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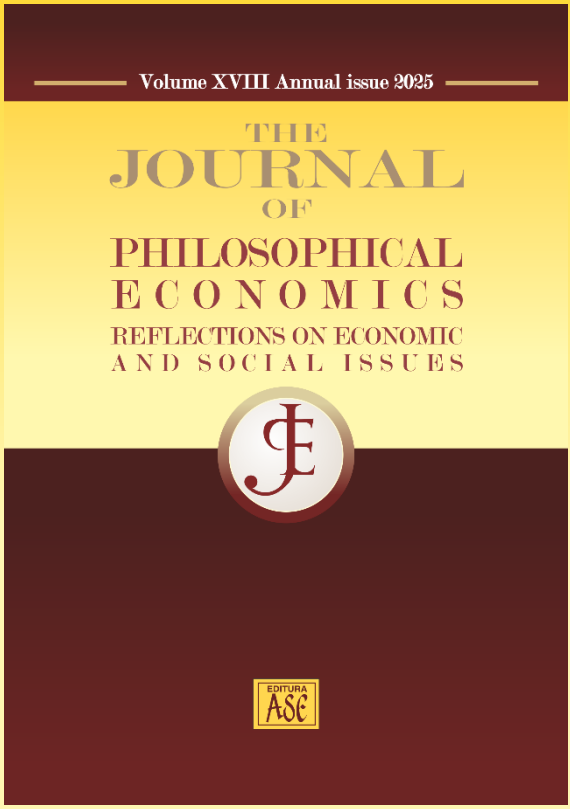

From rational to behavioural: an epistemological bridge between Markowitz, Fama, and Shiller

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EDITURA ASE

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Abstract: This article examines the epistemology of finance by analysing how different theoretical perspectives shape knowledge and decision-making in markets. A comparative analysis is adopted to contrast the underlying premises of each perspective and their applicability in contexts of uncertainty, volatility, and structural changes in markets. The findings demonstrate that, while each theoretical framework provides valuable analytical tools, their combination offers a more robust understanding of financial behaviour. The integration of these approaches, along with interdisciplinary methodologies, is essential for a more holistic and adaptable view of financial epistemology, allowing for a more accurate evaluation of the interaction between rationality, uncertainty, and behaviour in contemporary global markets.

Keywords: financial theory, behavioural finance, market efficiency, portfolio diversification.

Introduction

Epistemology is a fundamental aspect of financial theory, determining how knowledge about financial systems is generated, validated, and applied (Gasparin, Schinckus, and Green 2019). Financial epistemology employs various analytical approaches, including quantitative modelling, historical analysis, behavioural perspectives, classical finance, and neoclassical finance. It also examines the diversity of economic actors, market structures, and regulatory frameworks, reflecting variations in geographical, cultural, and socioeconomic contexts (Dörry 2016; Lai and Samers 2021). This allows for precise epistemological inquiries, such as how various perspectives enhance the robustness and predictive power of financial theories or under what conditions the basic assumptions of these perspectives lead to more resilient and equitable financial systems.

While it must be acknowledged that there is methodological diversity in the analysis of the financial system, this article focuses on the epistemological diversity within that system, which is understood here as a structured set of subsystems in which professionals are united by principles, analytical tools, normative objectives, and shared methodological approaches. Financial theorists and practitioners may adopt a slightly varied range of these elements, leading to a scenario where defining the exact boundaries of that system becomes inherently ambiguous. Indeed, financial subsystems may overlap, and individual actors may participate in multiple subsystems, either simultaneously or at different stages of their careers.

Many participants within a particular subsystem pursue aligned objectives and often embrace a diversity of analytical frameworks and investment strategies (Behera, Nanda, Behera, and Bhoi 2023). Nevertheless, these subsystems are also arenas for debate and conflict since there are competing perspectives vying to impose their dominance, which are in turn constrained by the degree of theoretical diversity the subsystem can sustain. This is because these subsystems must balance innovation with the need for coherence and shared reference points to ensure their functionality. It is also essential to recognize that these perspectives are not static; indeed, financial evolution is characterized precisely because some fragment or become obsolete, while new ones emerge to address changing economic realities (Holtfort 2019).

When the financial system is described as epistemologically diverse, the diversity may refer not only to different perspectives but also to a variety of knowledge and analytical skills for financial decision-making. For instance, a diversity of knowledge and skills is epistemically advantageous when it allows a team of financial analysts to tackle complex challenges that no individual could address independently. By way of illustration, the valuation of technology startups in the context of venture capital extends far beyond a mere examination of financial statements, particularly given that many such enterprises operate without positive cash flow in their early stages. Successful VC firms exemplify epistemic diversity by assembling multidisciplinary teams that include financial analysts, technology experts specializing in domains such as machine learning and blockchain, organizational psychologists capable of assessing the leadership and resilience of founding teams, and digital marketing specialists attuned to

growth potential and market dynamics. Similarly, diversity in the form of different perspectives can also be productive by fostering critical evaluation and robust debate. However, there is also a limit to the level of dissent that can be sustained, as financial analysts are often under pressure to reach a consensus to implement decisions within strict deadlines.

In this article, it is argued that financial epistemology can be approached by identifying three influential perspectives that have shaped the field: the Modern Portfolio Theory (MPT) by Harry Markowitz (1952), which introduced a mathematical basis for risk diversification and portfolio optimization, establishing a quantitative framework for the efficient allocation of assets; the Efficient Market Hypothesis (EMH) by Eugene Fama (1970), which proposed that asset prices reflect all available information, highlighting the rationality of economic agents; and the concept of Behavioural Finance (BF) by Robert Shiller (2003), which challenged the premises of the EMH by incorporating psychological and behavioural factors in financial decision-making, arguing that emotions and biases can create inefficiencies in the markets.

Although this work associates Robert Shiller with BF due to his prominent recognition in advancing this field, it is essential to acknowledge that his contributions are grounded in foundational ideas developed by earlier scholars. In fact, as noted by Chandra and Thenmozhi (2017, p.3), the pioneering work of Kahneman and Tversky (1979) introduced Prospect Theory, emphasizing the role of psychological factors in enhancing our understanding of economic decision-making. Their research highlighted how behavioural biases and heuristics systematically deviate from the assumptions of rational economic agents. Subsequently, Thaler (2000), Shefrin (2005), and Shiller himself (2003) expanded upon these concepts, collectively shifting the paradigm from the neoclassical *homo economicus* toward a more realistic representation of *homo sapiens* as boundedly rational actors.

The three perspectives (MPT, EMH, and BF) represent distinct approaches to understanding the global financial system and, moreover, each differs in the way it conceptualizes the role of decision-making. However, numerous studies indicate that these contributions are underpinned by a profound epistemological debate that challenges the apparent neutrality and universality of financial

models, the validity of strictly rationalist assumptions, and the excessive reliance on quantitative techniques. Below, some of the key aspects that characterize this epistemological debate within the field of finance are highlighted.

Despite the apparent diversity of financial theories, Ardalan (2003) highlights how major theoretical issues remain concealed beneath shared perspectives and underlying assumptions. In a subsequent study, Ardalan (2005) delves deeper into the influence of different epistemological paradigms on the use of mathematics in finance, emphasizing that the conceptualization of the relationship between quantitative models and financial reality is contingent upon the adopted paradigm. Similarly, Frankfurter and McGoun (1999) argue that financial epistemology is deeply embedded in ideological and value-laden frameworks, particularly those of a neoliberal orientation, thereby reinforcing the notion that conventional financial theories are not neutral but instead favour specific power structures. This ideological backdrop also shapes the interpretation of key phenomena, such as the scope and validity of the Efficient Market Hypothesis (Frankfurter and McGoun 2000).

Moreover, various authors emphasize the need to expand research methodologies in finance. Bettner et al. (1994) criticize the predominance of the quantitative approach, arguing that, on its own, it limits the ability to fully grasp the complexity of financial markets. Schinckus (2015) concurs with this critique, pointing out that, despite maintaining a positivist rhetoric, mainstream finance largely relies on a priori assumptions, such as the widespread use of the Gaussian distribution, that do not stem from rigorous empirical observation but rather from convenient methodological conventions. In this regard, Gippel (2013) suggests that the field of finance may be entering a period of extraordinary science in the Kuhnian sense, driven by emerging currents that integrate insights from psychology, evolutionary biology, neuroscience, and sociology, thereby challenging the dominant rationalist paradigm.

The 2007–2008 financial crisis underscored the need to reconsider the epistemological foundations of the discipline, particularly in light of the increasing complexity of financial markets. Datz (2013) argues that this complexity triggered not only a financial crisis but also an epistemological one,

with significant implications for how markets are understood and regulated. Davies and McGoey (2012) go further by examining the role of ignorance as a productive force in the crisis, positing that responses to extreme events should account for this factor as an essential component of economic analysis, rather than solely pursuing greater knowledge. Similarly, Erturk (2016) warns that regulatory practices targeting the shadow banking system may perpetuate fear and anxiety without necessarily addressing the underlying causes of financial instability.

In response to these challenges, fundamental changes have been proposed in the way finance is conceived and studied. For instance, Frankfurter (2006) introduces the Theory of Fair Markets, emphasizing the importance of upholding principles of equity and justice, rather than focusing solely on efficiency. Aligning with this critical perspective, Iquiapaza, Amaral, and Bressan (2009) highlight the emergence of alternative approaches, such as behavioural finance, which, despite being continuously challenged by the dominant paradigm, offer more holistic perspectives that are attuned to the plurality of financial behaviours. Similarly, Nawrocki and Viole (2014) stress the urgent need to adopt more flexible models that acknowledge the inherent irrationality and uncertainty of markets, moving away from the prevailing 'mathematical theory of everything' that dominates conventional finance.

