Revisiting the Expected Utility Theory and the Consumption CAPM

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Abstract

The concept of utility is the core component of many foundational theories in social sciences. It has evolved from a philosophical belief that people seek happiness and satisfaction to a mathematically derived theory in economics and finance. Beginning with a brief review of the developments in the Expected Utility Theory (EUT) and its applicability in equity pricing, this paper includes a critical appraisal of relevant theoretical and empirical studies from the fields of financial economics and behavioural studies, with a particular focus on the the Consumption Capital Asset Pricing Model (CCAPM).

Keywords: Expected Utility, Choice Behaviour, Equity Pricing, CCAPM

JEL: G11, G12, G41

1. Introduction

Individuals are faced with numerous issues which necessitate making choices. Most everyday problems are solved through quick responses based on intuition and feelings. While some which are more complex with a monetary consequence need to be tackled methodically based on analysis and reasoning (Kahneman and Frederick 2002). Unsurprisingly, this complexity is further accentuated when the available alternatives have risk implications or decisions are made under uncertainty. However, whether it is a decision to buy a new mobile-phone or to allocate wealth across investment avenues for retirement-planning, the common aim in most observable cases is to obtain highest value for a given price.

Early theoretical developments in economics advocated that individuals make decisions by ranking the choices based on perceived utility and select the one that provides most usefulness (Stigler 1950). The Expected Utility Theory (EUT) generalised this concept of utility maximisation under the microeconomic paradigm of rationality and served as a foundation to model decision-making with risky choices or uncertain outcomes. Apart from the assumption of a rational economic agent who makes consistent decisions by objectively valuing the expected utility of probable outcomes, EUT has been academically evaluated as both a *positive* and a *normative* theory (Mongin 1997). Therefore, even if it is primarily known as a descriptive theory based on observations - *How do individuals actually make decisions* - and consequently applied to make predictions; economists have appraised the EUT as prescriptive - *How should individuals ideally make decisions*. Section 2 reviews the developments in EUT and critically examines its ability to explain individuals' decision-making.

Theories in economics have made a significant impact on academic research in business and management, more so in corporate finance. The Portfolio Theory states that investors seek to maximise returns for a given level of preferred risk or alternatively minimise risk to achieve a certain return (Markowitz 1952, 1959). Undoubtedly, the notion of utility maximisation in EUT is critical to achieve an optimal investment portfolio through diversification[1]. However, behavioural finance theorists reject the assertion of generalised rationality. The law of diminishing marginal utility is foundational in economics and also a vital constituent of EUT. It is based on a perceptive notion that additional consumption provides incremental utility at a decreasing rate. This concept too is relevant in investment management as investors prefer more wealth (higher returns) and fluctuations in wealth lead to change in risk aversion. Stable utility functions can be defined to understand investors' preferences about risk and returns (Merton 1992). However, empirical findings of some equity pricing studies do not conform to the EUT hypothesis. Section 3 evaluates the applicability of EUT in financial asset pricing through the CCAPM.

[1] Bernoulli (1738, translated in 1954: 30) thought of diversification to minimise risk, *"It is advisable to divide goods which are exposed to some danger into several portions rather than to risk them all together."*

2. Developments in EUT

Daniel Bernoulli's definition of expected utility predates the formalised version of EUT applied today; *"determination of the value of an item must not be based on its price, but rather on the utility it yields"* (Bernoulli 1738, translated in 1954: 24). He proposed that every individual assigns a unique subjective value to each outcome which is significantly lower than the maximum monetary pay-off. Moreover, he explained the risk aversion in human behaviour, as individuals would prefer to preserve wealth even if the outcome is highly probable and promises high returns. His explanation of concave utility function is the bedrock of asset pricing theories in financial economics. However, Bernoulli's presumption of a cardinal utility scale wasn't well received by the neoclassical economists (Starmer 2000). They argued that merely sorting the preferences irrespective of the change in magnitude of utility can sufficiently explain decision-making. Hence, the 20th century definition of ordinal utility assumes continuity in choice wherein preference is unaffected by a small change in probability of the outcome (Binmore 2008).

