DETERMINANTS OF FINANCIAL DECISION MAKING RATIONALITY IN DEPOSIT-TAKING SAVINGS AND CREDIT COOPERATIVES IN KENYA

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Determinants of Financial Decision Making Rationality in Deposit-taking Savings and Credit Cooperatives in Kenya

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DECLARATION

This thesis is my original work and has not been submitted to any university for a degree.

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This thesis has been submitted for examination with our approval as University Supervisors.

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DEDICATION

This research is dedicated to my parents; the late Peter and Serah, my wife Virgy and our children Nernst, Velma and Henry. Their love and inspiration kept me going despite the rough but thrilling road I travelled through in my doctoral studies.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

APPENDICES

LIST OF ABBREVIATIONS

GDP – Gross Domestic Product

GESR – Generational Entropy Substitution Rate

IPO – Initial Public Offer

LOT-R – Life Orientation Test -Revised

ME – Margin of Error

ODM – Observable Dimension Model

ODV – Observable Dimension Variable

OVD – Observable Variable Dimension

ROA – Return on Assets

SACCO – Savings and Credit Cooperative Organization

SASRA – SACCO Societies Regulatory Authority

SDA – Senile Dementia Age

SDE – Stochastic Differential Equation

UCR – Updating Consistency rate

UVD – Unobservable Variable Dimension

DEFINITION OF KEY TERMS

Achievable rationality	The maximum rationality a financial decision maker can attain in their lifetime on any single decision over and above reflexive rationality (Lowi and Simon, 1992);
Attainable rationality	The maximum rationality a financial decision maker can attain in their lifetime on any single decision (Lowi and Simon, 2016);
Base rate neglect	Making a decision without regard to prior information known to the decision maker about the decision (Manktelow, 2012);
Belief Updating	The process of revising subjective assignments of the likelihood of an event on the basis of observed data (Brunsson, 2007);
Bounded Rationality	The idea that decision making deviates from rationality due to human limitations in cognition capability and willpower(Lerner, Li, Veldesolo & Kassam, 2014);
Cognitive style	The way individuals think, perceive and remember information in relation to financial decision making (Happe, 2000);
Decision urgency	Existing pressure on a financial decision maker to take a decision within a limited time (Reddi, 2000);
Deterministic Variable	A variable whose future value is known or can be certainly determined (Hull, 2012);
Drift rate	Refers to the mean change per unit time of a stochastic process (Hull,2012);
Entropy	A measure of randomness or disorder in statistical thermodynamics. This derives from the second law of thermodynamics in physical chemistry which states that the equilibrium state of an isolated system is the one in which the number of microscopic states is largest (Glasstone, 1991);
Financial decision making rationality	Magnitude of rationality exercised when making a financial decision (De Martino, 2010);

Incidental affect	Refers to feelings such as mood states that are independent of the stimulus but can influence the decision process (Beresford & Sloper, 2008);
Information	Facts told, read, or communicated that may be unorganized and even unrelated but relevant to a decision at hand (Yeager, 2005);
Instrumental Rationality	Rationality type whereby rational action to achieve goals is the primary notion, and rational belief and rational inference are secondary and derived. The fundamental standard for instrumental rationality is having reliable means to achieve goals (Koehler & Harvey, 2004);
Intrinsic irrationality	Rationality that cannot be eliminated by way of learning (Atkinson, 1994);
Integral affect	Refers to feelings experienced about a particular stimulus (or financial choice) and can influence the decision process (Beresford & Sloper,
Irrationality	Avoidance of use of a logical and structured approach to decision making. The search for information is not done or done partially, the assessment of information is not logical, and evaluation of the information is also avoided (Rosenberg, 2011);
Ito- Bayesian rationality algorithm	An algorithm developed to forecast rationality in continuous time and which has the same properties as those of an Ito process (Fei-fei and Perona, 2007);
Ito Process	This is a generalized geometric Brownian process in which the parameters ‘a’ and ‘b’ are functions of the underlying variable x and time t. An Ito process is algebraically written as **dx = a(x, t) + b(x, t)dz** (Hull, 2012);
Local rationality maximum	A maximum point at which an economic agent maximizes rationality substantially below 100% rationality, and which can be improved by reducing the proportion of irrational decisions made (Thomas and Finney, 1984);

Locus of Control	Locus of control is a personality variable that measures people's general expectancies about whether they can or cannot control events affecting them, and their tendencies to attribute the causes of their financial successes or failures to either internal or external sources (Allen, Weeks, & Moffitt, 2005);
Ordinary decision point	A decision time point where an economic agent takes a decision without reference to previous learning (Mathieu and Taylor, 2006);
Perception	A particular way of understanding or thinking about something (Macmillan, 2002);
Prior knowledge	An organized body of information, or the comprehension and understanding consequent on having acquired and organized a body of factual information possessed by the decision maker at the time of decision taking (Yeager, 2005);
Prospects of wealth increase after an irrational decision	A measure of the likelihood of benefiting from an illogical financial decision (Kahneman and Tversky, 1984);
Prospects of wealth increase after an irrational decision	A measure of the likelihood of benefiting from a logical financial decision (Kahneman and Tversky, 1984);
Rational choice	Prudent and logical decision making to yield highest financial benefit or satisfaction (Homans,1991);
Rationality	Rational decision making is characterized by the use of a logical and structured approach to financial decision making. The search for information, the assessment of information, and evaluation of the information are all carried out in a logical manner (Rosenberg, 2011);
Rationality learning age limit	Maximum age beyond which no more financial decision making rationality can be learned (Levy, 2015);

Reflexive rationality	Financial decision making rationality inherent in human beings at birth and which is therefore not acquired (Wilthagen, 1994);
Relative Entropy	Also known as Kullback-Leibler divergence is the measure of the distance between two probability distributions on a random variable (O'hara, 1995);
Self Efficacy	Self efficacy is a specific construct and the individual`s own beliefs about his or her ability in a specific situation. Self efficacy influences how people think, behave, feel and motivate themselves in financial decision making. (Caprara, Vecchione, Alessandri, Gerbino and Barbaranell, 2011);
Senile dementia age	The age where forgetfulness sets in by reason of advancement in age. At this age it is expected that no more learning takes place on an incremental basis (Macmillan, 2002);
Stochastic Variable	A variable whose future value is uncertain or cannot be determined with certainty (Hull, 2012);
The institution of the individual	Refers to the notion that the individual has a strong identity, is a composite, an 'indivisible' whole with clear boundaries. The individual is presumed to have special financial decision making characteristics that are relatively stable in time and space free wills—the ability to choose thoughts and wishes freely. (Brunsson, 2007);
Updating decision point	A time point at which an economic agent makes a financial decision on the strength of previous learning (Mathieu and Taylor, 2006);
Volatility	Refers to the variance per unit time of a stochastic process (Hull, 2012).

ABSTRACT

This thesis quantitatively established the effect of selected determinants on the financial decision making rationality exercised by SACCO members and their SACCO managements, for the complete rational man assumption – homoeconomicus, does not always hold. Rationality bounds in financial decision making as espoused in bounded rationality theory, whose analytical proof was incidental, were determined to reflect how much SACCOs actually rationalize their financial decisions. The objectives were: to establish the effects of first, prior knowledge about a financial decision; secondly, prospects of posting wealth increase after an irrational decision; thirdly, prospects of posting wealth increase after a rational decision as the determinants; and lastly, effect of wealth movement on the determinants as inputs into a binomial multi-period Bayesian decision model, using longitudinal design. Both frequentist and Bayesian paradigms applied where wealth movement modeled by geometric Brownian motion through Monte Carlo simulation acted as the observable dimension model with total assets (wealth) as the observable dimension variable and financial decision making rationality as the unobservable dimension variable in the process. Stochastic discrete and continuous time cases in were examined. This behavioural decision research used diffusion finance and market microstructure models to explore human intrinsic determinants of financial decision making rationality on a 0 – 100% open interval scale. The three biggest Kenyan Savings and Credit Cooperative Organizations namely, Unitas, Mwalimu National and Stima were purposively targeted. Two questionnaires were administered; one on the members and the other on management staffs. Simple random sampling was used on members amounting 271 and 46 management staffs. Hypotheses about population mean and about differences between populations means carried out tested significant. The results showed that prior knowledge affected financial decision making rationality positively and should therefore be maximized, but prospects of posting a wealth increase after a rational decision affected positively up to local rationality maximum, beyond which negative effect set in, suggesting that it should be maximum at this point and minimum at 0.6321. Prospects of realizing a wealth increase after making an irrational decision on the other hand, affected financial decision making rationality negatively and more adversely in the entire range; hence

should be minimized. Wealth increase and decrease was found to increase and decrease financial decision making rationality respectively, hence increases are favourable. On average, a SACCO member updated 11 times in the last 10 years; translating into an updating period of 10.91months. Only about 58.81% of financial decisions rationalization is exercised; the least educated group posting the highest rationality level of 76.34%. The rest of decisions were largely made on the basis of heuristics; meaning that standard finance and classical economic theories need urgent revision. The model used was validated through psycho-social economic equation which presents invaluable lessons in risk management. Further, that the rationality learning age limit is 67.27 years. Portfolio diversification problem entropy concept featured prominently coupled with the principle of minimum guess work. The concept of generational entropy-q substitution rate emerged. It is recommended that financial decision making entropy be adopted as a superior criterion to education for employee selection and credit rating by SACCO managements. Entropy-q rationality theory and model were proposed, including related problems solution tables; that are likely to find a broad range of applications in industry.

CHAPTER ONE

INTRODUCTION

1.1 Background of the study

Consistent departure from rational decision making by humans led to the birth of behavioural economics and behavioural finance as pointed out by various behavioural economists like Robert Shiller (1999). This notion formed the basis of the work of Herbert Simon (1996) who propounded the theory of bounded rationality characterization in decision making processes. If rationality is limited as opposed to complete as assumed by standard finance, it means there is inherent irrationality in financial decision making. Identification of choice human intrinsic determinants of financial decision making rationality in consumption, investment and savings' decisions was the primary subject matter of the study whose findings are reported in this thesis.

It ultimately provided a clear linkage between standard and behavioural finance; effectively positioning the study in quantitative bahavioural finance. The effect of each determinant was established. By reason of most forecasts for phenomena being stochastic rather than deterministic, the study considered stochastic environment as more realistic for use. Most scholarly break-through in the last 70 years has been in the field of investment finance; contextualized in financial markets. This is evidenced by studies by Harry Markowitz (1952) of portfolio theory, Sharpe and Lintner (1965), of Capital Assets Pricing Model, Ross (1976) of arbitrage theory among others. However, consideration of human aspects hinted by Adam Smith in his book, The Theory of Moral Sentiments (1759) had been absent until 1970s when Daniel Kahneman and Amos Tversky breathed life to behavioural finance. Application of mathematical models from the more developed investment finance in behavioural finance was elaborately made in this study.

Behavioural finance is the study of the influence of psychology on the behaviour of financial practitioners and the subsequent effect on markets Sewell (2007). Most other

scholars like Shefrin (2000), Thaler (2000), describe behavioural finance as the interaction of psychology with financial actions and performance of "practitioners" (all types of investors). Behavioural finance was born of inadequacy of efficient market hypothesis (Fama, 1970) in financial markets. As such, the discipline's definition has been contextualized in financial markets where the actors are investors (Ross, 2014). However, it is clear that human biases and errors are not only exercised by investors or restricted to financial markets. This observation led to a panel of behavioural proponents expanding the definition in 2009. They defined behavioural finance as the study of how psychology impacts financial decisions in households, markets and organizations (De Bondt, Muradoglu, Shefrin, and Staikouras, 2009). This is the definition, which includes consumption and savings' decisions, was predominantly adopted, since it covers households (individuals) and does not confine its application to financial markets. Behavioral finance combines the disciplines of psychology and economics to explain why and how people make seemingly irrational or illogical decisions when they spend, invest, save and borrow money (Belsky and Gilovich, 1999). This additional part of consumption and savings was particularly important to this study. The study as well endeavoured to aggregate several experiments done in psychology to contribute to formulation of public policy in financial planning. This involved crafting of conceptual constructs to enable decision making procedure analysis.

The idea of rationality can be viewed as both a measure and an ideal (Ryan, 1999). As an ideal, we often use rationality to highlight a negative or less than adequate aspect. For example, we label something "irrational" without actually specifying the components of the ideal. As a measure, we use the term to specify what is perceived as optimal. As both a measure and an ideal, there is no doubt rationality is socially iconic. Because of this, it is not surprising that rationality is held in high regard as the basis for the way we organize our social structures (Ryan, 1999). It can be inferred that rationality as an ideal does involve socio-cultural and politico-economic value systems of individuals and groups while rationality the measure appeals to a calibrated scale of best to worst regarding behaviour. In the light of this argument, this study confined itself to the

measure dimension of rationality within the confines of financial decision making. The effect of irrationality is a high likelihood of reduction of economic resources while the effect of rational decision making is a high likelihood of increasing economic resources of the decision maker. This takes place as a learning process setting off from a specified level of knowledge about the decision. Since rationality derives from cognitive and affective states of an individual; which determines judgement and is only manifested in observable phenomena like dressing, increase in wealth, speech among other indicators, it can be determined using Bayesian learning model (Bolstad, 2007). Determinants of rationality were only picked from an individual's cognitive and affective states as a function of time. This learning envisages prompt updating of the new learned behaviour; which refines subsequent decision quality (Manktelow, 2012). Both frequentist and Bayesian paradigms were used in this study.

Rationality in decision making can be practiced at both individual and group level. As long as the goal is clear to participant(s) in a decision making process, individual decisions are less effective than group decisions given a relatively equal level of knowledge and experience (Goldstein & Weber, 1995). This can be attributed to the likely limited knowledge of an individual compared to a group especially at corporate level. Since rationality is exercised by individuals whether for individual or group decisions, this study chose rationality determinants that relate to the individual, some of which relate to current level of knowledge, information, experience including instantaneous states of mind and emotions, and the rest is related to the more permanent attributes of personality.

Recent literature in empirical finance is surveyed in its relation to underlying behavioral principles, which come primarily from psychology, sociology and anthropology. Behavioral principles discussed by theorists include: prospect theory, regret and cognitive dissonance, anchoring, mental compartments, overconfidence, over- and underreaction, representativeness heuristic, the disjunction effect, gambling behavior and speculation, perceived irrelevance of history, magical thinking, quasimagical

thinking, attention anomalies, the availability heuristic, culture and social contagion, and global culture (Shiller, 1999). Of the above behavioural principles, culture and social contagion relate to external environmental influence while the rest are internal. In recognition of the fact that human beings are the basic units of productivity in an economy, in line with Ryan's idea that rationality forms the basis of social structure of an organization, it was prudent to extend that rationality is likely to influence economic structure of an organization as well. This permitted a look at the operating financial system in the Kenyan economy towards securing a justifiable approach which rationality analysis in the local scenario may be approached.

1.1.1 Bank-based financial system, consumption and saving

Kenya mainly operates a bank-based financial system where there exists high integration of banking and commerce; banks offer both banking and non-banking services like sale of other companies' shares to the public on commission basis (Allen & Rai, 1996). Few investment banks exist. The contribution of Nairobi Securities Exchange by market capitalization is about 40% of Assets (Kenya Economic Report, 2013) while by 2008, the cooperative sector; which has been steadily expanding by 25% in 2013 according to World Organizations Council of Credit Unions Report 2013, through credit unions (Savings and Credit Cooperative Organizations herein after known as SACCOs) was contributing 30% of GDP (SACCO Supervision Annual Report, 2013).

The fact that Kenya is more of bank-based rather than market-based financial system gives emphasis to the savings aspect including the personal entrepreneurial aspect; a major requirement in the operation of SACCO membership. Predominance of the bank-based financial system in Kenya necessitates extension of application of behavioural finance aspects to individuals and groups from the financial markets (marked-based financial system) especially with regard to consumption and saving. The financial markets context would confine financial decision making to investment decisions, yet, individuals' financial decisions include consumption to a large extent and also savings. While consumption decisions may be examined in both market-based and bank-based

financial systems, savings decisions are more envisaged in bank-based financial systems, where deposit-taking cooperatives belong. Credit advancement to a SACCO member is done on the basis of savings already made.

Rationality as probably the most fundamental assumptions made by classical economists enabled construction of economic and financial models similar to those crafted by natural scientists. This is the assumption that humans are completely logical in economic and financial decision making. This has been captured by Hirshleifer (1966) in the state preference theory in a number of axioms. First, the axiom of transitivity which states that human beings preferences are always logically ordered; that preferences are characterized by acyclicity and is complete. The second is that preferences are always continuous. This sometimes need not be the case, the reason why this study was considered in both discrete and continuous time settings. The third is homogeneous expectations of actors. It is common place to find heterogeneity of expectations in financial decision making agents. Besides, rational actors are assumed to be strongly independent in making economic choices (Arrow & Debreu, 1959). These anomalies affect both financial planning at both macro and micro levels.

Kenya like its partner states in East Africa is in the fore front of spending huge amounts of money in education and training of its population. Tertiary education has expanded by a huge margin as evidenced by high increases of universities and middle level colleges (Economic Survey of Kenya Report, 2014). This is expounded in its vision 2030. In the Vision 2030's blue print, Section 2.4 Human Resources Development under Socio-economic Pillar states: "Accurate data is required to strengthen management and coordination of human resources". Accurate data here means academic qualifications to the largest extent, experience to a sizeable extent and rate of updating to almost no extent. In section 4.2 of the document under the Social Pillar, headed Education and Training, enumerates five major challenges that the government seeks to address. Regrettably, none of them captures the aspect of how much learning is actually uploaded into the populations' way of living and which affects financial decision making progressively. Of course the amount and frequency of training is directly proportional to

knowledge retention, however, in this very important document, that rate is conspicuously missing. All these efforts are geared towards achievement of the national vision. The level of alignment of nationals' behaviour towards the national goal as a function of time remains unquantified. It is against this rationality notion within the Kenyan economic setting that representative groups and individuals were chosen for study to assess compliance with the notion.

1.1.2 Standard finance theories and the assumption of rational action

Most standard finance theories especially those with an investment orientation, operate on the assumption of rational action of the decision maker. Rational action entails complete information gathering followed by logical processing to arrive at the alternative that maximizes relevant wealth (Abell, 2000). The Efficient Market Hypothesis (Fama, 1970) assumes that market prices incorporate all known information; Modern Portfolio Theory assumes that, the investor is rational; Capital Assets Pricing Model (Sharpe, 1964) and Arbitrage Pricing Theory (Ross, 1976) assume that asset prices reflect all available information (Pandey, 2001) while Rational Expectations Theory assumes that people invest, spend and save according to what the decision maker believes will happen in future (Muth, 1961). Given the rational action assumption, which does not hold all the time, standard finance theories can therefore only be reliable at most, to the extent that economic agents act rationally. Kenyan SACCO members like all other decision makers are expected to be guided by rational decision making to the extent possible in their consumption, savings and investments decisions.

1.1.3 Rational financial decision making process and the probabilistic nature of selected determinants

As the most fundamental assumption of human financial decision making practice, rational action depicts logical decision processing for purposes of self interest (Pollock, 2006). This means that humans act in such a way that they maximize their well being. In finance terms, human beings engage in financial decisions to maximize their current wealth (Pandey, 2001). However, gathering of all decision related information for processing may be untenable (Keast & Towler, 2009). To simplify the condition, like in

efficient market hypothesis, the requirement is that prices reflect all available information rather than all existing information. Moreover, this is still an uphill task, considering that even after the decision maker has gathered all available information, they may not possess the ability to process it to arrive at the best alternative. Decisions are made then implemented but their benefits can only be realized in a subsequent period.

Factors that play out during this subsequent period are in most cases out of control of the decision maker (Gigerenzer, 2015), so that anticipated accruing benefits may not be realized. On the other hand, financial decision makers may not necessarily lose for not making rational decisions; that is, for not following a logical sequence of analysis to arrive at an alternative for implementation (Ariely, 2010). In the meantime, the prior knowledge about the decision at hand as determined by their decision making experience also affects the proficiency with which the current decision is made (Keast & Towler, 2009). These insights lead to the fact that rationality exercised in financial decision making derives from a probabilistic process comprising three components. However, existing empirical research has not identified the selected determinants in past studies, to process financial decision making stochastically. In summary, the immediate previous likelihood of making a rational decision, secondly, the likelihood of deriving financial benefits after an irrational decision and finally, the likelihood of deriving financial benefits from a rational decision were investigated. The effect of these components was explored in Kenyan deposit-taking SACCOs.

1.2 Statement of the problem

Kenya prides itself with the greatest cooperative movement in Africa; with about 30 million people (67% of the population) deriving its livelihood from SACCO activities contributing 48.55% of gross national savings (SACCO Supervision Annual Report, 2013). In the light of the personal or SACCO management's wealth maximization goal, I argue that a financial decision should be geared to increase individual SACCO member's wealth or the SACCO's wealth (in case of the SACCO management unit of

analysis). Again, assuming that any decision may either be rational or not (as depicted by standard finance), it can be viewed that not all rational decisions may yield wealth increase. As well, not all irrational decisions may yield a wealth decrease. Eventual wealth increase or decrease is a product of the interplay between the likelihood of realizing a wealth increase after a rational decision, the likelihood of realizing a wealth increase after an irrational decision and the proportion of prior knowledge about a financial decision out of the total knowledge existing about a financial decision. It is important to note that not all existing knowledge about a decision is available.

The problem was to establish the effect of the selected determinants on financial decision making rationality. Teachers SACCO members sought more expensive bank loans (Auka & Mwangi, 2013) regrettably between 2004 and 2009, selling them back later to their own SACCOs to secure an interest reprieve; meaning that they had made irrational decisions at the onset. Such SACCOs include Mwalimu National SACCO and Metropolitan National SACCO (then Known as Nakuru Teachers SACCO) (Auka & Mwangi, 2013). Setting off from a given self perception of rationality in financial decision making, it needed to be established how do prospects of increase in wealth after making either a rational or irrational decision affect financial decision making rationality level evolution with time when actual wealth increases or decreases are progressively observed.

The research aimed to establish how individual cognitive and affective dispositions, reactions and inclinations to economic environment as represented by the three determinants do actually determine the level of financial decision making rationality in Kenyan SACCOs. A number of studies on the effect of behavioural biases on financial decision making have been done. For instance, it was found that overconfidence and over-optimism highly affects investment decisions (Adel, Mariem, 2013; Bashir, Javed, Ali, Meer & Naseem, 2013; Bilgehan & Bayrakdaroglu, 2016). However, these studies were restricted to the effects of irrational decisions on financial decision making; not the

interplay between rational and irrational decision making. Besides, these studies depict states and not human learning processes.

The likelihood of making a rational decision is informed mainly by the knowledge possessed by the decision maker, (Choi, Kariv, Muller & Silverman, 2014; Katsikopoulos, 2014), but not entirely. Two individuals with the same information and faced by the same decision are likely to take different decisions. One gap is that their subjective view of accruing benefits after making a rational or irrational decision impacts greatly on the likely decision to be taken. This view mainly relate to their individual's affective and cognitive domain disposition. The key gap is to establish the effect of these determinants as an interaction with the actual wealth movement as an intervening factor on financial decision making rationality. Behavioural finance proponents increasingly feel that economic agents do not operate at complete rationality; this vital component of human nature has not been factored in both macro and microeconomic models (Simon, 1996); which would otherwise yield better financial models. However, it does not mean that all decisions are irrational (Binmore, 2015) some are while others are not. Actual determination of the average rationality level as a function of age is pertinent, which could alleviate grave macro-level financial planning fallacy effects (Kahneman & Tversky, 1984). With SACCOs supporting two-thirds of Kenyan livelihoods, their financial decision making behaviour would go a long way to guide financial policy. Existing empirical studies only relate financial knowledge to financial decision making quality measured in units other than rationality. Lack of empirical studies that especially involve the affective state of economic agents provided great motivation for this study.

In summary, this study addressed itself to the quantitative responses to the following questions: first, what is the effect of prior knowledge about a financial decision on financial decision making rationality? Secondly, what is the effect of prospects of wealth increase after making an irrational financial decision on financial decision making rationality? Thirdly, what is the effect of prospects of wealth increase after making a

rational financial decision on financial decision making rationality? Finally, what is the intervening effect of wealth movement on the determinants of financial decision making rationality? The determined effect will go a long way to modify standard finance models as well as form a firm basis for both micro and macroeconomic financial planning.

1.3 Research Objectives

1.3.1 General objective

The general objective was to establish the effect of determinants of financial decision making rationality in deposit taking cooperatives in Kenya.

1.3.2 Specific objectives

Specifically, objectives of the study include:

1. To establish the effect of prior knowledge on financial decision making rationality in deposit-taking SACCOs in Kenya;
2. To establish the effect of prospects of wealth increase after making an irrational financial decision on financial decision making rationality in deposit-taking SACCOs in Kenya;
3. To establish the effect of prospects of wealth increase after making a rational financial decision on financial decision making rationality in deposit-taking SACCOs in Kenya;
4. To establish the intervening effect of wealth movement on determinants of financial decision making rationality in deposit-taking SACCOs in Kenya.

1.4 Research hypotheses

1. **H_o:** There is no effect of prior knowledge on financial decision making rationality in deposit-taking SACCOs in Kenya;

   H_1: There exists an effect of prior knowledge on financial decision making rationality in deposit-taking SACCOs in Kenya;
2. **H_o:** There is no effect of prospects of wealth increase after making an irrational decision on financial decision making rationality in deposit-taking SACCOs in Kenya;

H_1: There exists an effect of prospects of wealth increase after making an irrational decision on financial decision making rationality in deposit-taking SACCOs in Kenya;

3. **H_o:** There is no effect of prospects of wealth increase after making a rational decision on financial decision making rationality in deposit-taking SACCOs in Kenya;

   H_1: There exists an effect of prospects of wealth increase after making a rational decision on financial decision making rationality in deposit-taking SACCOs in Kenya;

4. **H_o:** There is no intervening effect of wealth movement on the determinants of financial decision making rationality in deposit-taking SACCOs in Kenya.

   H_1: There exists an intervening effect of wealth movement on the determinants of financial decision making rationality in deposit-taking SACCOs in Kenya.

1.5 Significance of the study

The study chose SACCOs and their members since recommendations from the study may be implemented in a sector that contributes about 45% of GDP in Kenya (Smith, 2009). It is estimated that at least one out of every two Kenyans directly or indirectly derives their livelihood from SACCOs (Gweyi, Ndwiga & Karagu, 2013). Besides, SACCOs are recognized as the easiest forms of capital accumulation avenues which provide financial education across social demographic stratification (Cheruiyot, Kimeli & Ogendo, 2012). Findings from this study will be useful to SACCO members by reducing their level of guesswork in financial decision making. Managements may utilize the recommendations of increasing their generational entropy substitution rate to create greater capacity for productivity. In the meantime, since findings include comparative operational rationality values between SACCO managements and their members, SASRA may use this information to lodge interventions to correct the anomaly which if not corrected may lead to gross member withdrawal potentially collapsing the SACCO. Finally, the government may use these findings if generalizable to craft interventions for various sectors of the economy. The Cooperatives act

provides for an education committee in every SACCO so as to facilitate dissemination of financial education on a regular basis.

1.6 Scope of the study

Out of the 164 registered SACCOs (SACCO Supervision Annual Report, 2013), three SACCOs were targeted; Unitas SACCO, Mwalimu SACCO and Stima SACCO members and managements. These merited in terms of diversity in seven areas, namely: income, employment, geographical distribution, SACCO, SACCO size and registration category. Unitas SACCO combines a huge component of Agricultural-base and an emerging finance base component by the time the common bond restriction was scrapped by the Cooperatives Act 2008. Prior to this amendment, agricultural based SACCOs comprised 46% of the total number of SACCOs in operation (Gweyi, Ndwiga & Karagu, 2005). The SACCO also has many branches in Central Kenya and Nairobi areas. Unitas SACCO started in 1993 then as Murang'a Tea SACCO. It grew rapidly till 2007, when it rebranded to Muramati SACCO. After opening its common bond to include a wide range of savers, it rebranded a second time to adopt a national outlook, currently Unitas. Unitas currently has a membership of over 126,000 members. The diversity of its membership including self-employment nature of members is the major reason for studying it.

Stima and Mwalimu National SACCOs have formally employed individuals as their catchment and superior incomes to Unitas SACCO. It has several branches in Murang'a and Nairobi. Secondly, Mwalimu SACCO has the most distributed network in Kenya, with branches in almost every county. It was started in 1974 to take care of financial needs of teachers. It has a national-wide membership that has so netted over 57, 000 teachers as of March 2012. Mwalimu SACCO also rebranded to Mwalimu National SACCO in 2013 to reflect national a outlook. Stima SACCO, a finance-based SACCO, started in 1974 and had a membership of 26,468 as of December 2012 (Ngige, 2014). Since finance based SACCOs comprised 36% of all SACCOs as of 2012, a total of 82% of all SACCO types was covered by the choice of the tree SACCOs. Lastly, these

SACCOs were the best performing as of December 2012. This research study restricted itself to the three SACCOs; specifically Nairobi branches. Though there is considerable membership diversity and the national coverage of the SACCOs, that may permit generalization of findings to be drawn, findings related mainly to Nairobi branches of the SACCOs and Kenyan SACCOs in general.

1.7 Limitations of the study

During the piloting state, partly by reason of most individuals not keeping proper books of accounts and partly for confidentiality reasons some respondents did not surrender financial information in the last question in the questionnaire. This observation was made initially, when the research assistant had been employed. Later, this limitation was circumvented by the researcher collecting data personally. The question concerned was restated to avoid much detail. This resulted to more cooperation from the respondents and more approximation. Contrivance was made to ensure the acceptable response rate of over 70% was obtained (Mugenda and Mugenda, 2005). While targets SACCOs were purposively selected one of which reason was geographical distribution, most of the respondents hailed from Nairobi metropolitan. This might have affected the findings generalizability.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

In the financial decision making life of individuals (SACCO members included), both knowledge and their own perceptions of decisions at hand matter. This combination was well captured by four theories examined in this section; two standard finance theories and two behavioural finance theories. First is Modern Portfolio Theory (MPT) by Markowitz (1952); an investment oriented theory. The interest here was to analyze the theory's assumptions in relation to rationality. The second one is Rational Choice Theory (RCT) by Homans (1961); a consumption and savings oriented theory. Third is Cumulative Prospect Theory (CPT) by Kahneman & Tversky (1992) which describes how people rate economic gains and losses under risk; it advances that people suffer more by losing than they receive pleasure by gaining the same amount of money. Finally, Bounded Rationality Theory (BRT) by Simon (1996), which claims that human financial decision making rationality is limited was examined and formed the basis of the study findings.

2.2 Theoretical Framework

Modern portfolio theory is still the most compelling and widely acknowledged investment theory (Fama, 2012). The theory is based on complete rational action of the investor (SACCO member), and is anchored on a number of assumptions which if separated; over half of them allude to the investor's human rationality behaviour. This means that variation of these assumptions is likely to reduce reliability of this theory. The key aspect about the theory is that rational investment decision making increases returns of the investor. Rational choice theory postulates that decision makers reason out all information available about a decision and pick on the best alternative (Homans, 1991) hence complete rational action is assumed as the term suggests. This is the most fundamental theory that shapes standard finance.

Deviation of decision makers from this expectation is a matter of concern in this report. The cardinal point is that rational consumption decision making according to this theory optimizes utility. Cumulative prospect theory based on incomplete rational action of the decision maker, advances that the value of a decision is a product of subjective weights and utility accruing. The fact that subjective weights rather than objective probability apply in real life individual decision making justifies examination of the theory. Bounded rationality theory like cumulative prospect theory addresses how financial decision makers actually make decisions rather than how they should make them. For this purpose, decision making agents are assumed only to be partially rational. Bounded rationality theory suggests that the rationality level of economic agents is never complete; that is it is limited by inadequate access to information and cognitive information processing ability.

2.2.1 Modern Portfolio Theory

This theory by Markowitz (1952) was based on the idea that rational risk-averse investors may construct optimal portfolios that maximize returns for any given risk level and that higher returns serve as a reward for higher risk (Fama, 2012). Most important was that an investor can benefit by risk reduction through carefully diversifying their portfolio to sustain their desired rate of return. By constructing an efficient frontier, an investor could also combine risky investments with risk free investments and make choices as to the desired risk levels (Pandey, 2001). This was only possible if the selected investments (other than securities since SACCO members ordinarily do not buy shares) had negative correlations to one another. However, it is important to note that only unsystematic risk is diversifiable. Unsystematic differs from systematic risk in that it is firm specific (individual specific) while systematic risk is attributable to market-wide factors.

To identify the best level of diversification, the efficient frontier was developed. The investor SACCO member then embarks on establishing the best risk return combination using the efficient frontier. If for instance a two investments portfolio is considered say

A and B, a frontier that can possibly be used to select desired risk return combinations for the investments. Finally, the investor SACCO member would have to optimize the proportions of investments to be purchased using the resources at hand. All the explanation made regarding how best a SACCO member investor can develop a least risk portfolio for any given return is anchored on the theory's assumptions which were the major concern here. The first is that all investors have access to the same information at the same time. In fact, real markets contain information asymmetry, insider trading, and those who are simply better informed than others (Alexander, Sharpe & Bailey, 2001).

Secondly, Investors are interested in the optimization problem (maximizing the mean for a given variance). In reality, investors have utility functions that may be sensitive to higher moments of the distribution of the returns other than just mean and variance. For the investors to use the mean-variance optimization, one must suppose that the combination of utility and returns make the optimization of utility problem similar to the mean-variance optimization problem (Alexander, Sharpe & Bailey, 2001). Third, asset returns are (jointly) normally distributed random variables. It is frequently observed that returns in equity and other markets are not normally distributed (Pandey, 2001). Fourth, correlations between assets are fixed and constant forever. Correlations depend on systemic relationships between the underlying assets, and change when these relationships change. Examples include one country declaring war on another, or a general market crash. During times of financial crisis all assets tend to become positively correlated, because they all move down together. In other words, the theory breaks down precisely when investors are most in need of protection from risk (Alexander, Sharpe & Bailey, 2001).

