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A Review of Behavioral Finance and Econometrics: Theories and Applications

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Abstract

Purpose: Traditional financial theories based on the assumption of rationality cannot explain many paradoxes and anomalies in the financial markets. Behavioral Finance models are then developed to incorporate ideas from psychology and financial economics to explain market phenomena. Additionally, advanced Behavioral Econometric methods are proposed for testing theories in Behavioral Finance. This review paper introduces readers to theoretical frameworks and econometric modeling techniques for studying Behavioral Finance, with numerous applications in the literature.

Design/methodology/approach: This review provides comprehensive profiles of theoretical evolution, econometric methodology, and applied studies in Behavioral Finance, along with salient readings.

Findings: The results emphasize the ongoing development of theories in Behavioral Finance and Econometrics, from risk-seeking utility functions and stochastic dominance to advanced risk measures, econometric testing methods, and ultimately financial applications with testable implications. These advancements help readers understand the main research areas and emerging trends in this field.

Practical Implications: This review paper is valuable for academics and practitioners, as it advances Behavioral Finance and Behavioral Econometric theories, and also supports their application to portfolio construction, investment analysis, and risk management. Our study contributes to decision sciences by helping financial analysts understand their clients' behavioral traits and make optimal decisions that improve their risk-return trade-off.

Originality/value: Many studies treated the evolution of Behavioral Finance theory, Behavioral Econometrics, and empirical investigations in isolation. Our review paper not only summarizes existing work but also synthesizes these strands, ranging from theoretical model building to econometric testing and financial applications, into a unified framework.

Keywords: Behavioral Finance, Behavioral Econometrics, Applications

JEL classifications: C50, C58, G10, G11, G12, G40

1 Introduction

Behavioral Finance is a key area of financial economics because many traditional theories have been shown to fail in explaining numerous paradoxes and anomalies observed in financial markets (Woo et al., 2020). For example, the efficient market hypothesis (Fama, 1970) claims that investors cannot consistently outperform the market. However, empirical evidence indicates that some investors can beat the market. These discrepancies drive the development of Behavioral Finance, which questions the assumption of full rationality and incorporates psychological factors into financial decision-making models. Along with the development of theoretical models, scholars have introduced Behavioral Econometric methods to empirically evaluate these models and test for behavioral patterns in markets.

However, existing review studies tend to analyze the main strands of Behavioral Finance separately. They focus either on theoretical models (Nawrocki & Viole, 2014), econometric testing methods (Harrison, 2019), or financial applications (Hon et al., 2021). What is missing is a comprehensive review that combines Behavioral Finance models, Behavioral Econometric techniques, and financial applications into a unified framework. This review paper fills that gap by integrating these areas to help readers understand how behavioral model development, testing, and financial practice are interconnected. As a result, it provides insights for researchers and practitioners on how econometric methods are used to test the validity of theoretical models and how Behavioral Finance and Econometric models influence real-world applications.

Our study is relevant to the discipline of decision sciences because it helps financial analysts optimally make financial and investment decisions, intending to maximize their risk-return tradeoffs when facing risk, uncertainty, and cognitive limitations.

This paper is structured as follows: Section 2 provides a brief review of selected theoretical models of Behavioral Finance. Section 3 discusses Behavioral Econometric methods and test statistics used to study topics in Behavioral Finance. Section 4 examines the financial applications. Section 5 concludes.

2 Theoretical Models

According to prospect theory, investors exhibit risk aversion with a concave utility function when experiencing gains but become risk-seeking with a convex utility function when facing losses. Consequently, their behaviors may deviate from rationality and then violate the predictions implied by market efficiency. To analyze both risk-averse and risk-seeking behaviors, researchers have proposed different utility function specifications and their corresponding indifference curves. In addition, stochastic dominance has been developed to analyze various risk measures under different utility functions and to examine portfolio optimization and diversification decisions. Furthermore, the two-moment decision model provides a tractable approach for investigating risk-taking behavior within the context of stochastic dominance theory and investors' risk preferences. Finally, behavioral heuristics embedded in pseudo-Bayesian models offer explanations for excess market volatility that cannot be reconciled with a fully

rational and efficient market. This section reviews these theoretical contributions, which collectively form the foundational building blocks of Behavioral Finance in the literature.

2.1 Cost of capital and stock returns

Thompson and Wong (1991) estimate the cost of capital using a Discounted Cash Flow (DCF) method that requires forecasting dividends. They show that past dividend behavior may support more than one reasonable forecasting model and that such models can yield divergent estimates of the cost of capital. They also find no way to select the best cost of capital estimate. Any choice must ultimately be based on the analyst's judgment. Thompson and Wong (1996) extend the theory by proving the existence and uniqueness of a solution for the cost of equity capital. They also show that the cost of equity function is continuously differentiable and derive the formula for its reliability.