Along the same lines, De Scheemaekere (2009) suggests that the mathematical complexity employed in finance closely resembles that of the natural sciences. However, due to the radical uncertainty inherent in the social sciences, financial models cannot accurately predict market dynamics. McGoun (1992) and McGoun and Zielonka (2006) emphasize the need to recognize finance as a theoretical construct that, rather than uncovering independent truths, generates consensuses that function as conventions. Riles (2010) further argues that markets are heavily dependent on legal and documentary structures, thereby challenging the presumed scientific autonomy of the discipline. From a broader perspective, Muniesa and Doganova (2020) highlight that finance not only manages resources but also actively shapes society's relationship with time and the future.

The global financial crisis also underscored the difficulty of implementing substantial changes within the discipline, as highlighted by Gendron and Smith-Lacroix (2015). Despite calls for greater paradigm diversification, financial research remains largely anchored in traditional approaches. In this regard, Lagoarde-Segot (2015) advocates for a diversification strategy that integrates disciplines such as history, geography, and political science, while Lagoarde-Segot (2019) proposes a shift toward critical realism that acknowledges human agency and the social contextualization of finance, particularly in response to sustainability imperatives. Moreover, Lagoarde-Segot and Paranque (2018) argue that the tension between finance and sustainability stems from the underlying ideologies embedded in mainstream financial theory. Consequently, they emphasize the necessity of a radical shift in perspective, one that redefines finance as a common good rather than merely a market-driven mechanism.

Taken together, this landscape underscores the need to critically reassess the epistemological foundations of finance. From the early functionalist perspectives that inspired Markowitz's Modern Portfolio Theory (MPT) and Fama's Efficient Market Hypothesis (EMH) to the growing influence of Shiller's Behavioural Finance (BF), the discipline has witnessed an ongoing debate regarding the nature and validity of its assumptions, methods, and objectives. This study situates itself within this discussion, aiming first to provide a detailed examination of the foundations and contributions of Markowitz, Fama, and Shiller, and subsequently to position them within a broader epistemological debate. In doing so, it seeks to contribute to a critical understanding of financial theory and to the identification of new pathways for research and practice in an increasingly complex and challenging economic environment.

Evolution of financial epistemology

Financial theory has evolved from multiple perspectives that seek to explain market dynamics, investor decision-making, and optimal resource allocation, with the most representative perspectives being those of Markowitz, Fama, and Shiller, which have shaped the contemporary understanding of finance. However, these perspectives present significant epistemological differences that

affect their applicability and validity in various economic contexts. Indeed, to date, they have not achieved a harmonious integration, generating debates about their limits and complementarities. Specifically, this article analyses how MPT provides quantitative tools for asset allocation but faces challenges in practical applicability; how EMH has been questioned due to observed anomalies in asset prices; and how BF has introduced a psychological dimension, though without developing a mathematical predictive framework as consolidated as the previous ones.

For this purpose, a theoretical-conceptual approach has been adopted based on a review of specialized literature, allowing for a rigorous evaluation of the interaction between rationality, uncertainty, and behaviour in financial markets. The relevance of this debate is not only theoretical but also practical, as it impacts the formulation of investment strategies, market regulation, and the development of more robust predictive models. Thus, this article contributes to the discussion on the need for hybrid approaches that integrate different traditions of financial thought to address the challenges of an increasingly complex and dynamic economic environment.

Modern portfolio theory

In the context of Markowitz's MPT, diversification is understood as a fundamental principle for optimizing financial performance against risk. Efficient asset allocation can be considered a practical application of methodological diversification in finance, where uncertainty about future returns motivates the distribution of resources among different assets (Kanaparthi 2024). During periods of volatility or lack of clarity in the markets, diversification becomes a key tool to minimize idiosyncratic risk and capitalize on the imperfect correlation between assets. For instance, during the 2008 global financial crisis, empirical evidence demonstrated that international diversification grounded in the imperfect correlation between assets played a crucial role in mitigating idiosyncratic risk. A study analysing foreign equity portfolios across 22 source countries and 42 destination markets between 2001 and 2009 found that, as market uncertainty increased, international investors actively rebalanced their portfolios toward stock markets exhibiting lower correlations with their domestic markets (Vermeulen 2013). This behaviour,

absent in periods of relative stability, intensified during the crisis, suggesting a deliberate strategy aimed at reducing exposure to market-specific shocks. Indeed, from a mean-variance optimization perspective, the findings revealed that such active rebalancing yielded substantial utility gains by lowering overall portfolio volatility without compromising expected returns.

When different asset classes have potential returns and risk levels that vary in a non-correlated or partially correlated manner, combining these in a portfolio can reduce the overall risk without significantly sacrificing expected returns. This approach underscores that it is more prudent to construct a balanced portfolio than to concentrate all resources in a single asset or asset class (Guerard 2011, p.646; Mondello 2023). The probability of achieving an optimal risk-adjusted return increases by adopting this diversified framework, especially in complex and uncertain markets where the interaction of multiple economic and financial factors makes relying on a single strategy less sustainable. As noted by Kanaparthi regarding MPT: 'unanticipated market shocks, changes in investor mood, or disruptions in the economy could put the viability of the suggested methods in jeopardy' (2024, p.170).

The justification for diversification within the framework of MPT transcends simple risk mitigation and suggests that constructing a diversified portfolio not only reduces volatility but also maximizes efficiency in terms of the relationship between risk and expected return (Mondello 2023), even when certain assets appear to excel in individual performance. In this regard, Koumou (2020) suggests that prudent diversification should consider four aspects: the law of large numbers, correlation, the capital asset pricing model, and the principles of risk contribution diversification. Rather than endorsing an all-in allocation to the highest-expected-return asset, a stance that presumes extreme risk neutrality, this approach aligns with portfolio theory (e.g., Markowitz, CAPM) and expected-utility maximization, both of which balance expected return and risk and therefore imply diversified, not fully concentrated, optimal choices.

Similarly, MPT posits that incorporating assets with different correlations into a portfolio allows for an overall optimization that exceeds expectations based on isolated decisions (Guerard 2011; Yeter and Garbatov 2021). This strategy not only mitigates unforeseen risks but also explores combinations of assets that

could yield more robust risk-adjusted returns. Empirical evidence based on 41.989 equities (approximately 6.6 million monthly observations) across 48 markets, 25 developed and 23 emerging, over 1995 to 2021 strongly corroborates this proposition. Focusing on dollar-denominated total returns and country and industry attributes, the study by Attig, Guedhami, Nazaire and Sy (2023) documents that international diversification has systematically outperformed industry diversification over the past twenty-seven years, not only mitigating idiosyncratic and unforeseen risks but also harnessing more favourable cross-market correlation structures. In particular, its benefits stem from attenuating exposures to market, political, and inflation risks, thereby yielding asset combinations with more robust risk-adjusted return profiles than those attainable through purely local or sector-specific selection. Thus, diversification is not merely a mathematical tool, but an epistemically rational choice that reflects a deeper understanding of the uncertainties and dynamics inherent in financial markets.

On the other hand, the epistemology of MPT goes beyond the idea that diversification is rational solely as a response to risk aversion. Indeed, even in situations where investors have homogeneous objectives and share similar interpretations of market data, the construction of a diversified portfolio may obey additional strategic dynamics, such as the pursuit of unexpected opportunities or the ability to adapt to changing conditions (Akkaya 2021; Varmaz, Fieberg, and Poddig 2024). For example, investors may include assets with low correlations in their portfolios for the benefits of diversification, one of which is enhanced flexibility in the face of abrupt market changes. Furthermore, opting for unconventional or less popular assets can offer competitive advantages, such as discovering market niches or generating unique returns that are not available to those who adhere exclusively to traditional strategies.

In fact, the evidence reported by Fang and Peress (2009) is compelling: using a broad NYSE sample (predominantly large caps) and 500 NASDAQ firms from 1993 to 2002, and excluding stocks priced below USD 5 to avoid illiquidity and bid–ask bounce biases, Fang and Peress document a return premium for stocks with no media coverage that persists even after controlling for standard risk factors (market, size, book-to-market, momentum, and liquidity). On average, uncovered stocks outperform covered ones by more than 0.20% per month, and

this differential widens to 0.65 to 1% per month in segments typically disfavoured by consensus, namely small caps with high retail participation, low analyst coverage, and elevated idiosyncratic volatility, precisely the type of opportunities illustrating how 'unpopularity' can translate into distinctive returns and a selection advantage over conventional portfolios. Thus, diversification, within the framework of MPT, is not only a tool for reducing risk but also a strategic decision that reflects both individual rationality and an adaptation to the complexities and opportunities of the financial environment.

This adaptive approach reflects a collective rationality where the efficient allocation of assets does not solely imply the maximization of classic financial metrics, but also the consideration of contextual and strategic factors. These factors, being absent in the theoretical framework of MPT, constitute one of its main weaknesses:

'Portfolios generated based on the Markowitz theory are mathematically correct but deliver no feasible results in practice. The method generally overweighs assets with high estimated returns, negative correlations and small variances. Experience shows that portfolios often generate higher losses than expected because the MPT does not cover extreme risk scenarios which happen more frequently than expected. It also systematically underestimates the risk of loss and overestimates the opportunity for gain. Furthermore, it fails to protect against risk stemming from diversification, especially in times of turbulent markets. The assumption of a normal distribution of returns does not correspond to reality. Extreme price movements occur much more frequently than the normal distribution suggests. Therefore, the risks of loss tend to be systematically underestimated, and profit opportunities are rather overestimated as in reality volatility and correlations strongly deviate from theoretical assumptions. Thus, despite its scientific foundation, the MPT is not very widely used in practical operations within financial services, and its acceptance within asset management is rather limited' (Meier and Danzinger 2022, pp. 201-202).

Although including assets with low correlation or investing in emerging markets may seem suboptimal in the short term, in the long term, it could generate valuable opportunities and enhance stability. In this sense, MPT invites

theorists to revisit the traditional notion of diversification as a tool exclusively oriented toward risk and to explore its potential from a framework that promotes more robust and adaptive collective decisions in the complexity of modern financial markets.