Fifth, all investors aim to maximize economic utility (insatiable economic agents). This is a key assumption of the efficient market hypothesis, upon which the theory relies (Alexander, Sharpe & Bailey, 2001). Sixth, all investors are rational and risk-averse. This is another assumption of the efficient market hypothesis, but we now know

from behavioral finance that market participants are not rational. It does not allow for any kind of irrational behaviour or investors who will accept lower returns for higher risk. Gamblers clearly pay for risk, and it is possible that some stock traders will pay for risk as well (Fama, 2012). Seventh, investors have an accurate conception of possible returns (the probability beliefs of investors match the true distribution of returns). A different possibility is that investors' expectations are biased, causing market prices to be informationally inefficient. This possibility is studied in the field of behavioral finance, which uses psychological assumptions to provide alternatives to standard finance models. This thesis addressed behavioural findings in financial decision making (Alexander, Sharpe & Bailey, 2001). Eighth, there are no taxes or transaction costs. Real financial products are subject both to taxes and transaction costs, and taking these into account will alter the composition of the optimum portfolio.

These assumptions can be relaxed with more complicated versions of the model (Pandey, 2001). Ninth, all investors are price takers, i.e., their actions do not influence prices. In reality, sufficiently large sales or purchases of individual assets can shift market prices for that asset and others. An investor may not even be able to assemble the theoretically optimal portfolio if the market moves too much while they are buying the required securities (Alexander, Sharpe & Bailey, 2001). Tenth, all investors can lend and borrow an unlimited amount at the risk free rate of interest. In reality, every investor has a credit limit (Vernimmen, Quiry, Dallocchio, Le Fur & Salvi, 2014). Eleventh, all securities can be divided into parcels of any size. In reality, fractional shares usually cannot be bought or sold, and some assets have minimum orders sizes (Hirshleifer, 2001). Lastly, risk/volatility of an asset is known in advance/is constant. In fact, markets often misprice risk (e.g. the US mortgage bubble or the European debt crisis) and volatility changes rapidly (Fama, 2012).

Suppose all the assumptions equally contribute to perfect functioning of the modern portfolio theory. Assumptions 1, 2, 5, 6, 7, 9, and 12 (comprising about 60%) have something to do with human behavioural tendencies (including the SACCO members

under study) that point to irrationality and which affects the optimal functioning of the theory (Shleifer, 2000). Sometimes investors do not invest to maximize returns but for sentimental reasons. Other times investors are irrational by way of being risk seekers regardless of returns for instance in gambling (Kahneman & Tversky, 1992). Most of the time, some investors are in possession of more information than others (Shefrin, 1994). Worse still some investors do not have accurate conception of possible returns, may not necessarily be price takers (Simon, 1996). It is also very unlikely that the actual risk is known in advance and that it remains constant. The assumption of access to all information about a decision relates to the first determinant; prior knowledge. Since a financial decision maker cannot access all information at all times about a financial decision, the magnitude thereof becomes important. Likewise, since economic agents at times make decisions without full information, and in anticipation of economic benefits, the second determinant sets in. Of course not all times does rational decision making yield economic benefits, alluding to the last determinant.

2.2.2 Rational Choice Theory

This theory by Hommans (1961), asserts that all financial decisions are motivated by possibility of realizing profit. Further, individuals must anticipate the outcomes of alternative courses of their action and calculate which action will be best for them. In the end, rational individuals choose the course of action that is likely to give them the greatest satisfaction or profit. One key element in rational choice theory is the belief that all action is fundamentally "rational" in character (Homans, 1961). Rational decision making approach reduces chances of errors, assumption, distortions, guesswork, subjectivity, and many other causes of inequitable judgments (Hastie & Dawes, 2010). Like state preference theory, it is based on four axioms: the first one is that consumers know all the sets of alternatives in the market. This is the assumption of full information hence knowledge; which is unrealistic and is represented by the proportion of knowledge about a financial decision. Second is the axiom of transitivity. If A<B and B<C then, of necessity, A<C. Alternatively, if A=B, and B=C, then A=C. Third is the axiom of completeness. The decision maker either prefers A to B or B to A or is

indifferent between A and B. Finally, the consumer chooses the most preferred choice (Green, 2002).

Individual rationality like that of SACCO members in consumption expenditure is best considered in consumption theory. In this theory, preference relationship is represented by a utility function only if the relationship satisfies completeness and transitivity. The converse is also true provided that the number of alternative choices is finite. (Mas-Collel, Whinston, & Green, 1995) If the number of possible alternative choices is infinite, it may not be possible to represent the preference relation with a utility function in according to the third axiom. Like cumulative prospect theory rational choice analysis generally begins with the premise that the financial decision maker is maximizing utility by choosing the preferred alternative. An important element of the choice process is the presence of constraints. The presence of constraints makes choice necessary, and one virtue of rational choice theory is that it makes the trade-offs between alternative choices very explicit. A typical constraint in a simple one-period consumer choice problem is the budget constraint, which says that the consumer cannot spend more than their income. Multi-period models allow for borrowing, but in that case the constraint is that the consumer must be able to repay the loan in the future (Scott, 2000).

The use of utility functions means the idea of agents making the preferred choices from among available alternatives is translated into a mathematical exercise in constrained optimization. In this case, an agent is assumed to make the feasible choice that results in the highest possible value of their utility function. The solution to the constrained optimization problem generally leads to a decision rule. The decision rule shows how utility-maximizing choices vary with changes in circumstances such as changes in income or in the prices of goods. The third element of rational choice analysis involves assumptions about the environment in which choices are made. Simple economic models are often restricted to choices made in markets, with emphasis on how much of each good or service consumers want to purchase (or firms want to produce and sell) under any given set of circumstances (Green, 2002).

The fourth element of rational choice analysis is a discussion of how the choices of different agents in this case, a SACCO member, are made consistent with one another. A situation with consistent choices in which each agent is optimizing subject to constraints is called equilibrium. In simple market models, price plays a key role in the establishment of equilibrium. If SACCO member consumers want to purchase more than firms are producing, the price will be bid upward, which will induce more production by firms and reduce desired purchases by consumers. If consumers want to purchase less than firms are producing, the resulting glut will force prices down, which will reduce production by firms and increase purchases by consumers.

Fifth and last element, in the absence of strong reasons to do otherwise such as the imposition of price controls by the government, the analyst employing rational choice theory will generally assume that equilibrium outcomes in the model are adequate representations of what actually happens in the real world. This means, in the above example, that a rational choice theorist would explain changes in the actual price of a good observed in the real world by looking for possible causes of changes in the equilibrium price of the good in their model (Scott, 2000). Empirical studies show that rational choice theory does not hold in most cases. One of its main assumptions self interest of economic agents. However, a research done in 2002 found that the theory does not indoctrinate students into being self interested (Frey & Meier, 2002). Voluntary donation research was conducted over a number of years in Zurich and showed that students considered other persons more important than themselves negating the self interest axiom. In the same breath rational choice theory was found to function only partially in SACCO member decision making processes.

2.2.3 Cumulative prospect theory

Cumulative prospect theory is a psychological account that describes how people make decisions under conditions of uncertainty. It was propounded by Daniel Kahneman and Amos Tversky in 1992. These may involve decisions about anything where the outcome of the decision is risky and uncertain. The decisions range from deciding whether or not

to: enroll for a Doctorate Program, buy a lottery ticket, undergo chemotherapy treatment, to marry one's current partner, or to invest in life insurance among others. Prospect Theory predicts that people go through two distinct stages when deciding between risky options like these. In the first stage, decision makers are predicted to edit a complicated decision into a simpler decision, usually specified in terms of gains versus losses.

In the second stage, financial decision making agents choose between the edited options available to them. This choice is based on two dimensions: the apparent value of each option, and the weight subjectively assigned to those values or options. These two results into the overall value and its weight are then combined by the decision maker, and the option with the highest combined value is chosen by the decision maker. The most interesting feature of prospect theory for most psychologists is that it predicts when and why people will make decisions that differ from perfectly rational or normative decisions, and has therefore featured prominently in explanations of why people make a variety of evidently outright bad decisions in daily life.

Since probability responses received are subjective perceptions marred with biases, cumulative prospect theory decision weights function was necessary to transform the probabilities into objective ones (Wang, 2004). The decision weights function is a single parameter model where the parameter indicates optimism or pessimism level of an individual as shown in figure 2.1. The parameter is obtained by conducting a Life Orientation Test Revised (Scheier, 1994). Prospect Theory was a notable departure from existing theories before the 1970s dominated by normative theories that prescribe how people "ought" to make decisions in a perfectly rational way, by offering a descriptive theory of how people actually make decisions, rather than how they ought to do so. The simplest way to choose between risky options is to choose the option with the highest expected value, (the likelihood that an option will occur, multiplied by the value of that option). Imagine, for instance, that you are deciding whether to pay $1 for a lottery ticket that offers a 10% chance of winning $10. The expected value of this lottery ticket is $1 (0.1 x $10), the same as the cost of the ticket. Rationally speaking, one should

therefore be perfectly indifferent about buying this ticket or not. The problem, noted by both economists and psychologists, is that rational theories did not always describe people's actual behavior accurately. It was noted that few people would actually purchase the lottery ticket. The certain loss of a dollar simply does not compensate for the 10% change of winning $10 and a 90% change of winning nothing.

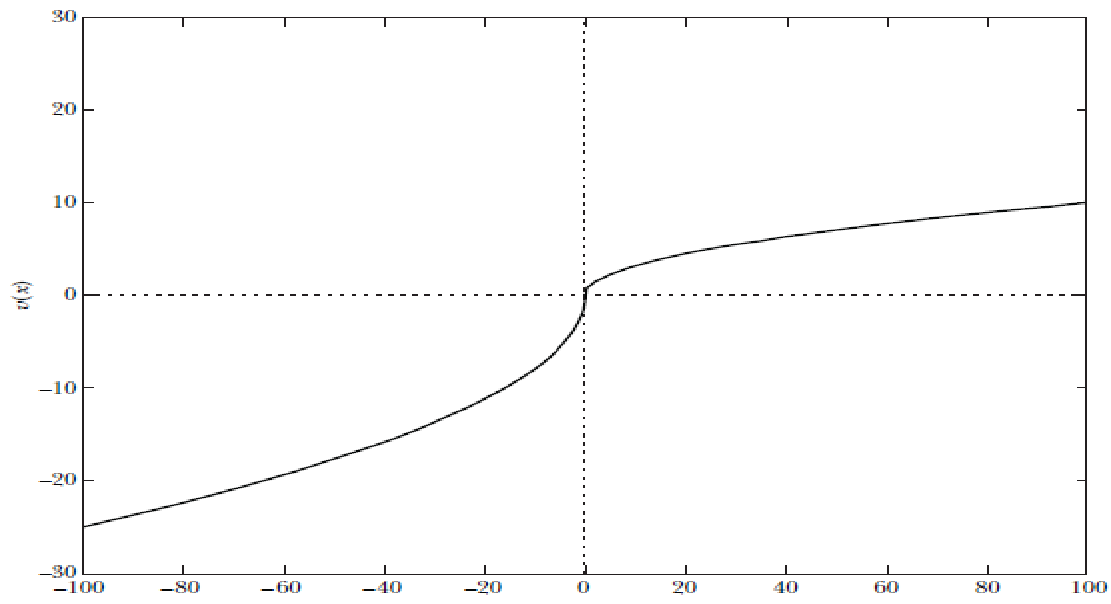


Figure 2.1: Cumulative Prospect Theory Value function
Source: Wakker (2010), Prospect theory for Risk and Ambiguity

The graph plots the value function proposed by Tversky and Kahneman (1992) as part of cumulative prospect theory, namely $v(x) = x^{\alpha}$ for $x > 0$ and $v(x) = -\lambda(-x)^{\alpha}$ for all $x < 0$, where x is monetary gain or loss. The authors estimate $\alpha = 0.88$ and $\lambda = 2.25$ from experimental data. The plot uses $\alpha = 0.5$ and $\lambda = 2.5$ so as to make loss aversion and diminishing sensitivity easier to see.

Under cumulative prospect theory, by contrast, the gamble is evaluated as:

$$\upsilon(*) = \sum_{i=m}^{n} \pi_i \, U(x_i) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2.1)$$

, where v(*), the value function, and π_i are decision weights. Decision weights are determined by the following single parameter equation:

$$\pi_i = \omega P = \frac{P^{\delta}}{\left\{P^{\delta} + (1-P)^{\delta}\right\}^{1/\delta}} \quad \text{..... (2.2)}$$

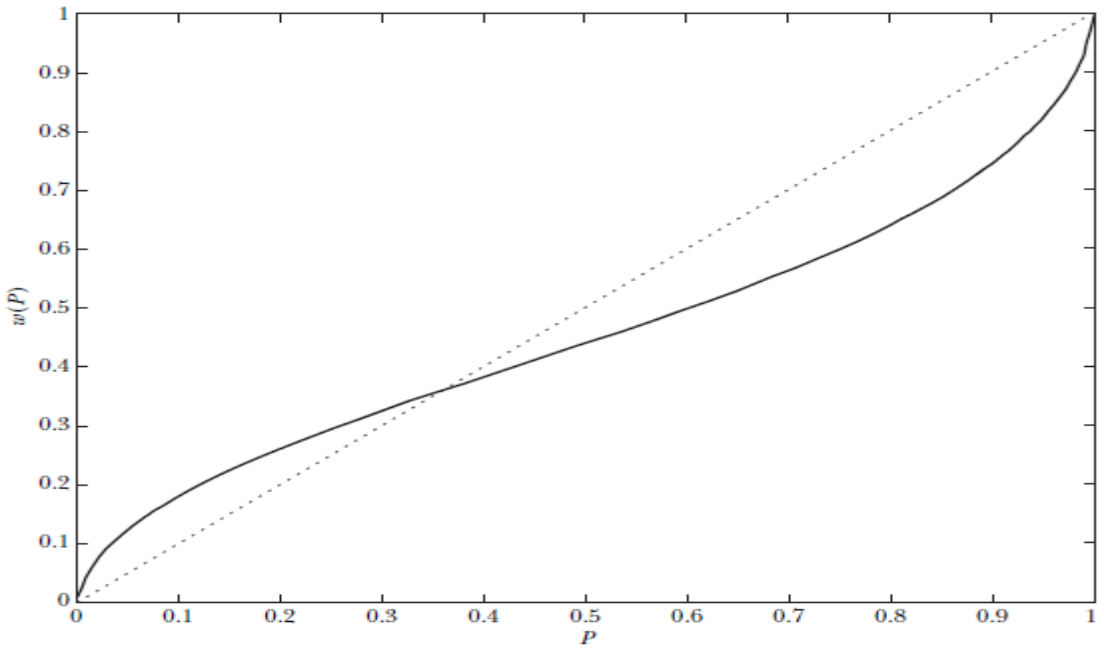


Figure 2.2: cumulative Prospect Theory Decision Weights function
Source: Wakker (2010), Prospect theory for Risk and Ambiguity

The graph plots the probability weighting function proposed by Tversky and Kahneman (1992) as part of cumulative prospect theory, namely $\omega(P) = P^{\delta}/[\ P^{\delta} + (1 - P)^{\delta}]^{1/\delta}$, where P is an objective probability, for two values of δ. The solid line corresponds to δ = 1, in other words, to linear probability weighting, where $\pi_i = \omega P$ is subjective decision weight while P is the objective probability and δ is a measure of individual optimism or pessimism. This formulation illustrates the four elements of prospect theory: reference dependence, loss aversion, diminishing sensitivity, and Probability weighting.

First, in prospect theory, people derive utility from gains and losses, measured relative to some reference point, rather than from absolute levels of wealth. We are more attuned to changes in attributes such as brightness, loudness, and temperature than we are to their absolute magnitudes. This explains why this study is structured around changes in net worth of an entity the premise on which subjective prospects will be solicited. In cumulative prospect theory, the weighting function is applied to cumulative probabilities.

Notably, probability weighting leads the individual to overweight the tails of any distribution. Under cumulative prospect theory, the unlikely state of the world in which the individual gains or losses $5,000 is over weighted in his mind, thereby explaining these choices. Kahneman and Tversky emphasize that the transformed probabilities $\pi_{i,}$ do not represent erroneous beliefs; rather, they are decision weights. Subsequent to Tversky and Kahneman's (1992) paper on cumulative prospect theory, several studies have used more sophisticated techniques, in conjunction with new experimental data, to estimate the value function v(·) and the weighting function w(·) more accurately (Gonzalez and Wu 1999; Abdellaoui 2000; Bruhin, Fehr-Duda, and Epper 2010). They provide especially strong support for subjective probability weighting. On the strength of this evidence, this study used the decision weights function in transforming subjective prior probabilities collected from SACCO members and management into objective probabilities, providing robust use for the decision weights function.

2.2.4 Bounded Rationality Theory

Propounded by Herbert Simon (1996), this theory states that human beings cannot achieve complete rationality for two reasons: one is that they have no access of full information regarding a specific decision by the time of making the decision. The other reason is that they have cognitive processing limitations, such that even if they get the information, they are unable to process it to secure the best alternative. In this case, decision makers go by what Simon calls "good enough" expressed by the term "satisficing" This theory is the one this study sought to propel by crafting a rationality

scale in the process; with an upper and lower bounds are required just like the way Karl Pearson formulated his coefficient of correlation to span between positive and negative one. Ken Binmore agrees with Simon (1976) that the neoclassical rationality orthodoxy is deficient in that it is substantive; that is it is concerned with what decisions are made rather than how they are made (Binmore, 2015). A strong element of how decisions are actually made took preeminence in this study for this theory the study is propelling. According to classical and neoclassical economic theories including the rational choice theory (1961), the main goal of decision making is to be rational by first collecting all the relevant information regarding the issue under investigation, evaluate alternatives and choose the optimal one (Kalantari, 2010).

The combined assumptions of rationality made by classical economists do not hold all the time; perhaps only to a given extent, leading to bounded rationality (Simon, 1996b). Numerous contributions in bounded rationality have since been made with the notion taking various dimensions. Bounded rationality has been described as incapable of speaking with one voice; by reason of having been researched in various fields such as finance, economics, psychology, engineering, and management. There are multiple views of bounded rationality as many authors including Rubinstein (1998) have pointed out (Katsikopoulos, 2014). Katsikopoulos has distinguished two cultures in discussing bounded rationality: the idealistic and the heuristic (pragmatic) cultures. In idealistic, utility theory has been modified by including elements of decision weights function, while in pragmatic culture, people are assumed to ignore information and use simple rules of thumb.

This study explored the idealistic culture element to estimate inherent operational rationality in individuals and organizational groups. It posits that humans as financial decision making agents cannot sustain wealth creation if they are not sufficiently rational; a person suffering from mental disorder cannot run a wealth creating entity. A certain minimum level of rationality is imperative. Rationality can be enhanced through

nudging or education (Katsikopoulos, 2014). Whichever the choice, this study established whether it is possible to achieve complete rationality in life.

In the world over, lots of investments are usually made to educate nationals of various countries and to train employees of organizations to enhance productivity. This seeks to equip them with theoretical reasoning in a structured manner. Not forgetting that all life is about learning, persons also acquire theoretical reasoning from general interaction with the environment; mainly fellow human beings. The theoretical reasoning so acquired is aimed at equipping the individual with rational beliefs about the world using rational inferences (Koehler & Harvey, 2004). But even after the acquisition, the actors may decide to utilize the information (rational beliefs) in their subsequent action (which Koehler and Harvey call judgement), or not. Persons who will update and those who will not update the information subsequently are regarded rational. This is known as instrumental rationality in experimental psychology (Koehler & Harvey, 2004). Instrumental rationality avoids condemnation of individuals for not updating information so acquired from the environment. It argues that the difference is mainly caused by different individual goals. The notion of bounded rationality has been interpreted by this study in the light of the rate of updating new learning (financial information) in individuals and organizations separate from the passing of examinations done in formal assessments. It is this rate whose optimization leads to achievement of national and organizational goals.

From the field of cognitivism in psychology, a number of theorists claim that most of our mental life is devoted to the task of creating and updating mental situation models that allows us to navigate through life. Since these mental situation models are the causal mediators of stimulus – response relationships, we must study these mental models to predict and explain behaviour (Hastie & Pennington, 1995). Hastie and Pennington further concede that there is considerable agreement that cognitive analysis occurs at one level of a system of theoretical levels that comprises levels above the cognitive level (e.g., a level at which theories concerned with optimally rational solutions to behavioral-

environmental problems are framed) and levels below the cognitive level (e.g., a level at which cognitive: processes are implemented in the neural medium of the brain; Stanovich & West, 1998; Marr, 1982; Newell, 1990; Pylyshyn, 1984). This admission portends that rates of updating may not be equal to rate at which new information is availed to the brain neither is it regular. It was hypothesized that by reason of inability to process financial information, SACCO members and managements possessed limited rationality. Limited rationality in effect caused suboptimal financial decisions leading to lower wealth creation than envisaged.

Financial decision making agents say SACCO members decipher cues from the environment say as price increments of commodities, erection of new buildings, to derive information therefrom. Any incorrect perception is likely to lead to an incorrect response to the stimuli. Moreover, depending on the SACCO member personality type (for instance directors, socializers, relaters and thinkers; Murphy & Longo, 2009) of the decision maker, mood and other dispositions, two financial decision making agents are likely to make different decisions; just like risk-averse and risk-taking characteristics of individuals. Field research on investor's emotions shows that high-performing investors regulated emotions better than low-performing investors, in particular by avoiding being influenced by negative emotions (Fenton-O´Creevy, Soane, Nicholson, & Willman, 2011). This was an expectation as SACCO financial performance was analyzed. Different personality types broadly adopt different judgement modes that may be optimistic or pessimistic as was exemplified in cumulative prospect.

2.3: Conceptual framework

An economic agent's decision making process is conceived as follows. When confronted by a financial decision, he may take the decision or not. If he does, it may be rational or irrational in the idealistic sense. The researcher conceptualizes that no decision maker takes a decision absolutely aimlessly, with no information, no satiable interest and with no time line. Moreover, it is also difficult for the decision maker to be absolutely rational on account of growing information to the eve of the decision. On the basis of this

assumption, the study therefore assumed that the decision maker may make subjective estimates of the probability of making a rational decision given the decision urgency, available information, cognitive processing ability and emotional disposition among other factors. In the process of making wealth, rational decisions are more likely to result to wealth increase than irrational decisions.

In case a rational decision was made (that is the most logical decision was made with available information and no other critical information emerged), the decision maker can attach a likelihood measure to the envisaged wealth increase. He may do the same in case he discovers that he made an irrational decision. He has no control of wealth movement which intervenes to generate decreases and increases in wealth over time. Interaction between wealth movement and the likelihoods of making a rational decision, of observing a wealth increase after an irrational decision and that of observing a wealth increase after a rational decision produces a new likelihood (prior knowledge) of making a rational decision whose expectation generates a new financial decision making rationality level through a Bayesian learning process as shown in figure 2.4. Conceptual framework comprises three independent variables and one intervening variable.

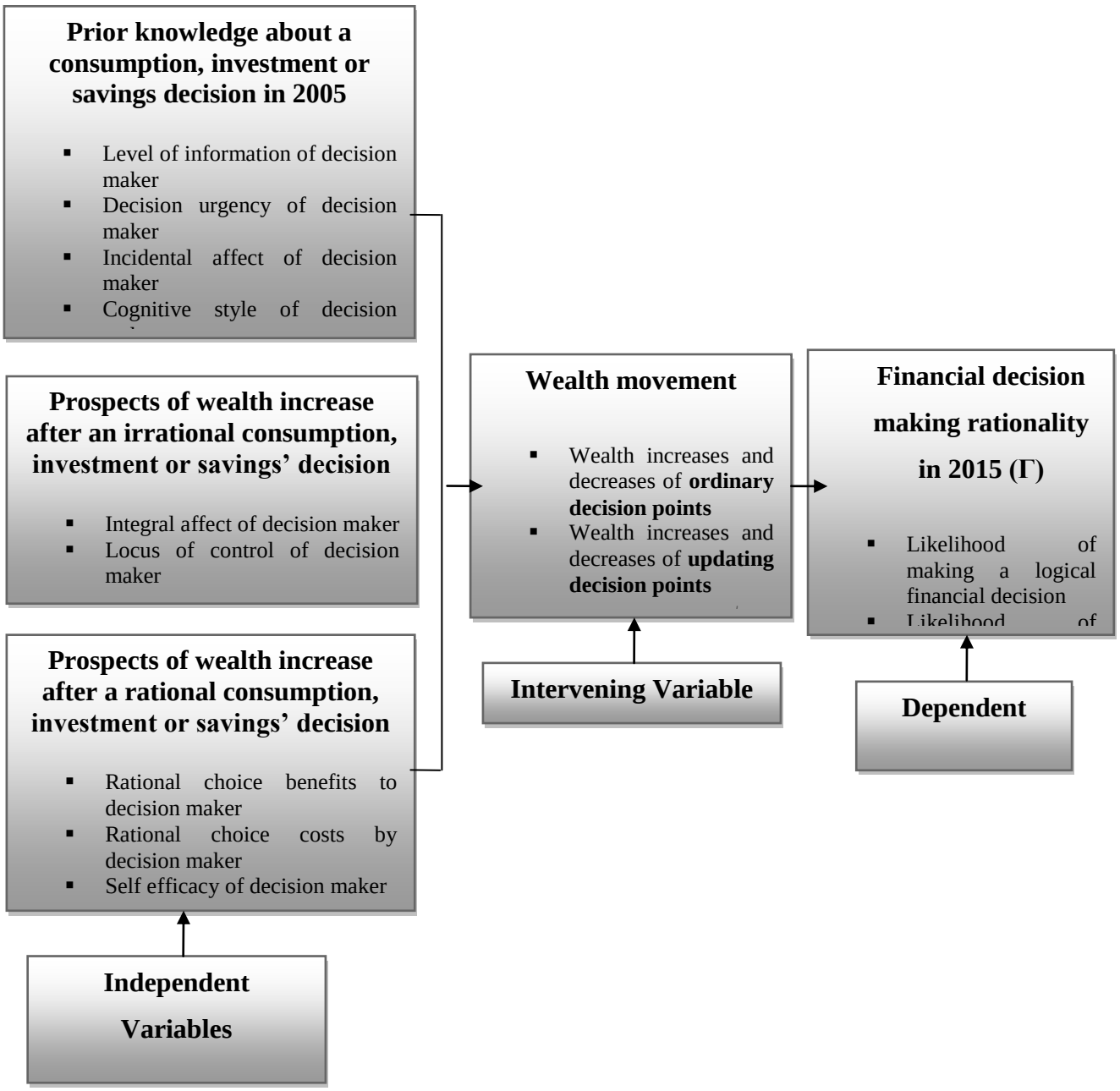


Figure 2.3Conceptual frame work

2.3.1Prior knowledge

This is about the knowledge level the decision maker assesses themselves to be having at the time of decision making before observing new data. This is determined primarily by the level of information they possess at the time, given that there may still be inaccessible information at the time especially that which has not yet unfolded by the eve of decision taking (Hunt, 2003). It is also determined by the urgency to take a decision; which affects information processing accuracy, the decision maker's cognitive style that is the way he processes information including the place of thinking and intuition use by the decision maker. Finally, incidental affect referring to the instantaneous feelings of the decision maker at decision taking time also affects the ultimate choice. These four factors are not conclusive. Many others are usually at play at the time of decision taking. While cognitive style is a personality variable, level of knowledge, incidental affect and decision urgency are environmental aspects. In all, prior knowledge is by both environmental aspects as well as personality variables. Level of information, cognitive style, decision urgency and incidental affect are only part of the entire factors that affect prior knowledge but which have been considered fundamental.

2.3.2Prospects of wealth increase after an irrational decision

The study further considers that the decision maker's prospects of posting a wealth increase after making an irrational decision as assessed by them is important. This may be represented by locus of control which refers to the decision maker's belief whether he has control of his current situations or other people do have control in his stead, integral affect which means the overall or general emotional disposition of the decision maker in connection with the product in question (whether a consumer product, investment product or a savings product) at the time of taking a decision (Cohen, 2006). Additionally, the decision maker is affected by incidental affect referring to the instantaneous emotional disposition of the decision maker alone (Retchin, 2007). Incidental affect and the locus of control are personality variables while integral affect is more of an environmental variable. Integral affect, incidental affect and locus of control

are just some of the factors that determine the prospects of a wealth increase after an irrational decision. Only that these have been identified as major. This prospect, in a nutshell is about the decision maker's experience of economic benefits deriving from guesswork in financial decision making.

2.3.3Prospects of wealth increase after a rational decision

Finally, an individual's prospects of posting a wealth increase after making rational decision determines his rationality. This derives from rational choice theory (Homans, 1991) that postulates rational choice by humans especially in economic undertakings. The theory gave birth to rational decision making models which proposed a six step process of decision making with four underlying fundamental assumptions: one, that the decision maker possesses perfect information at the time of decision making, secondly, that they have no cognitive processing limitations, third, that they operate on an optimizing objective and lastly, that they are not constrained by information processing time. Unfortunately, all the four assumptions are untenable; comprising the key criticisms of the theory. Bounded rationality theory alludes to these limitations, by claiming that human economic rationality is never complete. On this strength, prospects of a wealth increase given a rational decision has been made can only be probabilistic and of course, a high probability is expected. The financial decision maker in this regard perceives a given measure of prospects of posting wealth increase after making a rational decision. This can be measured by perceived benefits and perceived costs of rational decision making. Benefits are expected to affect these prospects positively while costs should affect the prospects negatively. Lastly, self efficacy denotes belief of success in any task by the individual (Caprara, 2011). It depends on life experiences of the decision maker.

2.3.4 Wealth movement

Ultimately, wealth movement intervenes as measured by return on assets through an Ito process. The process generates a number of expected wealth increases and inevitable wealth decreases which sum to ordinary decision points. However, since humans do not

update regularly as required by a Bayesian analysis, only part of the ordinary updating points serve as updating points. The process assumes that only the current level wealth can affect the next level of wealth. Return on assets is also bombarded with uncertainty (volatility) which is indicated by the second part of an Ito stochastic differential equation. A sample wealth diffusion path was generated by the help of Monte Carlo simulation in a binomial setting. The overall effect of independent and intervening variables interaction produced a new rationality level progressively.

2.3.5 Financial decision making rationality

Also known as economic rationality, financial decision making rationality has had little empirical studies as the dependent variable. It is worth pointing out that this variable bears the same characteristics as prior knowledge. Actually, it is the expected value of the likelihood of a rational decision and that of an irrational decision. Paraphrased differently, prior knowledge transforms into financial decision making rationality (current rationality) over time through its interaction with the evolving probability of making a rational decision through Bayesian learning. However, to obtain financial decision making rationality value, expected values are calculated as discussed in section 3.7.2. It only becomes necessary to denote previous rationality level by the term prior and the new rationality level obtained after data observation by financial decision making rationality. We may also note that prior knowledge is symbolized by r while financial decision making is symbolized by Γ to show growth of r into Γ throughout this thesis.

2.4 Empirical Studies

Several studies have been done on substantive specific objectives identified in chapter 1. The framing may be not for a SACCO group but specific experimental results. This can be generalized for any other groups on assumption of similar characteristics of humans with regard to decision making process interactions. Determinants of rationality viewed to arise from personality traits, self efficacy, knowledge level and cognitive style among others all of which reside in the institution of the individual (Brunsson, 2007).

2.4.1 Prior knowledge and financial decision making rationality

Regarding the level of possessed information relating to the decision at hand, Peters et al. (2006) argue that incidental affect has four different roles in judgement and decision-making: Affect (emotions) can act as information – feelings about a choice are information that guides decision-making and can shape the value of an alternative. Thus feelings influence the information brought to bear on the decision at hand. These feelings can be based on prior experiences or thoughts relevant to the choice option and/or can be the result of a less relevant current state of emotion or mood. Schwartz (2000) also notes that individuals are more likely to recall information from memory that is congruent with their current feelings.

Other studies have found that sadness promotes systematic information processing, whereas anger encourages heuristic processing (Bodenhausen, 1993; Lerner at al., 1998). Lerner & Tiedens (2006) reviewed research on the impact of anger on judgement and decision-making, concluding that anger has specific impacts leading to selective processing of information, increased risk-taking and optimism. Emotional processes are faster than cognitive processes; therefore if an individual is under increased pressure of time to make a choice, affect may have greater influence than cognitive processes (Svenson, 2003). Time pressure implies the compulsion feeling to take sudden decisions often without sufficient information. This may result in disappointment in case of a negative outcome from the chosen alternative or regret arising from the lost benefits of the non-chosen alternative (Zeelenberg, 1999). The decision maker faces a dilemma such that if the decision is compulsory as in the case of a medical condition, he must take the inherent risk.

Another factor affecting knowledge at decision taking point is cognitive style. This refers to a typical or habitual way of organizing and processing information which is predominantly consistent across situations and tasks undertaken by an individual. It is a trait that represents a more stable construct (Guilford, 1980) which affects our way of problem solving, thinking, perceiving, and remembering (Riding & Cheema, 1991;

Allison & Hayes, 1996). One of the first typologies of cognitive styles conceived people as capable of perceiving and judging the environment differently owing to individual differences. Perception is concerned with sensing or intuition while judgement has to do with thinking or feeling. By combining these bipolar dimensions, we obtain four cognitive styles: Sensing-thinking, Sensing-feeling, Intuition-thinking and Intuition-feeling (Jung, 1970). Sensing-feeling style attracts the least rational character while Intuition-thinking is associated with the highest rational character, and the typology has been used as a framework in both cognitive style and decision making style (Anderson, Green & McCulloch, 2000; Thunholm, 2004).