Wong and Chan (2008) extend their theory further by proving the existence and uniqueness of this reliability. In addition, they propose estimators for the reliability and prove that the estimators converge to the true parameter. The estimation approach is further simplified, hence rendering computation easier. In addition, the properties of the cost of capital and its reliability will be analyzed with illustrations of several commonly used Box-Jenkins models.

Obrimah and Wong (2022) establish the relationship between stock returns and the random walk process for trade imbalances and for the evolution of information.

2.2 Utility

Jeremy Bentham (1748-1832) laid the foundation of utilitarianism through the “greatest happiness” or utility principle, known as “good” as the maximization of satisfaction and the minimization of pain. Building on this philosophical framework, economists such as William Stanley Jevons (1835-1882) and Carl Menger (1840-1921) further developed utility theory as a tool for assessing the pleasure or discomfort that individuals derive from, or seek to ward off through, the consumption of goods or services.

2.2.1 Risk aversion and risk seeking

Early economic and financial models are largely built on the assumption of risk-averse behavior, as reflected in the seminal contributions of Bernoulli (1738), Arrow (1965), and Markowitz (1952a), among many others. In contrast, the literature on risk-seeking behavior has expanded more recently, with notable advances by Chan et al. (2020, 2022), Guo and Wong (2016), and Wong, Zhu et al. (2026). Prior to these studies, intermediate developments were offered by Wong and Ma (2008), Lam et al. (2006), Wong (2007), Wong and Li (1999), and Li and Wong (1999). The earliest foundations of this line of research can be traced to the works of Hammond (1974), Slovic (1964), Pratt (1964), Tobin (1958), and others.

2.2.2 (Reverse) S-shaped utility functions

The theoretical problems associated with strictly concave utility functions have attracted considerable attention in the literature (Friedman & Savage, 1948; Markowitz, 1952b). To address these shortcomings, some scholars introduce an S-shaped value or utility function, characterized by concavity in the domain of gains and convexity in the domain of losses (Kahneman & Tversky, 1979; Tversky & Kahneman, 1992). On the other hand, Thaler and Johnson (1990) propose a reverse S-shaped utility specification, under which individuals display a stronger aversion to losses while exhibiting greater risk-seeking behavior when experiencing gains. Empirical evidence provided by Ranganathan (2018) suggests that both S-shaped and reverse S-shaped utility forms play a significant role in making investment decisions. Levy and Wiener (1998) lend support to the reversed S-shaped utility function while rejecting the S-shaped formulation. Subsequent studies, including Levy and Wiener (1998), Levy and Levy (2002, 2004), Wong and Chan (2008), Broll, Egozcue et al. (2010), Egozcue et al. (2011a), and others, further develop stochastic dominance frameworks tailored to investors with S-shaped and reverse S-shaped utility functions. More recently, Wong, Yeung, and Lu (2023) made a pioneering contribution by formally developing theories and establishing theorems for mean-variance rules applicable to investors characterized by reverse S-shaped utility functions.

2.2.3 Skewness seeking

Using invention data, Åstebro (2003) shows that the internal rates of return are characterized by a skewed distribution, based on an experiment investigating preferences for skewness. Complementary findings by Åstebro et al. (2015) indicate that both university students and experienced executives exhibit a greater willingness to take risks when lottery outcomes display positive skewness.

2.2.4 Regret-aversion

The notion of regret aversion was initially formulated by Loomes and Sugden (1982), who incorporated regret into models of individual decision-making. Around the same time, Bell (1982) introduced regret as a modifying element within expected utility theory, arguing that its inclusion enhances the framework's descriptive relevance. Loomes and Sugden (1982) also provided the earliest formal theoretical treatment of regret. Subsequent theoretical developments, including the specification of regret-averse utility functions, are presented in later studies such as Egozcue et al. (2015) and Guo et al. (2015), which propose several well-defined forms of regret-averse utility functions.

2.2.5 Disappointment Aversion

Guo et al. (2021) have developed the optimal production decision theory for firms with disappointment aversion utility functions.

2.2.6 Multivariate utility functions

A substantial body of the literature employs multivariate or multidimensional utility functions (see, for example, Eisner & Strotz, 1961; Guo & Wong, 2016). A commonly adopted simplifying assumption is that these utility functions satisfy the separability property (Keeney & Raiffa, 1976).