Von Neumann and Morgenstern (VNM) (1944), in their seminal work that introduced the Game Theory, initiated the mathematical translation of Bernoulli's ideas about utility in a way that generalised the individual choice behaviour. The most crucial condition that facilitated the generalisation is rationality. It is assumed that an (any) individual possesses complete information about all possible outcomes, their respective probabilities and makes a consistent, logical choice. Savage (1954) formulated a significant variation of EUT, namely 'Subjective EUT' that differentiated uncertainty from riskiness and assessed the expected utility of outcomes with unknown probabilities. Marschak (1950) and Herstein & Milnor (1953) defined a formal framework for people's preferences based on a set of axioms and derived the VNM theorem of expected utility. EUT was fortified further by Fishburn (1970) and Kreps (1988) among others through additional postulations. Apart from the basic assumptions of transitivity and completeness, the two crucial axioms are; one, outcome with higher probability is preferred and two, preference order of any two outcomes is independent from the preference for any other outcome (Hargreaves Heap 1992). While the axiomatic, numerical expression of utility provided convenience in calculation, the conceptual appeal ensured wider acceptance of EUT. However, the very foundational elements of EUT were scrutinised, leading to anomalies and consequently, alternative theories such as the Random Utility Theory (McFadden 1980), Weighted Utility Theory (Chew and MacCrimmon 1979) and Multi Attribute Utility Theory (Loomes and Sudgen, 1986) (Starmer 2000).

Allais (1953), through a series of experiments, observed an unanticipated change in respondents' preference when the probabilities of two choices were scaled down by a common factor (Blavatskyy 2013). This 'Common Consequence Effect' violated both the rationality assumption and the independence axiom. Based on Allais' paradoxical results, Kahneman and Tversky (1979) proposed the much famed Prospect Theory. Their experiments illustrated that respondents preferred a gain of $3000 with a probability of 1 to $4000 with a probability of 0.8. Hence, people are highly averse to losses as they prefer certain outcomes over those probable. They argued, building on the Markowitz (1959) mean-variance model of Portfolio Theory, that individuals, in order to control losses, prefer the outcome with higher return, if it's

counterbalanced by a considerably low variance. However, same respondents chose $4000 gain with probability of 0.25 to $3000 with 0.2, thus violating the EUT assumption of high probability preference and the certainty principle, as the expected gain outweighed the relatively higher variability. Furthermore, they suggested an interpretation of utility conditional to a probable gain or loss. Here too, they derived from Markowitz (1952), *"He was first to propose that utility be defined on gains and losses rather than on final asset positions"* (Kahneman and Tversky 1979: 276); a reliable evidence that economics, finance and behavioural studies are interdependent.

Following Prospect Theory that discovered the impact of loss aversion on expected utility, numerous studies attempted to theorise decision-making with an all-encompassing yet liberal adaptation of EUT. While some conducted behavioural experiments, others explored the utility functions with non-probabilistic and non-additive characteristics. Quiggin (1982) and Schmeidler (1989) incorporated inherent beliefs and attitudes like optimism or negativity in their 'Rank Dependent EUT'. They proposed that individuals assign a 'decision weight' to every outcome which is contingent on how favourable it is to them compared to other outcomes and then rank the outcomes accordingly. Later, Tversky and Kahneman (1992) adopted this idea of ranking based on subjective weights and cumulative probabilities to develop the Cumulative Prospect Theory which satisfied the vital monotonicity assumption (more is preferred) of conventional EUT. Thaler (1985) observed that selling prices are usually higher than buying prices because the value of seller's prospective loss outweighs the value of buyer's probable gain. He argued that individuals are loss averse and thus evaluate expected utility with respect to a reference price or existing wealth position. He termed this as the 'endowment effect' that generates 'transaction utility'. Cicchetti and Dubin (1994) found that 57% respondents chose to purchase an insurance against repairs charges of telephone wiring with a 0.005 probability of incidental damage. Given that the monthly payment was higher than the probable cost, this choice breached the EUT assumption of rational and utility-maximising agents.