These sub-determinants collectively affect the overall perception of an individual's perception of rationality level they are likely to employ in each of decision making situations that arise. Unfortunately, no proportion effects on the ultimate decision have been given. Moreover, these may not be the only causes. More needs to be done to establish the effect of each and perhaps whether the list of causes is exhaustive. No two individuals react the same to similar circumstances. Besides, an individual may react in different intensities to the same situation experienced previously. Important yardsticks may be necessary to iron out the so subtle differences that feature in every decision making encounter. Most empirical work on prior knowledge's effect on financial decision making revolves around financial literacy which bears no reference on the influence of personal traits on decision quality; neither do they address the learning process. This presents a major methodological gap.

2.4.2 Prospects of wealth increase after an irrational decision and financial decision making rationality

People have emotions about decisions and expectations about emotional feelings that might result from different choices. Integral affect are emotions actually experienced as a result of the outcome of a choice which may or may not concur with earlier expectations; in this case, the decision maker has just discovered he made the wrong decision. These emotions help to prioritize between different options to alter the amount

of information to be processed; in this case to reduce the amount of information to be processed on subsequent decisions. It has been argued that emotions are particularly likely to play a role in conditions of uncertainty and incomplete information which characterize many decisions, as they reduce information processing (Lemerise & Arsenio, 2000).

On this note, when a financial decision maker realizes they made an irrational decision, this affects his expectations of improvement of wealth in subsequent decisions since they will more likely seek and hence process less information than previously. Affective reactions are often the first reactions to stimuli and will then guide processing and judgement; in some cases individuals may choose things they find attractive and then justify choices (Zajonc, 1980). The mechanisms by which emotion informs choice are known as 'somatic markers'; for example when a negative outcome becomes linked with a specific thought or behaviour, a negative 'somatic' or gut feeling is experienced which adaptively can protect against future losses and narrow down the field of alternatives to choose from, hence lower perceived prospects of increased economic well-being. This mechanism is usually adaptive, but can produce bias which is maladaptive (Damasio, 1994). Regret emotion has received considerable amount of attention in behavioural decision research. Connolly and Reb (2005) identify three types of regret: outcome regret – the target of regret is the outcome of the decision; option regret – the target of regret is the option chosen; process regret – here the target is the way in which the decision was made; say, in a hurry, insufficient information among others.

Decision Justification Theory (Connolly & Zeelenberg, 2002) posits two components of decision-related regret: one associated with evaluation of the outcome of the decision, the other with self-blame for having made a poor (that is, unjustified) choice. These two components do not necessarily occur together – an individual can regret an outcome but feel that the decision process was justified, or alternatively a good outcome can result from a poor decision. A number of empirical studies illustrate this. For example, Clark et

al. (2001) found that among men treated for metastatic prostate cancer, those who expressed more regret about treatment decisions were more dissatisfied with the decision-making process; they thought they had received less information and were more likely to feel that they did not have much of a choice. Early studies (for example, Kahnemann & Tversky, 1982) indicated that a bad outcome resulting from action seemed to engender more regret than the same bad outcome resulting from inaction. However, findings on concurrent regret have been contradictory. There is some evidence that people may regret inactions more than actions in the short term, and this pattern was also shown in a series of studies looking at real life retrospective regrets. In these circumstances, people tended to recall more omissions than commissions, the opportunities they had passed up rather than the actions they had taken (Gilovich & Medvec, 1995).

Locus of control has been characterized as a personality variable (Spector, 1988; Rotter, 1966), a relatively stable individual difference (Rotter, 1989). It measures peoples' general expectancies about ability to control events affecting them, including tendencies to attribute the causes of the successes or failures to either internal or external sources. Persons who perceive themselves as having little control over events and hold expectancies that outside forces or luck control reinforcements are considered to have an external locus of control (externals). Externals generally attribute success or failure to external sources such as situations, other people or luck (Allen et al., 2005; Rotter, 1966; Scott & Severance, 1975; Spector & O'Connell, 1994). Those who hold high expectancies that they have the ability to control reinforcing events in the environment and attribute success or failure to themselves are considered to have an internal locus of control (internals). Internals are likely to engage in a variety of behaviors that indicate their motivation to master or control their environment, while externals tend to feel helpless as they perceive that events are beyond their control (Keenan & McBain, 1979). Internals are more likely to act to achieve an attractive alternative while externals will be more likely to be passive observers of events as they perceive any attempts to control

desired outcomes would bear no fruit (Allen et al., 2005). Internals believe that change is possible and therefore destiny is controllable.

Lerner and Keltner (2000) explored both the certainty and uncertainty and individual control or lack of control appraisals associated with specific emotions and suggested that these influence judgments of risk, as they are 'cognitive metafactors' identified in the risk literature as reliably determining risk assessment. These metafactors are the level of 'unknown risk' – defined at its highest level as hazards judged to be uncertain; and level of 'dread risk', defined at its highest level as perceived lack of individual control (for example, McDaniels et al., 1997; Slovic, 1987). Fear involves appraisals of low certainty and low individual control whereas anger involves appraisals of high certainty and high individual control. If these appraisal tendencies influence judgement, then fear should lead to pessimistic risk assessments and anger should lead to optimistic risk assessments. On the other hand if valence is more important, both fear and anger would lead to pessimistic assessments.

Lerner & Keltner's (2000) study of 97 students found, as noted above, that fearful people made higher risk assessments whereas angry people made lower risk assessments. Their measures related to dispositional fear and anger, but they also found that dispositional emotions predicted current state (momentary) emotions. They suggest that the effects of dispositional emotions and momentary emotions will be similar but may differ in magnitude, with dispositional emotions having greater effects. This is likely because momentary emotions are likely to be consciously linked to a specific cause and this should reduce the effect on judgments of other events. In contrast, dispositions emerge early in life; remain stable over the life course (Helson & Klohnen, 1998); are reflected in stable differences in underlying neuro-chemical systems (Davidson, 1998); and are assumed to focus as ongoing schemas for organizing and interpreting events (Gasper & Clore, 1998).

Prospects of life betterment after wrong financial decision making are expected to be limited. The approach of this argument seems unrealistic since no more control is

possible after the decision is made. However, levels of personal confidence amidst challenges affects attitude and enables individuals identify opportunities of growth within the challenges. As in perception of prior knowledge, we cannot be sure that all factor causes of prospects appraisal amidst faulty decision making have been enumerated. For this reason, the researcher will design questions in such a way that respondents will have summed up most of the causative factors.

2.4.3Prospects of wealth increase after a rational decision and financial decision making rationality

This is equivalent to exploring empirical evidence of rational choice theory (Homans, 1961). The theory advances that human decisions are rationally processed. Processing of decisions is expounded by rational choice model that operates on a number of assumptions including perfect problem clarity, known options (finite), clear and constant preferences, no time and cost constraints and that, above all the decision maker picks on the maximum payoffs from among the alternatives. On the basis of the above assumptions prospects of wealth increase should be invariably perfect as well. That is, so long as the assumptions hold, the only question that requires determination is by how much wealth increases but not whether. Unfortunately there exists counterevidence which prompts for a wider set of assumptions by one group of theorists while others advocate for a major overhaul of the theory's core assumptions (Kroneberg & Kalter, 2012).

In 2006, De Martino, Kumaran, Seymour and Dolan researched on the framing effect biases in rational decision making in the human brain and found that emotions influence rational financial decision making; hence should be included in the model. It was also found out that greater maturity in workers (representing greater rationality) resulted in better financial performance in 160 state corporations (Williams & Fedorowicz, 2012). Styhre (2016) talks of expedient theorizing to save the rationality assumption in classical and neo-classical economics and hence accommodate irrational financial decision making. These and many more studies agree that the rationality assumption is necessary

in configuring economic and financial models but also are cognizant that the assumption works only partially.

Vida and Reardon conducted a research in 2008 on 174 consumers in an EU member state and found that ethnocentric and patriotic considerations dominated rational considerations in domestic consumption of a product as opposed to consumption of imported substitutes. These mixed studies reveal that rational decision making is not obvious. This prompts the next question; why it is not practiced across the board by humans. It may be hypothesized that it does not guarantee economic benefit for had this been the case, then all and sundry would not process financial decisions otherwise. This sets stage for expectation that it may or may not yield benefits. In this case, rational decision making practice would depend on the prospects of yielding economic benefits, and the costs associated in information gathering and processing.

Nevertheless, there exists greater likelihood of economically benefitting from rational decision making than from irrational decision making. If not, then there would not be any motivation for schooling and training to horn decision making skills. In terms of human ability and intentionality, rational decision making rests on existence of purpose and clear goals, ordered preferences, alternative processing with an aim to maximize utility, social structures represent utility maximizing individuals and that determination of resource distribution, opportunities, and nature of norms are rationally done (Jonathan, 1999).

Whereas traits are relatively unconditional behavioural tendencies that attest to individual's potentials in broad domains of functioning (McCrae & Costa, 1999), self-efficacy beliefs are knowledge structures that attest to the unique properties of human beings to self-reflect and learn from experience (Bandura, 1993). Self efficacy as a specific construct (Zimmerman, 2000) relates to the individual`s own beliefs about his or her ability in a specific situation, and is of concern (Rosenstock, Strecher & Becker, 1988). Self efficacy influences how people think, behave, feel and motivate themselves. Self efficacy implies appropriately and effectively organizing cognitive, social,

behavioral and motivational capabilities in a particular situation (Bandura, 1992). Rational financial decision making depends on self efficacy in any given situation. An individual's perceived self efficacy affects the choice of financial decisions, and environmental surroundings of an individual. People like to find themselves in situations they believe they are able to cope with.

Believing in overcoming a challenge will release efforts to actually do so, despite any obstacles. On the other hand, not believing in overcoming a challenging financial decision in the given situation, results in little effort being put into trying to get out of the situation (Bandura, 1977). There are four sources of information that affects self efficacy. These include enactive attainments, vicarious experience, verbal persuasion and psychological arousal (Bandura, 1982). If an individual experiences defeat, early in the course of events (financial decision) in a given task, it cannot be explained by having investing little time and effort to succeed. This will reduce his or her faith in coping. It will therefore contribute to a further reduction of the individual`s self efficacy in subsequent tasks. Experiencing success, on the other hand, will result in enhanced self efficacy. Vicarious experience is about comparing oneself with another person who succeeded in similar financial decision making or venture. Self efficacy is likely to increase if there exists previous successful persons, in the task or to reduce if there is not (Zimmerman, 2000). Verbal persuasion as a source of self efficacy is not very influential but works well in presence of any of the first two (Chambliss & Murray, 1979). Finally, psychological arousal measure vulnerability of an individual whereby high arousal indicates prospects of weaker financial decision making performance.

2.4.4The intervening effect of wealth movement on determinants of financial decision making rationality

Organizational decision making entails four interpretations. It has been argued that the role of decision-making can not only be choice and the mobilization of organizational action but also responsibility allocation and organizational legitimation (Brunsson, 2007) as shown in table 2.1.

Table2.1: Four Roles of Decisions

Role	Choice	Mobilization	Responsibility allocation	Legitimation
Handle uncertainty as to	Alternatives	Commitments	Decision-makers	Organizational legitimacy
Connection to actions	Connected	Connected	Connected	Disconnected
Design	Rationality	Irrationality	Irrationality for responsibility acceptance	Rationality in environments of inconsistent norms

Source: Nils Brunsson (2007), The Consequences of Decision Making

However, for purposes of this study, there was purposive confinement to choice consideration which results into either increase or decrease in wealth, though there was recognition that a combination of the four roles applies. Notably, different designs regarding degrees of visibility and rationality have different implications for the four roles; and different degrees of rationality provide the need for accounting information (Brunsson, 2007). This research collected financial accounting information to determine rationality levels exercised on the part of SACCO members and managements.

In most fields of human activity, people use data (in this case accounting information) to further their learning and to guide decision-making and action. The following steps, as itemized by from Berry (1996), have been described as "the scientific method." However, they can be used by a biologist seeking to better understand the behavior of toads, the marketing director of a supermarket chain determining where to open a new store, or a managing director deciding whether to accept a particular job offer. First, define the problem to be addressed, secondly, assess the relevant information already available. This will help in deciding whether it is sufficient for the purpose at hand. If yes,appropriate conclusions, make appropriate decisions, and take appropriate action. If not, proceed to the third step. Third, determine what additional information is needed and design a study or experiment to attempt to obtain it. Fourth, carry out the study

designed in the third step. Lastly use the data obtained in step 4 to update what was previously known. Return to step 2. Statistics is central to steps 2, 3, and 5.Bayesian statistics is particularly well suited to steps 2 and 5, because it provides a quantitative framework for representing current knowledge and for rationally integrating new information (Cowles, 2013).

Wealth movement represented as increases and decreases progressively provides data for personal appraisal of previous financial decisions taken. If an increase is realized there is greater probability hence motivation that the previous decision was rational. The converse is true in case wealth a reduction was posted. Wealth movement acts as the observable dimension (Bolstad, 2007) used by the decision maker to appraise previous decisions. For the same reason, employers prefer head hunting for more experienced individuals since they provide greater confidence (probability-wise) of driving their enterprise to prosperity. Through new information (data), the decision maker is able to update previous beliefs on perception of prior knowledge; to increase the likelihood of obtaining the desired outcomes.

In the medical field, Bayesian diagnostic processes can be attained through computer-aided systems that can offer measurable advantages over more conventional approaches. For example, in a study comparing the accuracy of the diagnosis of acute abdominal pain, a Bayesian computing system conducted by de Dombal et al, in 1972 demonstrated to be much more accurate and reliable than a "human" clinician team in detecting the true diagnosis; 91.8% vs. 79.6% (Cowles, 2013). Wealth movement produces a rationality path by using new posterior probabilities' expectation on rationality levels of 0 and 1 respectively. This method was used in determination of theoretical stock price convergence by Glosten and Milgrom in 1985, by taking limits of an infinite sequence. Practically, infinite sequences do not exist. This study was in finite but continuous time.

2.4.5 Financial decision making rationality

This dependent variable is generated by measuring the likelihood of making a rational decision as of year 2015. After this, the expectation of actual rationality worked out as

the sum of the likelihood of making a rational decision multiplied by unity and the likelihood of making an irrational decision multiplied by naught is obtained. Previous rationality levels have been determined through utility which did not factor in age progression and assumed complete information possession. While the traditional drawback of utility immeasurability persists, this study recognizes the affective domain of human psychology in addition to cognition as factor that causes of operational rationality.

2.5 Critique of the Existing Literature

The element of rationality measurement in financial decision making is conspicuously absent. Splendid description of human intentions, inabilities and inefficiencies regarding financial decision making are clear. However, this realization is not sufficient to solve problems occasioned by the observations. After pointing out existence of the planning fallacy and base rate neglect, cognizant of the fact that we may not change them unless gradually through education or nudging (Katsikopoulos, 2014), it can only be prudent to chart how to incorporate them in our financial planning to establish concrete levels of certainty in our quantitative expectations. Existing literature on rationality has been predominantly descriptive. Financial models that reflect human behavioural deviations from rational choice assumptions have not been developed. Researchers have not linked decision making quality to wealth increase but to utility, which is bounded (Ingersol, 1986).

Rationality of individuals is 'bounded' – that is, finite in scope and representational reach, and constrained by the opportunity cost of time. This cannot reasonably be controversial as an empirical matter hence economists should introduce bounds on the rationality of agents in their models not grudgingly or partially (Ross, 2014). With recognition of behavioural finance as a fully fledged financial discipline, more parameters like contextualization and generalizations need be made to help researchers find solid bases for further research. Ramsey's calibration (1926) of subjective probabilities does not eliminate subjectivity and remains discrete. It is difficult to apply

it to a large number of respondents unlike cumulative prospect theory decision weights function which has the advantage of continuity.

2.6 Research Gap

Behavioural finance proponents have done extensive work on various forms of heuristics used by humans. These include representativeness, overconfidence, herd behaviour, anchoring, and availability heuristics among others. The foundation of economic growth is rational economic and financial decision making. All types of heuristics were categorized as irrational decisions for the purposes of this research. Since heuristic decisions cannot sustain economic entities like businesses, governments and households, it means a given measure of rationalization of financial and economic decisions must be employed. The gap is that previous studies have not addressed this issue. Another grave methodological gap is that most studies in financial decision making handled using frequentist statistics which does not model processes but states.

Bayesian learning representation is superior in modeling processes. Binmore (2015) and Wang (2004) overly cling to neoclassical orthodoxy of rationality to a point of not noticing that Kahneman & Tversky's decision weights function (1992) brings about a solution to the unreliable subjective probabilities. Rationality in financial decision making has been restricted to grownups in all research previously done. This research study established conceptual constructs that enrich the subject of rationality in financial decision making in the light of developmental psychology for confirmation negation or modification in subsequent research studies. Measurement of rationality and its progression with age will help link human capital appraisals at both macro and micro levels. This study found a suitable use of cumulative prospect theory decision weights function and geometric Brownian model in human financial decision making behaviour modeling.

Table2.2: Summary of the research gap

Researcher	Year	Country	Objective of the study
1.Kubilay & Bayrakdaloglu	2016	Turkey	Investigating the effect personality traits and psychological biases on financial risk tolerance
2. Apesteguia & Ballester	2012	Spain	Establishing a rationality index for welfare analysis
3. Musschoff & Hirschauer	2011	Germany	Analyzing the role of incomplete information on financial decisions
4.Vida & Readon	2008	USA	Examining cognitive affective and normative mechanisms in EU consumer choice behaviour

Kubilay & Bayrakdaloglu (2016) in table 2.2 found interesting findings that personality traits have a significant relationship with psychological biases in financial risk tolerance. This study is thus restricted to heuristics effect on decision making. However, a good proportion of financial decisions have to be rationalized to realize growth. Musschoff & Hirschauer (2011) sought to analyze the role of incomplete information on financial decisions speaks to only one of the two reasons for bounded rationality (Simon, 1996) – insufficient information, leaving out cognitive limitations. Vida & Readon (2008) then address the effect of affective part not handled by Muschoff & Hirschauer (2011); on consumer choice behaviour. Conspicuously, none of them recognizes the learning process of the decision maker, that is, their studies relate to an event not a process. Apesteguia & Ballester (2012) finally attempt to establish a rationality index for welfare analysis. While 'welfare' is fluid in measurability (Nordhaus, & Tobin, 1972), at personal level, this study used total assets. Most important is that a stochastic frame is missing including the economic agent's prospects of gain or loss at decision taking point. No learning has been incorporated by all these researchers.

2.7 Summary

Human financial decision making rationality bounds exist and were established. Bounded rationality theory and prospect theory enabled dissection of the institution of

the individual who exists in a probabilistic world. For this reason geometric Brownian model and Bayesian decision theory became invaluably instrumental in modeling wealth movement used to derive rationality in discrete and continuous time rationality function to illustrate rationality evolution with time; cognizant of human learning. It is envisaged that the functions will go a long way to modify existing standard finance models to reflect human decision making patterns better.

CHAPTER THREE
RESEARCH METHODOLOGY

3.1 Introduction

This section comprises four main tasks accomplished for two time points; the data period (2005 – 2015) followed by prediction period (2016 – 2025). Secondly, these probabilities were passed through the cumulative prospect theory decision weights function for transformation into objective probabilities. Thirdly, rationality evolution was illustrated; culminating into boundedness and the operational multi-period Bayesian rationality model was obtained together with relevant equations describing respondents' financial decision making rationality patterns. The drift and volatility arising from this period were used to finally generate wealth increases and decreases from geometric Brownian model through a continuous Bayesian learning process (shortly reviewed in Sections 3.3.1 and 3.3.2) for prediction of rationality trend for the period 2016 – 2025. Bayesian learning had been used in determining stock price convergence in the Glosten and Milgrom model (1985) in Market Microstructure Theory.

3.2 Research Philosophy

While adopting social constructionist philosophy, that is, developing constructs from ongoing conversations and interactions of research for group decisions and constructivist philosophy for individual decisions (Doan, 1997); this research was not supported by this philosophy alone. The determinants interact with one another and with wealth movement to plot financial decision making rationality within a 0-1 continuum. Since the research examined individual (member) and group (managements) decision making, social constructionist and constructivism philosophies apply. Besides, because wealth movement intervening variable is largely out of control of the decision maker, these philosophies were supplemented by positivist philosophy which advances that factual knowledge can only be discovered through empicism. There are still many aspects of the positivist philosophy, that is, philosophical positions that emphasize empirical data and scientific methods (Doan, 1977) which complements the constructionist philosophy a great deal. This combination is justified by the fact that the researcher was to construct

a rationality measuring instrument on the basis of human financial decision making behaviour from Bayesian learning apparatus, to aid establishment of the effect of the determinants on financial decision making rationality.

3.3 Research Design

A longitudinal design under quantitative research designs was deemed appropriate, where retrospective self assessment responses considered more accurate than spot responses (Collopy, 1996; Levingson, Gordon & Skeff, 1990) were solicited from respondents at a single time point. Processing was facilitated by two models: Bayesian decision model and geometric Brownian motion model. This comprised self appraisal of action/reaction behaviour in the light of changing economic environment which the respondent is themselves part of the causal agents through a learning process. These are P[Rat=1], P[inc|Rat=0] and P[inc|Rat=1]. Life Orientation Test – Revised (1994) was used to determine optimism levels interpolated within the 0.61 and 0.69 (inclusive) to derive the single parameter for use in the cumulative prospect theory decision weighting function (Wakker, 2010) of respondents. Geometric Brownian model was then fitted through Monte Carlo simulation method using the R statistical package.

The key host apparatus in the construction of rationality measures was net worth (wealth) as the observable dimension variable (ODV). Utility has been used more by other scholars; but is bounded (Ingersoll, 1986). For this reason, net worth (wealth) was used necessitating invocation of accounting theory. A comparison of the sum of net worth changes was made to designated incomes for SACCO employees and employees who combine employment and small businesses to determine net wealth changes measured by return on assets (ROA). For SACCO managements, return on assets ratio was trailed over a ten year period on quarterly or half year basis; where return value used was geometric mean of wealth changes over the ten year period to preserve conditions of an Ito process. It is argued that the higher the rationality measure, the higher the increase in wealth. Yet wealth movements are not entirely dependent on the action of the financial decision making agent. In the SDE:

$$\Delta W = \mu W \Delta t + \sigma W \epsilon \sqrt{\Delta t} \quad \ldots\ldots (3.1)$$

, the drift μ represents financial decision making agent's desire to increase their wealth at the rate μ. But wealth increase is affected by other factors (stochastic) whose variability is represented by σ and follows a normal distribution N (0, 1). The ten year data collected was used to determine μ (ROA) and σ (volatility); ϵ was determined using simulation.

3.3.1 Bayesian Decision Model

Bayesian decision model entails accumulation of knowledge about parameters in a synthesis of prior knowledge with the data at hand. Bayesian methods in econometrics, including applications in linear regression, serial correlation in time series and simultaneous equations have been developed since 1960s; with the seminal work of Box & Tiao (2011) & Zellner (1971) (Congdon, 2003). This model was invariably the most important in this study which factored in the human decision making learning processes through assumed regular updating. This is the process of updating alluded to in the conceptual framework.

SACCO cooperators as individuals make financial decisions, towards increasing their wealth in line with the super-ordinate goal of a firm; that is current wealth maximization. These decisions are made at convenient intervals of time (discrete). The most important argument here is that for wealth to increase, the decisions made must be sufficiently and consistently rational. Besides, updating of the information learned should take place to improve subsequent decision quality. Further, some of the decisions made may be irrational by reason of informational irrationality. Bayesian statistics deals with two dimensions: one is the observable variable dimension (OVD) and the other is unobservable variable dimension (UVD) (Bolstad, 2007). Increase/decrease in wealth is observable while rationality is unobservable.

3.3.2 Accounting Theory and Geometric Brownian Motion Model

Wealth creation process can be through running a business or offering services in some form of employment or both, for an individual person. However, for a corporate entity

wealth creation is limited to business almost entirely, where periodic rational financial decisions on investment, consumption and savings need to be made by decision making organs; usually comprising more than one individual. In both situations, decisions are processed and made through the institution of individuals (Brunsson, 2007) since corporate entities operate through individuals. For corporate entities, decisions are mainly made through groups in form of committees, councils or institutionalized meetings. This is where SACCO managements fall under. For individuals, a decision process is almost exclusively personal. Progressive growth in wealth is measured in form of the financial position status at a point in time; which is captured by accounting theory (Wood & Sangster, 2007).

The fundamental function of financial accounting is to determine loss or profit for a specified period, and to show the financial position of a business at a point in time (wealth movement). But this process is not deterministic! It is influenced by numerous factors some of which are beyond control of the decision makers (Dessler, 2004). Industrial competition, change in government regulation, depletion of raw materials, inadequate human capital and so on, are a few of these factors. This characteristic renders the wealth variable to possess two fundamental attributes to be determined: the expected return (as a proportion of the current wealth) and the volatility/standard deviation as a result of the uncontrollable factors. This relationship is captured by geometric Brownian model also known as the Generalized Wieners process described by an Ito process, shown in figure 3.1. It is expressed by the stochastic differential equation:

$dx = adt + bdz$…… (3.2)

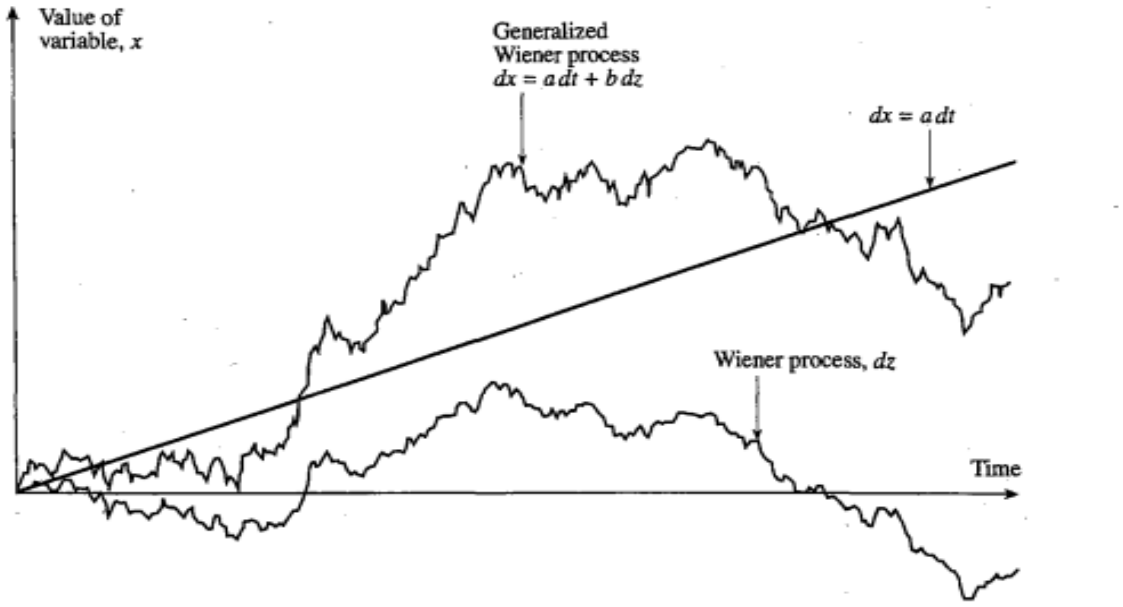


Figure 3.1: Geometric Brownian motion with and without drift
Source: John C. Hull (2012); Options, futures and other derivatives

Here, the straight line dx = adt shows the deterministic component of wealth movement which suggests that wealth should increase at the rate of a. The stochastic component bdz shows variability of expected wealth increase at a standard deviation of b.

A further argument is developed here. That the earning ability of an individual depends on the value of training and knowledge received coupled with the level of experience. This is evident from salary and remuneration structures of organizations as cited by classification method of job evaluation (Decenzo & Robbins, 2005). For business organizations, there is ploughing back of earnings into the organization, such that the ploughed back capital boosts the earning power of the entity. This argument suggests that expected returns depend on the wealth level at the start of a financial period and also volatility which is also dependent on the wealth level and time in both cases. These notions are captured by a special Brownian process known as the Ito process (Hull, 2012). The equation presenting this relationship is: dx = a(x, t)dt + b(x, t)dz. Accounting theory was instrumental as it structured expected wealth movements at any given point

in time while geometric Brownian model derived the progressive wealth movements by applying Monte Carlo simulation method.

3.4 Target Population

The study population comprised members of the 164 registered deposit-taking SACCOs with a membership of over 8million members (SACCO Supervision Annual Report, 2015). Three SACCOs and their members were targeted, namely Unitas, Mwalimu and Stima SACCOs. The membership of Unitas (about 126,000) is richly diverse; comprising different professional backgrounds but with a bigger proportion of assorted business members. Mwalimu SACCO, with a membership of about 57,000 is for teachers, who are evenly geographically dispersed in the country. Stima SACCO had a membership of about 35,000 members who are also geographically dispersed all over the country.

As of 2005 46% of all SACCOs were Agricultural–based and 36% Finance-based (Gweyi, Ndwiga & Karagu, 2013). Unitas was agricultural based (before change of common bond and name from Muramati SACCO) while Mwalimu and Stima SACCOs are Finance-based. The aim was to capture financial decision makers from both the employed and self-employed orientations. This gave findings that potentially represent practices of financial decision making agents throughout the economic sector. SACCOs also have membership of a wider distribution of income size as compared to banks which are preferred by upper-middle and high-end means financial decision making agents in the economy. The researcher argues that on the basis of the above characteristics of the SACCOs, coupled with the GDP contribution of the sector, results from this study can be generalized to represent the entire country's decision making practices with minor adjustments (Ngige, 2014).

Table3. 1: Membership of the SACCOs studied Comprising the Sampling Frame

SACCO	Sampling frame (membership) as of Dec 2012
Mwalimu National	57,000
Stima	26,000
Unitas	126,000

3.5 Sample and Sampling Design

Of the 164 SACCOs three were purposively (ref. sec. 1.6) sampled but actual respondents were randomly sampled. In total, the sampling frame goes beyond 200,000 a condition of equation 3.3 members. When the population is so large to be categorized as unknown, the formula deriving the minimum sample size (Wooldridge, 2003) is:

$$n = \frac{z^2\sigma^2}{ME^2} \quad \text{..... (3.3)}$$

, where n = sample size, z = confidence level required, σ = standard deviation and ME = margin of error required (Maxwell & Delaney, 2004).

In recognition of the fact that a standard deviation value is required in this formula to generate the minimum sample size (given that population mean is being sought), pilot data of 34 Stima SACCO members had been collected. It gave standard deviations of 1.121 for P[Rat=1], 1.113 for P[dec|Rat=1] and 1.118 for P[inc|Rat=0]. At a margin of error of 0.11, going by the highest standard deviation of 1.121 at a confidence level of 95%, a sample size of 399 respondents were required from SACCO membership and 46 from SACCO management; totaling 445 as summarized in table 3.2.

Table3.2 Proportion of sample size responses over target SACCOs

SACCO	Sample size distribution for SACCO members	Sample size distribution for Management	SACCO respondent number totals
Stima	50	16	66
Mwalimu National	109	14	123
Unitas	240	16	256
Total	**399**	**46**	**445**

The sampling method was pure simple random sampling for individual SACCO members and middle and top level management members from the SACCOs. This is because middle and top level managers are expected to be few. SACCO management members are not supposed to respond to part B in the questionnaire (appendix 7); this was secondary data from the SACCO (income statement and corresponding balance sheets for 2005 through 2015). Absent employees as of 2005 were required to indicate their year of entry and backward interpolation was done to arrive at working responses for 2005. Individual SACCO members and SACCO managements were the units of analysis, corresponding to members and management staffs as respective units of observation.

3.6 Research Instruments and Data Collection Procedure

3.6.1 Research Instruments

Simple random sampling was employed. Two questionnaires labeled 15A (carrying 20 questions) and 15B (carrying 18 questions) as shown in appendix 6&7 were administered to individual members and SACCO management respondents respectively.

3.6.2 Data Collection Procedure

Since the response rate of SACCO management respondents is more critical, the researcher personally presented the questionnaires to SACCO managements and administered to individual members waiting for service in the banking hall (for 3 weeks) to fill on the spot and surrender them to the researcher immediately. Follow up

was made daily to ensure that any questionnaires issued to respondents but not submitted back were collected.

3.7 Data Processing and Analysis

In this section the two time-point data (in 2005 and 2015) collected was processed to yield a six equation discrete time Bayesian learning model and a single deterministic continuous time exponential function was developed using the following procedure to obtain prior knowledge, financial decision making rationality, probability of wealth increase after an irrational decision and probability of wealth increase after a rational decision. These three variables were then let to interact with wealth movement via the Ito process that generated actual increases and decreases as shown in section 3.7.2.

3.7.1 Data Processing Algorithm for Bounded Rationality for n observations

Step 1: Averaging of subjective probability

$$\Pr = \frac{1}{n}\sum_{1}^{n} x_i \quad \text{……..……..……..…… (3.4)}$$

Using the data obtained during pilot testing for n=34 respondents, the processing proceeds thus;

$$P_s(Inc \mid Rat = 0) = \frac{1}{34}\sum_{1}^{34} y_i, \; P_s(dec \mid Rat = 1) = \frac{1}{34}\sum_{1}^{34} z_i$$

$$P_s(Rat = 1)_{2005} = \frac{1}{34}\sum_{1}^{34} x_i \quad P_s(Rat = 1)_{2015} = \frac{1}{34}\sum_{1}^{34} x_i^1 \quad \text{…….….. (3.5)}$$

P_s(inc|Rat=0) = 0.353, P_s(dec|Rat=1) = 0.430, P_s(Rat=1) =0.353**(2005),** P_s(Rat=1) =0.540 **(2015).**

Step 2: Averaging LOT-R scores out of 24 the group scores

$$\text{Sample LOT-R mean score} = \frac{1}{24}\left(\frac{1}{n}\right)\sum_{1}^{n} x_i \quad \text{…….. (3.6)}$$

$$Lot - R = \frac{1}{24} \times \frac{1}{34}\sum_{1}^{34} x_i = \mathbf{17.533}$$

Step 3: Linear interpolated delta parameter between 0.61 (optimism) and 0.69 (pessimism)

The general equation for δ estimation is given by:

$$\delta = 0.69 - \frac{1}{24n}\sum_{i=1}^{n} x_i (0.69 - 0.61) \quad \text{..... (3.7)}$$

$\delta = 0.69 - \frac{17.533}{24}(0.69 - 0.61) = 0.63156$, **approximately 0.63**, into equation:

$$P_s = \frac{P_o{}^{\delta}}{\left\{P_o{}^{\delta} + (1 - P_o)^{\delta}\right\}^{1/\delta}} \quad \text{..... (3.8)}$$

, where P_s = subjective probabilities; P_o = objective probabilities.

