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Editorial: Taking stock in econophysics

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Editorial on the Research Topic
Taking stock in econophysics

Econophysics is an interdisciplinary field that studies economic problems using physics concepts and methods. Its goal is to use mathematical models and statistical methods inspired by physics to understand economic behavior and market phenomena such as price formation and asset price fluctuations. Furthermore, econophysics aims to provide a fresh look at complex economic problems that are beyond the scope of conventional economics.

The Research Topic *Taking Stock in Econophysics* seeks to evaluate the current state and future direction of research in this field. It entails investigating past accomplishments, current challenges, and potential future developments. The Research Topic aims to identify econophysics' strengths and weaknesses, as well as where it can make the most significant contributions to the understanding of economic phenomena. This type of assessment can help to direct future research efforts and ensure that econophysics continues to make important contributions to economics.

One favorite research topic in econophysics is option pricing formulas, which aim to determine the fair price or theoretical value for a financial option, considering various factors such as the underlying asset price, time to expiration, strike price, volatility, interest rates, and dividends. Some of the most widely used option pricing models include: 1) the Black-Scholes model, which is a model for pricing European call and put options that assumes a constant volatility and efficient markets (European options can only be exercised at expiration while American options can be exercised at any time prior to expiration); 2) binomial option pricing, a tree-based model that allows for iterative calculation of option prices and can be used for options with early exercise; 3) Monte Carlo simulation, which is a statistical method that models the price movement of the underlying asset and uses simulations to calculate option prices; and 4) the finite difference method, which approximates the solution of a partial differential equation and is frequently used for pricing American options. All of these formulas provide a theoretical value for the option; however, due to market supply and demand factors, the actual market price of an option may differ. A free-boundary problem arises in the pricing of American options. Solving the free-boundary problem entails determining the option price that accounts for the possibility of early exercise and maximizes the value of the option for the holder. Because of its non-linear and multidimensional nature, this problem is difficult to solve and frequently necessitates the use of numerical methods.

In his viewpoint on this Research Topic, Alghalith relaxes the assumptions of constant volatility and interest rate (*New Developments in Econophysics: Option Pricing Formulas*). He then shows how, after overcoming the free-boundary problem, previous research as well as his own findings offer straightforward, closed-form pricing formulas for American options using the square root of the Brownian motion as a foundation.

Asset price volatility is a measure of the fluctuation of an asset's price over time. There are several methods for estimating asset price volatility, including: 1) historical volatility, which calculates the standard deviation of an asset's returns over a specific time period; 2) implied volatility, which uses option prices to estimate an asset's expected volatility; and GARCH statistical models, which estimate volatility by analyzing the relationship between an asset's past returns and its current volatility. Whatever method is used, it is critical to understand that asset price volatility is a forward-looking estimate that can change due to changes in market conditions or new information. Volatility estimation is an important research topic in finance and econophysics, and the volatility of volatility is also commonly assessed. Furthermore, probability density estimation is closely related to volatility estimation because it can be used to estimate volatility and volatility of volatility.

Alghalith shows recent simpler and less restrictive methods for estimating probability densities, volatility, and volatility of volatility in his perspective on this Research Topic, highlighting his own contributions to this literature (*Methods in Econophysics: Estimating the Probability Density and Volatility*). This is useful and has applications in other areas of econophysics.

Complex networks, which are a type of graph-based mathematical representation of complex systems distinguished by a large number of nodes and their connections, are another hot research topic in econophysics. They are used to model and analyze real-world systems such as the stock market. Small-world behavior, scale-free distributions, and high clustering coefficients are characteristics of complex networks. The interconnected relationships between various stocks, financial instruments, and market participants are referred to as stock market networks. These connections can be represented by a network of nodes (stocks or financial instruments) and edges (relationships or connections between the nodes). Threshold networks are a type of artificial neural network in which neurons are activated by threshold functions. A neuron's output is either 0 or 1, depending on whether the weighted sum of its inputs is greater than or less than a predefined threshold value. As a result, a highly simplified and efficient network is created, which can be used for tasks like pattern recognition and classification. Threshold networks have several advantages, including: 1) a simple architecture that makes them easy to implement and train; 2) robustness to noise in their inputs, as they only respond to input values that exceed a certain threshold; and 3) computational efficiency, as they only perform computations on a small subset of their inputs. The disadvantages of threshold networks include: 1) limited representational power, as they can only represent step functions, limiting their ability to model complex functions; 2) discontinuities at their threshold values, which can cause issues when performing gradient-based optimization; and 3) binary outputs, which can be a disadvantage in applications requiring continuous outputs.

In this Research Topic, Park et al. address the network measures used to assess the structure and dynamics of stock market networks, including degree distribution, clustering coefficient, and betweenness centrality (*A Perspective on Complex Networks in the Stock Market*). They focus on recent advances in complex networks generated from cross-correlation coefficients of the logarithmic return between the prices of securities or stock indices. They emphasize the benefits and drawbacks of threshold networks because determining the threshold value is an open question. They then concentrate on a threshold method that is more useful for estimating properties in generated threshold networks such as average degree, clustering coefficients, and centrality. Finally, they discuss how these relate to market stability, systemic risk, and investment strategies. They conclude that a more robust criterion for selecting the threshold value of a threshold network is required.

Several papers in econophysics discuss mutual funds, which are investment vehicles that pool money from multiple investors to purchase a diverse portfolio of securities such as stocks and other assets. An open-end mutual fund is a type of mutual fund in which the number of shares outstanding can fluctuate based on investor demand. In an open-end mutual fund, new shares are issued to meet investor demand and can be redeemed at the fund's net asset value per share. This distinguishes it from closed-end funds, which have a fixed number of shares and are traded on an exchange like stocks. The interconnections between various funds, such as mutual funds, hedge funds, and exchange-traded funds, are referred to as fund networks. Topological properties of these networks, such as degree distribution, clustering coefficient, and centrality measures, can be examined. The study of fund networks can provide insights into the systemic risk and interdependence of various funds, as well as aid in the identification of market key players. Co-holding networks are groups of people or businesses who share investments. These networks can form through direct investments, mutual funds, or other investment vehicles, and they can allow individuals or entities to pool their resources and invest in larger, more diverse portfolios.

The paper *Mutual Fund Net Flows in China: A Co-Holding Network Perspective* by Yue et al. in this Research Topic evaluates the net flows of mutual funds in China using a co-holding network that allows for an examination of the relationship between different mutual funds and the stocks they hold. This can help us understand how the underlying stocks affect mutual fund performance and asset flow. The authors build an undirected weighted fund network of Chinese open-end funds based on asset co-holding and investigate whether the co-holdings of funds influence their net flows. To investigate the impact of asset co-holding networks on fund flow changes, the network structure traits are introduced into a panel data model. They discover that the more connections a fund has with other funds, the more net flows it receives. When a fund's average co-holding value rises, however, outflows outnumber inflows. Furthermore, this effect is more pronounced for low-performing

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funds.

Finally, the papers in this Research Topic have shown that the econophysics agenda contributes and will likely continue to contribute to a better understanding of financial issues. We appreciate everyone who took the time to provide their valuable feedback. We hope that their perspectives will help to spark future research.

Author contributions

All authors listed have made a substantial, direct, and intellectual contribution to the work and approved it for publication.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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