Evidently, EUT economists received a compelling rebuttal from behavioural theorists and psychologists. As a result, the recent research on choice behaviour has significantly departed from the neo-classical description of utility. Yet, the findings of laboratory experiments have been inconsistent and don't necessarily facilitate the modelling of decision-making. For instance, Brooks and Zank (2005) exemplified that women are more loss-averse than men. However, Harrison and Rutstrom (2009) found no significant impact of socio-demographic factors. They concluded that Prospect Theory and EUT have similar explanatory power, albeit in diverse 'task domains'. Ramos et al (2011) showed that Prospect Theory predicts travellers' choice of routes more reliably than EUT. Similar studies that examined the applicability of EUT in varied areas such as health, agriculture and taxation and compared it with Non-EUT alternatives have yielded mixed results (Perpinan et al 2009; Dhami and Nowaihi 2010; Just and Peterson 2010; Bombardini and Trebbi 2012). Given the range of conflicting verdicts on EUT, parallel attempts are made to either amend or strengthen the original EUT by VNM and Savage (La-Mura 2009; Danilov and Lambert-Mogiliansky 2010; Hu 2013). An exhaustive review of theoretical advances, empirical analyses and experimental studies that respectively

built on, assessed and contradicted the EUT to explain the individual choice behaviour is beyond the scope of this essay. Nevertheless, it is apparent that a plethora of academic research emerged from the EUT leading to its practical applications in an array of diverse fields, particularly in equity pricing.

3. EUT and Equity Pricing

When investors purchase equities or bonds, they intend to achieve an optimal risk-return trade-off and smooth their consumption. In doing so, they make a critical wealth-allocation decision to either consume (invest) today or save for future consumption. Thus, consumption patterns of investors or their investment choices influence the prices of financial assets. Predictably, asset pricing models in the current financial economics paradigm draw from the EUT and assume rational investors with precise utility functions who trade securities in frictionless markets. One such model is the Consumption Capital Asset Pricing Model[2] (CCAPM). It posits that, at equilibrium (optimal market efficiency), the loss of utility accepted by an investor in purchasing an asset today, equals the increased expected utility (higher consumption) in the next period when the asset yields returns (Equation 1) (Danthine and Donandson 2014). The incremental returns expected in the future period is the premium for bearing additional risk or the Equity Risk Premium (ERP) in case of stocks.

$$P_{it}, u'(C_t) = E_t [\beta, u'(C_{t+1}), R_{t+1}] \quad (1)$$

Where, P_{it}, is price of asset i at time t and $u'(C_t)$ is marginal utility of current consumption. Their product reflects the loss in utility (forgone consumption) faced today through investment in asset i. β is the subjective discount factor of future consumption. It measures how keen the investor is to consume at time t as opposed to time t+1. Considering, a higher beta value increases total expected utility (E_t), high beta reflects the investor's desire to postpone consumption. While, $u'(C_{t+1})$, is the marginal utility of consumption at time t+1; R_{t+1}, is the future returns from asset i. Finally, E_t is the utility gain at time t+1, as expected at time t, through investment in asset i at price P_{it}.

Although CCAPM implements the intuitive reasoning of EUT, the early empirical studies conducted using the CCAPM challenge its ability to price equities. Hansen and Singleton (1983) built a widely tested variation of CCAPM, wherein the representative agent's utility of consumption is time separable. They failed to explicate the cross sectional returns on stock and bonds using the U.S. consumption data. The seminal paper of Mehra and Prescott (1985) found that the high observed ERP could not be justified using the CCAPM. The general consensus on the value of co-efficient of risk aversion for an average investor is in the range of 1 to 3. However, a high ERP of 6% demanded by the U.S. investors in the period 1889-1978 implied an exorbitantly high risk aversion of 30 to 40. While, Mehra and Prescott (1985) conceded that an expected utility and consumption based model to estimate ERP is theoretically sound; their

[2] It was developed with vital contributions from Rubinstein (1976), Lucas (1978), Breeden (1979) and Grossman and Shiller (1981)

empirical findings were termed as 'The ERP Puzzle' which to this date remains an unexplained anomaly. This necessitated modifications to the utility function of the representative, rational investor as assumed by the EUT.