2.3 Stochastic Dominance (SD)

Stochastic dominance (SD), a form of stochastic ordering, is used to compare and rank probability distributions. It plays a fundamental role in analyzing decision-making under alternative utility functions and, therefore, constitutes a core component of the theoretical development of Behavioral Finance. This section outlines several key aspects of SD. Theoretical developments and practical implementations are thoroughly covered in key references, notably Sriboonchita, Wong et al. (2009), Levy (2015), Egozcue and Wong (2010a), and related works.

2.3.1 Stochastic dominance (SD) for risk averters and risk seekers

Stochastic dominance (SD) serves as a central analytical framework for formulating portfolio and asset selection criteria for risk-averse and risk-seeking agents with a wide range of utility functions. The theoretical foundations of SD for risk-averse agents were established through early and influential studies by Rothschild and Stiglitz (1970, 1971), Tesfatsion (1976), and Meyer (1977), among others. In contrast, a distinct stream of research has expanded SD theory to accommodate risk-seeking behavior, with important contributions from Li and Wong (1999), Wong and Li (1999), Wong (2007), Levy (2015), Guo and Wong (2016), and subsequent studies. In addition, Wong, Ma et al. (2026) have developed a new SD theory for investors with both risk-averse and risk-seeking utilities.

2.3.2 Stochastic dominance (SD) for investors with (reverse) S-shaped utility functions

Second-order SD theory has been extended to accommodate investors characterized by reverse S-shaped utility functions (Levy & Wiener, 1998) as well as S-shaped utility functions (see, for example, Levy and Levy, 2002, 2004). Within this framework, SD theory for S-shaped preferences is referred to as prospect SD (PSD), whereas the corresponding concept for reverse S-shaped preferences is known as Markowitz SD (MSD). Further theoretical refinements and generalizations of both PSD and MSD were subsequently developed by Wong and Chan (2008).

2.3.3 Almost Stochastic Dominance

Leshno and Levy (2002) introduced the theory of ‘almost’ stochastic dominance (ASD) to identify preferences for “most” decision-makers. Since its introduction, ASD has been applied extensively in financial market studies, including those by Bali et al. (2009), Levy (2009), and Levy et al. (2010). Nonetheless, later research demonstrates that almost second-degree SD (ASSD) fails to satisfy expected utility maximization and does not preserve the hierarchy property (Guo et al., 2013; Tzeng et al., 2013). Guo et al. (2014) establish necessary conditions taking the form of restrictions on algebraic combinations

of moments of the probability distributions for ASD criteria of various orders. Guo et al. (2016) extend the theory of ASD to include the ASD for risk-seeking investors.

2.4 *Diversification Behaviors*

Diversification is a core topic in Behavioral Finance. Much of the existing theoretical literature has focused on diversification decisions made by risk-averse investors, with comparatively less attention given to risk-seeking behavior. To address this imbalance, several studies have examined how risk-seekers diversify their portfolios. Wong and Li (1999) have extended the convex SD theorem to include any distribution functions and to apply to both risk seekers and risk averters. Li and Wong (1999) have developed results on diversification preferences for risk averters and risk seekers. Egozcue and Wong (2010b) have developed some results on diversification by using both majorization theory and the SD theory. In addition, Egozcue et al. (2011a) have developed results on diversification for Markowitz preferences, and Lozza et al. (2018) have provided a general valuation of investors' diversification attitude.

2.5 *Indifference Curves*

Tobin (1958) was the first to explain the upward (downward) convexity of indifference curves for risk-averse (risk-seeking) investors and their horizontality for risk-neutral investors. Subsequent extensions within the location-scale family were developed by Meyer (1987) and Wong and Ma (2008). Building on these insights, Broll, Clark and Lukas (2010) developed a theory of risk-hedging decisions grounded in S-shaped utility functions and specific properties of indifference curves.

2.6 *Mean-Variance (MV) Portfolio Optimization*

Markowitz (1952a) developed the MV portfolio optimization theory for guiding the construction of optimal portfolios, in which investors either maximize expected return subject to a given level of risk or minimize risk for a specified level of expected return. The theory is built on the assumption that investors are risk-averse. However, subsequent research has shown that Markowitz's (1952a) MV model substantially overestimates actual portfolio returns, a result first proved by Bai et al. (2009a, 2009b).

2.7 *Risk Measures*

Risk measures are used to evaluate the risk and return performance of assets.

2.7.1 *Selection rules*

MV selection rules have been developed to account for both risk-averse behavior (Markowitz, 1952b; Tobin, 1958) and risk-seeking preferences (Wong, 2007). In addition, the relationship between MV rules and SD rules (Wong, 2007), as well as between the moment rules and SD rules for both types of investors (Chan et al., 2022).