Step 4: Cumulative Prospect Theory Decision Weights Function Transformed Probabilities (by iteration):

$$P_S = \frac{P_o^{0.63}}{\left\{P_o^{0.63} + (1 - P_o)^{0.63}\right\}^{1/0.63}}$$

P_o(inc/Rat=0) = 0.357 = **q**, therefore P_o(dec/Rat=0) = 0.643 = **1-q**

P_o(dec/Rat=1) = 0.5 = **1-p**, therefore P_o(inc/Rat=1) = 0.5 = **p**

P_o(Rat=1) =0.357 therefore, P_o(Rat=0) = 0.643.

Step 5:

a) **Evolution of probability hence rationality through increase/decrease in economic wealth**

Bayesian learning process using objective probabilities:

i) If a wealth increase is observed, we apply:

$$P(Rat = 1 \mid inc) = \frac{P(Rat = 1)P(inc \mid Rat = 1)}{P(Rat = 1)P(inc \mid Rat = 1) + P(Rat = 0)P(inc \mid Rat = 0)} \quad \text{..... (3.9)}$$

, where P(Rat=1) =0.357, P(inc/Rat=1) = 0.5, P(Rat=0) = 0.643, P(inc/Rat=0)

= 0.357 to give **0.4374**. This becomes the new prior in the next financial decision to be made. Meanwhile, financial decision making rationality (Γ) = P(Rat=1)(1) + P(Rat=0)(0) =0.4374(1) = 0.4374. That is, financial decision making rationality Γ depends on the likelihoods of making a rational decision and that of making an irrational decision.

ii) If another wealth increase is observed, we apply:

$$P(Rat=1|inc,inc)=\frac{P(Rat=1)P(inc|Rat=1)^2}{P(Rat=1)P(inc|Rat=1)^2+P(Rat=0)P(inc|Rat=0)^2} \quad \ldots\ldots (3.10)$$

; to get **0.5213.** Then, Γ = P(Rat=1)(1) + P(Rat=0)(0) =0.5213(1) = 0.5213

iii) If a wealth decrease is observed, we apply:

$$P(Rat=1|\text{dec},inc,inc)$$

$$=\frac{P(Rat=1)P(inc|Rat=1)^2P(dec|Rat=1)}{P(Rat=1)P(inc|Rat=1)^2P(dec|Rat=1)+P(Rat=0)P(inc|Rat=0)^2P(dec|Rat=0)}$$

…… (3.11)

, which results to **0.4585.** Again, Γ = P(Rat=1)(1) + P(Rat=0)(0) =0.4585(1) = 0.4585.

iv) If instead a wealth decrease was observed the first time, we apply:

$$P(Rat=1|dec)=\frac{P(Rat=1)P(dec|Rat=1)}{P(Rat=1)P(dec|Rat=1)+P(Rat=0)P(dec|Rat=0)} \quad \ldots. (3.12)$$

, to obtain a rationality level of 0.3015**,** at which point

Γ = P(Rat=1)(1) + P(Rat=0)(0) =0.3015(1) = 0.3015.

The evolution summary can be depicted thus:

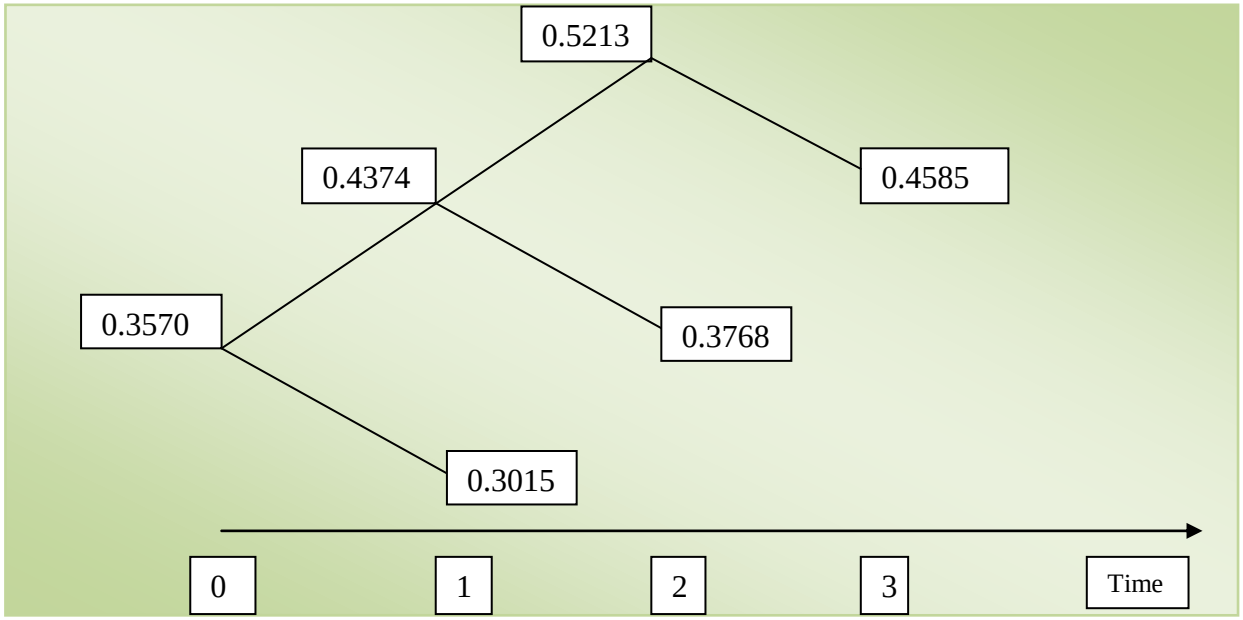


Figure 3.2: Evolution of Rationality with time

Step 5:

b) Evolution of rationality through increase/decrease in economic wealth

We define:

$p = P(\text{inc} \mid Rat = 1),\ \ 1\text{-}\ p = P(dec \mid Rat = 1)$

$q = P(inc \mid Rat = 0),\ 1\text{-}q = P(dec \mid Rat = 0)$, where 'i' and 'd' are respective numbers of increases and decreases.

$$P(Rat = 1 \mid i, d) = \frac{P(Rat = 1)\, p^{i}(1-p)^{d}}{P(Rat = 1)\, p^{i}(1-p)^{d} + P(Rat = 0)\, \mathrm{q}^{i}(1-q)^{d}}$$

$$P(Rat = 0 \mid i, d) = \frac{P(Rat = 0)\, \mathrm{q}^{i}(1-q)^{d}}{P(Rat = 1)\, p^{i}(1-p)^{d} + P(Rat = 0)\, \mathrm{q}^{i}(1-q)^{d}} \quad \text{……..}$$

(3.13)

Taking the posterior odds (the ratio of the probability that Rationality = 1to the probability that Rationality = 0), we get:

$$\frac{P(Rat = 1 \mid i, d)}{P(Rat = 0 \mid i, d)} = \frac{P(Rat = 1)\, p^{i}(1-p)^{d}}{P(Rat = 0)\, \mathrm{q}^{i}(1-q)^{d}} \quad \text{…….. (3.14)}$$

We then take the logs of both sides to arrive at:

$$\ln\left(\frac{P(Rat=1|i,d)}{P(Rat=0|i,d)}\right)=\ln\left(\frac{P(Rat=1)}{P(Rat=0)}\right)+\ln\left(p^i(1-p)^d\right)-\ln\left(q^i(1-q)^d\right)$$

$$=\ln\left(\frac{P(Rat=1)}{P(Rat=0)}\right)+i\ln p+d\ln(1-p)-i\ln q-d\ln(1-q)$$

Taking the mean of the odds ratio and the limit as a + b goes to infinity degenerates into:

$$\lim_{(a+b)\to\infty}\left\{\frac{1}{i+d}\ln\frac{P(Rat=1|i,d)}{P(Rat=0|i,d)}\right\}=\lim_{(a+b)\to\infty}\left\{\underbrace{\frac{1}{i+d}}_{\text{Goes to 0 as } i+d\to\infty\text{, so the term}\to 0}\ln\left(\frac{P(Rat=1)}{P(Rat=0)}\right)+\underbrace{\frac{i}{i+d}}_{\text{If Rat = 1, then this goes to q by definition of q, a.s.}}\ln\left(\frac{p}{q}\right)+\underbrace{\frac{d}{i+d}}_{\text{Goes to 1- q by definition a.s.}}\ln\left(\frac{(1-p)}{(1-q)}\right)\right\}$$

$$\lim_{(a+b)\to\infty}\left\{\frac{1}{i+d}\ln\frac{P(Rat=1|i,d)}{P(Rat=0|i,d)}\right\}=q\ln\left(\frac{p}{q}\right)+(1-q)\ln\left(\frac{1-p}{1-q}\right) \quad \text{….. (3.15)}$$

The right hand side of equation 3.15 represents an expression form of statistical entropy; a concept borrowed from the second law of thermodynamics in physical chemistry. Statistical entropy measures the difference between two probabilities as stated in equation 3.16.

$$I_q(p)=q\ln\left(\frac{q}{p}\right)+(1-q)\ln\left(\frac{1-q}{1-p}\right) \quad \text{……………………………………….. (3.16),}$$

Entropy derives from the second law of thermodynamics as a measure of randomness or disorder of an isolated system, formulated by Ludwig Boltzman in 1896.

$S=k_B\ln\Omega$, where Ω , is number of microstates in the system and k_B is Boltzman constant.

Relative statistical entropy stated as,

$D(q\,||\,p)=\sum_{x\in\chi}q(x)\ln\frac{q(x)}{p(x)}=I_{(q)}p$ has the following properties:

$I_q(p) \geq 0 \quad \forall q,\ p$

$I_q(q) = 0 \quad \forall q,\ p$

$I_q(p) \neq 0 \quad \text{if } q \neq p$

For the left hand side to be finite and negative,

$$\lim_{(a+b)\to\infty} \frac{1}{i+d} \ln \frac{P(Rat=1|i,d)}{P(Rat=0|i,d)} = q \ln\left(\frac{p}{q}\right) + (1-q)\ln\left(\frac{1-p}{1-q}\right) = -I_q(p) > -\infty$$

$\ln \frac{P(Rat=1|i,d)}{P(Rat=0|i,d)} = -\infty$, hence $P(Rat=1|i,d) = 0$, this is proof of bounded rationality. This condition can only be fulfilled if and only if $0 < p < 1$ and also $0 \leq q < 1$.

3.7.2 Stochastic Rationality Estimation for Discrete Time Case

The hypothetical data in use shows evolution of (objective) rationality in financial decision making from 0.357 in 2005 to 0.524 in 2010 to 0.687 in 2015 (Table B). Figure 3.3 shows such a hypothetical wealth evolution through a geometric Brownian Ito process. Increases and decreases in wealth follow the general Ito process in the SDE $\Delta W = \mu W \Delta t + \sigma W \epsilon \sqrt{\Delta t}$.

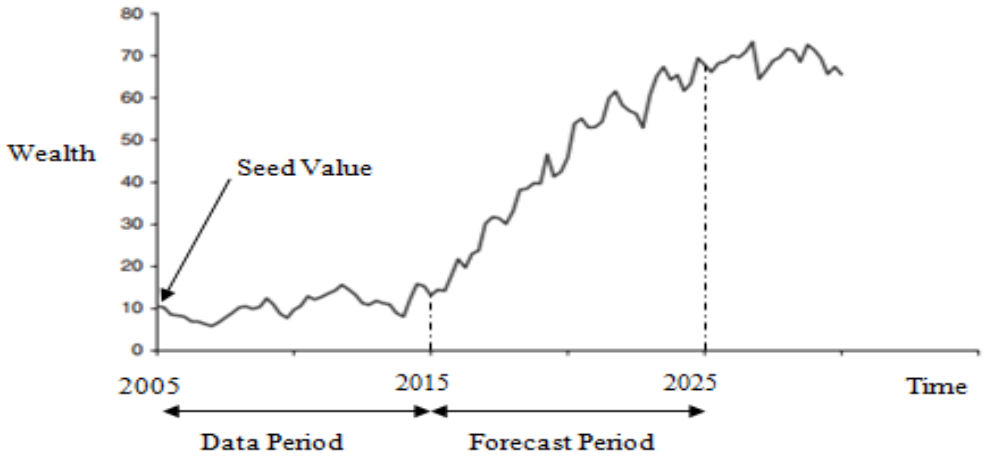


Figure 3.3: A hypothetical wealth movement graph for data and forecast period

The drift μ was estimated using the equation:

$$\mu = \left(\frac{W_T}{W_o} \right)^{1/T} \quad \text{..... (3.17)}$$

, where μ = expected return, T = time in years, W_T = wealth after expiry of time T years and W_o = original wealth. The expected value of drift was the geometric mean. For volatility;

Define:

$n+1$ = number of observations

W_i = wealth at the end of the i^{th} interval, i=1, 2, 3… n

T = length of time intervals in years and let

$u_i = In\left(\frac{W_i}{W_{i-1}} \right)$, for i =1, 2, 3….n. The usual estimate, σ, of the standard deviation of the u_i is given by

$$\sigma = \sqrt{\frac{1}{n-1} \sum_{i=1}^{n} (u_i - \bar{u})^2} \quad \text{..... (3.18)}$$

, where $\bar{u}$ is the mean of u_i.

These two parameters were used to project 10 years rationality; data period of collection should be equal to data period of projection (Hull, 2012). The ten years projection period assumes that drift and volatility parameters and the updating interval remain constant, while wealth increases and decreases are identically and independently distributed. From step 5 in section 3.6.1, the posterior probability after a number of wealth increases and decreases can be determined as:

$$P(Rat = 1 \mid i, d) = \frac{P(Rat = 1) p^i (1-p)^d}{P(Rat = 1) p^i (1-p)^d + P(Rat = 0) q^i (1-q)^d} \quad \text{..... (3.19)}$$

$p = P(\text{inc} \mid Rat = 1),\ \ 1 - p = P(dec \mid Rat = 1)$
$q = P(inc \mid Rat = 0),\ 1 - q = P(dec \mid Rat = 0)$, where 'i' and 'd' are the number of increases and decreases respectively.

We may further let P (Rat=1) = r so that we rewrite equation 3.14 as:

$$P(Rat = 1 \mid i, d) = \frac{rp^i(1-p)^d}{rp^i(1-p)^d + (1-r)q^i(1-q)^d} \quad \text{……………………………………… (3.20)}$$

The expected value of rationality is calculated thus;

$$E(R) = P(Rat = 1 \mid i, d)(1) + P(Rat = 0 \mid i, d)(0) = P(Rat = 1 \mid i, d) \quad \text{……………………… (3.21)}$$

Figure 3.3, is a hypothetical wealth movement graph showing the observable dimension variables of increases and decreases in wealth. These are supposed to be the actual movements from which we derive the actual i and d. It is noteworthy that the number of increases and decreases obtained by iteration (calculation) to arrive at the current (2015) rationality value of an financial decision making agent will necessarily not equal those (real) obtained from the wealth movement graph; in fact those from the wealth movement graph will certainly be equal or more, since humans are incomplete Bayesians (Jones, 1999).

Meanwhile, as a consequence of equation 3.21, Bayesian rationality estimation function is;

$$E(R) = \Gamma_{(R)} = \frac{rp^i(1-p)^d}{rp^i(1-p)^d + (1-r)q^i(1-q)^d} \quad \text{…………………………………… (3.22)}$$

When a financial decision making agent has made a decision, whether rational or irrational, he is said to have been decisive. Decisiveness level of the agent can be deduced by substituting r_D (as in Table B) for r in equation 3.23 to get;

$$\Gamma_{(D)} = \frac{r_D p^i(1-p)^d}{r_D p^i(1-p)^d + (1-r_D)q^i(1-q)^d} \quad \text{…………………………………………… (3.23)}$$

The difference between decisiveness and rationality levels amounts to irrationality level given by;

$$\Gamma_{(IR)} = \Gamma_{(D)} - \Gamma_{(R)} \quad \text{..... (3.24)}$$

At times a financial decision making agent does not take decisions (indecision). The proportion of decisions they do not take out of the total number of decisions they face can be calculated as;

$$\Gamma_{(IN)} = 1 - \Gamma_{(D)} \quad \text{..... (3.25)}$$

All the above rationality estimation formulas do not reflect base rate neglect (1 – updating rate) which can be estimated as;

$$Updating\ period = \frac{n}{i+d} \quad \text{..... (3.26)}$$

, where n is the number of months within which the observation is made.

Consistency rate of taking decisions is a critical parameter in forecasting and can only be obtained from the observable dimension variable represented by geometric Brownian motion. This information was not obtained in the preliminary responses; it had not been included in the questionnaire.

$$\Gamma_c = \frac{(i+d)_{calc}}{(i+d)_{real}} \quad \text{..... (3.27)}$$

These formulas were used to analyze rationality levels in financial decision making and behaviour for the ten years to be forecasted. Variables i and d derived from geometric Brownian sample path that were estimated using the drift and volatility parameters arising from the 10 year data from respondents. The study assumed that the rate of updating and updating consistency levels for the last 10 years will remain constant for purposes of forecasting rationality in financial decision making for the next ten years.

3.7.3 Summary of Tests of Hypotheses Carried Out

The first hypothesis test entailed a two-tailed Z-test about population mean using the normal distribution; that the variable r has no affect the financial decision making rationality level as the null hypothesis. The second and third are also two-tailed tests about population mean; that the variables p and q respectively do not affect rationality

level. Hypothesis number 4 was also be a two-tailed test about population mean; that increase or decrease in wealth has no effect on rationality level.

3.8 Statistical Validity and Reliability

This refers to the ability of a study is able to draw conclusions that agree with the statistical and scientific laws. Types of statistical validity include construct, content, internal, external and conclusion (Gujerati, 2016). The data collection instruments were constructed in such a way that they conform and reflect statistical validity. For instance the Markov property features in both Bayesian learning model and geometric Brownian motion model; which is in line with the general human learning process. As well, Bayesian decision theory from which the study's model derives, obeyed bounded rationality theory perfectly.

3.8.1 Criterion Related Validity

Validity of this kind is preoccupied with determining whether a test is valid, where the test is the criterion. The use of geometric Brownian model was both predictive and postdictive. Using the drift and volatility values from the data collected to derive the number of increases and decreases in wealth, and substituting the numbers in the rationality formula determined the required rationality against a given confidence level (Grissom & Kim, 2005). The study also answered the question whether the test is a valid measure of the conceptual constructs adopted.

3.8.2 Structural Validity

The experimental structure may cause findings to be invalid. Structural validity measures how well the structure of the research is valid for meaningful conclusions to be made from the research. The likelihood ratio test was used to rate the possible hypothesis number 5 for structural validity (Gujerati, 2016).

3.8.3 Reliability of the Research Data

Reliability is the extent to which an experiment, test, or any measuring procedure yields the same result on repeated trials. Without the agreement of independent observers being able to replicate research procedures, or the ability to use research tools and procedures

that yield consistent measurements, researchers would be unable to satisfactorily draw conclusions, formulate theories, or make claims about the generalizability of their research (Brooks, 2014). Reliability of the regression coefficients is usually done using the standard error of estimates. However, all Likert scale responses were tested using Cronbach's alpha to estimate the lower bound reliability estimate at 0.7.

$$\alpha = \frac{K}{K-1}\left(1 - \frac{\sum_{i=1}^{K} \sigma_{Y_i}^2}{\sigma_X^2}\right) \quad \text{..... (3.27)}$$

,where $\boldsymbol{\sigma_{Xi}^2}$ is the variance of the observed total scores, and $\boldsymbol{\sigma_{Yi}^2}$ is th i^{th} component fot the sample in question.

3.9 Data Presentation

This study data was captured in an operational data table (Appendix5). Extract tables were made for various sections followed by graphical presentations especially for purposes of generating the number of increases and decreases from a geometric Brownian sample path. Secondary data sourced from financial statements of SACCOs was summarized in tables to derive retained earnings and respective return on assets. These were passed through Brownian motion diffusions for analysis.

Table 3.3: Study Variables Operationalization to obtain objective probabilities

Variables	Meaning	Measurement	Subjective to objective conversion equation
Prior Knowledge about consumption, investment or a savings' decision in 2005 $P_o[Rat=1]_{2005}$ **= (r) =** r_o	Extent of thinking through before making a fin. decision in 2005 or proportion of decisions reasoned out in 2005	Proportion of logical decisions taken as mean Likert scores of information level, urgency, cognitive style and incidental affect for year 2005 interpolated as a probability[0, 1] = r_s	δ = 0.69 –[x/24(0.69-0.61)] where x = LOT-R score. $r_s = \frac{r_o{}^{\delta}}{\left\{r_o{}^{\delta} + (1-r_o)^{\delta}\right\}^{1/\delta}}$ (iteration is used)
Prospects of wealth increase after an irrational consumption, investment or savings' decision $P_o[inc\|Rat=0]$ = **(q) =** q_o	Likelihood of realizing financial benefits from a decision that was not reasoned out (benefiting from an illogical decision)	Likelihood of wealth increase after an illogical decision taken as mean Likert scores of integral affect and locus of control for 2005&2015 mean interpolated as a probability [0, 1] = q_s	δ = 0.69 –[x/24(0.69-0.61)] where x = LOT-R score. $q_s = \frac{q_o{}^{\delta}}{\left\{q_o{}^{\delta} + (1-q_o)^{\delta}\right\}^{1/\delta}}$ Where q_s and q_o are subjective & objective probabilities respectively
Prospects of wealth increase after a rational consumption, investment or savings' decision $P_o[inc\|Rat=1]$ = **(p) =** p_o	Likelihood of realizing financial benefits from a decision that was reasoned out (benefiting from a logical decision)	Likelihood of wealth increase after a logical decision taken as mean Likert scores of rational choice costs & benefits and self efficacy for 2005&2015 mean interpolated as a probability [0,1] = p_s	δ = 0.69 –[x/24(0.69-0.61)] where x = LOT-R score. $p_s = \frac{p_o{}^{\delta}}{\left\{p_o{}^{\delta} + (1-p_o)^{\delta}\right\}^{1/\delta}}$ (iteration is used)
Wealth movement i and **d** ϵN	No. of wealth increases and decreases realized	Number of wealth increases and decreases over the 10 year period as defined by the equation on R.H.S	$\Gamma = \frac{rp^i(1-p)^d}{rp^i(1-p)^d + (1-r)q^i(1-q)^d}$

Financial decision making rationality $\boldsymbol{\Gamma} = \Gamma_o$	Expected level of thinking through before making a fin. decision in 2015 or proportion of decisions reasoned out in 2015	Expected magnitude of reasoning out financial decisions taken as mean expected value of Likert scores for year 2015 interpolated as a probability[0, 1] such that: $\Gamma_s = P_s[\text{Rat}=1]_{2015}[1] + P_s[\text{Rat}=0]_{2015}[0]$.	$\delta = 0.69 - [x/24(0.69-0.61)]$ where x = LOT-R score. $\Gamma_s = \frac{\Gamma_o{}^{\delta}}{\left\{\Gamma_o{}^{\delta} + (1-\Gamma_o)^{\delta}\right\}^{1/\delta}}$ (iteration is used)

CHAPTER FOUR

RESEARCH FINDINGS AND DISCUSSIONS

4.1 Introduction

This chapter begins with descriptive statistics followed by inferential statistics. Analysis was made in 9groups, these are: all SACCOs members, all SACCOs female members and all SACCOs male members presented together, all Unitas SACCO members, all Stima SACCO members and all Mwalimu National SACCO members presented together. Finally, Unitas SACCO management, Stima SACCO management and Mwalimu National SACCO management analysis was presented together. Nine major sections have been outlined. First is an analysis of the effect of each independent variable on the dependent variable for the 9 groups. From this analysis, the principle of minimum guesswork and generational entropy substitution rate emerge as additional knowledge. Secondly, analysis of the collective effect of all independent variables on the dependent variable was done including tabular and graphical presentations.

Tabular presentations are all over since Bayesian decision model is discrete hence non-differentiable. Thus variable effects must be viewed from every data point. Thirdly, the gross effect of independent and intervening variables on the dependent variable deriving updating points was analyzed. Fourth, Determination of updating consistency rate arising from determination of ordinary decision points is deduced from simulation procedures using R-Statistical package. Fifth, projections of financial decision making rationality are done for the next 10 years for each of the groups in discrete time. Sixth, Ito-Bayesian projection of financial decision making rationality is done for the 9 groups for the next 10 years. Eighth, validation of average rationality values as the real rationality values is derived as the most important methodological finding of the study. Ninth, a summary of discussion of findings is given. Finally, the proposed entropy-q rationality theory was diagrammatically illustrated.

4.2 General Information

Real time responses receipt was important given the amount of data required and that it would be time consuming and difficult to follow respondents to surrender the questionnaires. Incomplete questionnaires were removed from the analysis exercise, incongruently responded to questionnaires were subjected to data cleaning before a table of raw data summary was assembled in appendix 4.

4.2.1 Response rate

The expected responses were 434 out of which 317 were obtained; reflecting a responses rate of 73%. This was considered adequate since a response rate of 70% is considered sufficient (Mugenda and Mugenda, 2005). The data is summarized in table A (appendix 4).

4.2.2 Background information of the respondents

These SACCOs were picked because of their representativeness of deposit taking SACCOs in the aspects of general registration categories geographical coverage as well as demographic representation across gender age and income levels. The age brackets are also shown in the table with an almost normal distribution with age 37 with highest respondents. Other higher and lower ages cascade on either side of the distribution. This distribution reflects age membership of deposit taking SACCOs. Education level indices for the three SACCOs were 3.19, 2.27, and 1.28 respectively for Mwalimu National SACCO, Stima SACCO and Unitas SACCO; where the indices are derived as indicated under table 4.2. Table 4.1 summarizes actual responses obtained from the three SACCOs, while table 4.3 shows reliability of q1 and q2 pair wise and that of p1 and p2 pair wise.

Table 4.1: Population of Sample Size Responses over Target SACCOs

SACCO	Sample size distribution for SACCO members	Sample size distribution for SACCO Managements	Respondents number
Stima	47	14	61
Mwalimu	91	16	107
Unitas	133	16	149
Total	**271**	**46**	**317**

The proportion of SACCO management responses out of the total was 14.5%, leaving 85.5% of all responses to SACCO members.

Table4. 2: Age distribution for SACCO members

Age	Frequency	Percentage
22	5	1.8
27	32	11.8
32	54	19.9
37	60	22.1
42	43	15.9
47	41	15.1
52	28	10.3
57	8	03.0
Total	**271**	**100**

*Management responses were irrelevant in analyzing Managements as a unit of analysis

Stima and Mwalimu National SACCO respondents are in formal employment while Unitas SACCO members are in self employment. They operate small and medium enterprises as small scale entrepreneurs. The modal and median age was 37as shown in table 4.2, but the mean age was 38.14. This shows a slight positive skewness. Given the retirement age of 60 years in Kenya, this age can be considered the prime age of the national labour force.

4.2.3 Gender balance

The key study population was SACCO members in Kenya. But also, there was a secondary interest to look at the interactive aspects between members and management. For this reason, no distinction about gender was made on SACCO managements, only on SACCO members. 146 male and 125 female member respondents totaling 317 as per table 4.3, a proportion of 55.5% to 44.5% respectively for male and female respondents respectively surrendered the required information. This can be considered near parity for reliable conclusions to be made. In responding to the question of how rational a SACCO management has been, reliability may be compromised by reason of respondent employees not having been with the organization for the whole ten year period in question; unlike responses about an individual SACCO member who has been alive all through. For this reason gender response for SACCO managements was not collected.

Table4. 3: Distribution of gender in the data collected from SACCO members

SACCO	Males	%	Females	%	Total
Mwalimu	47	51.6%	44	48.4%	91
Stima	32	68.1%	15	31.9%	47
Units	67	50.4%	66	49.6%	133
	146		**125**		**271**

*management was not required to respond

4.2.4 Education distribution of SACCO member respondents

Only 30.65% of sample respondents had acquired a university degree, while 44.62% and 24.73% had acquired basic education (high school) and diploma level education respectively as exhibited by table 4.4. All high school graduates plus a few diploma holders belong to Unitas SACCO while the rest belong to Mwalimu National and Stima SACCOs.

Table4. 4: Education distribution of SACCO member

Education	Index	Total	Proportion of total respondents
High School	1	121	44.62%
Diploma	2	67	24.73%
Bachelors	3	56	20.43%
Masters	4	23	8.06%
PhDs	5	4	2.15%
Total		**271**	**100.00%**

*management was not required to respond. Index was assigned for analysis purposes

4.2.5 Working experience

SACCO members were required to respond to questions about their own financial decision making lives. At an average age of 39, and assuming a start work age of 24, some 15 years of work experience had accrued. However, a slight challenge was encountered in soliciting information about SACCO managements. Some respondents had joined the SACCOs as employees later than 10 years ago. Luckily, these comprised less than 20% of the total responses. The challenge was circumvented by extrapolating backwards. Conspicuously missing was the ages of the units of observation for SACCO managements. It was deemed unnecessary given that they were to furnish information

about the SACCO and not themselves. Perhaps the SACCO ages was more appropriate and was obtained as part of secondary data.

4.2.6 Respondents designation

SACCO managements' respondents were randomly selected from lower, middle and top management cadres to enhance reliability of information. Since these were personal views that did not require documentary support, specific designations were not necessary. Nevertheless, it is important to note that these views needed to go through a scientific process to transform them into objective information with the aid of cumulative prospect theory decision weights function. On the part of SACCO member respondents, job groups were required. It was however noted that most respondents ranged within two job groups, paving way for treatment of this aspect as a constant. SACCO managements' designation distribution is shown on table 4.5.

Table4. 5: Summary distribution of SACCO management respondents' designation

SACCO	Unitas	Stima	Mwalimu	Total
Top level	1	1	0	2
Middle level	3	4	11	18
Lower level	11	10	5	26
Total	15	15	26	**46**

4.2.7 Type of the organization

As mentioned earlier, the target population was individual SACCO members as private economic agents. Their SACCO managements served to disclose complementary interactions. A SACCO is a member owned depository institution formed for purposes of advancing credit to members themselves at low interests. It operates under the cooperatives act in the statutory laws of Kenya. Given that SACCO members form the main unit of analysis, it is observed that since Unitas SACCO was initially agricultural based, representing mainly self employed members, the sample size from Unitas commensurately represents 46% of Agricultural-based SACCOs. Stima and Mwalimu

National SACCOs represent finance-based SACCOs which formed 36% of all SACCOs as of 2008. A summary of organization and employment types is shown on table 4.6.

Table 4.6: Summary of SACCO type and percentage representation in the study

SACCO	SACCO Type	Employment	*% representation
Unitas	Agricultural-	Self	46
Stima	Finance-based	Formal	36
Mwalimu N.	Finance-based	Formal	36

*% representation cannot sum up to 100%; Stima and Mwalimu represent same type

4.3 Descriptive statistics of independent and dependent variables

4.3.1Prior knowledge

The responses obtained regarding prior knowledge level of economic agents was 271, the sum of indicated figures in bold for the SACCO members and 46 for SACCO managements. Useful descriptive for purposes of this study have been summarized in table 4.7. This shows the mean values for the level of information, decision urgency and cognitive style sub-variables. Decision urgency was scored in the reverse to reflect negative effect on prior knowledge.

Table 4.7: Prior knowledge descriptive

	n	Prior knowledge about a
Mwalimu	**91**	0.7971
Female	44	0.8450
Male	47	0.7472
Mgt	16	0.8173
Stima:	**47**	0.8800
Female	15	0.8321
Male	32	0.9012
Mgt	14	0.6866
Unitas:	**133**	0.8576
Female	66	0.8627
Male	67	0.8556
Mgt	16	0.5592
All Females	125	0.8142
All Males	146	0.8211
SACCOS Overall	**271**	0.8182

The highest and lowest prior values were 0.9012 recorded by Stima male members and 0.7472 recorded by Mwalimu male members respectively for SACCO members. For SACCO managements, the highest and lowest were 0.8173 by Mwalimu and 0.5592 by Unitas management. Corresponding ages are also shown. The average prior knowledge for all SACCO members was 0.8182 observed from a total of 271 members who had an average education level of diploma.

Table 4.8: Descriptive statistics for the prior knowledge

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
rawr	271	.0000	1.0000	.693421	.2735401
Valid N (listwise)	271				

Minimum and maximum values refer to the highest (1.000) and lowest (0.000) r value responses for the 271 respondents; their mean and standard deviation were 0.6934 and 0.2735 respectively.