Many scholars in the field of financial theory have expanded on Markowitz's ideas (for example, Tobin 1958; Sharpe 1964; Lintner 1965; Mossin 1966; Black and Litterman 1991), suggesting that diversification can have benefits that extend beyond reducing individual risk. For instance, the Capital Asset Pricing Model (CAPM), developed by Sharpe, Lintner, and Mossin, is based on this idea and adds dimensions such as systematic risk and the expected market return. Likewise, these frameworks highlight that diversity in portfolios can arise even within communities of investors who share similar objectives but have different assumptions about asset correlations or return expectations. This latter point is consistent with the ideas of Black and Litterman (1991), who introduced ways to incorporate investor expectations into the portfolio optimization process.

In addition to the above, during the evolution of asset allocation models in the second half of the 20th century, alternative approaches such as the incorporation of international assets or the integration of macroeconomic factors significantly contributed to expanding the framework of Markowitz (Tamiz, Azmi, and Jones 2013; Claessens and Kose 2018). Furthermore, it has been argued that financial regulators and fund managers have the responsibility to ensure that diversified approaches are not prematurely discarded in favour of simpler strategies. Unlike proponents of passive portfolios, Markowitz does not share the view that optimal diversification occurs automatically in the markets. Instead, he emphasizes that diversification is a powerful but complex analytical tool, whose success depends on the interaction between the investor's judgment and the specific characteristics of the selected assets.

Furthermore, from a critical perspective, Robiyanto, Nugroho, and Lako (2020) and Liagkouras, Metaxiotis, and Tsihrintzis (2022) highlight that traditional approaches of MPT fail to address the morally and socially significant challenges that emerge in the management of diversified portfolios. Indeed, by emphasizing the mathematical optimization of risk and return, these approaches often overlook how some non-financial factors (such as social or environmental

priorities) can influence investment decisions. It follows that the pursuit of return maximization can sometimes perpetuate business practices that exacerbate global problems like inequality or climate change, questioning the role of MPT in a world increasingly oriented towards sustainable investment.

These challenges align with broader ethical criticisms directed at traditional financial models, which suggest that integrating environmental, social, and governance factors into portfolio construction could be a necessary step towards a more inclusive MPT. In any case, MPT remains 'a standard topic in college courses and texts on investments' (Guerard 2011, p. 656).

Efficient market hypothesis

In the epistemology of finance, both the EMH and the MPT reveal underlying differences in their epistemological and economic foundations. The EMH posits that asset prices reflect all available information, whereas the MPT focuses on diversification as a strategy to optimize the relationship between risk and return. Likewise, in debates on informational efficiency, the EMH highlights the tensions between predictive accuracy and the frictions observed in real markets. Using panel data from 735 listed manufacturing firms across five South Asian emerging economies (2008–2024), Khan, Shoaib, Aftab, Yasir, and Saeed (2025) show that conventional asset-pricing models tend to overestimate expected returns when financial frictions are ignored. Once these frictions are incorporated, abnormal returns and alpha values decline sharply, suggesting that much of the previously observed predictive skill or excess performance was, in fact, an artifact of unaccounted transactional and financing constraints.

This evidence reinforces the EMH's contention that while prices may reflect available information in theory, the presence of structural frictions such as liquidity limits, capital restrictions, and market inefficiencies significantly constrains investors' ability to translate predictive insights into superior realized returns. Similarly, the MPT faces debates between purely quantitative theoretical approaches and practical applications that account for the inherent uncertainty in asset correlation. Thus, both perspectives demonstrate how epistemological foundations can influence the construction and evaluation of analytical frameworks in finance.

Neither of these two perspectives is fully validated by empirical evidence, and both rely on assumptions that reflect distinct epistemological issues. Fama's proposal emphasizes the rationality of agents and the ability of markets to reflect all available information in prices (Schwert 2023), whereas Markowitz's approach highlights the importance of diversification as a response to uncertainty and asset correlations (Zhang, Wu, Zhang, and Chen 2022).

These underlying issues influence their respective criteria for success: the EMH prioritizes simplicity and predictability, assuming that markets operate efficiently without intervention, whereas MPT addresses complexity by seeking optimal asset combinations to balance risk and return. Thus, both perspectives illustrate how epistemological assumptions can shape complementary, though sometimes contradictory, approaches within financial theory, providing different tools for understanding and acting in markets. Although distinct in their approaches, both perspectives share a commitment to financial optimization but diverge in how they conceptualize challenges and solutions in markets.

Markowitz's perspective on diversification, grounded in MPT, provides a useful framework for contrasting its approach with Fama's EMH. The former focuses on optimizing asset combinations to maximize expected returns for a given level of risk, emphasizing the importance of diversification in reducing volatility. This leads to the construction of efficient portfolios that minimize unsystematic risk through the careful selection of low-correlation assets (Yeter and Garbatov 2021). The latter posits that asset prices reflect all available information, implying that it is impossible to consistently achieve returns above the market average based on public information analysis. Consequently, price movements follow a random walk, making the prediction of future trends inherently uncertain (Nonejad 2024).

Now then, what criticisms revolve around the EMH perspective regarding the rationality of agents? It has already been noted that asset prices reflect not only the explicit information processed by investors but also implicit assumptions that may be influenced by aspects not consciously recognized. These underlying assumptions do not need to be intentional or conscious to influence market behaviour. Thus, the apparent efficiency of markets may be encoded in assumptions that prioritize certain interpretations of investor behaviour over

others. For instance, by assuming that asset prices fully reflect all available information, a model of rational behaviour is privileged, potentially overlooking factors such as cognitive limitations or the emotional dynamics of agents.

The study by Rabbani, Azam, Hawaldar, Aljalahma, and Dsouza (2024) on G7 stock markets empirically illustrates the central tension within the EMH between the assumption of rationality and the actual behaviour of investors. Based on daily data from 2015 to 2021 and employing vector autoregressive models with impulse response functions, the study provides robust evidence of overconfidence bias, particularly in the Canadian and Italian markets. This bias reveals that cognitive limitations and emotional dynamics influence investment decisions and lead to temporary deviations from informational efficiency.

In line with the above, both rational and irrational agents may unconsciously rely on these value-laden assumptions without being fully aware of how they influence their reasoning or the broader implications of their decisions. In this sense, the EMH remains susceptible to being reconfigured in a way that also reflects a worldview imbued with subjective connotations that warrant critical scrutiny. Therefore, if the hypothesis that efficient markets fully reflect all available information, as Eugene Fama asserts, is correct, then financial epistemologists must address how the underlying assumptions of this hypothesis can be managed within financial analysis and regulatory processes.

To address this challenge, several principles have been proposed to enhance the critical evaluation of the foundations of the EMH: (i) incorporating concepts borrowed from other fields of knowledge, an excellent example of this eclectic approach is Lo's Adaptive Markets Hypothesis (2004, 2005), (ii) fostering feedback from behavioural (Bloomfield 2010) and regulatory perspectives (Ford 2010), (iii) maintaining evaluation standards based on empirical data (Mauboussin 2002), and (iv) balancing the influence of economic schools of thought in research and policy formulation (Willett 2010).

These principles are essential for fostering objectivity within the debates on the EMH as they enable a transformative review of its assumptions. Such a review involves critically analysing the validity of informational efficiency claims, examining how market anomalies challenge these assumptions (Jegadeesh and Titman 1993; Zacks 2011), and considering adjustments that reflect behavioural

dynamics or institutional frictions. By integrating these practices, the epistemic nature of the EMH as an analytical framework can be strengthened, while simultaneously enhancing its ability to adapt to the complexity and evolution of financial markets.

The Efficient Market Hypothesis (EMH) not only considers different sources of information and analytical methodologies but also emphasizes the inclusive participation of individuals from diverse backgrounds. Thus, the concept of epistemic equality is highlighted, that is, academics and professionals who study and apply the EMH are characterized by their diverse cultural, social, and professional origins, bringing different approaches to 'narrow the distance between theory and the reality of the financial system' (Bocher 2022, p. 36). This epistemic equality is understood as a balance between recognizing technical expertise and allowing the critical contribution of those with alternative perspectives. While some participants may have more advanced technical knowledge, this equality ensures that everyone can question assumptions, provide feedback, and propose different interpretations of market efficiency. This approach is crucial in preventing the dominance of views influenced by prevailing financial or political interests and in enriching critical analysis through a plurality of perspectives.

From this perspective, the EMH can epistemically benefit from well-integrated social diversity, as the underlying assumptions of efficiency and rationality in markets are more likely to be recognized and critically evaluated when participants come from diverse backgrounds. Ultimately, this fosters a more robust and dynamic debate environment, which is essential for addressing the complexities and limitations inherent in the EMH framework. Moreover, Fama's perspective has been positively received not only in academic circles but also in broader debates on financial and regulatory policies. For instance, it has been invoked to justify measures that promote transparency in financial information disclosure (Roscoe and Willman 2021) and to encourage the participation of various stakeholders, such as regulators, institutional investors, and retail investors (Abad, Díaz, Escribano, and Robles 2018), to ensure that information is widely disseminated and reflected in market prices.

The EMH has also faced other significant criticisms. On one hand, some scholars argue that it fails to fully capture market anomalies (Peón, Antelo, and Calvo 2019), which can be epistemically valuable for understanding dynamics such as speculative bubbles (Szafarz 2012) or the impact of behavioural biases (Lo 2005). On the other hand, there is concern that the emphasis on mathematical modeling may marginalize ethical or social considerations that could enrich financial practices, potentially creating tensions between traditional economic objectives and societal demands for sustainability and equity. 'A model can also be a way to understand what assumptions (conditions) are needed in order to obtain certain consequences in a market. In this case, the ethical problem of the use of mathematics in finance becomes central because performativity and reverse finance put us in front of a new scenario, that is, the possibility to push a market to produce certain consequences by means of the introduction and dissemination of certain models and their initial conditions' (Ippoliti 2021, pp. 779-780).