2.7.2 Sharpe Ratio

Originating within the MV framework, the reward-volatility ratio, also known as the Sharpe ratio (Sharpe, 1966), measures performance as the risk premium per unit of risk. Several extensions of this measure have been proposed, including multiple Sharpe ratios (Leung & Wong, 2008) and mixed Sharpe ratios (Wong et al., 2012). The linkage between the Sharpe ratio and SD for risk-averse investors is further analyzed by Chow et al. (2019). Additionally, alternative performance criteria based on mean-VaR and mean-CVaR measures have been developed (Guo, Chan, Wong, & Zhu, 2019). Broader extensions and applications of these performance measures are documented in Leung and Wong (2008), Bai, Wang, and Wong (2011), Bai, Li, McAleer, and Wong (2015), Leung, Roura-Pascual et al. (2012), Ng et al. (2017), and Chan et al. (2020).

2.7.3 Omega ratio

Introduced by Shadwick and Keating (2002), the Omega ratio is the probability-weighted ratio of gains to losses relative to a specific threshold return target for performance evaluation. Guo, Jiang, and Wong (2017) investigate its relationship with SD. Building on this work, Chow et al. (2019) further develop the theoretical links between the Omega ratio and SD for both risk-averse and risk-seeking investors, demonstrating the superiority of the Omega ratio over the Sharpe ratio as a performance measure.

2.7.4 First- and higher-order risk measures

Niu et al. (2016) establish the consistency of the Farinelli and Tibiletti (FT) ratios with respect to first-order SD, and show that second-order SD is not consistent with the FT ratios. On the other hand, Niu et al. (2017) extend the theory of the Kappa ratio and SD and risk-seeking SD. For details, read Guo, Niu and Wong (2019).

2.8 *Two-Moment Decision Model*

According to SD theory and the preference structures of both risk-averse and risk-seeking investors formulated by Wong and Ma (2008) and related studies, a two-moment decision model has been developed. This framework has been applied widely in Behavioral Finance, with illustrative applications reported in Broll et al. (2006) and Broll et al. (2011, 2015).

On the other hand, Alghalith et al. (2016) present a stochastic factor model with an additive background risk and a dynamic model of simultaneous (correlated) multiplicative and additive background risks. In addition, Alghalith et al. (2017) examine the effects of joint energy and output price uncertainties on input demands in a mean–variance framework.

2.8.1 Two-Moment Decision Model with Background Risk

Alghalith et al. (2016) develop some results for the investment model with background risk, Guo et al. (2018) develop some results for the two-moment decision model with additive risks, and Guo, Chan,

Wong, and Zhu (2019) develop some results for the mean–variance, mean–VaR, and mean–CVaR models with background risk.

2.9 Behavioral Models for Overreaction and Underreaction

Drawing on the behavioral heuristics of conservatism and representativeness, a stream of studies has developed Bayesian models to account for short-run underreaction, long-run overreaction, the magnitude effect, and excess volatility (Barberis et al., 1998; Fung et al., 2011; Guo, McAleer, Wong, & Zhu, 2017; Lam et al., 2010, 2012). In particular, Fung et al. (2011) incorporate financial crises into the analysis by modeling stock returns as random walks with and without drift, while Guo, McAleer, Wong, and Zhu (2017) extend the theoretical framework by relaxing the distributional assumptions and allowing returns to follow an exponential family distribution.

2.10 Covariance and Copulas

Egozcue et al. (2009) derive some covariance inequalities for monotonic and non-monotonic functions. Egozcue et al. (2010) sharpen the upper bound of a Grüss-type covariance inequality by incorporating a notion of quadrant dependence between random variables and also utilizing the idea of constraining the means of the random variables. Egozcue et al. (2011a) show that Grüss-type probabilistic inequalities for covariances can be considerably sharpened when the underlying random variables are quadrant dependent in expectation (QDE). Egozcue et al. (2011b, 2011c) establish new results for determining the covariance sign and provide further insights into the area. Egozcue et al. (2012) establish the smallest upper bound for the p th absolute central moment over the class of all random variables with values in a compact interval. Egozcue et al. (2013) establish general results that determine when convex combinations of arbitrary quadrant dependent (QD) copulas give rise to negatively or positively QD/QDE copulas.

2.11 Other Financial Economics Models

Egozcue and Wong (2010a) and Egozcue et al. (2014) have developed some results for the theory of the integration–segregation decisions. Alghalith and Wong (2022, 2024) and Alghalith et al. (2018) have developed some results for the theory of options, while Alghalith and Wong (2020a) have developed some results for the theory of macro hedging. Alghalith and Wong (2020b) have extended Stein's lemmas to include general functions and distributions, and Ogrimah and Wong (2022) have developed some results for the theory of stock returns.