4.3.2Prospects of wealth increase after an irrational decision q

Table4. 9: Prospects of wealth increase after an irrational decision

	No. of	**Pr(Inc|Rat=0)**	**Pr(Inc|Rat=0)**	**Pr(Inc|Rat=0)**
Mwalimu N.:	**91**	0.454	0.4796	0.4668
Female	44	0.4817	0.7314	0.6066
Male	47	0.4294	0.4688	0.4491
Mgt	**16**	0.807	0.4681	0.6376
Stima:	**47**	0.4464	0.5778	0.5121
Female	15	0.4859	0.4859	0.4859
Male	32	0.4265	0.6205	0.5235
Mgt	**14**	0.5021	0.6205	0.5613
Unitas:	**133**	0.5686	0.6237	0.5962
Female	66	0.7365	0.6831	0.7098
Male	67	0.4128	0.574	0.4934
Mgt	**16**	0.7171	0.6637	0.6904
Gender:				
Female	125	0.5242	0.4811	0.5027
Male	146	0.4229	0.5311	0.4770
SACCOS	**317**	0.452	0.5104	0.4812

Bearing in mind that this study was longitudinal, in that the prior knowledge level discussed in the previous section is assumed to relate to year 2005, two sets of variable q were collected; one for 2005 and the other for 2015. The objective was to determine whether q changed significantly during the period. Bayesian analysis is premised on a constant q and a constant p. It is therefore important to first establish whether any change in q had taken place. In the meantime, the highest and lowest q values were 0.7314 recorded by Mwalimu female members and 0.4688 by their male counterparts in year 2015. In year 2005, the highest and lowest q values were 0.7365 and 0.4128 for Unitas female male members respectively. For the managements unit of analysis, the highest and lowest values for 2005 were 0.8070 recorded by Mwalimu National and 0.5021 recorded by Stima SACCO. In 2015, the highest and lowest q values by managements were 0.6627 by Unitas and0.4681by Mwalimu National SACCO as shown in table 4.9. SACCO member respondents for this question were 271 while management staffs were 46; totaling 317 as shown on table 4.9. This summarizes integral & incidental affect and locus of control sub-variable responses. Question (ii) under locus of control was scored in the reverse to reflect the required effect.

Table 4.10: Descriptive statistics for the mean q_1 (2005) and q_2 (2015)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
rawq	271	.0000	1.0000	.443370	.3191447
Valid N (listwise)	271				

The mean of 0.4434 shown in table 4.10 is for the raw data not the operational data. Transformation of the value into operational data through cumulative prospect theory decision weights function yields 0.4812. As well, the standard deviation of 0.3191 relates to the raw data. Magnified in the same direction, the operational standard deviation becomes 0.3463.

4.3.3 Prospects of wealth increase after a rational decision p

The highest and lowest probabilities recorded for SACCO members were 0.9031 and 0.7926 from Mwalimu and Unitas male members respectively in 2005. In 2015, the highest and lowest responses were 0.8562 and 0.7429 Mwalimu and Stima female members respectively. The male and female categories relate to SACCO members only not SACCO staff. This means that males resign earlier in life regarding rationalization of financial decisions as compared to females. Again, since Bayesian analysis contemplates a constant value of p, it was necessary to determine whether there was a significant change in the quantity during that period. It is after all clear that over the period, there was no significant change in the p values as shown by tables 4.10 and 4.11. Respective highest and lowest p values for SACCO managements have been shown in table 4.10. The average figures in the last column are relevant for purposes of all inferences. Rational choice costs in the questionnaire were scored in the reverse also to reflect the negative effect it bears on prospects of wealth increase after rational decision making.

Table 4.11: Prospects of wealth increase after a rational decision

		No. of	**Pr(Inc|Rat=1) 2005**	**Pr(Inc|Rat=1) 2015**	**Pr(Inc|Rat=1) Average**
Mwalimu		**91**	0.8884	0.8483	0.86835
	Female	44	0.8711	0.8562	0.86365
	Male	47	0.9031	0.8296	0.86635
	Mgt	**16**	0.9424	0.8891	0.91575
Stima:		**47**	0.8584	0.8061	0.83225
	Female	15	0.8489	0.7429	0.7959
	Male	32	0.8631	0.8347	0.8489
	Mgt	**14**	0.9319	0.9411	0.9365
Unitas:		**133**	0.8275	0.8374	0.83245
	Female	66	0.8229	0.8202	0.82155
	Male	67	0.7926	0.8035	0.79805
	Mgt	**16**	0.8582	0.8835	0.87085
Gender:					
	Female	125	0.7802	0.7553	0.76775
	Male	146	0.7771	0.7544	0.76575
SACCOS Overall		**271**	0.7785	0.7548	0.76665

Both the mean and standard deviation of p1 and p2 values did not change significantly in the 10 year period as shown in table 4.11. On average, is clear that economic agents perceive a lower likelihood of financial benefits after rationalizing their decision in year 2015 compared to year 2015. This was observed across all the SACCO groups save for Unitas male members and Unitas SACCO management.

Table 4.12: Paired sample statistics for p_1 (2005) and p_2 (2015)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	p1	.67576	271	.305843	.023810
	p2	.63258	271	.343631	.026752

4.3.4 Wealth movement descriptives

Wealth movement was assumed to oscillate within only two states; either an increase or a decrease; otherwise known as a binomial setting. While it is possible for the start and end wealth level to be the same within an interval of time, such a case is very unlikely. In such occurrences, the researcher would pick on the state which the wealth graph spent more time within the interval under consideration. Fortunately, no such cases were recorded. Wealth movement was traced using simulation in R statistical soft ware.

As of 2015, Mwalimu National SACCO was commanding the highest wealth level in terms of member asset values at KeS8,073,526,000, followed by Unitas at KeS827,386,000 and lastly Stima at KeS23,209,000(table 4.13). While Mwalimu members had a wealth level of KeS350,000 in 2005, Stima SACCO started with a slightly lower wealth level of KeS320,000 and Unitas members, the least, at KeS140,000 by reason of belonging to the small and medium enterprises. Respective returns on assets disclose that Stima has the highest (32.08%) with the highest risk as well at 23.04%. Unitas SACCO seemingly adopted a unique business model that

allowed them to strike a relatively high return of 27.35% but with the lowest risk at just about 9%.

Table 4.13: Initial Wealth level, drift and standard deviation of the SACCOs

SACCO Groups		No. of	Drift	Std Dev	Wo
Mwalimu		**91**	0.1505	0.233	350
	Female	44	0.1298	0.2943	350
	Male	47	0.1699	0.1883	350
	Mgt	**16**	**0.154**	**0.1646**	**8,073,526**
Stima:		**47**	0.2814	0.2579	320
	Female	15	0.3703	0.1052	320
	Male	32	0.2577	0.2987	320
	Mgt	**14**	**0.3208**	**0.2304**	**23,209**
Unitas:		**133**	0.2889	0.46036	140
	Female	66	0.3341	0.48781	140
	Male	67	0.2536	0.43771	140
	Mgt	**16**	**0.2735**	**0.09034**	**827,386**
Gender:	Female	125	0.2735	0.4047	285.2
	Male	146	0.2335	0.3518	301.7
SACCOS Overall		**271**	0.2508	0.3941	292.7

Mwalimu National SACCO maintained recorded the lowest return of 15.4% with almost an equivalent risk of 16.46%. On the other hand, Mwalimu National SACCO members maintained a similar asset margin like their SACCO but operated at a higher risk of 23.3%. Unitas members had the highest asset returns with as high a risk while Stima SACCO members oscillated in the middle. In general, these observations are in line with the high return high risk rule (Fama and French, 2011). Additionally, this data discloses gender preferences of lower risk-lower return combination for male SACCO members as opposed to a higher risk- higher return combination for female members with a 4 to 5% point difference. Table 4.13 displays this information.

4.3.5: Financial decision making rationality descriptives

This dependent variable relates to respondents rationality for 2015, ten years after the prior knowledge. Definitely, the respondent has acquired lots of financial decision making experience progressively over the ten years. It was expected that they should post higher rationality levels, which is evident. In 2005, rationality level as depicted by

the prior knowledge ranged 50% to 80% while in 2015, the same ranges between87% and 98% as exhibited in table 4.14. This shows that the SACCO member has all along been learning and updating the learning in their decision making behaviour. In the next section, an attempt is made to analyze the updating process for purposes of testing hypothesis in the specific objectives. (Table 4.14 is an extract of Table B in appendix5)

Table 4.14: Financial decision making rationality distribution over SACCO groups

	n	**Fin. Decision making rationality Γ**
Mwalimu. N:	**91**	0.9808
Female	44	0.9836
Male	47	0.9781
Mgt	16	0.8769
Stima:	**47**	0.9699
Female	15	0.97
Male	32	0.9708
Mgt	14	0.9361
Unitas:	**133**	0.9665
Female	66	0.967
Male	67	0.9646
Mgt	16	0.8934
All Females	125	0.9471
All Males	146	0.9438
SACCOS Overall	**271**	0.9451

4.4Inferential statistics

4.4.1 Hypothesis test of rationality for 95% confidence interval of prior knowledge r on financial decision making Γ (Objective one)

The basic mathematical definition of a function f is a rule that assigns a unique element f(x) in set R (range) to each element in set D (domain) (Trench, 2012). This is the proof required regarding the relationship between r and financial decision making rationality. Approaching it from a statistics viewpoint, two conditions, one necessary and the other sufficient conditions need to proven. The necessary condition is that holding p, q, i, and d constant as determined from the data, an arbitrary value of r out of a 95% confidence

interval generates a value f(r) outside the range interval. Secondly, it requires to be shown that the function f(r) is a monotone. By so doing, it will be clear that r is a determinant of financial decision making rationality Γ. From table 4.7, the value 0.8182 (in operational data summaries table B) the resultant of raw probability transformation using cumulative prospect theory decision weights function is the mean and the corresponding standard deviation is 0.3227. Working out the interval using the formula: Mean r $\pm 1.96\, s/\sqrt{n}$ giving the interval 0.7981 to 0.8383. From the excel spreadsheet, corresponding rationality values for 0.7981 and 0.8383 are 0.9372 and 0.9514 respectively. If any arbitrary point q is taken out of this interval say 0.4325 and 0.8435, corresponding rationality levels are 0.7422 and 0.9532 respectively, both of which are outside the interval 0.9372 and 0.9514.

Lastly, to show strict monotonicity of this function as an increasing function, we define:

$\Gamma = f(r)$ …… (4.1); where Γ and r are financial decision making rationality and prior knowledge levels respectively. An increasing monotone function fulfills the condition:

$f(r_1) < f(r_2)$ for all r_1 and r_2 in the interval (0,1) such that $r_1 < r_2$, (Trench, 2012). Clearly, this condition has been met as exemplified by the graph shown in figure 4.1. Similar arguments apply for the gender categories, individual SACCO members and SACCO managements. The null hypothesis is rejected and the alternative hypothesis is accepted. Objective one has therefore been achieved. Bayesian model is a discrete model which then is not differentiable anywhere unlike the regression model which is continuous and differentiable; in which case the independent variable coefficients are the gradients for the variable when partial derivatives are taken. The discrete model for use in this objective may be depicted thus:

$$\Gamma = \frac{ar}{ar + (1-r)b}$$ …… (4.2); where Γ = Financial decision making rationality, a and b are constants and r = prior knowledge

4.4.1.1 Relationship between prior knowledge and financial decision making rationality

Collected into four decimal places, the prior knowledge trend (table 4.15), has been iterated to show effect of its changes upwards and downwards together with the corresponding financial decision making rationalities. This has been accompanied by a graph figure 4.1 showing a non-linear relationship, evident from the varying gradient figures in the third column for the groups of all members, female and male members groups. It can be inferred that in the graphs, high prior knowledge results in high financial decision making rationality; a direct variation relationship. There are many factors that inform prior knowledge level during decision taking. All these factors were tested by posing a single question to the respondent. Some of the factors discussed include level of knowledge possessed by the decision maker, decision agency, cognitive style and incidental affect. Undoubtedly, information is expected to affect financial decision making positively. Nowhere in the questionnaire was this information collected directly but in form of indecision; in reference to inability to take decisions when limited information is at hand. The inadequacy accruing in this response is that it does not give the amount of information the decision maker has when taking the decision. Given that there are many and diverse financial decisions one has to take, it is perhaps not possible to gage information at the decision makers disposal unless a specific decision is in question. But there is a greater advantage in letting the question to remain general. The respondent's rating of magnitude of own belief in making logical decisions affords them invocation of all possible causes including subconscious reasons which is more encompassing.

This was also linked to the indecision in the questionnaire partly and partly with the question of being lucky after making an irrational decision. When a decision maker has inadequate information for a given decision at hand, they either choose to avoid it or to consult their previous experience of how lucky they have been when similar decisions were previously made. A similar advantage in the responses was that other reasons than decision urgency informs the decision maker's choices. Everybody has their own way of

processing cognitive data based on their learning experiences and genetic makeup. Without categorizing them, the study anticipated that in responding to the questions posed, everyone answered in their own peculiar way. It is therefore assumed that the collected responses reflect personal cognitive styles. As argued before, incidental affect is an environmental variable. Every decision depends on the decision maker's state of mind at the time where this state has been occasioned by both internal and external environment at the time. Sadly, even as the respondents were answering to the questions, they were subjects of incidental affect. It was only hoped that the associated bias did not significantly affect the true picture. Following is a detailed analysis of the effect of prior knowledge level on financial decision making rationality. All analysis is based table 4.5, which had been processed from the raw data summary table B on appendix 4.

While it seems immediately obvious that prior knowledge is a determinant of financial decision making rationality from the graph, an analytical proof is required. This is done in two stages. First, it is important to show that any arbitrary point on the X-axis (r) without a 95% confidence interval produces a rationality level outside a designated interval. This is treated as a necessary condition. And finally, it is important to show that financial decision making rationality (Y) as a function of prior knowledge (X) is a strictly monotonically increasing function (Trench, 2012). This is the sufficient condition for the proof. For purposes of establishing the confidence interval, the standard deviation and 271 observations in table 4.6 was used in determining the applicable standard error of mean. Before providing this proof, it was noted that the rate of increase of rationality as a function of prior knowledge is primarily dependent on the distance between the probability distributions q and p. Table 4.15 and the corresponding figure 4.1 shows a concave function as opposed to figures 4.1 and 4.2. This has been discussed more in section 4.4.3.

While both male and female members individually are on a decreasing trend at 0.3989 and 0.3224 respectively, men have a slightly higher starting point (0.8211) than women (0.8142), but end up at a lower rationality level (0.9377) compared to 0.9488 for women

on the highlighted raw. Since this function is not linear, it was necessary to show the effect of prior knowledge on financial decision making rationality on a substantial domain. This was done by calibrating 7 points of width 0.004 below and above the operational level highlighted, resulting to table 4.15, 4.16 and 4.17. Female members have a higher rationality level consistently over the illustrated range. This computation derives from the fact that the intention of humans is to increase their wealth indefinitely over their lifetime.

Table 4.15: Effect of prior knowledge on financial decision making rationality for the entire SACCO members including female and male members separately

All Members			Females			Males		
r	Rat-All SACCOs	Grad	r	Rat-Females	Grad	r	Rat-males	Grad
0.7902	0.9343		0.7862	0.9396		0.7931	0.9263	
0.7942	0.9358	0.3689	0.7902	0.9409	0.3366	0.7971	0.928	0.4145
0.7982	0.9373	0.3663	0.7942	0.9422	0.3342	0.8011	0.9296	0.4118
0.8022	0.9387	0.3638	0.7982	0.9436	0.3318	0.8051	0.9313	0.4092
0.8062	0.9402	0.3613	0.8022	0.9449	0.3294	0.8091	0.9329	0.4066
0.8102	0.9416	0.3588	0.8062	0.9462	0.327	0.8131	0.9345	0.404
0.8142	0.9430	0.3564	0.8102	0.9475	0.3247	0.8171	0.9361	0.4014
0.8182	0.9444	0.354	0.8142	0.9488	0.3224	0.8211	0.9377	0.3988
0.8222	0.9458	0.3516	0.8182	0.9501	0.3201	0.8251	0.9393	0.3963
0.8262	0.9472	0.3492	0.8222	0.9513	0.3178	0.8291	0.9409	0.3938
0.8302	0.9486	0.3469	0.8262	0.9526	0.3156	0.8331	0.9424	0.3913
0.8342	0.9500	0.3445	0.8302	0.9538	0.3134	0.8371	0.944	0.3889
0.8382	0.9514	0.3422	0.8342	0.9551	0.3112	0.8411	0.9455	0.3865
0.8422	0.9527	0.34	0.8382	0.9563	0.309	0.8451	0.9471	0.3841
0.8462	0.9541	0.3377	0.8422	0.9576	0.3069	0.8491	0.9486	0.3817

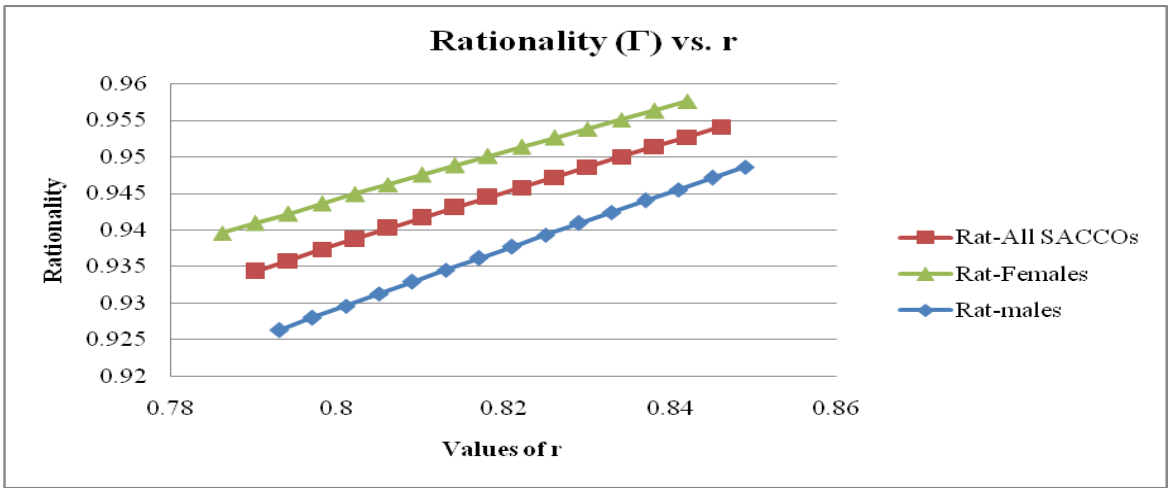


Figure 4.1: Prior knowledge and financial decision making rationality for the entire SACCO members including female and male members separately

This has been discussed under the effect of the intervening variable; represented by an exponential curve which is ever increasing in its derterministic form. However, stochastic approach is more realistic and was the one adopted throughout this study.

Table 4.16: Effect of prior knowledge on financial decision making rationality for members of the separate SACCOs

Unitas Members			Stima Members			Mwalimu N. Members		
r	**Rat(Γ)-U**	**Grad**	**r**	**Rat(Γ) -S**	**Grad**	**r**	**Rat (Γ) -M**	**Grad**
0.5682	0.9594		0.852	0.9612		0.7691	0.9788	
0.5722	0.9605	0.2748	0.856	0.9624	0.2946	0.7731	0.9793	0.1161
0.5762	0.9615	0.2728	0.86	0.9636	0.2926	0.7771	0.9798	0.115
0.5802	0.9626	0.2708	0.864	0.9647	0.2906	0.7811	0.9802	0.1139
0.5842	0.9637	0.2689	0.868	0.9659	0.2886	0.7851	0.9807	0.1129
0.5882	0.9648	0.2669	0.872	0.9670	0.2867	0.7891	0.9811	0.1118
0.5922	0.9658	0.2650	0.876	0.9682	0.2847	0.7931	0.9816	0.1108
0.5962	0.9669	0.2631	0.88	0.9693	0.2828	0.7971	0.9820	0.1098
0.6002	0.9679	0.2612	0.884	0.9704	0.2809	0.8011	0.9824	0.1088
0.6042	0.9690	0.2594	0.888	0.9715	0.2790	0.8051	0.9829	0.1078
0.6082	0.9700	0.2575	0.892	0.9726	0.2771	0.8091	0.9833	0.1068
0.6122	0.9710	0.2557	0.896	0.9737	0.2753	0.8131	0.9837	0.1059
0.6162	0.9720	0.2539	0.9	0.9748	0.2734	0.8171	0.9841	0.1049
0.6202	0.9730	0.2521	0.904	0.9759	0.2716	0.8211	0.9846	0.104
0.6242	0.9740	0.2504	0.908	0.9770	0.2698	0.8251	0.9850	0.1031

Notably, Unitas members have the lowest prior knowledge but a comparatively high learning rate as indicated by the gradient at 26.31%.

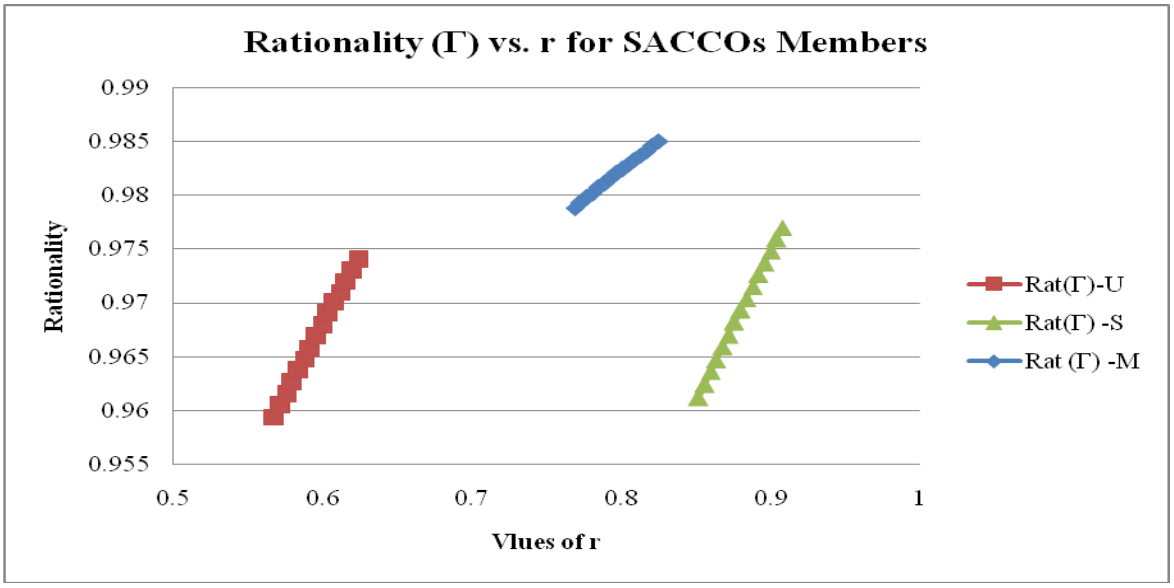


Figure 4.2: Prior knowledge and financial decision making rationality for members of the separate SACCOs

This invariably shows a lot of focus in their financial decisions. This high learning rate might be causal to the stability of Unitas SACCO by way of low levels of non-performing loans. Stima SACCO members possess a greater learning ability than the other groups considered so far. Their prior knowledge is the highest with the highest gradient. This group is likely to engage their management in very productive discussions resulting to meaningful contributions about the financial front of their SACCO affairs. Unlike other SACCO members, Mwalimu national SACCO members are the lowest on the diminishing marginal rationality function at 10.98%, but have the highest rationality levels. This lowest gradient is on account of bounded rationality since financial decision making rationality is capped at below 100%. This may be attributable to the fact that they have the highest financial decision making rationality at 98.2%, nearing 100%. Further, this observation may be attributed to their age being the most advanced of the three groups of SACCO members.

Table 4.17: Effect of prior knowledge on financial decision making rationality for the separate SACCO managements

Unitas SACCO Mgt			Stima SACCO Mgt			Mwalimu N. SACCO		
r	Rat (Γ)- U	Grad	r	Rat	Grad	r	rat (Γ)-	Grad
0.5312	0.8847		0.6586	0.9267		0.7893	0.8407	
0.5352	0.8863	0.4074	0.6626	0.9279	0.3007	0.7933	0.8439	0.8044
0.5392	0.8879	0.4028	0.6666	0.9291	0.2978	0.7973	0.8471	0.8025
0.5432	0.8895	0.3984	0.6706	0.9303	0.295	0.8013	0.8503	0.8005
0.5472	0.8911	0.3939	0.6746	0.9314	0.2922	0.8053	0.8535	0.7985
0.5512	0.8926	0.3896	0.6786	0.9326	0.2895	0.8093	0.8567	0.7966
0.5552	0.8942	0.3853	0.6826	0.9338	0.2868	0.8133	0.8599	0.7946
0.5592	0.8957	0.3811	0.6866	0.9349	0.2842	0.8173	0.8630	0.7927
0.5632	0.8972	0.377	0.6906	0.936	0.2816	0.8213	0.8662	0.7907
0.5672	0.8987	0.3729	0.6946	0.9371	0.279	0.8253	0.8693	0.7888
0.5712	0.9002	0.3689	0.6986	0.9382	0.2765	0.8293	0.8725	0.7869
0.5752	0.9016	0.3649	0.7026	0.9393	0.274	0.8333	0.8756	0.7849
0.5792	0.9031	0.3611	0.7066	0.9404	0.2715	0.8373	0.8788	0.783
0.5832	0.9045	0.3572	0.7106	0.9415	0.269	0.8413	0.8819	0.7811
0.5872	0.9059	0.3535	0.7146	0.9426	0.2666	0.8453	0.8850	0.7792

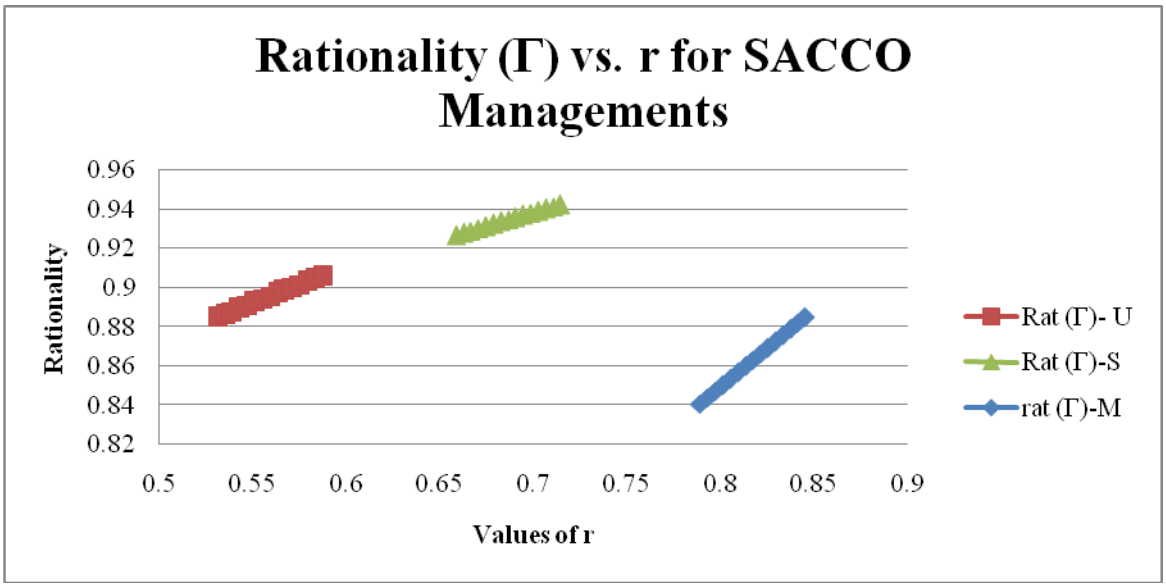


Figure 4.3: Prior knowledge and financial decision making rationality for the separate SACCO managements

Unitas management begins from a lower rationality level than their members and over the same period achieves a lower rationality level than their members. But they raise it steadily unlike Mwalimu National SACCO management which starts at a slightly higher level but holding other factors constant, declines over the same period. Better still much as Unitas management is on a diminishing marginal rationality like the rest, its rate is at 38.11% unlike Stima SACCO's at 28.42. Unfortunately, Mwalimu National SACCO is on a steady decline, losing 1.012 rationality units for every unit increase in prior knowledge. So far, Stima is the SACCO management with the highest prior knowledge, matching with their members. Both members and management share the level of rationality trend. These observations suggest a general level of agreement between members and management; a sign of possible low agency conflict. Nevertheless, Unitas SACCO management believes it has more room for learning before saturation than Stima SACCO management (compare 0.8957 to 0.9349). Besides, Unitas SACCO is at a higher point on the diminishing marginal rationality graph at 38.1% against Stima SACCO's 28.42%.

4.4.2Hypothesis test of rationality for 95% confidence level for prospects of wealth increase after irrational decision q and financial decision making rationality Γ (Objective two)

From the previous discussion, table 4.12 (a), the mean of q operational data is 0.4812 with a standard deviation of 0.3463 for the entire SACCO membership, working out the interval using the formula for the necessary and sufficient conditions as in section 4.4.1:

Mean q $\pm$ 1.96 $s/\sqrt{n}$ giving the interval 0.4387 to 0.5237. From the excel spreadsheet, corresponding rationality values for 0.4387 and 0.5237are 0.9657 and 0.9178 respectively. If any arbitrary point q is taken out of this interval say 0.4325 and 0.6435, corresponding rationality levels are 0.9682 and 0.8367 respectively, both of which are outside the interval 0.9657 and 0.9178.

Lastly, to show strict monotonicity of this function as a decreasing function, we define:

$$\Gamma = f(q) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4.3),$$

where Γ is the financial decision making rationality level and q is the prospect of wealth increase after making an irrational decision. A decreasing monotone function fulfills the condition:

$f(q_1) > f(q_2)$ for all q_1 and q_2 in the interval (0,1) such that $q_1 < q_2$, (Trench, 2012). Clearly, this condition has been met as illustrated by the graph shown in figure 4.4. Similar arguments apply for the gender categories, individual SACCO members and SACCO managements. The null hypothesis is rejected and the alternative hypothesis is accepted. Objective two has been achieved. This proof applies on variable r for Mwalimu SACCO as well.

Table 4.18: Paired sample statistics for q_1 (2005) and q_2 (2015)

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	q1	.43	271	.343	.026
	q2	.47	271	.358	.028

From the SPSS output tables, it can be seen that there was no significant change in paired differences, which is the most important aspect here as shown on table 4.18. That for every individual their measure of q never changed significantly during the ten year period. Keeping in mind that q measures success rate when financial decisions are made by guesswork, we see that the mean changed from 43% to 47%. Subsequent analysis for q will utilize the mean of q for the two periods

Table 4.19: Paired sample correlations for q_1 (2005) and q_2 (2015)

Paired Samples Correlations				
		N	Correlation	Sig.
Pair 1	q1 & q2	271	.794	.000

.Table 4.20: Paired sample tests for q_1 (2005) and q_2 (2015)

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair 1	q1 - q2	-.036	.225	.017	-.070	-.002	-2.093	168	.038

Table 4.21: Reliability of q_1&q_2 measured by Cronbach's Alpha

Case Processing Summary

q1&q2		N	%
Cases	Valid	271	100.0
	Excluded[a]	0	0.0
	Total	271	100.0

a. List wise deletion based on all variables in the procedure.

Reliability Statistics

Cronbach's Alpha	N of Items
.884	2

Tables 4.18 to 4.21 show standard deviations of q1 = 0.343, q2 = 0.358, the correlation of $q_1$and q_2 0.794, insignificance of mean differences at a p-value of 0.038 and a fairly

high reliability Cronbach's alpha of 0.884 respectively. Any alpha value beyond 0.7 is acceptable.

4.4.2.1 Relationship between prospects of increase after an irrational decision and financial decision making rationality

The symbolic relationship may be depicted thus:

$$\Gamma = \frac{a}{a + bq^{i}(1-q)^{d}} \quad \text{..... (4.4);}$$

where Γ is financial decision making rationality, q is the measure of prospects of wealth increase after an irrational decision and a, b, i, d are constants.

From table B in appendix 5, the values highlighted in table 4.22 have been derived. The functional relationship is non-linear. Holding other variables constant and calibrating a difference of 0.004 units of q from the existing highlighted values for 8 values below and above, table 4.22 obtains. Higher initial rationalities only increase the financial decision making rationality by 56.27% at a decreasing rate up to 48.4%. This is in line with bonded rationality theory (Simon, 2006).

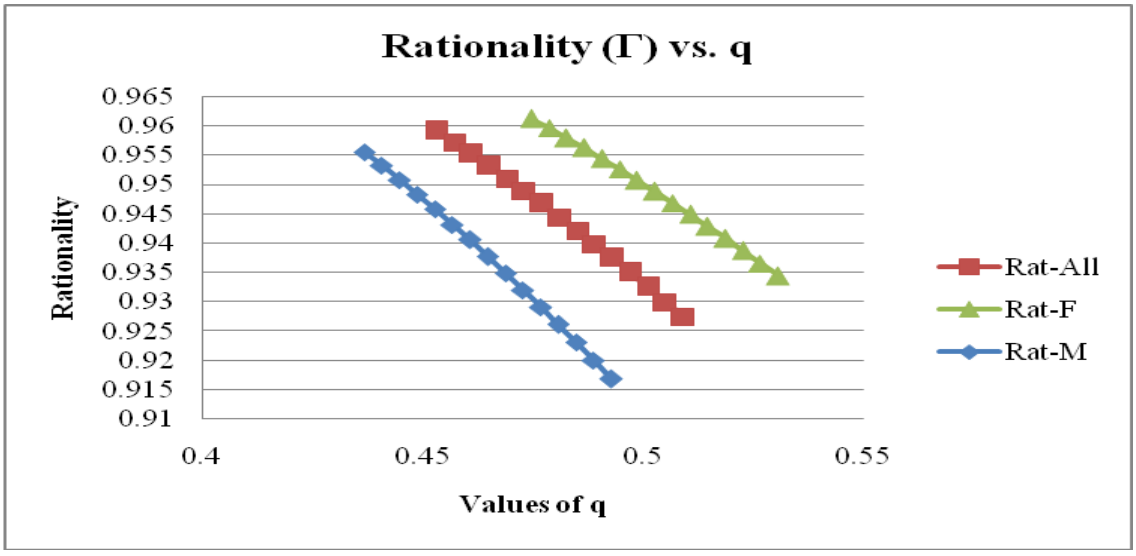


Figure 4.4: Prospects of gaining after an irrational decision and financial decision making rationality for the entire SACCO members including separate female and male genders

The relevant graph has been shown as figure 4.4 corresponding to this functional relationship. Female members have higher levels of irrationality compared to their male members and also gain less for every unit of q they reduce.