The first critique, focused on the limitations of epistemic access, highlights the tension between the core assumption of the EMH and the actual dynamics of financial markets. While the EMH posits that asset prices reflect all available information, the process by which information is incorporated into prices depends on actors who face costs associated with acquiring and processing information. Consequently, this dependency introduces a paradox: if all market participants assumed that prices were fully efficient, there would be no incentives to seek information, ultimately undermining market efficiency itself. However, proponents of the EMH argue that any inefficiency is marginal and quickly corrected, whereas critics contend that inefficiencies, such as transaction costs and irrational behaviours, can lead to persistent anomalous outcomes. This debate thus underscores the need to reassess how efficiency assumptions are defined and applied in complex and dynamic financial contexts.

The second critique, focused on the challenges posed by the practical limitations of the EMH, suggests that the efficiency assumption may inadvertently exclude perspectives that question the perfect rationality of financial markets. While the EMH provides a framework for understanding how prices reflect available information, its uncritical acceptance may be leveraged by certain market actors to justify practices that perpetuate economic or social inequalities. For instance, large financial institutions could exploit their preferential access to information

to reinforce competitive advantages that are inaccessible to smaller or less connected participants. The study by Bushee and Goodman (2007) provides strong empirical evidence in support of this claim.

Analysing data from the SEC's Form 13F [1] between 1983 and 2004, Bushee and Goodman demonstrate that institutions managing more than 100 million USD are capable of executing profitable trades based on private information about earnings and future returns. By introducing specific indicators that measure the magnitude and nature of institutional positions in each firm, the study uncovers consistent patterns of informed trading, showing that these institutions not only possess superior information but also act upon it before it becomes fully incorporated into market prices. Consequently, their strategic decisions reinforce a structural information asymmetry that consolidates their competitive power relative to investors with more limited access to or capacity for processing information. This dynamic creates a tension between the EMH's theoretical goal of fostering more transparent markets and its potential to reinforce structural inequities, thereby consolidating positions of financial power while excluding those actors unable to bear the high costs associated with acquiring information. This presents a dilemma: while the EMH aspires to be an egalitarian model in its theoretical foundation, in practice, it may generate anti-egalitarian outcomes that contradict its fundamental assumptions.

'Rather than viewing the failures of efficient market theory as a severe blow to economics and finance theory, I believe we should view them as an exciting and challenging opportunity for research to improve our understanding of market behaviour. Recognition that financial markets do not always behave fully efficiently is not an end, it is a beginning. And one in which efficient markets theory should not be scrapped– it just needs to be dethroned from the position of being the only view worth considering' (Willett 2010, p. 194).

The previously discussed issues highlight the need for the continuous refinement of Fama's perspective so that it can integrate and assess not only new methodological approaches but also the social and political dynamics that influence its applicability in globalized financial markets.

Behavioural finance

Robert Shiller's theory of BF has garnered significant interest among researchers, partly due to its innovative approach that integrates psychological factors into financial analysis (Shefrin 2002), partly because of its strong empirical foundation based on historical market data (Zhao, Zhang, Wu, and Coyte 2023), and partly because Shiller addresses behavioural patterns observed in investors' decision-making, in contrast to the rational assumptions that prevail in Markowitz's MPT and Eugene Fama's EMH. These elements significantly contribute to the widespread attention given to Behavioural Finance, particularly in academic settings where multifaceted explanations of market fluctuations are valued over the more mathematical perspectives that dominate traditional finance schools.

In recent years, Robert Shiller's perspective on BF has garnered increasing interest in the United States, partly due to the growing concern among American economists and psychologists regarding the psychological foundations of financial decision-making and partly due to the receptiveness of financial analysts and investment professionals. These professionals have shown particular interest from the outset, especially because a significant portion of Shiller's work integrates empirical observations of market anomalies that challenge traditional assumptions (Zhao, Zhang, Wu, and Coyte 2023). However, the scope of interest has expanded considerably and is no longer confined solely to the United States (Willett 2022). This increased focus on BF contrasts with the perspectives of Markowitz and Fama, as it represents a paradigmatic shift toward incorporating human psychology into financial models and theories.

Indeed, within Shiller's framework of BF, investor behaviour is determined by a complex interaction of psychological factors and market sentiment (Hui, Dong, Jia, and Lam 2017), analogous to the activation of specific cognitive centres within the human psyche. Within this framework, there is a continuous accumulation of psychological events that partially shape financial decision-making. Thus, when investors encounter certain market stimuli, such as economic indicators or news events, these stimuli trigger investment actions that may deviate from the predictions of purely rational models (Bybee, Kelly, Manela, and Xiu 2024). Therefore, unlike the perspectives of Markowitz and

Fama, Shiller's perspective acknowledges that investor behaviour is influenced by emotions, heuristics, and irrational exuberance.

The BF perspective allows for the coordination of investment decisions independently of the strictly mathematical principles underlying traditional financial theories, which can even lead to the emergence of financial bubbles. This latter idea has been explicitly articulated by Shiller himself in his definition of the concept of a bubble: 'A situation in which news of price increases spurs investor enthusiasm which spreads by psychological contagion from person to person, in the process amplifying stories that might justify the price increases and bringing in a larger and larger class of investors, who, despite doubts about the real value of an investment, are drawn to it partly through envy of others' successes and partly through a gambler's excite' (2014, p. 1487). This implies that when market conditions do not align with the expected rational stimuli, specific psychological events can lead to unexpected market movements and deviations from equilibrium. Moreover, the more frequently these psychological events occur, the more easily and intensely they can trigger investor actions, potentially resulting in more significant and often unpredictable fluctuations in financial markets.

For example, when investors perceive an increase in market optimism, this heightened sentiment can lead to a greater propensity to invest (Scherbina 2001; Shiller 2014). In other words, the accumulation of positive sentiment lowers the threshold for investment actions, thereby facilitating more aggressive market participation. This behaviour operates independently of the purely rational calculations advocated by Markowitz and the information efficiency proposed by Fama, highlighting how psychological factors can lead to market anomalies such as bubbles and crashes, phenomena that traditional financial theories may not adequately explain.

In Shiller's perspective on Behavioural Finance (BF), the entirety of investor behaviour, including cognitive biases, emotional responses, and social influences, revolves around the concept of market sentiment (Frydman, Mangee, and Stillwagon 2021). This sentiment drives financial decision-making independently of purely rational calculations and influences investor behaviour by manifesting in specific financial actions, such as the buying or selling of

assets. As López-Cabarcos, Pérez-Pico, and López (2020) highlight, sentiment operates as an aggregated psychological state functioning as a non-fundamental variable in asset valuation. For instance, when sentiment is elevated, it tends to be associated with overconfidence, speculative trading, and heightened volatility, often anticipating lower subsequent returns. Moreover, its influence is now amplified through social media and digital platforms, intensifying price dynamics driven more by noise than by information. It is crucial to recognize that, according to Shiller, the objective of this behaviour is not merely to secure financial gains or avoid losses, but to engage in the very act of investing itself (Shiller, 2003). In other words, the behavioural impulses are fulfilled not through the direct outcomes of investing, such as portfolio growth or risk reduction, but through participation in the investment process per se.

The evidence synthesized by López-Cabarcos et al. (2020), Fink (2021), and Bihari, Dash, Kar, Muduli, Kumar, and Luthra (2022) converges on the view that cognitive biases, among them overconfidence, the disposition effect, anchoring, availability, confirmation, representativeness, and herding, systematically distort investment decision-making and, in the aggregate, erode the informational efficiency of markets. These biases induce over- and underreactions to new information, delays in price adjustment, and the persistence of prior beliefs (conservatism), thereby pushing prices away from fundamental value and giving rise to anomalies such as bubbles, sudden crashes, and calendar-based patterns (e.g., the Monday effect, commonly referred to as the Weekend effect, which denotes the tendency for returns on Mondays to be lower and often negative compared to those observed on other weekdays).

At the micro level, the disposition effect prompts premature sales of winners and the retention of losers, generating buy/sell pressures that feed inefficient price paths; anchoring and availability cause salient (though not necessarily relevant) signals to dominate information processing; and herding coordinates behaviour in the same direction, making markets more prone to persistent deviations (Bihari et al. 2022). Such patterns violate the rationality and homogeneous-expectations assumptions of the EMH, so that prices do not fully reflect available information; over- or undervaluation and delayed or excessive reactions are observed, and the statistical predictability of returns increases (Fink 2021). Finally, distinguishing between cognitive biases (errors of reasoning and

memory) and emotional biases (e.g., loss aversion, regret avoidance, self-attribution, framing, self-control) helps explain how, under limited arbitrage, both classes of bias degrade the quality of the price formation process and generate observable inefficiencies in returns, volatility, and portfolio composition.

The above is particularly evident when contrasting Shiller's approach with Markowitz's Modern Portfolio Theory and Fama's Efficient Market Hypothesis, as Shiller emphasizes the role of irrational behaviour and psychological factors in market dynamics (Shiller 2003). For instance, during periods of heightened market optimism, investors may exhibit greater confidence and a propensity to invest more aggressively, driven by accumulated positive sentiment rather than objective financial indicators (Shiller 2014). This behaviour can lead to asset price bubbles that neither Markowitz's nor Fama's models adequately explain, as both assume rational behaviour and the efficient processing of information.

Shiller, on the other hand, introduces the concept of 'animal spirits', a term originally coined by Keynes to describe the emotional and psychological motivations that drive investors to make decisions deviating from purely logical analysis. These animal spirits contribute to the complexity of financial actions, emerging from a combination of innate tendencies and learned responses. Indeed, Shiller acknowledges that investor behaviour is influenced by a variety of factors, including overconfidence, herd behaviour, and cognitive biases (Akerlof and Shiller 2010). This multifaceted approach underscores the limitations of traditional financial theories by highlighting that market movements cannot be fully understood without considering the underlying psychological drivers.