3 Behavioral Econometric Methods

With the evolution of theoretical models as shown above, various econometric methods, such as testing procedures, test statistics, and estimators, have been developed to evaluate the validity of Behavioral Finance theories and to enhance estimation performance. In this section, we review several key Behavioral Econometric methods.

3.1 Investors' behavioral models by using conservative and representative heuristics

Lam et al. (2008) and Fabozzi et al. (2013) have developed three test statistics to examine the magnitude effects of the underreaction and overreaction phenomena in the stock market.

3.2 Stochastic Dominance (SD) Tests

A wide range of stochastic dominance (SD) testing procedures has been developed in the Behavioral Econometrics literature, with notable contributions from Davidson and Duclos (2000), Barrett and Donald (2003), Linton et al. (2005), Post and Versijp (2007), and Linton et al. (2010). Many existing SD tests, however, rely on technically complex formulae that limit their practical applicability. To address this issue, Ng, Wong and Xiao (2017) introduce a new class of SD tests that can be implemented using standard quantile regression routines available in commonly used software packages, including R, SAS, MATLAB, and RATS. Moreover, Bai et al. (2015) develop SD statistics for both risk-averse and risk-seeking investors, while Bai, Li, Liu, and Wong (2011) develop new statistics for both prospect and Markowitz SD of the first three orders. They have derived the asymptotic distributions and employed bootstrapped critical values. These SD test statistics have been applied to examine market efficiency and arbitrage opportunities. More recently, Chan et al. (2020) have developed a testing procedure for third-order SD applicable to both risk-aversers and risk-seekers.

3.3 Tests for Market Efficiency

In its weak form, the efficient market hypothesis (EMH) holds that asset prices fully reflect all information contained in past market data, implying that historical price patterns cannot be systematically exploited to forecast future returns (Fama, 1970). Bai, Li, Wong and Zhang (2011), Bai et al. (2015) and Ng et al. (2017) developed SD statistics to assess market efficiency. Guo, Jiang and Wong (2017) further argue that both SD criteria and the Omega ratios provide effective tools for evaluating market efficiency. A large body of empirical research, including Lean, McAleer and Wong (2010), Lean et al. (2012), Tsang et al. (2016), Zhu et al. (2019), and Lv et al. (2023), applies SD tests and/or the Omega ratio and reports evidence inconsistent with market efficiency. Additional findings against market efficiency are documented in Sriboonchita et al. (2009), Woo et al. (2020), and Wong (2007). Beyond these approaches, alternative methodologies have also been employed. For instance, studies relying on technical analysis, such as Wong, Chew, and Sikorski (2001), Wong et al. (2003), Wong et al. (2005), and Kung and Wong (2009), demonstrate that trading strategies based on technical indicators can generate abnormal returns, thereby challenging market efficiency. Further evidence using technical analysis is provided by Chan et al. (2014). Rejection of market efficiency supports the validity of the Behavioral Finance model in describing investors' behavioral patterns in financial markets.

3.4 Estimation Methods for Mean-Variance (MV) Portfolio Optimization

Recent advances in econometric techniques have enhanced the analysis of portfolio optimization. Prior research shows that estimates derived from the classical MV portfolio optimization model (Markowitz,

1952a) tend to substantially overstate actual returns (Bai et al., 2009a, 2009b). To correct this bias, the bootstrap-corrected estimation methods have been proposed (Bai et al., 2009a, 2009b; Bai, Li, Wong & Zhang, 2011; Bai & Silverstein, 2010). Empirical evidence indicates that these approaches effectively alleviate over-prediction and significantly improve estimation accuracy. Leung, Ng, and Wong (2012) develop a new estimator for the optimal portfolio return based on an unbiased estimator of the inverse of the covariance matrix and its related terms, and derive explicit formulae for the estimator of the optimal portfolio return. Li, Bai, Wong, and McAleer (2022) have developed the spectrally corrected estimation for the theory of portfolio optimization. Li, Jiang, Chen, and Wong (2022) have proposed a new portfolio selection model with two mental accounts.

3.5 Tests for Risk Measures

Leung and Wong (2008) developed a multiple Sharpe ratio test statistic to assess the equality of multiple Sharpe ratios, along with their limiting distributions and related properties. Subsequently, Wright et al. (2014) proposed an alternative testing method for the equality of multiple Sharpe ratios and reported empirical findings that differ from those of Leung and Wong (2008). Moreover, many studies grounded in optimal stopping theory argue that the ‘bang-bang’ (intermediate buy-or-sell) strategy outperforms the conventional ‘buy-and-hold’ strategy. Nonetheless, Wong et al. (2012) developed the mixed Sharpe ratio to test the null hypothesis of equal performance between the two strategies, and their findings indicate that the ‘bang-bang’ strategy delivers superior performance. Bai, Wang, and Wong (2011) developed the mean-variance-ratio statistic to test the equality of the mean-variance ratios and prove that their proposed statistic is uniformly most powerful unbiased. Bai, Hui, Wong, and Zitikis (2012) have developed a uniformly most powerful unbiased (UMPU) mean-variance-ratio (MVR) statistic for comparing the performance of prospects after the effect of the background risk has been mitigated.