Table 4.22: Effect of prospects of wealth increase after an irrational decision on financial decision making rationality for the SACCO members and separate female and male members

All Members			Females			Males		
q	**Rat-All**	**Grad**	**q**	**Rat-F**	**Grad**	**q**	**Rat-M**	**Grad**
0.4532	0.9591		0.4747	0.9612		0.4368	0.9555	
0.4572	0.9572	-0.484	0.4787	0.9596	-0.413	0.4408	0.9532	-0.583
0.4612	0.9552	-0.4975	0.4827	0.9579	-0.4237	0.4448	0.9508	-0.6009
0.4652	0.9531	-0.5109	0.4867	0.9562	-0.4343	0.4488	0.9483	-0.6186
0.4692	0.9510	-0.5242	0.4907	0.9544	-0.4449	0.4528	0.9458	-0.6361
0.4732	0.9489	-0.5373	0.4947	0.9526	-0.4554	0.4568	0.9431	-0.6532
0.4772	0.9467	-0.5501	0.4987	0.9507	-0.4658	0.4608	0.9405	-0.67
0.4812	0.9444	-0.5627	0.5027	0.9488	-0.4761	0.4648	0.9377	-0.6863
0.4852	0.9421	-0.5751	0.5067	0.9468	-0.4863	0.4688	0.9349	-0.7022
0.4892	0.9398	-0.5871	0.5107	0.9449	-0.4963	0.4728	0.932	-0.7176
0.4932	0.9374	-0.5988	0.5147	0.9428	-0.5061	0.4768	0.9291	-0.7325
0.4972	0.9350	-0.6101	0.5187	0.9408	-0.5157	0.4808	0.9261	-0.7467
0.5012	0.9325	-0.621	0.5227	0.9387	-0.5252	0.4848	0.9231	-0.7603
0.5052	0.9299	-0.6315	0.5267	0.9365	-0.5343	0.4888	0.92	-0.7732
0.5092	0.9274	-0.6416	0.5307	0.9344	-0.5433	0.4928	0.9168	-0.7853

Table 4.22 communicates that given the fixed attributes of r, p, i, and d, for the entire SACCO fraternity, if q is varied for values before and after the q value for group as highlighted, every unit of q increased results in a decline of rationality level by 0.56 units; worse still at an increasing rate progressively. Moreover, female members' rationality decline at a lower rate of 0.4761 than their male members at 0.6863 units. Apparently, women have a higher level of guesswork than men SACCO members but it influences rationality level in the negative at a lower rate than men SACCO members. It is unlikely that custodians of national financial planning are in possession of this information. There is need therefore to recognize these parameters not just at a micro-

level but also at a macro-level to inform public financial policy as well as financial planning as cited in the statement of the problem.

Table 4.23: Effect of prospects of wealth increase after an irrational decision on financial decision making rationality for members of the separate SACCOs

Unitas Members			Stima Members			Mwalimu N. members		
q	**Rat-U**	**Grad-u**	**q**	**Rat-S**	**Grad-s**	**q**	**Rat-M**	**Grad-m**
0.5682	0.9764		0.4841	0.9813		0.4388	0.9893	
0.5722	0.9751	-0.3047	0.4881	0.9798	-0.3631	0.4428	0.9884	-0.21568
0.5762	0.9739	-0.3158	0.4921	0.9783	-0.3841	0.4468	0.9875	-0.22959
0.5802	0.9726	-0.3270	0.4961	0.9767	-0.4056	0.4508	0.9865	-0.24411
0.5842	0.9712	-0.3383	0.5001	0.9750	-0.4277	0.4548	0.9855	-0.25925
0.5882	0.9698	-0.3497	0.5041	0.9732	-0.4503	0.4588	0.9844	-0.27501
0.5922	0.9684	-0.3612	0.5081	0.9713	-0.4734	0.4628	0.9832	-0.29139
0.5962	0.9669	-0.3727	0.5121	0.9693	-0.4968	0.4668	0.9820	-0.30839
0.6002	0.9654	-0.3842	0.5161	0.9672	-0.5206	0.4708	0.9807	-0.32601
0.6042	0.9638	-0.3957	0.5201	0.9650	-0.5446	0.4748	0.9793	-0.34424
0.6082	0.9621	-0.4072	0.5241	0.9628	-0.5689	0.4788	0.9779	-0.36307
0.6122	0.9605	-0.4187	0.5281	0.9604	-0.5932	0.4828	0.9763	-0.38249
0.6162	0.9587	-0.4301	0.5321	0.9579	-0.6177	0.4868	0.9747	-0.40248
0.6202	0.9570	-0.4414	0.5361	0.9553	-0.6421	0.4908	0.9730	-0.42304
0.6242	0.9552	-0.4526	0.5401	0.9527	-0.6663	0.4948	0.9713	-0.44413

Seemingly, Unitas SACCO members are the most disadvantaged. They are operating at the highest q values which guarantee lowest rationality levels as shown on table 4.23. This may be attributable by the low education levels. However, they lose 0.37 units of a unit of rationality for every unit of q gained which is higher than that of Mwalimu National SACCO members. Stima members gain the highest per every unit of q lost at 0.47 units. Table 4.24 shows effect of q values variation on SACCO managements' rationality.

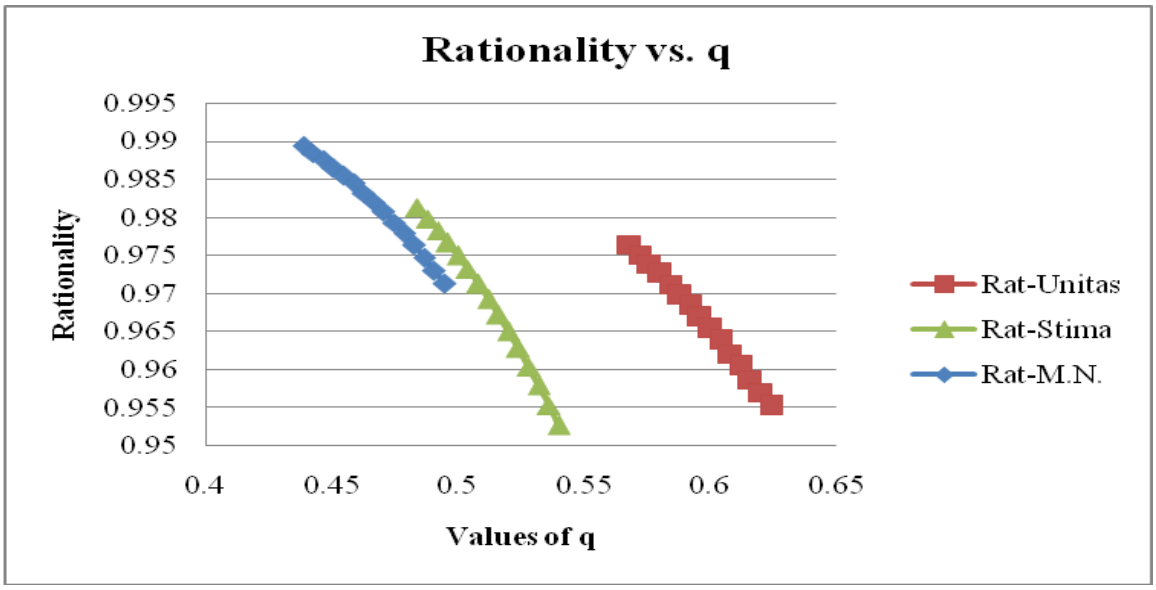


Figure 4.5: Prospects of wealth increase after an irrational decision and financial decision making rationality in separate SACCOs' members

Unitas management suffers the most from gaining units of q. A unit of q results to a loss of 1.3 units of rationality. This means that management should be very careful to ensure that q does not increase. It means it should engage in a master plan of recruiting new employees with less q values potential level of management. One strong point which Unitas has used is making very few mistakes. Recording only one decrease out of 13 is such a mark. However, when burnout sets in, there will be no fall back on the intrinsic attributes of management employees. One other point is that comparatively, all managements would gain more rationality by losing a unit of q than their members by losing the same unit of q. This is remarkably dangerous.

It means that SACCO managements' mistakes would cost them more than individual member's mistakes. This raises an alarm about the entire SACCO managements' risk managements' strategies. Incidentally, Mwalimu National SACCO member group has the lowest q value of 0.4668. The group also operates on 30% per unit rationality loss for every single unit gain of q value. Their level of making mistakes rests at 21%. At their average age of 41, this profile works well for them. It is besides, the group that maintained their q value the most by only gaining 6%, while Stima and Unitas gained

29% and 10% respectively (from table B appendix 5). This makes this group the most stable in their decision making processes. This character makes the group not experience high discrepancies in their wealth level.

Table 4.24: Effect of prospects of wealth increase after an irrational decision on financial decision making rationality for separate managements of the SACCOs

Unitas SACCO Mgt			Stima SACCO Mgt			Mwalimu N. SACCO Mgt		
q	**Rat (Γ)**	**grad**	**q**	**Rat (Γ)**	**grad**	**q**	**rat (Γ)**	**grad**
0.6624	0.9283		0.5333	0.9625		0.6096	0.8905	
0.6664	0.9242	-1.03042	0.5373	0.9593	-0.8094	0.6136	0.8867	-0.947
0.6704	0.9199	-1.0739	0.5413	0.9558	-0.865	0.6176	0.8829	-0.96
0.6744	0.9154	-1.11802	0.5453	0.9522	-0.9229	0.6216	0.879	-0.972
0.6784	0.9107	-1.16271	0.5493	0.9482	-0.9831	0.6256	0.8751	-0.983
0.6824	0.9059	-1.20785	0.5533	0.944	-1.0455	0.6296	0.8711	-0.994
0.6864	0.9009	-1.25337	0.5573	0.9396	-1.1101	0.6336	0.8671	-1.004
0.6904	0.8957	-1.29913	0.5613	0.9349	-1.1766	0.6376	0.863	-1.012
0.6944	0.8903	-1.34504	0.5653	0.9299	-1.2449	0.6416	0.8589	-1.02
0.6984	0.8848	-1.39097	0.5693	0.9247	-1.3149	0.6456	0.8548	-1.027
0.7024	0.8790	-1.43679	0.5733	0.9191	-1.3864	0.6496	0.8507	-1.032
0.7064	0.8731	-1.48236	0.5773	0.9133	-1.4592	0.6536	0.8466	-1.037
0.7104	0.8670	-1.52755	0.5813	0.9071	-1.533	0.6576	0.8424	-1.04
0.7144	0.8607	-1.57222	0.5853	0.9007	-1.6076	0.6616	0.8382	-1.043
0.7184	0.8542	-1.61622	0.5893	0.894	-1.6826	0.6656	0.8341	-1.044

Stima SACCO members are not as careful (26% error) as Unitas members at (17% error). They lose 50% of a rationality unit for every q unit gained. They are therefore likely to reach their rationality upper bounds faster than their unitas counterparts. If through education they could be more careful by reducing mistakes, they can increase their rationality levels to very high limits.

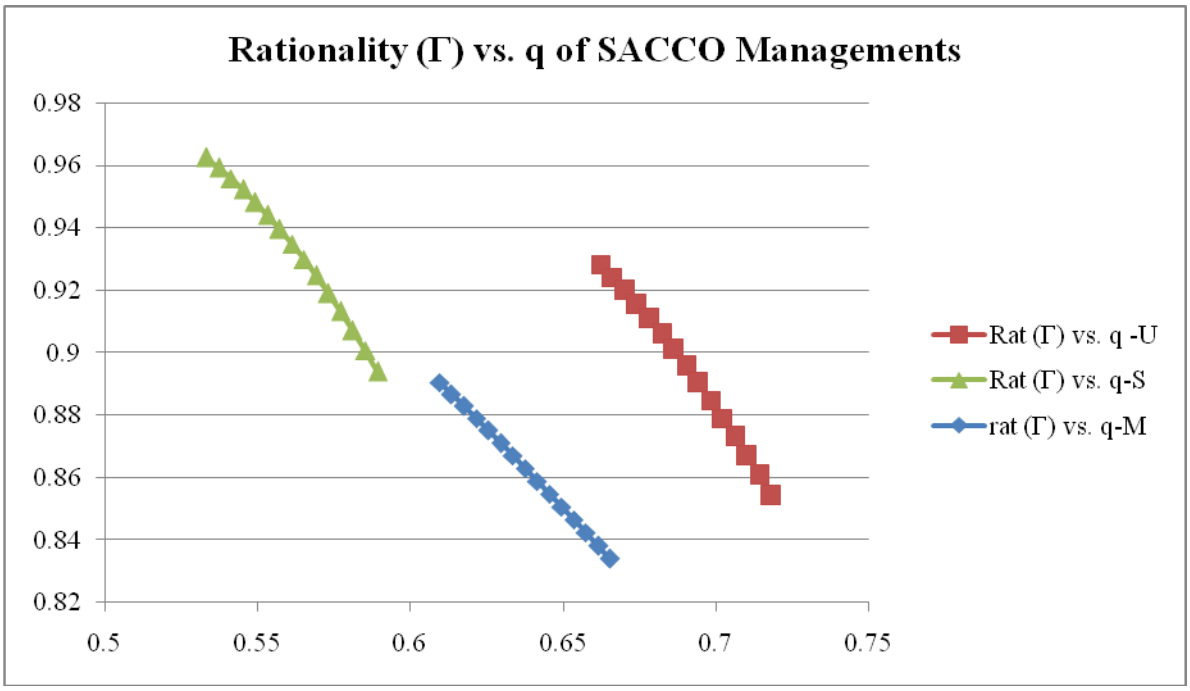


Figure 4.6: Prospects of wealth increase after an irrational decision and financial decision making rationality in separate SACCO managements

It also has one of the highest q values. So far, it is evident that high q values are detrimental to rationality level. For this reason, the SACCO operating at higher q values means losing out on rationality level at a higher rate; clearly, at 118%. This means that for every unit of q gained, 1.18 units of rationality are lost at the given p values. Higher q values go together with ambition and overconfidence. Stima management should tame ambition to maintain their rationality values at the optimum. This management group has the highest rationality reduction for every unit of q gained at 1.0122 units represented by the gradients column. This means that there is a lot of potential locked Mwalimu National SACCO management but not being utilized; possibly utilized in other dimensions. This may be a symptom of the agency dilemma. There is little evidence that this is a learning organization (Senge, 1990).

As cited previously, locus of control refers to the level of belief by an individual that they have control over life circumstances; no specific question measured this aspect. Like in previous arguments, it was hoped that while responding to the three questions

about q, p and r, effects of locus of control came into play, so that it is one of the causal factors that aggravates irrational decision making. This serves as a plausible assumption because actual responses are a function of feelings, beliefs and experiences of an individual. As a personality variable, integral affect is carried by a decision maker throughout their lives and is reflected in every decision they make. It refers to emotional orientation of an individual by reason of innate traits. Integral affect was never the key subject of concern, but it helped theorize causes of observed financial decision making behaviour. It is therefore considered to be one of the factors that contributed to the responses made by the economic agent.

Another causal factor is self-efficacy. Being purely an environmental variable, it depicts a person's belief in ability to perform a specific task which arises from the confidence or otherwise accruing in their life regarding to similar tasks experienced. Even during data collection, some respondents were so quick in giving quantitative information claiming that it was at their fingertips for many years. They believed in themselves a lot more hence creating confidence in the collection process. It is definite that this aspect affected the actual responses given. Many other factors aid irrational decision making, which are assumed to be at play at the time of decision taking. All these were represented by a single question to generate a general response representing the respondent's inclination to make irrational decisions in anticipation of benefits.

4.4.3Hypothesis test of rationality for 95% confidence level for prospects of wealth increase after a rational decision p on financial decision making rationality Γ (Objective three)

Table 4.25: Paired sample correlations for p_1 (2005) and p_2 (2015)

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	p1 & p2	271	.826	.000

Table 4.26: Paired sample tests for p_1(2005) and p_2(2015)

Paired Samples Test

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	Std. Deviation	Std. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
Pair	p1 - p2	.043182	.195049	.015185	.013199	.073164	2.844	164	.005

Table 4.27: Descriptive statistics for p

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
rawp	271	.0000	1.0000	.654494	.3056220
Valid N (listwise)	271				

Table 4.28: Reliability p1&p2 measured by Cronbach's Alpha

Case Processing Summary

p1&p2		N	%
Cases	Valid	271	100.0
	Excluded[a]	0	0.0
	Total	271	100.0

a. List wise deletion based on all variables in the procedure.'

Reliability Statistics

Cronbach's Alpha	N of Items
.902	2

From tables 4.25 to 4.28, the mean of p (0.6545) operational data is 0.7667 after translation through cumulative prospect theory decision weights function with a

standard deviation of 0.3056 magnified to 0.358. Unfortunately, the function here unlike previously is not a monotone. However, it is a combination of an increasing and a decreasing monotone as shown on figure 4.7. The first portion increases from 0.9472 to 0.9489 for values of p 0.7398 to 0.7718. The other part of the function ranges from 0.9489 to 0.9485 for values of p in the domain 0.7718 to 0.7958 only for female members, the second portion being the decreasing monotone as was worked out for q. Working out the interval limits using the same formula on the entire SACCOs: Mean p $\pm 1.96\, s/\sqrt{n}$, on the interval p = 0.8031 to p = 0.7303 yields a rationality of 0.9367 and 0.9468. Any arbitrary value of p outside this interval yields rationalities outside 0.9367 and 0.9468. For instance p=0.81 yields Γ= 0.9344. Lastly, to show strict monotonicity of this function as an increasing/decreasing function, we define:

$$\Gamma = f(p) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (4.5),$$

where Γ is the financial decision making rationality level and p is the prospect of gaining after making an rational decision. An increasing and a decreasing monotone function fulfills the following conditions respectively: $f(p_1) < f(p_2)$ for all p_1 and p_2 in the interval (a,b) such that $q_1 < q_2$ and $f(p_1) > f(p_2)$ for all q_1 and q_2 in the interval (c,d) such that $q_1 < q_2$ (Trench, 2012). Clearly, this condition has been met as illustrated by the graph shown in figure 4.7. Similar arguments apply for the gender categories, individual SACCO members and SACCO managements. The null hypothesis is rejected and the alternate hypothesis is accepted. Objective three has been achieved.

Incidentally, rational decision making model is probably the best model that reduces chances of suboptimal decisions. However, there is not a guarantee that practising the same yields economic benefits since the underlying assumptions do not hold good all the time. Sometimes, when economic agents make rational decisions, they tend to overestimate their prospect of profiting from the decision – known as overreaction. Overreaction is an environmental variable arising from the agent's perception of future prospects given the current experiences. In general, humans harbour a specific view of themselves given their experiences unless they are in a crisis never experienced before.

When a respondent says they strongly agree to the claim that they expect financial gain from a rational decision, it can be caused by overconfidence.

Though not measured, it was assumed to affect every response in some way. On the contrary, underreaction occurs when prospects are understated given available evidence. While this is also an environmental factor, the level of optimism or optimism comes in; the reason why the life orientations test was performed. Some respondents might have under reacted and others over reacted. It is believed that all these aspects were reflected in their responses as a sum total. Moreover, there are instances when the economic agent is overconfident of the prospects of economic benefits due to arise from rational decision making. This is a personality variable. Some people are always overconfident by reason of biological traits. Myriad factors come into play to affect rational decision making; eventually distorting the process and hence outcome. This changes the outcome into probabilistic expectation.

4.4.3.1 Relationship between prospects of wealth increase after a rational decision and financial decision making rationality

The relevant functional relationship in this case is shown by equation 4.5.

$$\Gamma = \frac{ap^{i}(1-p)^{d}}{ap^{i}(1-p)^{d}+b} \quad \text{..... (4.6);}$$

where Γ is financial decision making rationality, p is the measure of prospects of wealth increase after a rational decision and a, i, d, b are constants. Surprisingly, increasing p value only benefits the female group according to table 4.29 and figure 4.7. Increasing p value for the male group is so detrimental that it would rather reduce. According to the maximum entropy principle (Jaynes, 1957), highest entropy maximizes rationality of individuals. However, in this case the principle is not holding good. The reason is that the proportion of irrational decisions out of the total number of decisions engaged is very high; so high that further rationalization of the few logical decisions does not add rationality but rather reduces it.

Table 4.29: Effect of prospects of wealth increase after a rational decision on financial decision making rationality for the entire SACCO members including separate female and male members

All Members			Females			Males		
p	Rat-All	Grad	p	Rat-Females	Grad	p	Rat-males	Grad
0.7387	0.9466		0.7398	0.9472		0.7378	0.9442	
0.7427	0.9465	-0.0389	0.7438	0.9475	0.0843	0.7418	0.9435	-0.17
0.7467	0.9463	-0.0512	0.7478	0.9478	0.0753	0.7458	0.9428	-0.1884
0.7507	0.9460	-0.0639	0.7518	0.9481	0.0662	0.7498	0.9419	-0.2079
0.7547	0.9457	-0.077	0.7558	0.9483	0.0571	0.7538	0.941	-0.2284
0.7587	0.9453	-0.0906	0.7598	0.9485	0.0479	0.7578	0.94	-0.2503
0.7627	0.9449	-0.1048	0.7638	0.9487	0.0386	0.7618	0.9389	-0.2735
0.7667	0.9444	-0.1196	0.7678	0.9488	0.0292	0.7658	0.9377	-0.2982
0.7707	0.9439	-0.1351	0.7718	0.9489	0.0197	0.7698	0.9364	-0.3246
0.7747	0.9433	-0.1514	0.7758	0.9489	0.0099	0.7738	0.935	-0.353
0.7787	0.9426	-0.1686	0.7798	0.9489	-7E-	0.7778	0.9335	-0.3834
0.7827	0.9419	-0.1868	0.7838	0.9489	-0.01	0.7818	0.9318	-0.4161
0.7867	0.9410	-0.2061	0.7878	0.9488	-0.021	0.7858	0.93	-0.4515
0.7907	0.9401	-0.2266	0.7918	0.9486	-0.032	0.7898	0.928	-0.4897
0.7947	0.9391	-0.2484	0.7958	0.9485	-0.043	0.7938	0.9259	-0.531

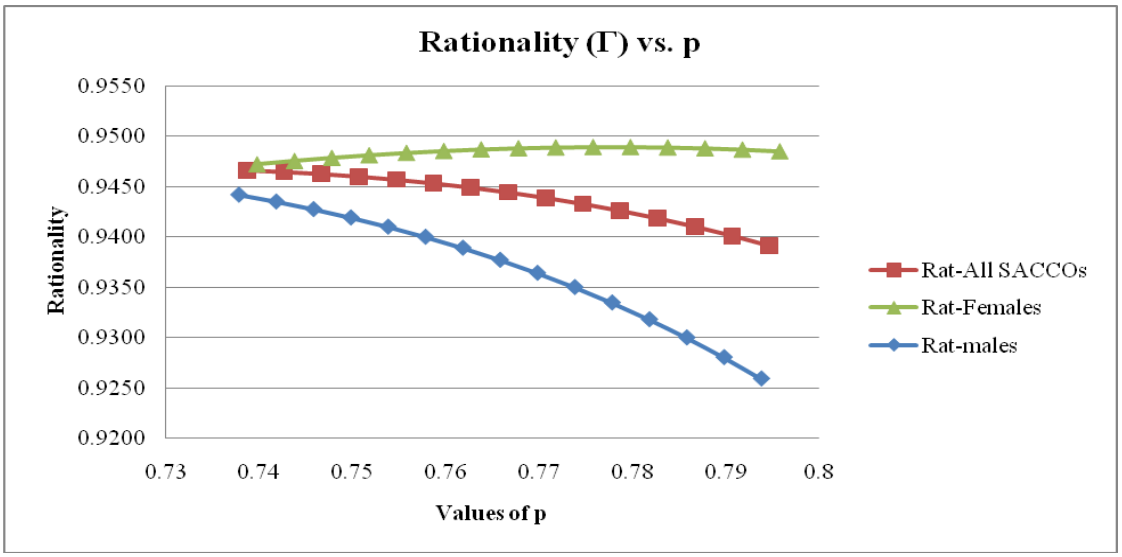


Figure 4.7: Prospects of wealth increase after a rational decision and financial decision making rationality for the entire SACCO members and separate female and male members

4.4.4The Principle of Minimum Guesswork

As part of new knowledge discovered in this research is the principle of minimum guesswork. Making reference to the meaning of variable q as the probability of recording a wealth increase after making an irrational decision, this is a decision based on guesswork! It may not necessarily be disadvantageous. But for every set of prior knowledge and update rate, there exists a maximum value of q such that when an economic agent engages a higher q than that i.e. his proportion of irrational financial decision are beyond proportion, he ends up creating a local rationality upper bound that is way below 100%. Figure 4.7 clearly shows that the average SACCO member in Kenya (at the highlighted attributes in table 4.29) cannot better his rationality level by increasing the rationalization level of financial decisions that takes after careful thought and logical analysis!

In fact he can only lose by trying to do so. At this point, it is only prudent to reduce his guesswork level. This will no doubt increase his rationality level. By reducing q value at the same rate previously increased on the value of p, the economic agent increases their rationality level by 0.0023 (0.9467-0.9444) thereby reversing the trend. It should be born in mind that the probability p and that of q are independent. Regrettably, the trend in humans is not to reduce guesswork but to increase it with age. The rest of this second objective concentrated on determining rationality bounds of SACCO groups.

A fundamental finding is that SACCO members will not increase their rationality by applying greater logical analysis on the proportion of financial decisions they decide to apply but rather will increase rationality by reducing the proportion of decisions they apply guesswork. This is supported by the gradient columns of the entire SACCO behaviour by varying q and p separately. A reduction of a unit of q increases rationality by 0.5627 units while increasing p by a unit reduces (rather than increases) rationality by 0.1196 units as of 2015. The entire SACCO members' rationality is bounded at 94.68%, which they attained some time back. The only way to raise it is to reduce guesswork which is not easy at advanced ages. Female SACCO members have their rationality

bounded at 94.89%, slightly higher than the entire SACO's members, which is a short while away before they start their anticlimax stretch.

Since their mean age is 38.9 while that of male members is 39.9, it is reasonable to assume that the rate of financial learning was the same for both genders. What is more disturbing is that SACCO members dropped their guard too early; before age 40. Male SACCO members reached their rationality ceiling much earlier at 94.76%, than their female counterparts.

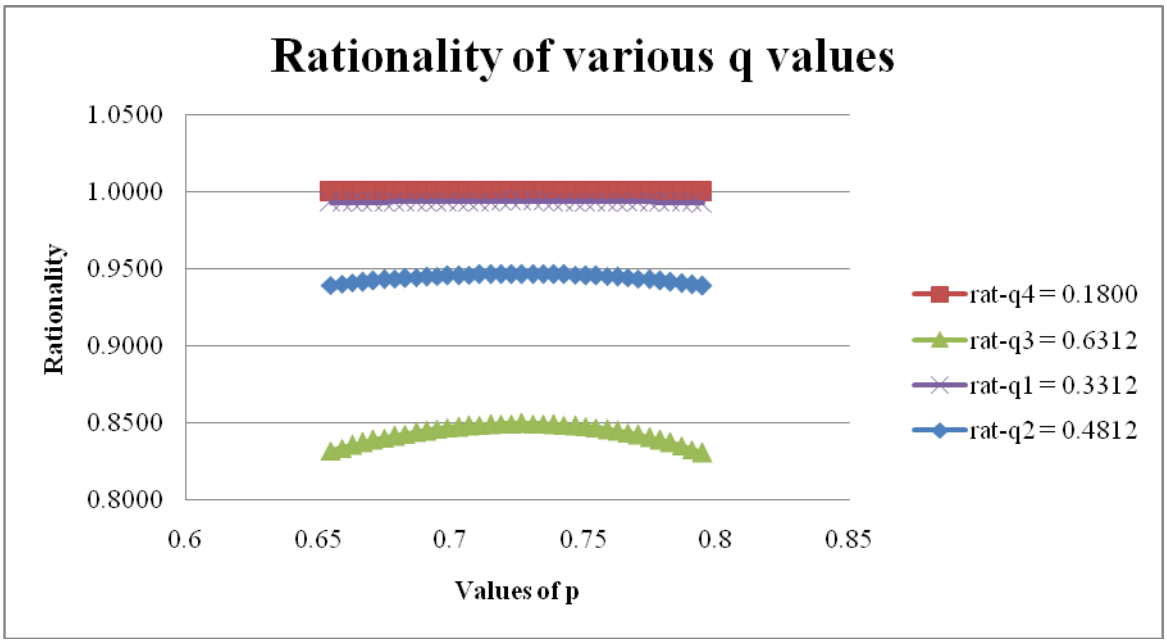


Figure 4.8: Rationality of various q values over range 0.6547 ≤ p≤ 0.7947 values for fixed r = 0.4812, i = 8, and d = 3.

The importance of the principle of minimum guesswork is underscored by figure 4.8 showing that for fixed values of r, i, and d (representing the entire SACCO members) on a fixed range of p, the minimum q value of 0.18 maximizes financial decision making rationality at 0.9999 and also straightens the graph through maximization of entropy. Reduction of q is the singular intervention that economic decision makers need to employ to enhance financial decision making rationality to the ideal position. In summary, for all values of p greater 0.6321 and greater than q, a decision maker can maximize their rationality by reducing their q values only.

Table 4.30: Effect of prospects of wealth increase after a rational decision on financial decision making rationality for members of the separate SACCOs

Unitas Members			Stima Members			Mwalimu N. members		
p	Rat-U	Grad	p	Rat-S	Grad	p	Rat-M	Grad
0.8045	0.9658		0.8043	0.9769		0.8404	0.9855	
0.8085	0.9661	0.0678	0.8083	0.9761	-0.1937	0.8444	0.9851	-0.08657
0.8125	0.9663	0.0582	0.8123	0.9753	-0.2152	0.8484	0.9847	-0.09697
0.8165	0.9665	0.0485	0.8163	0.9743	-0.2391	0.8524	0.9843	-0.10846
0.8205	0.9667	0.0387	0.8203	0.9733	-0.2657	0.8564	0.9838	-0.12122
0.8245	0.9668	0.0286	0.8243	0.9721	-0.2954	0.8604	0.9833	-0.13544
0.8285	0.9669	0.0183	0.8283	0.9708	-0.3288	0.8644	0.9827	-0.15138
0.8325	0.9669	0.0077	0.8323	0.9693	-0.3664	0.8684	0.9820	-0.16933
0.8365	0.9669	-0.0033	0.8363	0.9677	-0.4089	0.8724	0.9812	-0.18964
0.8405	0.9668	-0.0147	0.8403	0.9658	-0.4571	0.8764	0.9804	-0.21274
0.8445	0.9667	-0.0267	0.8443	0.9638	-0.5121	0.8804	0.9794	-0.23914
0.8485	0.9666	-0.0392	0.8483	0.9615	-0.5750	0.8844	0.9784	-0.2695
0.8525	0.9663	-0.0526	0.8523	0.9589	-0.6472	0.8884	0.9771	-0.30459
0.8565	0.9661	-0.0667	0.8563	0.9560	-0.7305	0.8924	0.9758	-0.34539
0.8605	0.9657	-0.0819	0.8603	0.9527	-0.8269	0.8964	0.9742	-0.39313

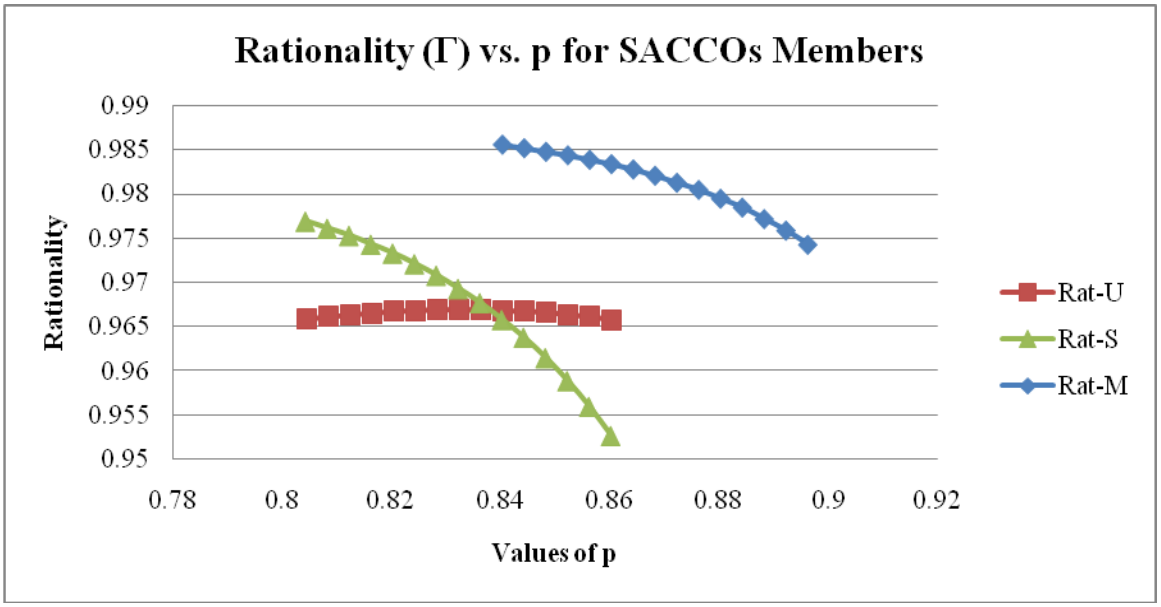


Figure 4.9: Prospects of wealth increase after a rational decision and financial decision making rationality for members in the separate SACCOs

Unitas SACCO members have just gotten to the pinnacle of their rationality journey at 96.69%. Their q value is very high at 60% (table 4.30). Unless they at individual level resolve to reduce it now that their age is 38.4, just a little lower than the average SACCO members' age. Nevertheless, they make few financial mistakes hence will take a longer time before getting beaten by the anticlimax. Continued increase in p value will reduce its financial decision making rationality.