A comparative analysis of Markowitz, Fama, and Shiller

Zhang, Wu, Zhang, and Chen (2022) point out that, according to Markowitz, the sustainability of diversified portfolios in financial markets can be optimized by understanding the correlations among assets and their impact on overall performance. Moreover, the value of diversification, according to MPT, does not merely lie in the inclusion of a variety of assets but in strategic diversification

based on changing correlations. These correlations represent relationships between assets that are stable enough to allow for the construction of efficient portfolios in the short term but may shift due to market dynamics, necessitating periodic re-evaluation of portfolio composition (Kwapień, Drożdż, and Oświe 2006).

That strategic diversification must also be dynamic, as the same apparent stability in correlations that benefits an initial portfolio can lead to excessive risk exposure if market conditions change. Thus, MPT emphasizes that investors must not only identify asset combinations that minimize volatility but also be prepared to adjust their strategies as asset relationships evolve and new opportunities emerge in global markets. This approach underscores the importance of balancing the initial exploration of assets with the ability to adapt to structural changes in the market.

Now then, in the context of the EMH, it is noteworthy that irrational behaviours [2] and market frictions, such as transaction costs, taxes, or regulatory constraints, are not included (Fakhry 2016), whereas MPT introduces the complexity of asset correlations, challenging the assumption that markets always function optimally (Fabozzi, Gupta, and Markowitz 2002). In other words, while Fama prioritizes informational efficiency as a theoretical ideal, Markowitz emphasizes the need for pragmatic tools to address uncertainty and optimize decision-making in a dynamic financial environment. These differences enrich financial theory by offering complementary perspectives on market dynamics, ultimately strengthening both Fama's EMH framework and Markowitz's MPT by highlighting their respective strengths and limitations.

In the case of the EMH, some criticisms highlight its difficulty in explaining market anomalies such as speculative bubbles or excessive reactions to new information, which may encourage theorists to refine their models by incorporating behavioural elements that challenge the notion of fully rational markets. On the other hand, within the framework of MPT, critical debate may focus on the model's reliance on historical correlations and stable asset behaviour, leading to adjustments that account for structural and complex changes in markets. Although criticisms of both perspectives do not necessarily aim to refute their conceptual foundations, their epistemic value lies in clarifying

and justifying their assumptions, thereby improving their applicability and scope across different contexts. This process of critical debate prevents both EMH and MPT from becoming crystallized as absolute truths and instead positions them as dynamic and complementary perspectives within a broader and more robust financial epistemological framework. By incorporating Shiller's BF perspective into this analysis (see Table 1), a holistic and comparative view of the three perspectives examined in this article is achieved.

Table 1 A comparison between three financial perspectives

Dimension	Modern Portfolio Theory (Markowitz)	Efficient Market Hypothesis (Fama)	Behavioural Finance (Shiller)
Unit of analysis	The investment portfolio, which is managed considering correlations, overall performance, risk optimization, and diversification.	The price of assets and their reflection of the information available in the market.	Investor behaviour, which is explained by psychological biases, herd mentality, and irrational exuberance.
Ontological Positioning	Assumes that markets are quantifiable and, therefore, dynamic correlations between assets and uncertainty can be statistically modelled to seek optimization.	Presupposes the existence of sufficiently perfect markets where prices almost immediately reflect all relevant information.	Recognizes that markets are complex systems, influenced by cognitive and emotional factors that affect price formation.
Epistemological Positioning	Empirical and positivist, based on statistical modelling of returns and risks using probabilistic inference.	Positivist, relies on the observation of market prices and empirical tests of efficiency, assuming that 'the market knows all'.	Interdisciplinary, incorporating elements of psychology to explain phenomena that do not fit within purely rational frameworks.

Dimension	Modern Portfolio Theory (Markowitz)	Efficient Market Hypothesis (Fama)	Behavioural Finance (Shiller)
Methodological Positioning	Utilizes mathematical models for optimization and analysis of historical correlations between assets.	Based on statistical and econometric analysis to assess the capacity of prices to incorporate information.	Applies both qualitative and quantitative methods to identify patterns of biases or irrational attitudes and capture the complexity of investor behaviour.
Axiological Positioning	Primarily normative in prescribing how investors should diversify to maximize risk-adjusted returns.	Normative in that it conceives prices as the correct reflection of available information, legitimizing rationality and efficiency.	Descriptive/Critical as it focuses on describing current behaviour rather than prescribing it and questions existing assumptions.
Strengths	Provides concrete and widely used tools for portfolio management, clarifying the importance of correlations and their impact on the overall volatility of the portfolio.	Offers a robust unifying framework that largely explains price formation, enabling verifiable predictions.	Incorporates human fallibility and challenges the supposed perfect rationality by highlighting the influence of factors not purely economic.
Weaknesses	Relies on historical correlations that may not be stable over time, thus failing to explain phenomena such as speculative bubbles or collective irrationality.	Since it overlooks market frictions and irrational behaviours, it struggles to explain anomalies and episodes of high volatility, euphoria, or collective panic.	Introduces greater complexity by depending on multiple psychological assumptions, which makes it easier to critique any of its premises.

Dimension	Modern Portfolio Theory (Markowitz)	Efficient Market Hypothesis (Fama)	Behavioural Finance (Shiller)
Interdisciplinary Conversation	Strongly linked with statistics, econometrics, and quantitative analysis to measure and optimize risk.	Engages with microeconomics, econometrics, information theory, and signalling theory.	Interacts with psychology, sociology, and increasingly with neuroeconomics and data science.
Individual Rationality	Assumes that the investor is rational in optimizing their portfolio but acknowledges that information and correlations are changeable.	Presumes almost perfect rationality, thus investors use all available information and adjust their decisions efficiently.	Highlights the limited rationality of investors, given that they are influenced by cognitive and emotional biases.
Market Characteristics	It is an environment where investors can model the risk-return relationship through dynamic correlations by periodically reassessing in response to structural changes.	It is an efficient system where prices fully and rapidly reflect available information, thus ignoring or minimizing the effects of transaction costs, taxes, and prolonged irrational behaviours.	It is influenced by psychological and cultural factors, with possibilities of anomalies, bubbles, and sharp falls, where price formation is not always rational, deviating from fundamental values for extended periods.

Source: Own elaboration.

Table 1 highlights several aspects that merit further consideration. Indeed, to compare the perspectives of Robert Shiller, Harry Markowitz, and Eugene Fama, it is essential to employ a rigorous analytical framework that allows for the evaluation of their respective fundamental assumptions and logical coherence. Shiller's approach challenges the rational agent model inherent in both Markowitz and Fama by introducing psychological biases and market sentiment (Shiller 2003; Shiller 2014) as critical determinants of investor behaviour and asset prices. Specifically, while Markowitz's theory is based on the premise that

investors seek to optimize their portfolios through diversification to maximize expected returns for a given level of risk (Mondello 2023), and Fama's hypothesis asserts that asset prices fully reflect all available information (Schwert 2023), Shiller posits that irrational exuberance and herd behaviour can lead to persistent deviations from fundamental values (Shiller 2005; King and Koutmos 2021).

Using the rules of logical inference (Ghasemi, Handley, and Howarth 2022; Kilienė and Norvaiša 2022), according to *modus ponens*, one could argue that if behavioural biases exist (premise), then markets cannot be perfectly efficient (conclusion). However, applying *modus tollens* to this argument reveals that if markets are observed to be efficient, then behavioural biases cannot fully explain investor behaviour, necessitating a reassessment of Shiller's assumptions. This underscores the logical tension among the three perspectives: while Markowitz and Fama provide an elegant and empirically robust mathematical framework supported by rationality and informational efficiency (Fama 1970; Markowitz 2005), Shiller offers a complementary perspective that accounts for anomalies and psychological factors overlooked by these traditional models. This synthesis not only addresses the limitations identified through logical scrutiny but also enriches the theoretical landscape by bridging the gap between quantitative rigor and the qualitative nuances of human behaviour. In other words, the comparative analysis of Shiller, Markowitz, and Fama's perspectives highlights the need to incorporate psychological dimensions to achieve a holistic and logically consistent framework for analysing and predicting market dynamics

Shiller argues that multiple psychological factors must coexist to explain market phenomena such as bubbles and crashes. This makes his arguments more susceptible to refutation, as disproving any individual psychological assumption, such as the presence of herd behaviour, can undermine his entire explanatory framework. In contrast, the theories of Markowitz and Fama employ an approach in which the fulfilment of any one of several sufficient conditions (e.g., rational investor behaviour in Markowitz's model or informational efficiency in Fama's model) can lead to the desired outcome of optimal portfolio performance or market equilibrium. Consequently, refuting these traditional theories requires disproving all sufficient conditions, a task that is significantly more

challenging. This distinction highlights the relative ease with which BF can be critiqued compared to the more robust traditional models.

It is worth noting that there is still no definitive logical structure that ensures the full integration of BF within established paradigms:

> Behavioural finance is a relatively new but quickly expanding field that seeks to provide explanations for people's economic decisions by combining behavioural and cognitive psychological theory with conventional economics and finance. Fuelling the growth of behavioural finance research has been the inability of the traditional expected utility maximization of rational investors within the efficient markets framework to explain many empirical patterns. (Baker and Nofsinger 2010, p. 3)

Specifically, there is no argumentative framework capable of making a valid transition from the singular behavioural assumptions postulated by Shiller to the general conclusions upheld by MPT or the EMH with the certainty provided by *modus ponens*. This inherent limitation implies, from my perspective, that distinguishing between the psychological foundations of investor behaviour and the mathematically driven assumptions of Markowitz and Fama does not resolve the fundamental issues of theoretical coherence and predictive sufficiency.