3.6 Covariance and Copula

The econometric concepts of covariance and copula are closely related to Behavioral Finance, as investors’ behavioral patterns influence the dynamics of covariance, which itself evolves. A copula, defined as a multivariate cumulative distribution function, provides a flexible and robust statistical framework for modeling such time-varying dependence structures. Covariance inequalities proposed by Egozcue, Garcia and Wong (2009) have been employed to support empirical investigations into phenomena such as excess stock market volatility arising from conservatism and representative heuristics in behavioral models. Subsequent refinements to these covariance inequalities were made by Egozcue et al. (2011b, 2011c), further enhancing their applicability in Behavioral Econometric testing.

3.7 Robust Bayesian Estimation

Bian and Dickey (1996) developed a Bayesian estimation approach that remains robust across a broad class of distributions, including flat-tailed distributions commonly observed during periods of stock market crashes. Bian and Wong (1997) made further improvements to the Bayesian estimation method. Bian et al. (2013) applied the robust Bayesian estimator to reexamine the Capital Asset Pricing Model,

showing that the resulting coefficient estimates are more efficient than those obtained using least-squares estimators.

3.8 *Spurious model*

The literature has found that regression of independent (nearly) nonstationary time series could be spurious. However, Cheng et al. (2021) have shown that under some situations, the regression of two independent and nearly non-stationary series does not have any spurious problem at all.

Cheng et al. (2022), Wong, Cheng, and Yue (2024), Wong, Pham, and Yue (2024), Wong and Yue (2024), and Wong and Pham (2022a, 2022b, 2023a, 2023b, 2025a, 2025b, 2026a, 2026b) have further explored the theory. For example, Cheng et al. (2022) found that significant regression could appear significant in some cases, but significant regression cannot be treated as insignificant in some other cases. On the other hand, Wong, Cheng, and Yue (2024) have found that regression of stationary time series may yield spurious outcomes in some situations.

3.9 *Other estimation and statistics*

Bian and Wong (1997) have developed an alternative approach to estimate regression coefficients. Bian, McAleer, and Wong (2011) have developed a trinomial test for paired data when there are many ties. Tiku and Wong (1998) have developed a unit root test to test whether the variable following an AR(1) model has a unit root.

Wong et al. (2007) introduced a time-varying cointegration approach in which the cointegrating parameter is allowed to follow a smooth function of time. We apply this technique to study the cointegration relationship between the US mortgage and capital markets and find that they are cointegrated after 1982 with a time-varying cointegrating parameter. Penm et al. (2003) proposed using a zero-non-zero (ZNZ) pattern for the vector error-correction model (VECM) and demonstrated the usefulness of the ZNZ-patterned VECM with applications.

Lam et al. (2006) have developed a new variance ratio test in which the autocorrelation of the k-period returns is not restricted to the AR(1) process but takes the form of a general ARMA process.

Bai et al. (2010) and Qiao et al. (2009) have developed a nonlinear causality test in multivariate settings. Bai, Li, Wong, and Zhang (2011) have developed a nonlinear causality test in multivariate settings and conducted simulations to demonstrate the superiority of their proposed test. In addition, Bai et al. (2018) have improved the statistics by re-estimating the probabilities and reestablishing the central limit theorem of the new test statistic. Moreover, Chow et al. (2018) have modified the test to be a panel nonlinear causality test.

Niu et al. (2018) have constructed a one-sample confidence interval for the economic performance measure (EPM), constructed confidence intervals for the difference in the EPM of two independent samples, and derived the corresponding asymptotic distributions.

Wong and Miller (1990) have developed a theory and methodology for repeated time series (RTS) measurements on an autoregressive integrated moving average-noise (ARIMAN) process. Wong, Miller, and Shrestha (2001) have extended the RTS model where the fundamental component follows an ARMA process by using the Kalman filter technique.

Matsumura et al. (1990) have introduced a multinomial distribution model within the dollar-unit sampling framework, with a Dirichlet prior distribution for auditing.

Tiku et al. (1999a) have introduced the modified maximum likelihood (MML) estimators to estimate the autoregressive model of order with asymmetric innovations represented by gamma and generalized logistic distributions, Tiku, Wong, Vaughan, and Bian (2000) have extended the work by using the Student's t distribution, and Wong and Bian (2005) have extended the work by using the generalized logistic distribution.