The standard general equilibrium model of asset pricing based on Lucas' (1978) pure exchange economy assumes that an investor's utility of consumption in any given period is independent of its consumption in either preceding or following periods. However, given the negligible empirical evidence in support of CCAPM's suitability to estimate expected returns (or the ERP), Sunderesan (1989) and Constantinides (1990) suggested the inclusion of the 'Habit Formation' aspect into the model. They argued that marginal utility of future consumption is affected by past consumption and hence it is not independent. Therefore, the utility function in equation 1 is modified from $u'(C_t)$ to $u'(C_t, X_t)$ where X_t is the habit that varies over multiple periods. Furthermore, the model assumed that future consumption of any investor is affected by the past choices of only that individual and any outside influence is disregarded. While they described this factor as 'internal habit', it is expected to be relatively inelastic to change in future consumption. Although, Constantinides (1990) disproved the ERP Puzzle by justifying the high ERP with low risk aversion, Lettau and Ludvigson (2001) questioned his model as it required a consumption growth series with positive autocorrelation.

Abel (1990) proposed an alteration to include the 'external habit' formation or what he described as 'catching up with the Joneses'. He argued that the marginal utility of future consumption is impacted by the aggregate consumption lagged by one period but is independent of individual's choices. This model found that higher risk aversion reduces the risk-free rate thus overestimating the ERP. Furthermore, incorporating the assumptions made by Mehra and Prescott (1985) lead to a higher variance in risk-free rate, increased its covariance with stock returns and consequently generates higher ERP. Although, Abel (1990) claimed his model solved the ERP Puzzle, the 'time complementarity' feature leads to a more volatile marginal utility of future consumption as it is now derived from consumption from an earlier period. This leads to higher volatility in risk-free rate, making it inconsistent with historical interest rates which have been relatively steady (Abel 1999).

A more plausible version of the above alterations was presented by Campbell and Cochrane (1999). They included the external habit formation factor and variable risk aversion relative to consumption, unlike their predecessors who assume a constant risk aversion. They showed that the time variability characteristic coupled with smooth consumption and stable risk-free rate generates more reliable estimates of ERP. The intuitive logic for this argument is; unexpected shocks to consumption that lead to higher risk aversion reduce consumption up to a level where an investor cannot trim it any further due to ingrained habits. Subsequently, stock prices decline and drive up the ERP. Although fairly robust, they were forced to maintain a constant risk-free rate in order to achieve stability, which is the opposite extreme of the inconsistency in Abel's model (Guvenen 2005).

However, as it is rooted in the expected utility hypothesis, CCAPM's ability to explain investors' decisions has been questioned. Some argued that investors evaluate income and consumption in isolation (Shiller 1999; Welch 2000); while others suggested that consumption

data in unreliable (Black, 1990) and wealth is more appropriate given its higher volatility (Vivian, 2007). Considering the ERP Puzzle still exists after 30 years, one can argue that the notion of rational economy underpinning CCAPM is flawed and non-standard investor preferences should be included.

4. Conclusion

EUT introduced simple, intuitive concepts of rational expectations and utility as fundamental ingredients for decision-making. However, it received criticism for this very simplicity that ignored the intricacies of the often unpredictable and idiosyncratic human behaviour. This criticism is based on the argument that individuals have distinctive tastes, varying level of risk aversion, do not possess all the information, have limited computational ability and hence rely on crude techniques such as rule-of-thumb. But the argument has proved inadequate as it is largely supported by the results of laboratory experiments that test individuals' choice behaviour in hypothetical scenarios and not when they make real, practical decisions.

While there is some evidence to question the descriptive ability of EUT, the unconventional framework has limitations in modelling decision-making in a way that can be widely applied and thus is unable to present a robust Non-EUT alternative. There is little doubt that the expected utility hypothesis, which has developed over a period of 300 years, has successfully withstood scrutiny for the past five decades. Until there is an appropriate substitute, EUT undeniably outranks others as a normative theory that simply states *individuals should behave rationally and seek value.*

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