Given the above, while Shiller's BF provides valuable explanatory power for market anomalies and investor irrationality (Shefrin 2002; Bybee, Kelly, Manela, and Xiu 2024), it cannot unilaterally guarantee the sufficiency of its explanatory scope within the finite set of established financial theories. This epistemological boundary necessitates a more nuanced approach that goes beyond mere differentiation, encouraging scholars to explore integrative methodologies that reconcile behavioural factors with traditional financial principles. Consequently, the effort to synthesize BF with modern frameworks of portfolio optimization and market efficiency must extend beyond the simple juxtaposition of positive and normative elements, adopting instead a more holistic and robust paradigm that accommodates the complexities of human behaviour within financial markets.

It is worth noting that Shiller's BF does not seek to invalidate the principles of portfolio optimization or market efficiency but rather to complement them by incorporating the complexities of human behaviour. This integrative approach

underscores the need to consider both quantitative and qualitative factors in financial analysis, providing a more comprehensive understanding of market movements and investor behaviour. Thus, the comparison between Shiller's BF, Markowitz's MPT, and Fama's EMH illustrates the evolving landscape of financial theory, where the interaction between rational models and behavioural perspectives enriches the discourse and enhances the explanatory power of economic frameworks.

For the purpose of comparing the perspectives of Shiller, Markowitz, and Fama, each can be considered an argument supporting specific propositions or predictions about financial markets (Brav, Heaton, and Rosenberg 2004). As such, these perspectives can be regarded as consistent only within a conjunction of assumption statements, where each statement is postulated as true. As noted by Besnard and Hunter (2001), for an argument to be sufficient, it must operate within a deductive framework, meaning that some assumptions must be general statements that support the conclusions. However, without an inductive logic that substantiates the generalization of specific assumptions into broader conclusions, the methodological challenges faced by traditional economic theories remain unresolved. Consequently, the question arises: when can a financial theory be assumed to be accurate?

These are the challenges that Shiller's BF seeks to address by integrating psychological insights with conventional financial models. In fact, unlike Markowitz or Fama, Shiller introduces assumptions about cognitive biases, herd behaviour, and emotional influences that drive market anomalies (Shiller 2003, 2005, 2014). This makes his approach multifaceted, complicating the deductive structure of financial theories, as the interaction between behavioural factors and traditional assumptions requires a more nuanced logical framework. Consequently, assessing the validity of BF involves not only evaluating the truth of its individual assumptions but also understanding how these assumptions interact to produce the observed market phenomena.

These complexities underscore the need for Shiller's theory to evolve toward a more sophisticated integration of behavioural elements to adequately explain deviations from the predictions of MPT and the EMH. In this regard, the comparative analysis of Shiller's BF outlined in this article highlights the

intricate balance between psychological realism and mathematical rigor, illustrating both the challenges and the potential of developing a comprehensive theory that captures the full spectrum of investor behaviour and market dynamics. Although this integration of behavioural insights into financial models will become increasingly crucial, the stability and applicability of BF will depend on several factors, including the availability of comprehensive psychological data, the development of robust empirical methodologies, and the ability to mitigate cognitive biases in investment decision-making processes.

In line with the above, the acquisition of behavioural data at low cost and the use of advanced analytical techniques, such as machine learning and big data analysis, can play a crucial role in advancing BF by providing deeper insights into investor behaviour patterns and sentiment indicators. Furthermore, fostering interdisciplinary collaboration between finance and data science is essential to overcoming the limitations of purely quantitative models and proposing new solutions to the most pressing challenges in financial markets. As noted by Ioachimescu and Shaker (2025), data science finds application in diverse industries, 'from finance and healthcare to technology and beyond, where the objective is to transform raw data into actionable intelligence for improved decision-making and problem-solving' (p. 11). The synergy between BF and traditional theories will likely lead to more resilient and adaptable financial models, capable of addressing the dynamic and often unpredictable nature of global financial markets.

Conclusion and future research directions

The epistemology of finance, conceived as the study of how knowledge is generated, validated, and applied in markets, has advanced significantly thanks to the perspectives offered by MPT, the EMH, and BF. However, while the analytical richness of each of these perspectives provides valuable insights, it also exposes their limitations and leaves open the possibility for a more robust synthesis. The following outlines four key contributions highlighted in this article, which collectively reveal a more complex yet also more promising horizon for financial research and practice.

The epistemological complementarity

The comparative analysis of Markowitz, Fama, and Shiller reveals that no single theory fully captures the dynamic nature of markets. While MPT underscores the importance of diversification based on correlations and the EMH emphasizes informational efficiency, BF posits irrationality and the psychological dimension as determining factors. Recognizing that bounded rationality and cognitive biases can influence markets as much as mathematical foundations or efficiency conditions makes it clear that these theories should not be viewed in absolute opposition but rather combined to enrich the understanding of market phenomena. The integration of these perspectives is not merely a summation of parts; it requires the construction of logical and methodological bridges that expand explanatory scope, particularly in contexts of uncertainty and volatility.

The need for a holistic and interdisciplinary approach

Financial epistemology is not solely concerned with the truth of hypotheses but also with how professional and academic communities use, adapt, and ultimately transform them. This underscores the importance of enriching financial theory with approaches from other disciplines, such as psychology, sociology, neuroeconomics, and even data science, that introduce new methods and research questions. The potential of these interdisciplinary approaches lies in their ability to reveal dynamics that are not captured by purely quantitative models or by theories that assume efficiency as a fundamental premise. This interdisciplinary openness does not seek to overturn the canonical findings of Markowitz or Fama but rather to strengthen them by illuminating blind spots that, if left unaddressed, limit the predictive effectiveness and practical relevance of their frameworks.

Building on the work of Peffers, Tuunanen, Rothenberger, and Chatterjee (2007), renowned for their methodology to structure complex research and application processes within the field of Design Science, this study proposes a holistic and interdisciplinary approach to finance composed of six interrelated phases: problem identification, objective definition, design and development, demonstration, evaluation, and communication. This approach not only motivates the pursuit of a new theoretical framework in finance but also enables

a deeper understanding of the reasoning underlying the identification of the epistemological problem. Moreover, it ensures that each of the six stages adheres to a design logic oriented toward solution development and the generation of rigorous knowledge.

Phase 1. Identification of the epistemological problem in finance: this phase would address the need to critically examine the epistemological foundations of the theories of Markowitz, Fama, and Shiller, identifying their underlying assumptions, internal tensions, and explanatory gaps. Its purpose would be to delineate the central problem that might hinder a more comprehensive understanding of financial reality and to establish the groundwork for an integrative and pluralistic framework.

Phase 2. Definition of objectives for an interdisciplinary framework: building on the initial diagnosis, this phase could seek to define the theoretical and practical objectives of a holistic financial model that would integrate insights from psychology, sociology, neuroeconomics, and data science. It would be expected to specify the goals of disciplinary integration and the research questions that could guide the development of the new approach.

Phase 3. Design and development of hybrid models: inspired by the third stage of the Design Science Research Methodology (DSRM), this phase might involve the design and development of hybrid models that could merge the mathematical formalization of MPT and the EMH with the behavioural and sociocognitive dimensions of BF. Techniques such as agent-based simulations, network modelling, and machine learning would be expected to capture the interaction among bounded rationality, imperfect information, and adaptive learning.

Phase 4. Contextual demonstration and empirical validation: in this phase, the proposed models could be applied to diverse institutional and geographical contexts, contrasting their outcomes with real data from both developed and emerging markets. The objective would be to demonstrate their potential explanatory capacity and practical relevance through empirical testing and cross-context comparisons that might reinforce the validity and adaptability of the model.

Phase 5. Evaluation and translation into policy design: this phase would aim to assess the model's potential effectiveness in informing public policy and

institutional strategy. Based on the results obtained, it could propose guidelines applicable to ethical regulation, financial education, and systemic risk prevention. The evaluation would be expected to ensure that the pluralistic framework could contribute to more adaptive, equitable, and sustainable policies.

Phase 6. Communication, reflexive learning, and institutional transfer: the final phase would focus on disseminating the knowledge generated and fostering mechanisms for institutional and reflexive learning. Through observatories, interdisciplinary networks, and training initiatives, it could promote continuous feedback among theory, evidence, and practice, ensuring that financial epistemology remains open, evolutionary, and oriented toward the public good.

The imperative of evaluating assumptions in environments of structural change

A significant portion of financial literature assumes stability in correlations, information, or behavioural patterns, despite contemporary markets being shaped by technological disruptions, geopolitical realignments, and macroeconomic shocks. This necessitates a reformulation of the initial assumptions of each approach and, consequently, the adoption of more flexible methodologies. For instance, MPT could benefit from big data and machine learning techniques to recalibrate asset correlations in real time. The EMH could incorporate growing evidence on transaction costs and institutional biases that hinder the immediate dissemination of information. Meanwhile, BF, to avoid an uncontrolled proliferation of psychological factors, requires rigorous empirical validation frameworks that distinguish between transient biases and those that genuinely influence large-scale price formation.

Towards a financial theory with broader scope and ethical awareness

Ultimately, the convergence of these three perspectives highlights an increasingly relevant ethical debate: what does financial knowledge imply for equity, sustainability, and the resilience of economic systems? MPT, as a mathematical optimization framework, does not inherently exclude social or

environmental factors; when returns and covariances are adjusted to reflect them, the model will optimize accordingly. The EMH is chiefly challenged by documented market anomalies rather than by broader issues such as persistent inequalities or the overrepresentation of certain actors. BF explains why markets deviate from EMH assumptions by accounting for cognitive and emotional biases, and it yields policy-relevant insights (e.g., nudges, investor protection, herding-related systemic risk) without implying that policy should integrate speculative behaviour per se. In this context, theoretical evolution requires acknowledging that financial models, even unintentionally, can shape market practices and public policies. Therefore, advancing toward a broader financial theory also entails designing regulatory and normative frameworks in which the plurality of perspectives not only enhances the accuracy of risk assessments but also guides decision-making with higher standards of social responsibility and sustainability.