Tiku et al. (1999b) have introduced the MML estimators to estimate the simple regression model with autocorrelated errors, following the Student's t distribution. Bian, McAleer, and Wong (2013) have extended the work by developing the MML estimator for the multiple linear regression model with an underlying Student's t distribution. Wong and Bian (2000) have introduced the robust Bayesian estimator to the estimation of the Capital Asset Pricing Model.

Bian et al. (2011) develop a new test, the trinomial test, for pairwise ordinal data samples to improve the power of the sign test by modifying its treatment of zero differences between observations, thereby increasing the use of sample information. Simulations demonstrate the power superiority of the proposed trinomial test statistic over the sign test in small samples in the presence of tie observations. We also show that the proposed trinomial test has substantially higher power than the sign test in large samples and also in the presence of tie observations, as the sign test ignores information from observations resulting in ties.

4 Applications

In this section, we review the recent applications of Behavioral Finance theories and Behavioral Econometric methods to the analysis of real-world financial issues. These applications illustrate the practical relevance of psychological behavior in financial markets and the effectiveness of corresponding econometric techniques in explaining investors' behaviors and observed market anomalies in empirical studies.

4.1 Stochastic Dominance (SD)

Lv et al. (2021) conjecture that an optimal investment choice favors assets with high expected returns and low variance. By evaluating portfolio performance with and without healthcare and 6-month US T-bills, they provide empirical support for this conjecture, showing that portfolios containing such assets yield higher expected utility. Their analysis also reveals a limited number of arbitrage opportunities across the markets considered. Building on this line of inquiry, Wong, Yeung and Lu (2023) further suggest that

portfolio performance measured by higher expected utility and/or potential arbitrage opportunities can be enhanced by including assets with the highest mean returns, assets that stochastically dominate a large set of other assets, and assets with minimal standard deviation. Using stocks from both emerging and developed markets, they confirm that these conjectures hold in terms of expected utility and identify a small number of stocks that exhibit first-order SD over others.

Extensions include adding other assets in the portfolios, for example, gold (Hoang, Lean & Wong, 2015; Hoang, Wong and Zhu, 2015; Hoang et al., 2019 and 2020), oil (Lean, McAleer & Wong, 2010, 2015), real estate (Lv et al., 2023; Qiao & Wong, 2015; Tsang et al., 2016), wine (Bouri et al., 2018), warrants (Chan et al., 2012), futures (Clark et al., 2016; Qiao et al., 2013), etc. Extensions also include using more advanced portfolio estimation; see, for example, Bai et al. (2009a, 2009b), Leung, B., Roura-Pascual et al. (2012), Li et al. (2018a, 2018b), Li, Bai, Wong and McAleer (2022), Li, Jiang, Chen and Wong (2022), Chan et al. (2022), and Hui et al. (2024). Extensions could also include the preferences of different investors on the issue; see, for example, Fong et al. (2005; 2008), Egozcue et al. (2011a), Qiao et al. (2012), Lozza et al. (2018), Wong, Yeung, and Lu (2023), and preferences of investors on different events, such as a crisis (Lean et al., 2015; Zhu et al., 2019).

4.2 Underreaction and Overreaction

Fabozzi et al. (2013) propose a set of three tests designed to detect short-term underreaction, long-term overreaction, and the magnitude effect, and their results provide support for the presence of these phenomena. In a related study, Wong et al. (2018) used questionnaire survey data to empirically assess the Bayesian models developed by Lam et al. (2010, 2012). By testing for conservative and representative heuristics among Hong Kong small investors who employ momentum and contrarian trading strategies, they find evidence consistent with the predictions of these behavioral models.

4.3 Herding Effect

We have been applying existing theories and methods from Behavioral Finance and Econometrics to study the herding effect. See, for example, Munkh-Ulzii et al. (2018), Batmunkh et al. (2018; 2020), Chojjil et al. (2022), and others for more information.

Munkh-Ulzii et al. (2018) used the return dispersion model to study herding behavior in the Chinese and Taiwan stock markets. They observed significant herding in both markets overall, during periods of high and low trading volume, and in both bull and bear markets. Batmunkh et al. (2020) applied the cross-sectional absolute deviation (CSAD) model to analyze herding in the Mongolian stock market across the full sample, during bull and bear markets, under high- and low-volatility conditions, and around four major events in Mongolia. Chojjil et al. (2022) employed bibliometric methods to review research on herding behavior in financial markets and documented substantial growth in this area. Conversely, Vieito et al. (2024) utilized a modified return dispersion approach to examine herding in the Latin American Integrated Market (MILA) and to assess the presence of ARCH or GARCH effects. Their results indicate strong herding under general market conditions, with moderate and partial herding during specific regimes,

including bull and bear phases and high- and low-volatility periods. They also detected stronger herding in the pre-MILA period than in the post-MILA period, along with significant ARCH and GARCH effects associated with herding behavior.

