesis (EMH), the search for serial correlations in stock returns has been one of the main criteria to assess market efficiency (Fama, 1965; Bhoptimk and Wang, 2020).

Three main theoretical and empirical issues are associated to serial correlations:
1. Sample size and power of econometric tests (Shiller, 2015).
2. Sources of statistical dependence and randomness (Fama, 1965).
3. Informational component of stock prices (Mantegna and Stanley, 1999).

Given the centrality of the informational content of stock prices raised by the EMH, how could we deploy such information to better understand the behavior of stock returns?

OBJECTIVES

1. Analyzing statistical regularities of stock returns over different market periods, by developing an entropy-constrained statistical equilibrium model.
2. Explaining randomness in stock prices as the unintended consequence of investors seeking higher rates of return.
3. Providing an original assessment of the EMH by considering the role of unfulfilled expectations of investors, and how they impact stock market volatility.

DATA COLLECTION

We compute logarithmic daily returns of the individual companies listed in the S&P 500, over the period 01/01/1988 – 12/31/2019.

We divide our sample into bull, bear markets (declines of 20% or more over at least a two-month period), and corrections (declines of 10% from the most recent peak).

We consider the cross-sectional distributions of individual companies’ returns, and then analyze their statistical regularities (Figures 1 and 2).

METHODOLOGY

To explain the observed statistical regularities in the distributions of stock returns, we adopt the Quantal Response Statistical Equilibrium (QRSE) model (Scharfenaker and Foley, 2017).

The logic of the model is based on a process of Smithian competition. Investors, seeking above-average rates of return from their transactions, generate “endogenous gravitation” around an average rate of return as an unintentional result of their interactions with other actors.

Based on an entropy-constrained framework, the model derives equilibrium as an information theoretic probability distribution representing all possible states of the system.

THE QRSE MODEL

1. Quantal response behavior of market participants:
   • $\mu$: Fair value (expected average payoff).
   • $T$: Agent responsiveness to variations in returns.
2. Negative feedback of individual actions on market outcomes:
   • $a$: “Conventional” (market) rate of return.
   • $S$: Market responsiveness to variations in returns.
3. The role of expectations, as captured by the skewness:
   • $\xi = \mu - a (\neq 0, > 0, < 0)$: Degree of expectation fulfilment.

CONCLUSIONS

We find evidence of punctuated statistical equilibrium over multiple market periods, disrupted by structural changes affecting the stock market (Figure 3).

We find evidence of significant deviations of individual expectations from market outcomes over extended time periods, even though they remain quite consistent over the long-run (average $\xi = 0.06 \%$/day).

We show how the stochastic nature of stock prices can be explained as the spontaneous convergence of the system towards a market convention.