In summary, this comparative analysis of the perspectives of Markowitz, Fama, and Shiller demonstrates that the complexity of financial markets cannot be fully explained by adhering to a single framework. Sustaining the vitality of financial theory requires moving beyond dichotomous views and fostering a space of convergence that integrates both the analytical power of mathematics and statistics and the psychological and social realities of market agents. This article, therefore, advocates for the necessity of a research and practical agenda that draws from epistemological plurality and, rather than merely incrementally adapting existing models, establishes the foundations for a truly holistic and adaptive theory. In doing so, it will be possible to address the challenges of an increasingly volatile and uncertain global environment, shaped by tensions that exceed the boundaries of traditional rationality, thus advancing an innovative, interdisciplinary, and socially conscious financial epistemology.

Endnotes

[1] Form 13F is a mandatory quarterly report filed with the U.S. Securities and Exchange Commission (SEC) by institutional investment managers that exercise investment discretion over accounts holding at least $100 million in Section 13(f) securities. As required by Rule 13f-1 under the Securities Exchange

Act of 1934, managers must submit Form 13F within 45 days of the end of each calendar quarter to disclose their equity holdings and promote market transparency.

[2] The EMH assumes that investors act rationally, seeking to maximize their profits and making decisions based on all available information. However, investors often exhibit irrational behaviours influenced by their cognitive biases. Moreover, market participants may not have access to all information, and even if they do, 'they may have different sentiment about the information' (Fakhry 2016, p. 436).

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References

Abad, P., Díaz, A., Escribano, A., and Robles, M. D. (2018), 'Institutional versus retail investors' behaviour around credit rating news', in Mili, M., Samaniego Medina, R., and di Pietro, F. (eds), *New Methods in Fixed Income Modeling: Fixed Income Modeling*, Cham: Springer International Publishing, pp. 241-261.

Akerlof, G. A., and Shiller, R. J. (eds) (2010), *Animal Spirits: How human psychology drives the economy, and why it matters for global capitalism*, Princeton University Press.

Akkaya, M. (2021), '*Behavioural portfolio theory*', in Adıgüzel Mercangöz, B. (eds), *Applying Particle Swarm Optimization: New solutions and cases for optimized portfolios*, Cham: Springer International Publishing, pp. 29-48.

Ardalan, K. (2003), 'Theories and controversies in finance: a paradigmatic overview', *International Journal of Social Economics*, 30 (1/2), 199-208.

Ardalan, K. (2005), 'Mathematics and academic finance: the role of paradigms', *International Journal of Social Economics*, 32 (4), 276-290.

Attig, N., Guedhami, O., Nazaire, G., and Sy, O. (2023), 'What explains the benefits of international portfolio diversification?', *Journal of International Financial Markets, Institutions and Money*, 83, 101729. doi: 10.1016/j.intfin.2022.101729.

Baker, H. K., and Nofsinger, J. R. (2010), 'Behavioural finance: an overview', in Baker, H. K. and Nofsinger, J. R. (eds), *Behavioural Finance: Investors, corporations, and markets*, John Wiley & Sons, pp. 1-21.

Behera, I., Nanda, P., Behera, M., and Bhoi, T. (2023), 'Thriving in uncertainty: effective financial analytics in the age of VUCA', in Gupta, R., Bartolucci, F., Katsikis, V.N., and Patnaik, S. (eds), *Recent Advancements in Computational Finance and Business Analytics*, Cham: Springer Nature Switzerland.

Besnard, P., and Hunter, A. (2001), 'A logic-based theory of deductive arguments', *Artificial Intelligence*, 128 (1-2), 203-235.

Bettner, M., McGoun, E., and Robinson, C. (1994), 'The case for qualitative research in finance', *International Review of Financial Analysis*, 3 (1), 1-18.

Bihari, A., Dash, M., Kar, S. K., Muduli, K., Kumar, A., and Luthra, S. (2022), 'Exploring behavioural bias affecting investment decision-making: a network cluster based conceptual analysis for future research', *International Journal of Industrial Engineering and Operations Management*, 4 (1-2), 19-43.

Black, F., and Litterman, R. (1991), 'Asset allocation combining investor views with market equilibrium', *Journal of Fixed Income*, 1 (2), 7–18.

Bloomfield, R. (2010), 'Traditional versus behavioural finance', in Baker, H. K. and Nofsinger, J. R. (eds), *Behavioural Finance: Investors, corporations, and markets*, John Wiley & Sons, pp. 23-38.

Bocher, R. (2022), 'The intersubjective markets hypothesis', *Journal of Interdisciplinary Economics*, 34 (1), 35-50.

Brav, A., Heaton, J. B., and Rosenberg, A. (2004), 'The rational-behavioural debate in financial economics', *Journal of Economic Methodology*, 11 (4), 393-409.

Bushee, B. J., and Goodman, T. H. (2007), 'Which institutional investors trade based on private information about earnings and returns?', *Journal of Accounting Research*, 45 (2), 289-321.

Bybee, L., Kelly, B., Manela, A., and Xiu, D. (2024), 'Business news and business cycles', *The Journal of Finance*, 79 (5), 3105-3147.

Chandra, A., and Thenmozhi, M. (2017), 'Behavioural asset pricing: review and synthesis', *Journal of Interdisciplinary Economics*, 29 (1), 1-31.

Claessens, S., and Kose, M. A. (2018), 'Frontiers of macrofinancial linkages', *BIS Paper*, 95. Available at SSRN: https://ssrn.com/abstract=3107418.

Datz, G. (2013), 'The narrative of complexity in the crisis of finance: epistemological challenge and macroprudential policy response', *New Political Economy*, 18 (4), 459-479.

Davies, W., and McGoey, L. (2016), 'Rationalities of ignorance: on financial crisis and the ambivalence of neo-liberal epistemology', *Economy and Society*, 41 (1), 64-83.

De Scheemaekere, X. (2009), 'The epistemology of modern finance', *Journal of Philosophical Economics*, 2 (2), 99-120.

Dörry, S. (2016), 'The role of elites in the co-evolution of international financial markets and financial centres: the case of Luxembourg', *Competition & Change*, 20 (1), 21-36.

Erturk, I. (2016), 'Shadow banking: a story of the Doppelgänger (the Double) in science of finance', *Journal of Cultural Economy*, 10 (4), 377-392.

Fabozzi, F. J., Gupta, F., and Markowitz, H. M. (2002), 'The legacy of modern portfolio theory', *The Journal of Investing*, 11 (3), 7-22.

Fakhry, B. (2016), 'A literature review of the efficient market hypothesis', *Turkish Economic Review*, 3 (3), 431-442.

Fama, E. F. (1970), 'Efficient capital markets', *The Journal of Finance*, 25 (2), 383-417.

Fang, L., and Peress, J. (2009), 'Media coverage and the cross- section of stock returns', *The Journal of Finance*, 64 (5), 2023-2052.

Fink, J. (2021), 'A review of the post-earnings-announcement drift', *Journal of Behavioural and Experimental Finance*, 29, 100446. doi: 10.1016/ j.jbef.2020.100446.

Ford, C. (2010), 'Principles-based securities regulation in the wake of the global financial crisis', *McGill Law Journal*, 55 (2), 257-307.

Frankfurter, G. M. (2006), 'The theory of fair markets (TFM) toward a new finance paradigm', *International Review of Financial Analysis*, 15 (2), 130-144.

Frankfurter, G. M., and McGoun, E. G. (1999), 'Ideology and the theory of financial economics', *Journal of Economic Behaviour & Organization*, 39 (2), 159-177.

Frankfurter, G. M., and McGoun, E. G. (2000), 'Market efficiency or behavioural finance: the nature of the debate', *The Journal of Psychology and Financial Markets*, 1 (3-4), 200-210.

Frydman, R., Mangee, N., and Stillwagon, J. (2021), 'How market sentiment drives forecasts of stock returns', *Journal of Behavioural Finance*, 22 (4), 351-367.

Gasparin, M., Schinckus, C., and Green, W. (2019), 'Thinking outside the box to get inside the black box: alternative epistemology for dealing with financial innovation', *Social Epistemology*, 33 (3), 218-233.

Gendron, Y., and Smith-Lacroix, J. H. (2015), 'The global financial crisis: essay on the possibility of substantive change in the discipline of finance', *Critical Perspectives on Accounting*, 30, 83-101.

Ghasemi, O., Handley, S., and Howarth, S. (2022), 'The bright homunculus in our head: individual differences in intuitive sensitivity to logical validity', *Quarterly Journal of Experimental Psychology*, 75 (3), 508-535.

Gippel, J. K. (2013), 'A revolution in finance?', *Australian Journal of Management*, 38 (1), 125-146.

Guerard Jr, J. B. (2011), 'Harry Markowitz', in Assad, A. A. and Gass, S. I. (eds), *Profiles in Operations Research: Pioneers and innovators*, Boston, MA: Springer US, pp. 643-658.

Holtfort, T. (2019), 'From standard to evolutionary finance: a literature survey', *Management Review Quarterly*, 69 (2), 207-232.

Hui, E. C. M., Dong, Z., Jia, S., and Lam, C. H. L. (2017), 'How does sentiment affect returns of urban housing?', *Habitat International*, 64, 71-84.

Ioachimescu, O. C., and Shaker, R. (2025), 'Translational science and related disciplines', *Journal of Investigative Medicine*, 73 (1), 3-26.

Ippoliti, E. (2021), 'Mathematics and finance: some philosophical remarks', *Topoi*, 40, 771-781.

Iquiapaza, R. A., Amaral, H. F., and Bressan, A. A. (2009), 'Evolução da pesquisa em finanças: epistemologia, paradigma e críticas', *Organizações & Sociedade*, 16, 351-370.