Comparative to Unitas SACCO members, Stima SACCO members' rationality curve is flatter owing to a low q value. A low q value is more important than high entropy. It maintains rationality levels high more consistently, underscoring the principle of minimum guesswork. Like all other groups, Mwalimu National SACCO members are operating on a rationality anticlimax. The highest rationality level being 98.74% achieved quite a while back. But again by reason of a low q value (46.68%), the group has maintained a very low rate of rationality loss of 16.93% as of 2015.

Unfortunately, the last five iterations show that the rate of rationality loss is increasing (from 12.12% to 18.96%), prompting the need for an intervention. Of all the groups, Unitas SACCO management is the only one on a rise at a rationality level of 89.57% (table 4.31). It can still increase it to 91.14% which is the lowest upper bound for all the groups. The reason is that this is the group with the lowest entropy; so that the principle of maximum entropy (Jaynes, 1957) is working for the group. But it still has a high q value at 55.92% which makes it quickly reach the upper bound. The only way is to reduce q afterwards to increase the upper bound. Stima SACCO management enjoys the highest entropy level at 56%. Yet, though there is a high correlation with its financial performance, it does not enjoy the highest rationality level (93.61% compared to others in the range of 94% to 96%. The reason is that its q value is fairly high at 56.13%. what maintains its entropy is its very high p value at 93.65%.

There are four aspects here that need restatement for at most clarity: first, fiinancial/economic benefits out of rational decisions **(p),** secondly, financial/economic losses out of rational decisions **(1-p),** thirdly, financial/economic benefits out of

irrational decisions; and **(q),** financial/ economic losses out of irrational decisions **(1-q).** It may be noted that **p** and **q** are two out of the three independent variables in the conceptual framework effectively representing all the four aspects, and that the principle of minimum guesswork advanced by this thesis alludes to minimizing **q** value. As long as individuals or managements do not endeavour to minimises q value, however much training administered to them to maximize financial/economic successes out of rational decisions, their rationality levels will still decline. For every unit of p value increased, 1.025 units of rationality are lost by Mwalimu National SACCO management (table 4.31).

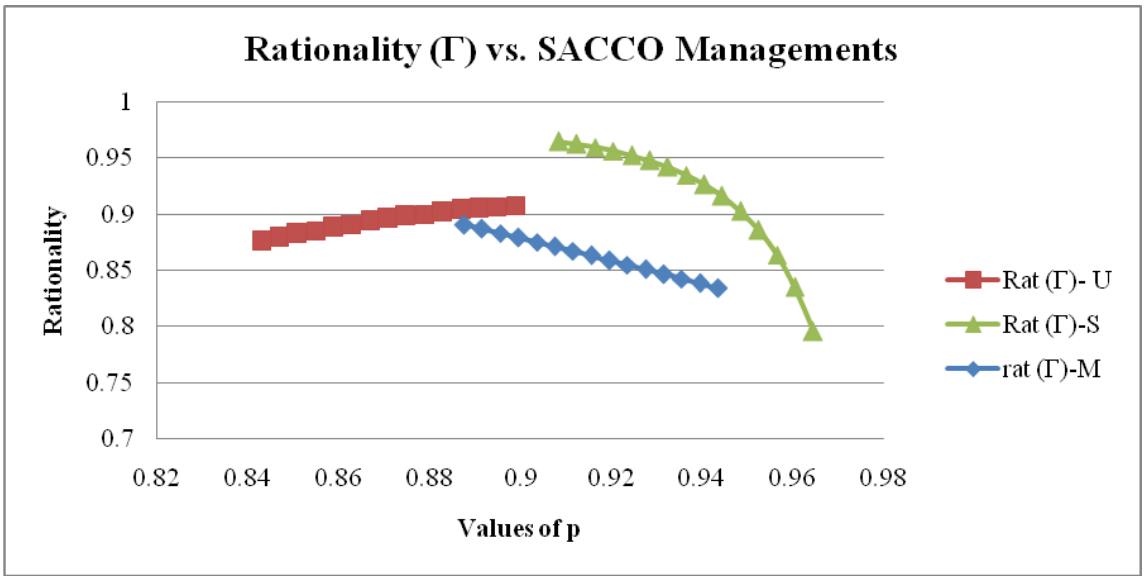


Figure 4.10: Prospects of wealth increase after a rational decision and financial decision making rationality for the separate SACCO managements

Table 4.31: Effect of prospects of wealth increase after a rational decision on financial decision making rationality for the separate SACCO managements

Unitas Mgt			Stima Mgt			Mwalimu N. Mgt		
p	**Rat (Γ)-**	**Grad**	**p**	**Rat**	**Grad**	**p**	**rat (Γ)-**	**Grad**
0.8429	0.8759		0.9085	0.9646		0.8876	0.8905	
0.8469	0.8793	0.8330	0.9125	0.9622	-0.6011	0.8916	0.8867	-0.95
0.8509	0.8824	0.7890	0.9165	0.9594	-0.7040	0.8956	0.8829	-0.95
0.8549	0.8854	0.7461	0.9205	0.9561	-0.8291	0.8996	0.879	-0.975
0.8589	0.8882	0.7042	0.9245	0.9521	-0.9830	0.9036	0.8751	-0.975
0.8629	0.8909	0.6631	0.9285	0.9474	-1.1743	0.9076	0.8711	-1
0.8669	0.8934	0.6229	0.9325	0.9418	-1.4147	0.9116	0.8671	-1
0.8709	0.8957	0.5832	0.9365	0.9349	-1.7207	0.9156	0.863	-1.025
0.8749	0.8979	0.5441	0.9405	0.9264	-2.1152	0.9196	0.8589	-1.025
0.8789	0.8999	0.5054	0.9445	0.9159	-2.6309	0.9236	0.8548	-1.025
0.8829	0.9018	0.4668	0.9485	0.9026	-3.3152	0.9276	0.8507	-1.025
0.8869	0.9035	0.4282	0.9525	0.8857	-4.2367	0.9316	0.8466	-1.025
0.8909	0.9050	0.3894	0.9565	0.8637	-5.4960	0.9356	0.8424	-1.05
0.8949	0.9064	0.3502	0.9605	0.8348	-7.2400	0.9396	0.8382	-1.05
0.8989	0.9077	0.3102	0.9645	0.7960	-9.6781	0.9436	0.8341	-1.025

This is a worrying trend, given that this management has been bestowed with managing the highest asset values of over 16 billion Kenya shillings as of year 2015. An urgent and drastic intervention is required to restore rationality values on an increasing trend like Unitas SACCO by affecting p values.

4.4.5Combined effect of independent variables on financial decision making rationality

Combining the three independent variables to evaluate their effect on the dependent variable results in a discrete functional relationship of the following nature:

$$\Gamma = \frac{rp^a(1-p)^b}{rp^a(1-p)^b + (1-r)q^a(1-q)^b} \quad \text{..... (4.7); where } \Gamma$$

is financial decision making rationality, r is prior knowledge, p is prospects of wealth increase after a rational decision, q is prospects of wealth increase after an irrational financial decision and a, b are constants. Since there are three variables, each of which may increase or decrease, there are $2^3 = 8$ ways of evaluating their effect on financial

decision making rationality. An examination of the overall SACCO function yields the results in table 4.32.

Table 4.32: Combined effect of r, q and p on financial decision making rationality for the entire group of SACCO members

Case 1: When r increases				Case 2: When r decreases			
Rat p,	**Rat p-**	**Rat q-**	**Rat q,**	**Rat p,**	**Rat p-**	**Rat q**	**Rat q,**
0.9534	0.9469	0.9177	0.9066	0.9677	0.9630	0.9066	0.9341
0.9522	0.9465	0.9221	0.9132	0.9650	0.9608	0.9132	0.9357
0.9510	0.9462	0.9263	0.9193	0.9621	0.9584	0.9193	0.9372
0.9497	0.9459	0.9303	0.9251	0.9591	0.9559	0.9251	0.9387
0.9484	0.9455	0.9341	0.9304	0.9558	0.9533	0.9304	0.9402
0.9471	0.9452	0.9377	0.9354	0.9523	0.9505	0.9354	0.9416
0.9458	0.9448	0.9412	0.9401	0.9485	0.9475	0.9401	0.9431
0.9444	0.9444	0.9444	0.9444	0.9444	0.9444	0.9444	0.9444
0.9431	0.9441	0.9475	0.9485	0.9401	0.9412	0.9485	0.9458
0.9416	0.9437	0.9505	0.9523	0.9354	0.9377	0.9523	0.9471
0.9402	0.9434	0.9533	0.9558	0.9304	0.9341	0.9558	0.9484
0.9387	0.9431	0.9559	0.9591	0.9251	0.9303	0.9591	0.9497
0.9372	0.9427	0.9584	0.9621	0.9193	0.9263	0.9621	0.9510
0.9357	0.9424	0.9608	0.9650	0.9132	0.9221	0.9650	0.9522
0.9341	0.9422	0.9630	0.9677	0.9066	0.9177	0.9677	0.9534

Table 4.32 was constructed by extrapolating below and above the current status point of the SACCO members' seven intervals above and below. Every interval is 0.004 units. The current point corresponds to 8 on the horizontal axis; the reason why it looks like the convergence point. From figure 4.10, it can be inferred that the economic decision maker can only increases their financial decision making rationality by reducing both p and q at best or reducing q. any other option results in a decrease in their rationality. A similar case emerges when r is decreasing, only that the increase will be at a very low rate. In general, human resource practitioners should envisage assisting economic agents to reduce their p and q values. The maximum entropy principle applies for $0.6321 \leq p \leq 0.7267$; but reduction in q from 0.4812 to 0.3312 raises rationality upper bound from 0.9468 to 0.9940. Increasing q from 0.4812 to 0.6312 drops the rationality upper bound from 0.9468 to 0.8497, twice the margin had q reduced. This underscores the principle

of minimum guesswork as superior to the principle of maximum entropy. **Critical q value is 0.18**.

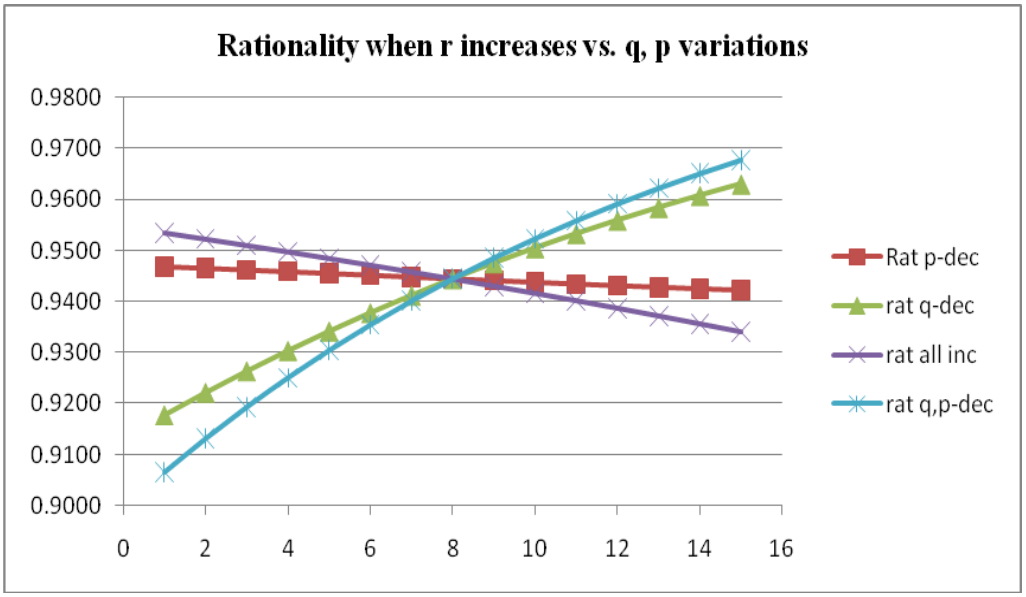


Figure 4.11: Financial decision making rationality when r increases vs. q, p variations

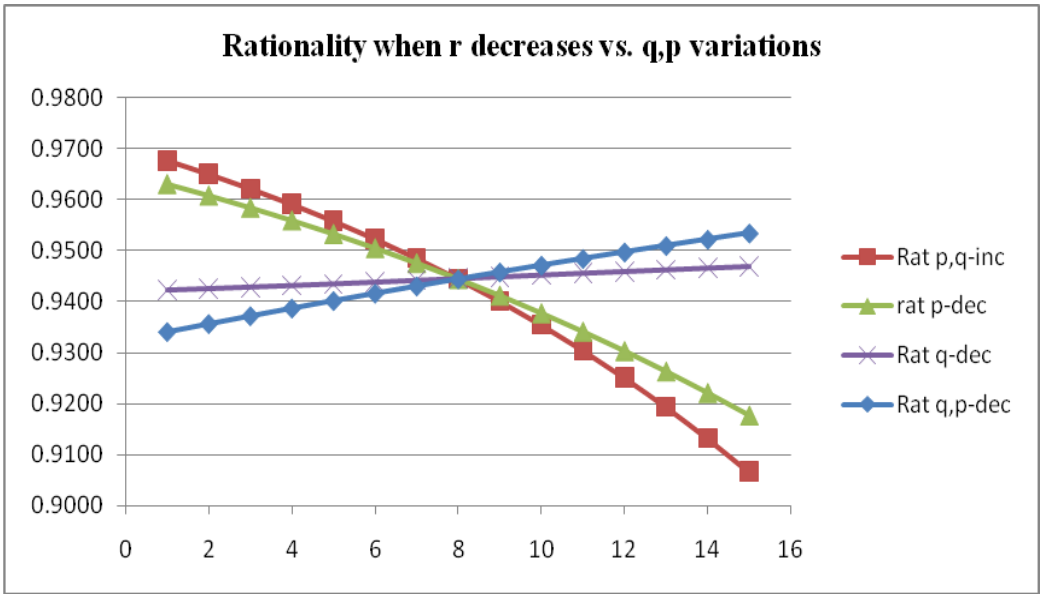


Figure 4.12: Financial decision making rationality when r decreases vs. q, p variations

4.4.6 Hypothesis test of rationality for 95% confidence interval for the intervening effect of wealth movement on the other determinants of financial decision making rationality Γ (Objective four)

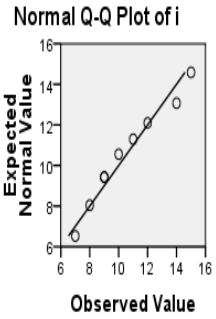
This is the ultimate section that complements all previous analysis. Bayes theorem for purposes of this research thesis is a single period model. However, economic agents make decisions at intervals throughout their life, necessitating the use of a multi-period Bayes model developed in chapter three and represented by equation 3.18. Other than this section just dealing with the update rate represented by i and d, it ventured into interactive effects between all independent variables and the dependent variable. Specifically, the section deals with four issues. First, the primary bit of showing the intervening effect of wealth movement on other determinants through hypothesis testing. Secondly, it establishes the actual rationality path (permutation) by constructing wealth diffusion sample paths using R. This also established the updating consistency rate cited in chapter 3 equation 3.25. Third, it generates the discrete time rationality paths for both the 10 year data period and 10 year forecasts as exemplified by figure 3.2, which has been presented in graphs and tables. Lastly, an Ito-Bayesian rationality diffusion algorithm is constructed for purposes of forecasting rationality in continuous time and which is also presented in graphical form. The overall functional relation is here invoked, where all variables are subject to change as represented by equation 4.8.

$$\Gamma = \frac{rp^{i}(1-p)^{d}}{rp^{i}(1-p)^{d} + (1-r)q^{i}(1-q)^{d}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4.8)$$

Here, it needs to be shown that at 95% confidence level, the actual multi-period model comprising 8 increases and 3 does affect the dependent variable in the single period model. A single period model may comprise an increase or a decrease.

Table 4.33: Effect of updating rate on rationality when p, q and r remain constant

r	q	p	entropy	i	d	Rat
0.8182	0.4812	0.7667	0.1905	8	3	0.9444
0.8182	0.4812	0.7667	0.1905	1	0	0.8776
0.8182	0.4812	0.7667	0.1905	0	1	0.6693



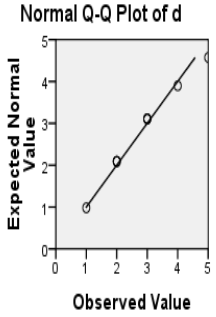


Figure 4.13: Normality test for i; **Figure 4.14: Normality test for d**

Though the mean integral value for i is 8, but the arithmetic mean for the 9 SACCO groups is 10.56 with a standard deviation of 2.698 and is normal according to figure 4.13, while that of d becomes 2.778 with a standard deviation of 1.202 and also normal as per figure 4.14, the 95% confidence interval using t-distribution is 10.56 + or – (2.698*2.306/3)*1.96. That is 14.625 and 6.495. From table 4.33, it is clear that taking a value i out of the interval higher or lower say 15 and 6 yields rationality values out of the range. Similarly, it can be shown that rationality is a monotone function of i. as in previous sections. When d is the variable, a 95% confidence interval yields 2.778 + or – 1.96*1.202*2.306/3 giving 4.589 and 0.967. For purposes of this hypothesis, the condition of i and d, taking positive integral values is momentarily lifted, so that i and d take any values in the real line. Mean and standard deviations have been calculated from the 9 SACCO groups under consideration; as the value of n shown in table 4.34.

Table 4.34: Effect of changes in i and d on rationality

r	q	p	entropy	i	d	Rat
0.8182	0.481	0.767	0.1905	10.56	2.778	0.9853
0.8182	0.481	0.767	0.1905	14.63	2.778	0.9978
0.8182	0.481	0.767	0.1905	6.495	2.778	0.9097
0.8182	0.481	0.767	0.1905	15	2.778	0.9981
0.8182	0.481	0.767	0.1905	6	2.778	0.8888
0.8182	0.481	0.767	0.1905	10.56	2.778	0.9853
0.8182	0.481	0.767	0.1905	10.56	4.589	0.9402
0.8182	0.481	0.767	0.1905	10.56	0.967	0.9965
0.8182	0.481	0.767	0.1905	10.56	5	0.9189
0.8182	0.481	0.767	0.1905	10.56	0.5	0.9976

This means that there is a significant intervening effect of update rate on other determinants of rationality. The null hypothesis is rejected and the alternate hypothesis is accepted. Effectively, objective four has been achieved. Ordinarily, economic agents make financial decisions to maximize their wealth. They do not envisage a situation where there business enterprises make losses. Had loss making been their primary motivation, they would not engage in business. Most Unitas SACCO members fall in this class. Likewise employed economic agents make money and derive their livelihoods from offering services to individuals and corporates. This class includes medical doctors, judges SACCO employees and more importantly, teachers and Kenya Power employees who were the key unit of observation and analysis in this research study.

They pursued academic excellence and training in anticipation of securing jobs to maximize their wealth through employment. Nevertheless, economic agents face challenges in life that lead to suboptimal financial performance ranging from competition to sickness to irrational financial decisions to firm specific factors. Cognizant of the fact that all factor inputs are driven by human resources who are inadequate at times, this accounts for the decreases (d) seen in all the columns of the tables in preceding sections. Had there been no mistakes, we would observe only increases reducing the Bayesian rationality equation 3.18 to:

$$\Gamma = \frac{rp^i}{rp^i + (1-r)\,\mathrm{q}^i} \quad \text{..... (4.9)}$$

Definitely, this is unrealistic. In this section, two questions are pertinent. First, having determined that a certain SACCO group requires 8 increases and 3 decreases in wealth to attain the rationality level disclosed by respondents, what is the specific permutation of the increases and decreases, that is, what specific path was followed in the process? Secondly, did the economic agent make exactly 11 decisions 8 of which led to wealth increases and 3 that led to wealth decreases or were there more than 11 decisions made during the period under consideration? It is important to clarify that it is not realistic for an economic agent to make only 11 financial decisions in 10 years! Rather what 11 decisions mean is that from a preceding level of internalization of financial decision making patterns, the agent updated 11 times. That means that many other decisions might and must have been taken but the process of making reference to previous learning never took place. Jones (1999), laments that humans are Bayesian incomplete.

This means that humans do not consistently update learning. Sometimes they do and sometimes they do not for the same two reasons cited by Herbert Simon (1996) in bounded rationality theory as is evident in all rationality graphs in the previous sections. One that they are unable to solicit all information pertinent to a decision and secondly, that they are cognitively limited in data processing. For purposes of this study, decisions made with reference to previous learning will be referred to as **updating decision points;** and decisions made without reference to previous learning will be referred to as **ordinary decision points.** To navigate the two concerns in this section, the aid of an Ito process from geometric Brownian motion model is required. An Ito process is represented by equation 2.3 restated as follows:

$$\Delta W = \mu W \Delta t + \sigma W \varepsilon \sqrt{\Delta t} \quad \text{..... (4.10)},$$ where W, ΔW, μ, σ, Δt and ϵ, represent Wealth, change in wealth, rate of change in wealth, volatility in the change in wealth and a normally distributed random variable (0,1)

respectively. This means simulation will be done to determine possible diffusion sample paths. Wt in equation 4.6 is simulated with R.

$$W_t = W_{t-1} + \Delta W_t \quad \text{..... (4.11)}$$

$$\Delta\Gamma = \mu\Gamma\Delta t + \sigma\Gamma\varepsilon\sqrt{\Delta t} \quad \text{..... (4.12)}$$

$$\Delta\frac{1}{\lambda} = \mu\frac{1}{\lambda}\Delta t + \sigma\frac{1}{\lambda}\varepsilon\sqrt{\Delta t} \quad \text{..... (4.13)}$$

4.4.7 Solubility of stochastic differential equations

In general, it is difficult to find antiderivatives of most ordinary differential equations through Newtonian integral calculus. This leads to the use of numerical methods for such solutions. More difficult to find are solutions of stochastic differential equations of the form of equation 4.5. The complication here is that first, the solution may not exist at all and second, that the solution may not be unique (Klebaner, 2012). The choice of equation 4.5 is justified by the fact that its solution both exists and is unique. This equation is used to predict stock prices and their derivatives. The equation and its variation will be used to determine the possible permutation of wealth increases and decreases by developing diffusion sample paths for wealth and also to construct an Ito-Bayesian rationality diffusion algorithm to forecast rationality in continuous time using the open source R statistical package version 3.2.0 (2015). The general solution for an Ito process equation 4.5 is:

$$Wt = Wo\exp\{(\mu - \frac{1}{2}\sigma^2)t + Bt\} \quad \text{..... (4.14)}$$

This equation works perfectly for the wealth variable but not for rationality! Two reasons for this are that one, rationality of individuals tend to stabilize with age. For this reason, the raggedness of the rationality diffusion should decrease with age.

Two, while wealth is an unbounded variable, rationality of humans is bounded. The other two assumptions of Markov property and normality of volatility are similar for both Ito-Bayesian and wealth processes. For the said reason, it is imperative that the

general Ito process is converted into an Ito-Bayesian process to respond to the two points of difference. This is done by taking the reciprocal of rationality as in equation 4.8 so that lower rationality levels impact more volatility than higher ones. Then when plotting, the reciprocal is taken. This process necessitates that the drift becomes negative. To introduce boundedness, plotting is done of $1-1/\lambda$ against time so a graph such as equation 4.13 is obtained. From equation 4.11, it can be inferred that wealth volatility increases with wealth; such that at higher wealth levels display more ragged graphs than lower wealth levels. Table 4.35 summarizes the ingredients for the process deriving from table B in the appendix.

Table 4.35: Update rate, drift, volatility and initial wealth with prior SACCO group properties

Sacco Group	r	q	p	entropy	i	d	Rat	Rat bounds	Drift	Sd	W_o Sh'000
Sacco Overall	0.8182	0.4812	0.7667	0.1905	8	3	0.9444	**0.9468**	0.2508	0.3941	292.7
Females	0.8142	0.5027	0.7678	0.1658	7	2	0.9488	**0.9488**	0.2735	0.4047	285.2
Males	0.8211	0.4648	0.7658	0.2102	9	4	0.9377	**0.9476**	0.2335	0.3518	301.7
Unitas											
Members	0.8576	0.5962	0.8325	0.1563	10	2	0.9669	**0.9669**	0.2889	0.4604	140
Unitas Mgt	0.5592	0.6904	0.8709	0.1105	12	1	0.8957	**0.9114**	0.2735	0.0903	827,386
Stima											
Members	0.88	0.5121	0.8323	0.2723	14	5	0.9693	**0.982**	0.2814	0.2579	320
Stima Mgt	0.6866	0.5613	0.9365	0.5606	15	3	0.9349	**0.9783**	0.3208	0.2304	23,209
M. N.											
Members	0.7971	0.4668	0.8684	0.4562	11	3	0.982	**0.9874**	0.1505	0.233	350
M. N.Mgt	0.8173	0.6376	0.9156	0.2974	9	2	0.863	**0.914**	0.154	0.1646	8,073,526

Table 4.35 interpretation:

Through iteration procedure, 8 wealth increases and 3 wealth decreases are required to raise rationality level from 87.23% in 2005 to 96.9% in 2015. To derive the 8 increases and 3 decreases using a simulation procedure that utilizes geometric Brownian motion model (figure 4.15), 18 wealth increases and 3wealth decreases were obtained. It is noteworthy that fewer intervals yield lower decreases than 3. This means that in the ten year interval 8 increases and 3 decreases amounted to updating decision points; the balance of 7 increases are interpreted as decision points where no updating had occurred, that is, there had been no reference to previous learning. Since any of these diffusions is not unique, a representative diffusion must fulfill two conditions: one is that it must post the exact number of wealth decreases required and secondly, the final wealth level must be within the 95% confidence interval (using table B). All SACCO groups record more decision points than updating points. This is in line with the principle of base neglect (Manktelow, 2012), whereby human economic agents fail to refer to previous lessons learnt to help them make a more quality decision than the immediate past decision. Equivalently, it means that these are decision points where no rationalization of the decision concerned had been made, so they were irrational decisions that turned out to be beneficial. So, 7 increases within the wealth diffusion curve (figure 4.15) were ignored, so that they only were ordinary decision points. This records an update consistency rate of (18-7)/18 = 61.11%.

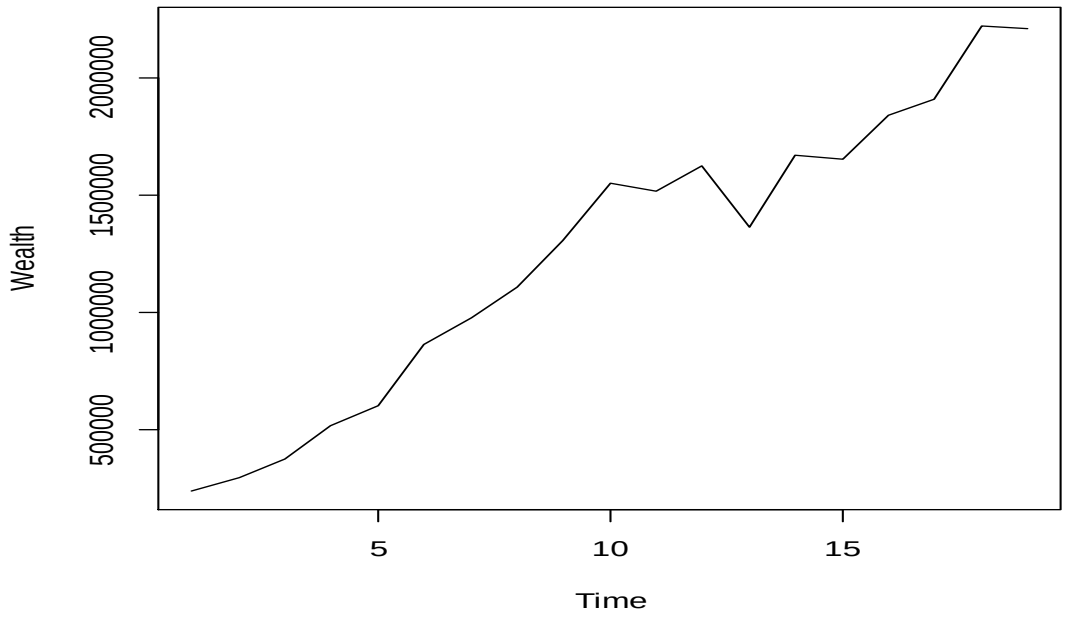


Figure 4.15: Wealth diffusion sample path for the entire SACCO members' fraternity

All other subsequent diffusion tables were interpreted likewise. Further, it may be noted that even wealth decreases may turn out to be ordinary decision points. This would mean that when an economic agent loses they will have ignored previous learning in a subsequent decision while ignoring increases means that an economic agent will have ignored previous learning by way of getting excited over earnings or treating them as wind falls. Psychology recons that of the four basic emotions of human beings: joy (happiness), anger, sadness and fear, presence of each of them in an individual generates irrational, irrational, rational and rational decisions respectively (Bechara, Damasio and Damasio, 1997).

Table 4.36: Discrete time rationality values from wealth diffusion sample path for the entire SACCO fraternity including forecasts highlighted from year 2016 to 2025

r	q	p	entropy	i	d	Rat	year	UCR	Age
0.8723	0.452	0.7785	0.2507	1	0	0.9217	2005	61.11%	29.36
0.9217	0.4578	0.7761	0.2379	1	0	0.9523			
0.9523	0.4636	0.7737	0.2255	1	0	0.9708			
0.9708	0.4694	0.7713	0.2134	0	1	0.9348			
0.9348	0.4752	0.7689	0.2017	1	0	0.9587			
0.9587	0.481	0.7665	0.1904	1	0	0.9737			
0.9737	0.4868	0.7641	0.1794	1	0	0.9831			
0.9831	0.4926	0.7617	0.1688	1	0	0.989			
0.989	0.4984	0.7593	0.1585	0	1	0.9773			
0.9773	0.5042	0.7569	0.1485	0	1	0.9548			
0.9548	0.51	0.7545	0.1389	1	0	**0.969**	2015		39.36
0.969	0.5158	0.7521	0.1296	1	0	0.9785	2016		40.36
0.9785	0.5216	0.7497	0.1207	1	0	0.985			
0.985	0.5274	0.7473	0.1121	1	0	0.9893			
0.9893	0.5332	0.7449	0.1038	0	1	0.9807			
0.9807	0.539	0.7425	0.0958	1	0	0.9859			
0.9859	0.5448	0.7401	0.0882	1	0	0.9896			
0.9896	0.5506	0.7377	0.0809	1	0	0.9922			
0.9922	0.5564	0.7353	0.0739	1	0	0.9941			
0.9941	0.5622	0.7329	0.0673	0	1	0.9903			
0.9903	0.568	0.7305	0.0609	0	1	0.9846			
0.9846	0.5738	0.7281	0.0549	1	0	**0.988**	2025		49.36

This means that a SACCO member in Kenya is on average, just about 61.11% rational – that only 61 financial decisions out of every 100 decisions they make are rationalized and 39 are processed through irrational means which includes the use of heuristics. Finally, by maintaining the rate of change of p and q values for the next ten years, retaining the same permutation of wealth increases and decreases, and updating every time yields a rationality level of 98.78% on the decisions actually rationalized by the year 2025.

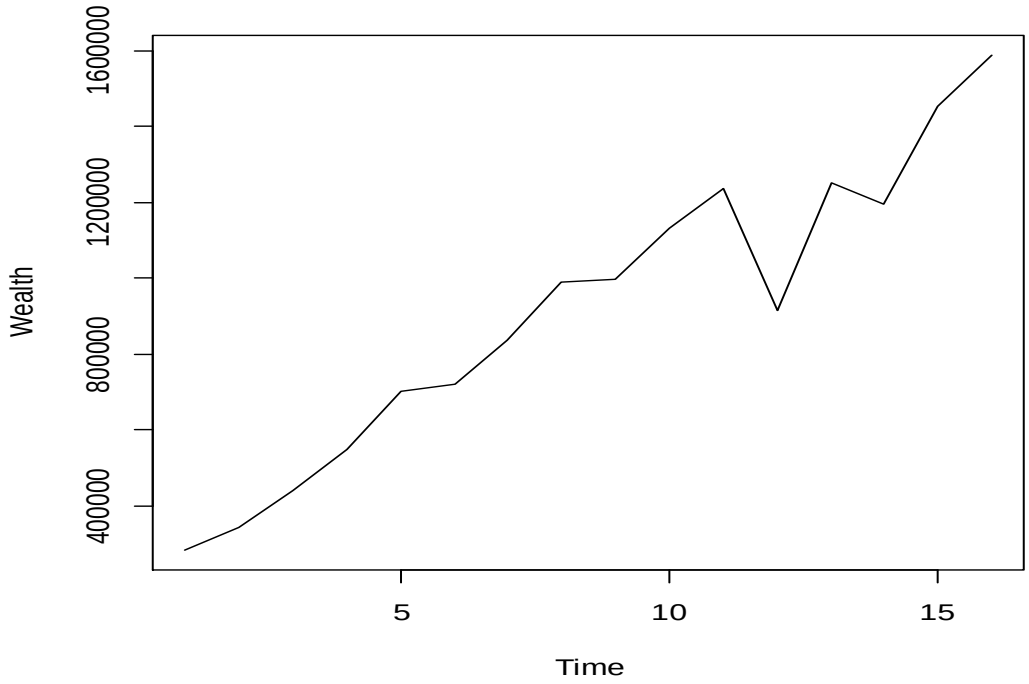


Figure 4.16: Wealth diffusion sample path for the female SACCO members

Female SACCO members managed to update 9 times where 7 of the times were recorded wealth increases and 2 of them were wealth decreases. The minimum decision points generated by simulation for the group were 15. This means that 6 of the 15 decisions taken during the 10 year period were ordinary decision points. This translates to an updating consistency rate of 60% (9/15*100). Interpreted differently, it means that 40% of decisions taken by female SACCO members are not rationalized. It may safely be assumed that these decisions are processed through heuristics method which is not considered rational for purposes of this research.