4.4 Economic and Financial Indicators

In contrast to the efficient market hypothesis, which asserts that technical indicators cannot systematically outperform the market, a wide range of financial indicators have been shown to possess predictive power for market movements and to generate abnormal returns. For example, Wong, Chew, and Sikorski (2001) propose a novel forecasting indicator constructed from bond yields and earnings-price (E/P) ratios. They further introduce two test statistics to assess the indicator's effectiveness in evaluating stock market performance. Empirical results indicate that signals generated by this indicator enable investors to mitigate losses during market downturns and benefit from market upswings, thereby achieving performance superior to the overall market.

4.5 Technical Analysis

Technical analysis has strong links to Behavioral Finance because it is capable of producing trading signals that distinguish between bull and bear market conditions, such as the financial indicator introduced by Wong, Chew, and Sikorski (2001). Extending this line of research, Wong et al. (2003) employ moving averages and the relative strength index as tools for generating buy and sell signals and develop corresponding test statistics to assess their performance. Their empirical results indicate that these indicators are able to deliver significantly positive abnormal returns. In a related study, Wong et al. (2005) analyze stock market profitability in Shanghai, Taiwan, and Hong Kong using entry and exit signals derived from various moving-averages strategies, and they further document that such strategies can indeed generate abnormal profits.

4.6 Contagion Tests

Wan and Wong (2001) develop a model of refinancing games under incomplete information that provides a theoretical explanation for financial contagion and inducement. In the Behavioral Econometrics literature, several empirical contagion tests proposed by Fry et al. (2010) and Fry-McKibbin and Hsiao (2018) are widely used to investigate cross-market contagion effects. Building on these contributions, Fry-McKibbin, Hsiao, and Martin (2019) introduce joint contagion tests. Applying these tests to daily eurozone equity returns over the period 2005-2014, they uncover evidence of contagion transmission during the European debt crisis that is not captured by traditional correlation-based tests. These findings have important implications for risk pricing and the design of well-diversified portfolios.

4.7 Diversification Strategies

Investors may adopt a variety of diversification strategies. According to Markowitz's (1952a) MV portfolio optimization theory, complete diversification constitutes the optimal allocation. In contrast, when risk seekers follow the selection criteria proposed by Li and Wong (1999), they tend to concentrate their investment in a single asset. Nevertheless, some investors favor holding a limited number of assets rather than a fully diversified portfolio (Statman, 2004). Furthermore, Plakandaras et al. (2019) argue that diversification does not always lead to superior performance. In this context, Jiang et al. (2021) propose a smart beta strategy that outperforms naïve diversification.

5 Concluding Remarks

This review is driven by the need to unify the major strands of Behavioral Finance and Behavioral Econometrics. Although these fields are conceptually connected, the current literature often treats them separately. This fragmentation creates a knowledge gap by impeding a comprehensive understanding of how models are developed, how they are empirically validated, and how their insights can be applied practically in finance. Our review's originality lies in synthesizing these strands, thereby highlighting their natural interconnections and offering academics and practitioners a solid foundation for developing theories, conducting empirical research, and designing practical financial strategies. Interested readers are encouraged to consult the relevant literature in Woo et al. (2020) and Hon et al. (2021). The theories discussed here can be applied by both academics and practitioners across many areas, including stock markets (Cheng et al., 2019; Hassan, et al., 2023; Demirer et al, 2019; Gasbarro et al., 2007, 2012; Shrestha, 2024; Li et al., 2025; Qiao et al., 2010; Wong et al., 2003, 2005, 2018), capital markets (Dev et al., 2023), commodity markets (Bai et al., 2013); futures markets (Lean, Lien & Wong, 2010; Lean, McAleer & Wong, 2010), housing markets (Cho & Jung, 2024; Gupta et al., 2019), Bitcoin (Wong, Zhu, Jiang, and Bouri, 2026). and beyond.

Additionally, this review paper has several limitations that should be acknowledged. Its scope is selective and does not encompass all topics in the literature. Although machine learning and artificial intelligence (AI) are increasingly applied in economics and finance (Ahmed et al., 2022), these areas fall outside the focus of this paper. For example, topics such as the use of AI and machine learning techniques to identify and predict investors' behavioral biases (Gupta & Rao, 2025), as well as quantitative methods for applying AI and machine learning in behavioral finance (Hojaji et al., 2022), are not addressed.

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