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Minireview

Investment horizon heterogeneity and wavelet: Overview and further research directions

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HIGHLIGHTS

- Systematic literature review of wavelet theory in finance has been conducted.
- Evolution of wavelet has been delineated in a succinct way.
- The migration of wavelet into different verticals of finance has been sketched.
- Relationship between horizon heterogeneity and information heterogeneity is probed.
- New research possibilities in this domain are explored.

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ABSTRACT

Wavelet based multi-scale analysis of financial time series has attracted much attention, lately, from both the academia and practitioners from all around the world. The unceasing metamorphosis of the discipline of *finance* from its humble beginning as *applied economics* to the more sophisticated depiction as *applied physics* and *applied psychology* has revolutionized the way we perceive the market and its complexities. One such complexity is the presence of heterogeneous horizon agents in the market. In this context, we have performed a generous review of different aspects of *horizon heterogeneity* that has been successfully elucidated through the synergy between wavelet theory and finance. The evolution of wavelet has been succinctly delineated to bestow necessary information to the readers who are new to this field. The migration of wavelet into finance and its subsequent branching into different sub-divisions have been sketched. The pertinent literature on the impact of horizon heterogeneity on risk, asset pricing and inter-dependencies of the financial time series are explored. The significant contributions are collated and classified in accordance to their *purpose and approach* so that potential researcher and practitioners, interested in this subject, can be benefited. Future research possibilities in the direction of "*agency cost mitigation*" and "*synergy between econophysics and behavioral finance in stock market forecasting*" are also suggested in the paper.

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1. Introduction

Heterogeneity in the financial market is induced by agents who exhibit different consumption requirements [1], varied trust and risk tolerance level [2,3], heterogeneous assimilation of information ([4–6]), institutional constraints [7,8] and heterogeneous belief [9–12]. These *heterogeneities* are closely linked to the assorted perception towards investment horizon. For example, negative news may induce short-term agent to sell stock, while *long-term* agent may perceive the same news as buying opportunity provided she infers the news to have temporary bearing on the market. It can be inferred from the example that *horizon heterogeneity* is an outcome of *perceptual heterogeneity*. Often *institutional constraints* lead to *horizon heterogeneity*, for example, pension funds and government investments are constrained to be *long-term*. *Edgar E. Peters* did a series of work on *Fractal Market Hypothesis (FMH)* where he emphasized the impact of information and investment horizon on the behavior of the investors [13–17]. FMH advocates that market consists of agents trading at different scales, ranging from seconds (*algorithmic trading*) to several years. Liquidity is ensured through aggregate balance between "*buy*" and "*sell*" orders, which results either from restricted access to information or from different interpretation of the same information. Same information may be perceived differently by different horizon investors and this "*complexity*" is instrumental behind the stability and clearing of the market. These works had led to the foundation of *heterogeneous market hypothesis* [18,19] which instigated the need to study *frequency* properties of stock market along with the prevailing studies on time properties. The conjecture that heterogeneous-horizon investors react differently to incident information can be strengthened by the evidence that empirical distribution of returns behaves differently at different frequencies. The widely used parametric models like the *random walk with GARCH*, *random walk with stochastic volatility*, *jump diffusion processes* etc. have been found insufficient in explicating the underlying dynamics of the financial market across all frequency levels [20]. The *stylized facts* of the financial time series like the presence of *excess kurtosis, fat tail, volatility clustering* and *long memory* can also be explicated using the dynamic interaction of the heterogeneous horizon agents in the market [21,22]. According to Muller et al. [19] fractal theory can be defined as a procedure wherein "*objects are analyzed on different scales, with different degrees of resolution, and the results are compared and interrelated*". Lack of access to sophisticated *scientific computing* and *data analysis* techniques had prevented traditional economist and financial researcher from studying the properties of the market beyond the traditional—*long* and *short* term. The advent of wavelet theory had bridged this gap and subsequently the social science research community witnessed incredible growth in application of wavelet theory, particularly in the realm of finance and economics [23–26]. The objective of this work is to highlight the significant development which initiated through the synergy between wavelet theory and finance with particular reference to the heterogeneous horizon argument. The study posits the following research questions.

RQ1: *How wavelet theory has evolved over time?*
RQ2: *What are the different facets of horizon heterogeneity that has been explained through wavelet theory in the past?*
RQ3: *What further dimensions can be explored in the future?*

In order to answer these questions, *systematic literature review*, as proposed by Tranfield et al. [27] has been adapted in the study. This endeavor is aimed towards synthesizing the *cross-functional developments* between *finance and wavelets* in a systematic manner so that potential researchers can be benefited from the same. The rest of the paper is structured as follows. Section 2 elucidates the research methodology wherein the rigor of systematic literature review has been delineated. Section 3 sketches the evolution of wavelet theory which is essential for recognizing the essence of the study. Section 4