Jegadeesh, N., and Titman, S. (1993), 'Returns to buying winners and selling losers: implications for stock market efficiency', *Journal of Finance*, 48 (1), 65–91.

Kahneman D., and Tversky, A. (1979), 'Prospect theory: an analysis of decision under risk', *Econometrica*, 47 (2), 263–291.

Kanaparthi, V. K. (2024), 'Navigating uncertainty: enhancing Markowitz asset allocation strategies through out-of-sample analysis', *FinTech*, 3 (1), 151-172.

Khan, S., Shoaib, A., Aftab, R., Yasir, M., and Saeed, M. B. (2025), 'Financial frictions and stock return: a novel least minus more frictional factor for asset pricing models in emerging economies', *PLoS One*, 20 (7), e0325917. doi: 10.1371/journal.pone.0325917.

Kilienė, I., and Norvaiša, R. (2022), 'Solving word problems with reasoned judgement', *Lithuanian Mathematical Journal*, 62 (4), 467-480.

King, T., and Koutmos, D. (2021), 'Herding and feedback trading in cryptocurrency markets', *Annals of Operations Research*, 300 (1), 79-96.

Koumou, G. B. (2020), 'Diversification and portfolio theory: a review', *Financial Markets and Portfolio Management*, 34 (3), 267-312.

Kwapień, J., Drożdż, S., and Oświe, P. (2006), 'The bulk of the stock market correlation matrix is not pure noise', *Physica A: Statistical Mechanics and its Applications*, 359, 589-606.

Lagoarde-Segot, T. (2015), 'Diversifying finance research: from financialization to sustainability', *International Review of Financial Analysis*, 39, 1-6.

Lagoarde-Segot, T. (2019), 'Sustainable finance. A critical realist perspective', *Research in International Business and Finance*, 47, 1-9.

Lagoarde-Segot, T., and Paranque, B. (2018), 'Finance and sustainability: from ideology to utopia', *International Review of Financial Analysis*, 55, 80-92.

Lai, K. P., and Samers, M. (2021), 'Towards an economic geography of FinTech', *Progress in Human Geography*, 45 (4), 720-739.

Liagkouras, K., Metaxiotis, K., and Tsihrintzis, G. (2022), 'Incorporating environmental and social considerations into the portfolio optimization process', *Annals of Operations Research*, 316, 1493–1518.

Lintner, J. (1965), 'Security prices, risk, and maximal gains from diversification', *The Journal of Finance*, 20 (4), 587-615.

Lo, A. W. (2004), 'The adaptive markets hypothesis: market efficiency from an evolutionary perspective', *Journal of Portfolio Management*, 30 (5), 15-29.

Lo, A. W. (2005), 'Reconciling efficient markets with behavioural finance: the adaptive markets hypothesis', *Journal of Investment Consulting*, 7 (2), 21-44.

López-Cabarcos, M., M Pérez-Pico, A., and López Perez, M. L. (2020), 'Investor sentiment in the theoretical field of behavioural finance', *Economic Research-Ekonomska Istraživanja*, 33 (1), 2101-2228.

Markowitz, H. M. (1952), 'Portfolio selection', *The Journal of Finance*, 7 (1), 77–91.

Markowitz, H. M. (2005), 'Market efficiency: a theoretical distinction and so what?', *Financial Analysts Journal*, 61 (5), 17-30.

Mauboussin, M. J. (2002), 'Revisiting market efficiency: the stock market as a complex adaptive system', *Journal of Applied Corporate Finance*, 14 (4), 47-55.

McGoun, E. G. (1992), 'On knowledge of finance', *International Review of Financial Analysis*, 1 (3), 161-177.

McGoun, E. G., and Zielonka, P. (2006), 'The platonic foundations of finance and the interpretation of finance models', *The Journal of Behavioural Finance*, 7 (1), 43-57.

Meier, R., and Danzinger, R. (2022), 'Personalized portfolio optimization using genetic (AI) algorithms', in Soldatos, J. and Kyriazis, D. (eds), *Big Data and Artificial Intelligence in Digital Finance: Increasing personalization and trust in digital finance using big data and AI*, Cham: Springer International Publishing, pp. 199-214.

Mondello, E. (2023), 'Efficient risky portfolios', in Mondello, E. (ed), *Applied Fundamentals in Finance: Portfolio management and investments*, Wiesbaden: Springer Fachmedien Wiesbaden, pp. 101-143.

Mossin, J. (1966), 'Equilibrium in a capital asset market', *Econometrica: Journal of the Econometric Society*, 34(4), 768-783.

Muniesa, F., and Doganova, L. (2020), 'The time that money requires: use of the future and critique of the present in financial valuation', *Finance and Society*, 6 (2), 95-113.

Nawrocki, D., and Viole, F. (2014), 'Behavioural finance in financial market theory, utility theory, portfolio theory and the necessary statistics: a review', *Journal of Behavioural and Experimental Finance*, 2, 10-17.

Nonejad, N. (2024), 'Point forecasts of the price of crude oil: an attempt to "beat" the end-of-month random-walk benchmark', *Empirical Economics*, 67, 1497-1539.

Peffers, K., Tuunanen, T., Rothenberger, M. A., and Chatterjee, S. (2007), 'A design science research methodology for information systems research', *Journal of Management Information Systems*, 24 (3), 45-77.

Peón, D., Antelo, M., and Calvo, A. (2019), 'A guide on empirical tests of the EMH', *Review of Accounting and Finance*, 18 (2), 268-295.

Rabbani, M. R., Azam, M. Q., Hawaldar, I. T., Aljalahma, R., and Dsouza, S. (2024), 'Does an overconfidence bias affect stock return, trading volume, and liquidity? Fresh insights from the G7 nations', *Cogent Economics & Finance*, 12 (1), 2373266. doi: 10.1080/23322039.2024.2373266.

Riles, A. (2010), 'Collateral expertise: legal knowledge in the global financial markets', *Current Anthropology*, 51 (6), 795-818.

Robiyanto, R., Nugroho, B. A., and Lako, A. (2020), 'Safe haven and performance of extension-Markowitz portfolio on Indonesian ethical investments', *International Journal of Economic Policy in Emerging Economies*, 13 (3), 225-243.

Roscoe, P., and Willman, P. (2021), 'Flaunt the imperfections: information, entanglements and the regulation of London's Alternative Investment Market, *Economy and Society*, 50 (4), 565-589.

Scherbina, A. (2001), 'Stock prices and differences of opinion: empirical evidence that prices reflect optimism', *Kellogg Graduate School of Management Working Paper*. doi: 10.2139/ssrn.267665.

Schinckus, C. (2015), 'Positivism in finance and its implication for the diversification finance research. Diversifying finance research: from financialization to sustainability', *International Review of Financial Analysis*, 40, 103-106.

Schwert, G. W. (2023), 'Eugene F. Fama (1939–)', in Cord, R. A. (eds), *The Palgrave Companion to Chicago economics*, Cham: Springer International Publishing, pp. 925-938.

Sharpe, W. F. (1964), 'Capital asset prices: a theory of market equilibrium under conditions of risk', *The Journal of Finance*, 19 (3), 425-442.

Shefrin, H. (eds) (2002), *Beyond Greed and Fear: Understanding behavioural finance and the psychology of investing*, New York, Oxford University Press.

Shefrin, H. (eds) (2005), *A Behavioural Approach to Asset Pricing*, Atlanta, Elsevier Academic Press.

Shiller, R. J. (2003), 'From efficient markets theory to behavioural finance', *Journal of Economic Perspectives*, 17 (1), 83-104.

Shiller, R. J. (2005), *Irrational Exuberance*, 2nd ed., Princeton, New Jersey, Princeton University Press.

Shiller, R. J. (2014), 'Speculative asset prices', *American Economic Review*, 104 (6), 1486-1517.

Szafarz, A. (2012), 'Financial crises in efficient markets: how fundamentalists fuel volatility', *Journal of Banking & Finance*, 36 (1), 105-111.

Tamiz, M., Azmi, R. A., and Jones, D. F. (2013), 'On selecting portfolio of international mutual funds using goal programming with extended factors', *European Journal of Operational Research*, 226 (3), 560-576.

Thaler, R. H. (2000), 'From homo economicus to homo sapiens', *Journal of Economics Perspectives*, 14 (1), 133–141.

Tobin, J. (1958), 'Liquidity preference as behaviour towards risk', *The Review of Economic Studies*, 25 (2), 65-86.

Varmaz, A., Fieberg, C., and Poddig, T. (2024), 'Portfolio optimization for sustainable investments', *Annals of Operations Research*, 341 (2), 1151-1176.

Vermeulen, R. (2013), 'International diversification during the financial crisis: a blessing for equity investors?', *Journal of International Money and Finance*, 35, 104-123.

Willett, T. D. (2010), 'Some lessons for economists from the financial crisis', *Indian Growth and Development Review*, 3 (2), 186-208.

Willett, T. D. (2022), 'New developments in financial economics', *Journal of Financial Economic Policy*, 14 (4), 429-467.

Yeter, B., and Garbatov, Y. (2021), 'Optimal life extension management of offshore wind farms based on the modern portfolio theory', *Oceans*, 2 (3), 566-582.

Zacks, L. (eds) (2011), *The Handbook of Equity Market Anomalies: Translating market inefficiencies into effective investment strategies*, Hoboken, New Jersey, John Wiley & Sons.

Zhao, P., Zhang, W., Wu, X., and Coyte, P. C. (2023), 'Quasi-variable discount rates and market volatility: An empirical study', *Journal of Systems Science and Systems Engineering*, 32 (5), 515-530.

Zhang, X., Wu, X., Zhang, L., and Chen, Z. (2022), 'The evaluation of mean-detrended cross-correlation analysis portfolio strategy for multiple risk assets', *Evaluation Review*, 46 (2), 138-164.

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