Table 4.37: Discrete time rationality values from wealth diffusion sample path of female members including forecasts highlighted from year 2016 to year 2025

r	q	p	entropy	i	d	Rat	year	UCR	Age
0.8142	0.5242	0.7802	0.1654	1	0	0.8682	2005	60%	29.88
0.8682	0.5188	0.7771	0.1671	1	0	0.9089			
0.9089	0.5134	0.774	0.1688	1	0	0.9383			
0.9383	0.508	0.7709	0.1642	1	0	0.9589			
0.9589	0.5026	0.7678	0.1659	1	0	0.9730			
0.973	0.4972	0.7647	0.1678	0	1	0.9434			
0.9434	0.4918	0.7616	0.1696	1	0	0.9631			
0.9631	0.4864	0.7585	0.1714	1	0	0.9763			
0.9763	0.481	0.7554	0.1733	0	1	**0.9510**	2015		39.88
0.951	0.4756	0.7523	0.1752	1	0	0.9684	2016		40.88
0.9684	0.4702	0.7492	0.1772	1	0	0.9800			
0.98	0.4648	0.7461	0.1791	1	0	0.9874			
0.9874	0.4594	0.743	0.1811	1	0	0.9922			
0.9922	0.454	0.7399	0.1831	1	0	0.9952			
0.9952	0.4486	0.7368	0.1852	0	1	0.9900			
0.99	0.4432	0.7337	0.1873	1	0	0.9939			
0.9939	0.4378	0.7306	0.1894	1	0	0.9963			
0.9963	0.4324	0.7275	0.1915	0	1	**0.9924**	2025		49.88

Female SACCO members are more consistent with age than their male counterparts.

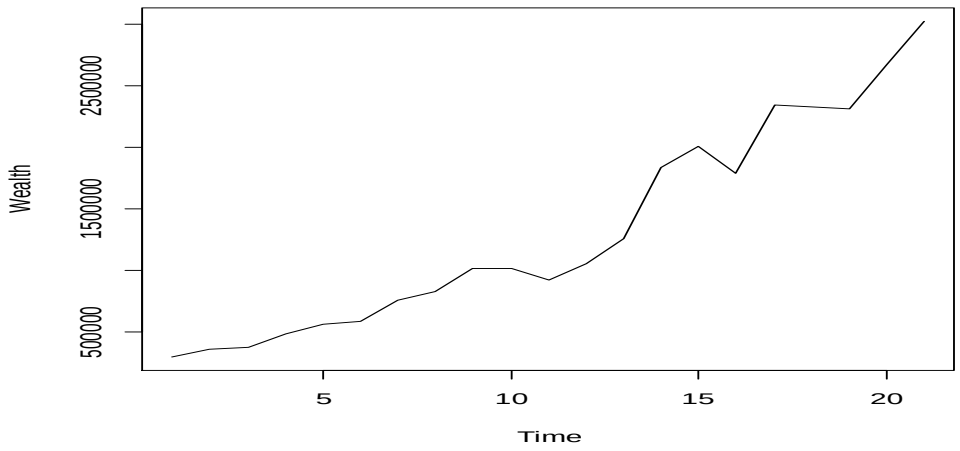


Figure 4.17: Wealth diffusion sample path for the male SACCO members

Table 4.38: Discrete time rationality values from wealth diffusion sample path of male members including forecasts highlighted from year 2016 to year 2025

r	q	p	entropy	i	d	Rat	Year	UCR	Age
0.8211	0.3984	0.7771	0.3311	1	0	0.8995	2005	65%	28.92
0.8995	0.4095	0.7752	0.3089	0	1	0.7731			
0.7731	0.4206	0.7733	0.2875	1	0	0.8624			
0.8624	0.4317	0.7714	0.2669	1	0	0.9180			
0.918	0.4428	0.7695	0.2471	1	0	0.9511			
0.9511	0.4539	0.7676	0.2281	1	0	0.9705			
0.9705	0.465	0.7657	0.2098	1	0	0.9819			
0.9819	0.4761	0.7638	0.1923	1	0	0.9886			
0.9886	0.4872	0.7619	0.1756	0	1	0.9758			
0.9758	0.4983	0.76	0.1596	0	1	0.9508			
0.9508	0.5094	0.7581	0.1444	1	0	0.9664			
0.9664	0.5205	0.7562	0.1299	0	1	0.9359			
0.9359	0.5316	0.7543	0.1162	1	0	**0.9540**	2015		38.92
0.954	0.5427	0.7524	0.1033	1	0	0.9664	2016		39.92
0.9664	0.5538	0.7505	0.0911	0	1	0.9414			
0.9414	0.5649	0.7486	0.0796	1	0	0.9552			
0.9552	0.576	0.7467	0.0689	1	0	0.9650			
0.965	0.5871	0.7448	0.059	1	0	0.9722			
0.9722	0.5982	0.7429	0.0498	1	0	0.9775			
0.9775	0.6093	0.741	0.0414	1	0	0.9814			
0.9814	0.6204	0.7391	0.0337	1	0	0.9844			
0.9844	0.6315	0.7372	0.0268	0	1	0.9782			
0.9782	0.6426	0.7353	0.0207	0	1	0.9708			
0.9708	0.6537	0.7334	0.0154	1	0	0.9739			
0.9739	0.6648	0.7315	0.0108	0	1	0.9677			
0.9677	0.6759	0.7296	0.007	1	0	**0.9700**	2025		48.92

A comparative look at the trends of male (table 4.38) and female (table 4.37) members shows that in 2005 female members had a rationality value of 86.82% while that of male members had a value of 89.95%. At the time of this data collection (end of 2015), females had a rationality value of 95.1% while males had a value of 95.4%, almost at par. However, by the 2025 the same group of females will have overtaken their male SACCO members to operate at a rationality level of 99.24% greater than the males value predicted at 97%. Consequently, it is thus advisable for a married couple bearing these characteristics to share more financial decision making with the wife for better decisions from 2015 going forward. This may also apply to family businesses. The active business partner does not have to raise a red flag when losses have been incurred. Such a test

should be administered long before to establish a succession plan scientifically. This trend is attributable to progressive reduction of q value by female members while the opposite is happening in male members. That is the level of guesswork increases with age for men and decreases for women in this group. Unitas SACCO members updated 12 times out of 15 times. This means only three of the times they did not update. Their consistency rate is at80% higher than that of the entire SACCO as well as both genders.

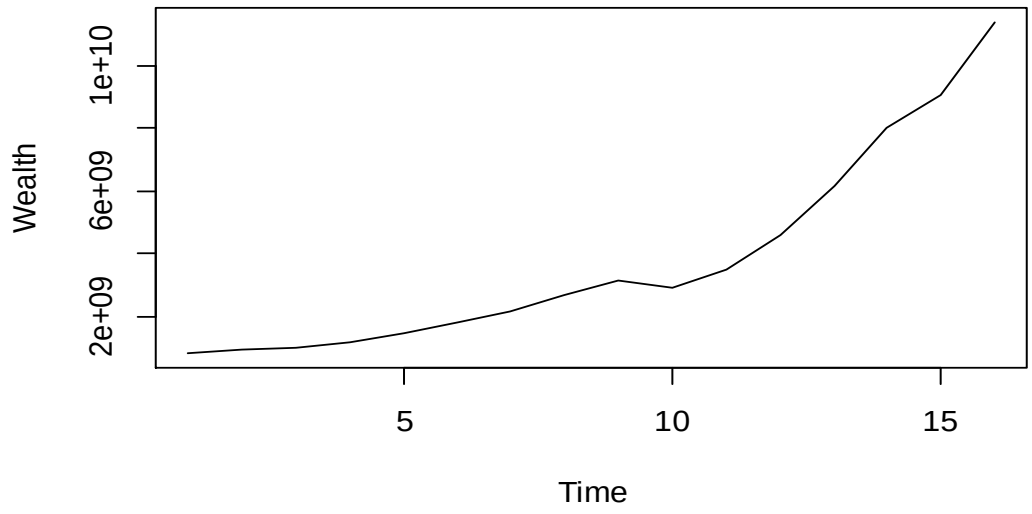


Figure 4.18: Wealth diffusion sample path for Unitas SACCO members

Evidently, the risk profile of Unitas SACCO (table 4.40) is encouraging. It also seems like the staff are sufficiently motivated since their financial rationality level is on the rise, unlike other in SACCOs. Their corporate entropy is also rising. Only two iterations could show a single loss. Surprisingly, in 10 years individual member rationality readings only improved from between 4 to 7 percentage points, while SACCO managements rationality readings improved in upwards of 15 points; specifically 17% for Unitas SACCO management. The reason is that SACCO management rationality is corporate. It is an aggregation of different people at different ages and experiences and learning abilities. Unlike an individual person, SACCO employees can be replaced with

better performing ones – with better entropies, so that the rate of substitution of these employees can be manipulated to enhance corporate rationality.

Table 4.39: Discrete time rationality values from wealth diffusion sample path of Unitas SACCO members including forecasts highlighted from year 2016 to year 2025

r	q	p	entropy	i	d	Rat	Year	UCR	Age
0.8576	0.5686	0.8275	0.1821	1	0	0.8976	2005	80%	28.4
0.8976	0.5736	0.8284	0.1773	1	0	0.9268			
0.9268	0.5786	0.8293	0.1725	1	0	0.9478			
0.9478	0.5836	0.8302	0.1678	1	0	0.9627			
0.9627	0.5886	0.8311	0.1632	1	0	0.9733			
0.9733	0.5936	0.832	0.1586	0	1	0.9378			
0.9378	0.5986	0.8329	0.154	1	0	0.9545			
0.9545	0.6036	0.8338	0.1496	1	0	0.9666			
0.9666	0.6086	0.8347	0.1451	1	0	0.9754			
0.9754	0.6136	0.8356	0.1407	1	0	0.9818			
0.9818	0.6186	0.8365	0.1364	0	1	0.9586			
0.9586	0.6236	0.8374	0.1321	1	0	**0.9689**	2015		38.4
0.9689	0.6286	0.8383	0.1279	1	0	0.9765	2016		39.4
0.9765	0.6336	0.8392	0.1237	1	0	0.9821			
0.9821	0.6386	0.8401	0.1196	1	0	0.9864			
0.9864	0.6436	0.841	0.1155	1	0	0.9895			
0.9895	0.6486	0.8419	0.1115	1	0	0.9919			
0.9919	0.6536	0.8428	0.1075	0	1	0.9824			
0.9824	0.6586	0.8437	0.1036	1	0	0.9862			
0.9862	0.6636	0.8446	0.0998	1	0	0.9891			
0.9891	0.6686	0.8455	0.096	1	0	0.9914			
0.9914	0.6736	0.8464	0.0922	1	0	0.9931			
0.9931	0.6786	0.8473	0.0885	0	1	0.9856			
0.9856	0.6836	0.8482	0.0849	1	0	**0.9884**	2025		49.4

This begets a new concept; **Generational Entropy-qc Substitution Rate (GESR).** It can be argued that if the rate of increase of rationality of a SACCO member is higher than the rate of increase for the SACCO, there is a problem with the GESR of the SACCO.

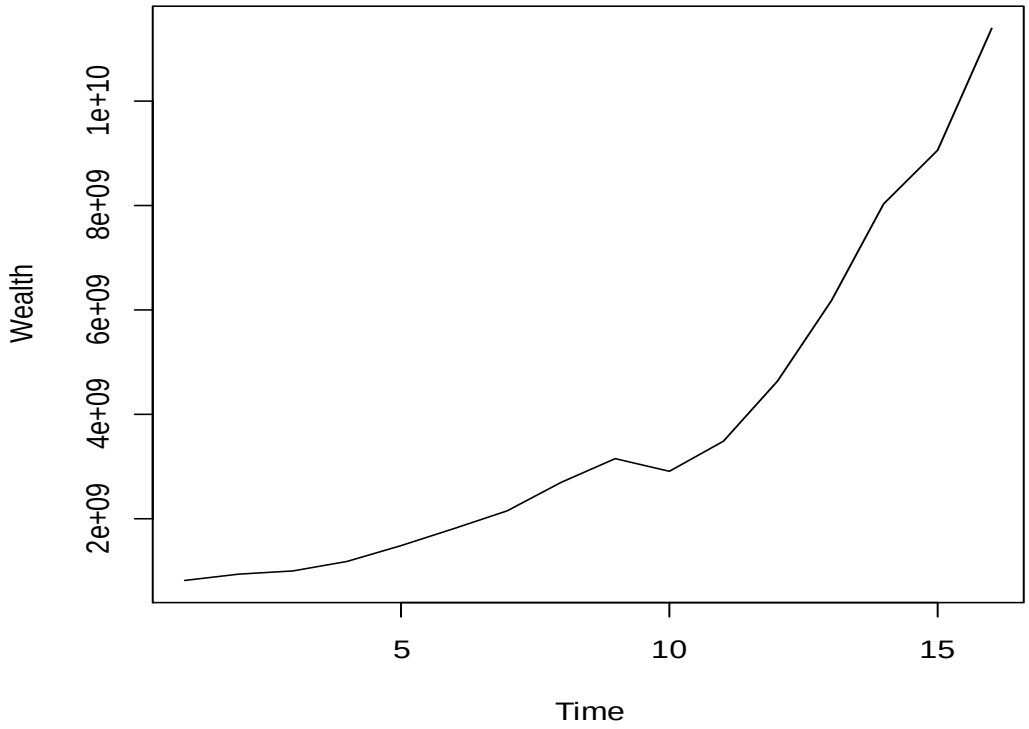


Figure 4.19: Wealth diffusion sample path for Unitas SACCO management

This may escalate the existing agency conflict. Unitas SACCO's Generational Entropy-qc Substitution Rate is impressive. Its update consistency rate is also high at 13/15 (86.7%). A firm's GESR should continually be revised to ensure better financial decision making quality that their members which grows the members wealth. This creates an important metric against which the principal (members) gauges performance of the agent (management).

Table 4.40: Discrete time rationality values from wealth diffusion sample path of Unitas SACCO management including forecasts highlighted from year 2016 to year 2025

r	q	p	entropy	i	d	Rat	Year	UCR
0.5592	0.7171	0.8582	0.0666	1	0	**0.6029**	2005	86.70%
0.6029	0.7127	0.8603	0.073	1	0	0.6470		
0.647	0.7083	0.8624	0.0797	1	0	0.6905		
0.6905	0.7039	0.8645	0.0868	1	0	0.7327		
0.7327	0.6995	0.8666	0.0942	1	0	0.7725		
0.7725	0.6951	0.8687	0.1019	1	0	0.8093		
0.8093	0.6907	0.8708	0.11	1	0	0.8425		
0.8425	0.6863	0.8729	0.1184	1	0	0.8719		
0.8719	0.6819	0.875	0.1271	1	0	0.8972		
0.8972	0.6775	0.8771	0.1362	1	0	0.9187		
0.9187	0.6731	0.8792	0.1456	1	0	0.9366		
0.9366	0.6687	0.8813	0.1555	0	1	0.8410		
0.841	0.6643	0.8834	0.1656	1	0	**0.8755**	2015	
0.8755	0.6599	0.8855	0.1762	1	0	0.9042	2016	
0.9042	0.6555	0.8876	0.1872	1	0	0.9274		
0.9274	0.6511	0.8897	0.1985	1	0	0.9458		
0.9458	0.6467	0.8918	0.2102	1	0	0.9601		
0.9601	0.6423	0.8939	0.2224	1	0	0.9710		
0.971	0.6379	0.896	0.235	1	0	0.9792		
0.9792	0.6335	0.8981	0.248	1	0	0.9852		
0.9852	0.6291	0.9002	0.2615	1	0	0.9896		
0.9896	0.6247	0.9023	0.2754	1	0	0.9928		
0.9928	0.6203	0.9044	0.2898	1	0	0.9951		
0.9951	0.6159	0.9065	0.3047	1	0	0.9966		
0.9966	0.6115	0.9086	0.32	0	1	0.9858		
0.9858	0.6071	0.9107	0.3359	1	0	**0.9905**	2025	

It may be noted from figure 4.20 that 30 intervals were necessary to generate 14 increases, 5 wealth decreases and at 4 simulation runs. Moreover 6 decreases were actually recorded which means that after a member updated their 19 decision points the 11 remaining comprised 1 decrease and 10 increases.

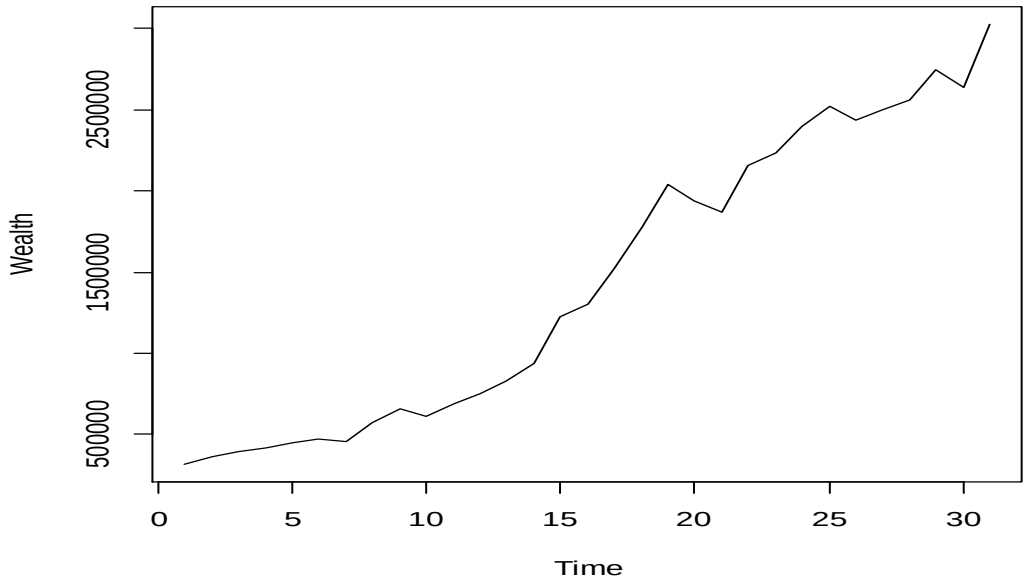


Figure 4.20: Wealth diffusion sample path for Stima SACCO members

A low standard deviation (lower than the drift) prompted the increase in intervals. The update consistency rate is 19/30 (63%). These SACCO members have highly reducing entropy even if they are updating at the highest rate. The effect is that over the next ten years, they are forecasted to increase their rationality level by only 1%. Of all the SACCO groups, Stima members possess the highest decision volume handling ability. This derives from making 30decisions within 10 years. However, this group is also the most irrational as evidenced by the taking of 11 decisions without reference to previous learning (ordinary decision points). If the group would reduce the error rate, it would possess the highest wealth making ability.

Table 4.41: Discrete time rationality values from wealth diffusion sample path of Stima SACCO members including forecasts highlighted from year 2016 to year 2025

r	q	p	entropy	i	d	Rat	Year	UCR	Age
0.88	0.4464	0.8584	0.4629	1	0	0.9338	2005	63.30%	26.8
0.9338	0.4537	0.8555	0.4388	1	0	0.9638			
0.9638	0.461	0.8526	0.4154	1	0	0.9801			
0.9801	0.4683	0.8497	0.3928	1	0	0.9889			
0.9889	0.4756	0.8468	0.3709	1	0	0.9937			
0.9937	0.4829	0.8439	0.3498	1	0	0.9964			
0.9964	0.4902	0.841	0.3294	0	1	0.9886			
0.9886	0.4975	0.8381	0.3097	1	0	0.9932			
0.9932	0.5048	0.8352	0.2907	1	0	0.9959			
0.9959	0.5121	0.8323	0.2723	0	1	0.9881			
0.9881	0.5194	0.8294	0.2547	0	1	0.9672			
0.9672	0.5267	0.8265	0.2377	0	1	0.9152			
0.9152	0.534	0.8236	0.2213	1	0	0.9433			
0.9433	0.5413	0.8207	0.2056	1	0	0.9619			
0.9619	0.5486	0.8178	0.1905	1	0	0.9741			
0.9741	0.5559	0.8149	0.176	1	0	0.9822			
0.9822	0.5632	0.812	0.1622	0	1	0.9596			
0.9596	0.5705	0.8091	0.1489	1	0	0.9712			
0.9712	0.5778	0.8062	0.1363	1	0	**0.979**	2015		36.8
0.9792	0.5851	0.8033	0.1242	1	0	0.9847	2016		37.8
0.9847	0.5924	0.8004	0.1127	1	0	0.9887			
0.9887	0.5997	0.7975	0.1018	1	0	0.9914			
0.9914	0.607	0.7946	0.0915	1	0	0.9935			
0.9935	0.6143	0.7917	0.0818	1	0	0.9949			
0.9949	0.6216	0.7888	0.0726	1	0	0.996			
0.996	0.6289	0.7859	0.064	0	1	0.9931			
0.9931	0.6362	0.783	0.0559	1	0	0.9944			
0.9944	0.6435	0.7801	0.0484	1	0	0.9953			
0.9953	0.6508	0.7772	0.0414	0	1	0.9927			
0.9927	0.6581	0.7743	0.035	0	1	0.989			
0.989	0.6654	0.7714	0.0291	0	1	0.984			
0.984	0.6727	0.7685	0.0238	1	0	0.986			
0.986	0.68	0.7656	0.019	1	0	0.9875			
0.9875	0.6873	0.7627	0.0147	1	0	0.9887			
0.9887	0.6946	0.7598	0.011	1	0	0.9897			
0.9897	0.7019	0.7569	0.0078	0	1	0.9874			
0.9874	0.7092	0.754	0.0052	1	0	0.9881			
0.9881	0.7165	0.7511	0.0031	1	0	**0.989**	2025		47.8

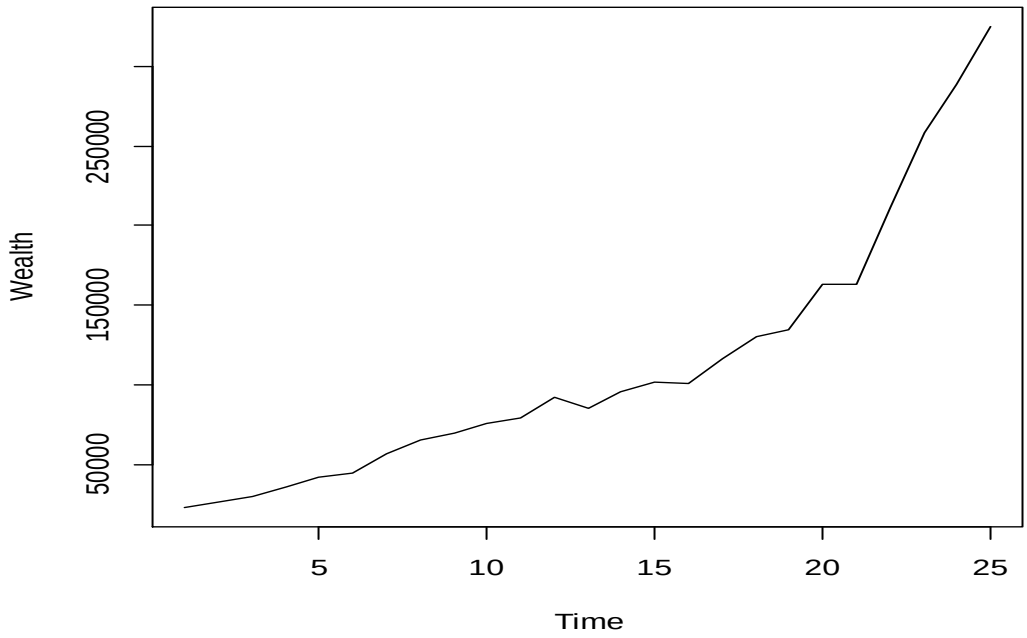


Figure 4.21: Wealth diffusion sample path for Stima SACCO management

The update consistency rate for Stima management is 18/24 (75%) as shown in table 4.42. Again, with its lower volatility than the drift, a lot of wealth creation consistency is observed. This is the SACCO management group with the highest entropy (wealth making potential) as evidence by its decision volume of 24 decisions compared to 15 for both Unitas and Mwalimu National SACCOs. Bearing in mind that Stima SACCO management has the highest drift (32.08%) compared to Mwalimu National (15.4%) and Unitas (27.35%), had members from Unitas and Mwalimu National this information, other factors held constant, there would be migration to Stima SACCO. A deterrent would be the fact that Unitas serves low-end self employed members and hence its business model is not like that of Stima. But Mwalimu National has a similar catchment of members as does Stima. With revision of the common bond requirement in the Cooperatives Act2008, SACCOs are likely to encounter migration of members more frequently. It is envisaged that with this information, SASRA will institute measures that foster stability in the running of these SACCOs to maximize shareholders wealth.

Table 4.42: Discrete time rationality values from wealth diffusion sample path of Stima SACCO management including forecasts highlighted from year 2016 to year 2025

r	q	p	entropy	i	d	Rat	Year	UCR
0.6866	0.5021	0.9319	0.68	1	0	0.8026	2005	75%
0.8026	0.5091	0.9324	0.6652	1	0	0.8816		
0.8816	0.5161	0.9329	0.6505	1	0	0.9308		
0.9308	0.5231	0.9334	0.6359	1	0	0.96		
0.96	0.5301	0.9339	0.6214	1	0	0.9769		
0.9769	0.5371	0.9344	0.6071	1	0	0.9866		
0.9866	0.5441	0.9349	0.5928	0	1	0.9131		
0.9131	0.5511	0.9354	0.5787	1	0	0.9469		
0.9469	0.5581	0.9359	0.5646	1	0	0.9677		
0.9677	0.5651	0.9364	0.5507	0	1	0.814		
0.814	0.5721	0.9369	0.5369	1	0	0.8775		
0.8775	0.5791	0.9374	0.5232	1	0	0.9206		
0.9206	0.5861	0.9379	0.5096	1	0	0.9489		
0.9489	0.5931	0.9384	0.4961	1	0	0.9671		
0.9671	0.6001	0.9389	0.4827	0	1	0.8178		
0.8178	0.6071	0.9394	0.4694	1	0	0.8741		
0.8741	0.6141	0.9399	0.4562	1	0	0.914		
0.914	0.6211	0.9404	0.4432	1	0	**0.941**	2015	
0.9415	0.6281	0.9409	0.4302	1	0	0.9602	2016	
0.9602	0.6351	0.9414	0.4174	1	0	0.9728		
0.9728	0.6421	0.9419	0.4047	1	0	0.9813		
0.9813	0.6491	0.9424	0.3921	1	0	0.987		
0.987	0.6561	0.9429	0.3796	1	0	0.9909		
0.9909	0.6631	0.9434	0.3672	1	0	0.9936		
0.9936	0.6701	0.9439	0.3549	0	1	0.9636		
0.9636	0.6771	0.9444	0.3427	1	0	0.9736		
0.9736	0.6841	0.9449	0.3307	1	0	0.9808		
0.9808	0.6911	0.9454	0.3188	0	1	0.9001		
0.9001	0.6981	0.9459	0.307	1	0	0.9243		
0.9243	0.7051	0.9464	0.2953	1	0	0.9425		
0.9425	0.7121	0.9469	0.2837	1	0	0.9561		
0.9561	0.7191	0.9474	0.2723	1	0	0.9663		
0.9663	0.7261	0.9479	0.261	0	1	0.8452		
0.8452	0.7331	0.9484	0.2498	1	0	0.876		
0.876	0.7401	0.9489	0.2388	1	0	0.9006		
0.9006	0.7471	0.9494	0.2279	1	0	**0.92**	2025	

So far Stima SACCO management is the only group that records reduced rationality forecasts by year 2025 as shown in table 4.42. The greatest undoing here is its high q value. An urgent intervention is required to reverse this trend. Its high entropy value

effect is completely eroded by the high q values. Absence of this intervention may also aggravate existing agency conflict especially because at the moment, their rationality stands 3% lower than their members.

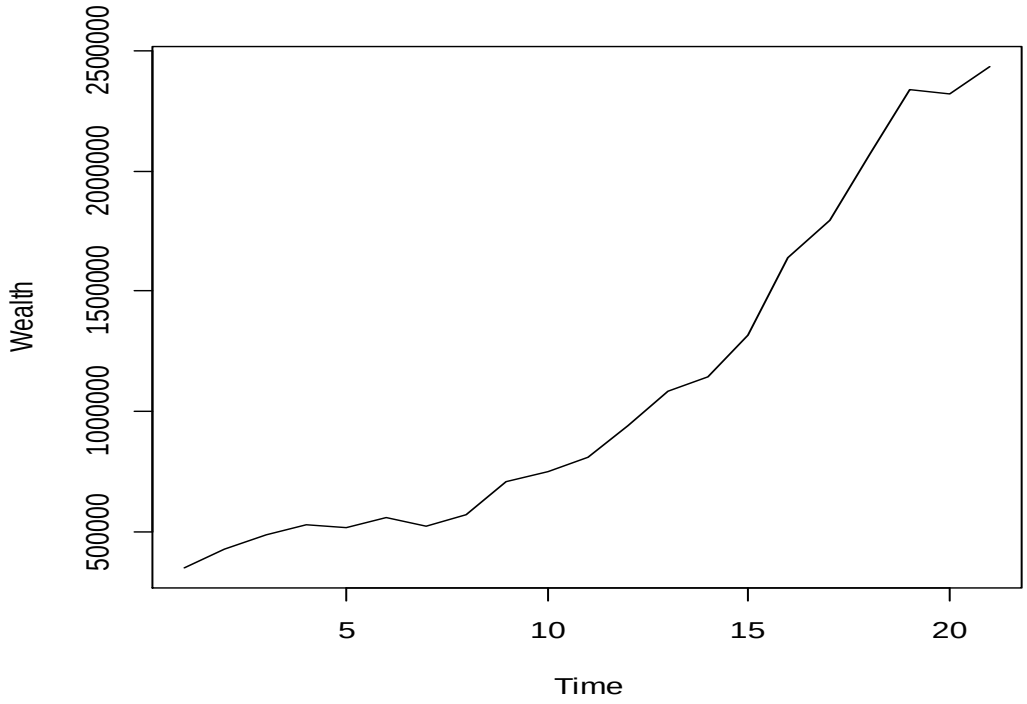


Figure 4.22: Wealth diffusion sample path for Mwalimu National SACCO members

Mwalimu National SACCO member's update consistency rate stands at 14/20 (70%) as illustrated in figure 4.22. Though his initial entropy is high, it reduces steadily as well as his p value but he ensures to reduce his mistakes by increasing his q value by a very small margin of about 2.6%. Mwalimu National members have an entropy level more than one and a half times higher than their management. This is likely to pose grave agency conflict unless objectives other than maximization of members wealth overrides. Management, on recognition of this difference are supposed to reorganize themselves to improve their entropy in order to mitigate imminent conflicts likely to manifest in terms of membership withdrawal. On the same breadth, their members update faster than

management, again escalating potential agency conflict. Something urgently needs to be done to alleviate a likely bad scenario from unfolding.

Table 4.43: Discrete time rationality values from wealth diffusion sample path of M. N. SACCO members including forecasts highlighted from year 2016 to year 2025

r	q	p	entropy	i	d	Rat	Year	UCR	Age
0.7971	0.454	0.8884	0.5621	1	0	0.8849	2005	70%	31
0.8849	0.456	0.8853	0.5443	1	0	0.9372			
0.9372	0.458	0.8822	0.527	1	0	0.9664			
0.9664	0.46	0.8791	0.5102	1	0	0.9821			
0.9821	0.462	0.876	0.494	0	1	0.9268			
0.9268	0.464	0.8729	0.4782	1	0	0.9597			
0.9597	0.466	0.8698	0.4628	0	1	0.8531			
0.8531	0.468	0.8667	0.4479	1	0	0.9149			
0.9149	0.47	0.8636	0.4334	1	0	0.9518			
0.9518	0.472	0.8605	0.4193	1	0	0.973			
0.973	0.474	0.8574	0.4056	1	0	0.9849			
0.9849	0.476	0.8543	0.3923	0	1	0.9477			
0.9477	0.478	0.8512	0.3793	1	0	0.9699			
0.9699	0.48	0.8481	0.3667	1	0	**0.983**	2015		41
0.9828	0.482	0.845	0.3544	1	0	0.9901	2016		42
0.9901	0.484	0.8419	0.3424	1	0	0.9943			
0.9943	0.486	0.8388	0.3308	1	0	0.9967			
0.9967	0.488	0.8357	0.3194	1	0	0.9981			
0.9981	0.49	0.8326	0.3084	0	1	0.9941			
0.9941	0.492	0.8295	0.2976	1	0	0.9965			
0.9965	0.494	0.8264	0.2871	0	1	0.9899			
0.9899	0.496	0.8233	0.2769	1	0	0.9939			
0.9939	0.498	0.8202	0.267	1	0	0.9963			
0.9963	0.5	0.8171	0.2573	1	0	0.9977			
0.9977	0.502	0.814	0.2478	1	0	0.9986			
0.9986	0.504	0.8109	0.2386	0	1	0.9963			
0.9963	0.506	0.8078	0.2296	1	0	0.9977			
0.9977	0.508	0.8047	0.2209	1	0	**0.999**	2025		51

Over the period of 10 years, surprisingly, Mwalimu SACCO management has only gained 6%, by updating only 11 times while similar potential groups, the likes of Stima SACCO members have updated 19 times as shown in table 4.43. This points to possible existence of the agency conflict, especially because it is the biggest SACCO in terms of

member deposits and loan disbursements. Furthermore, it's the group at the highest level of the diminishing marginal rationality function at 79.27%, prompting an urgent intervention.

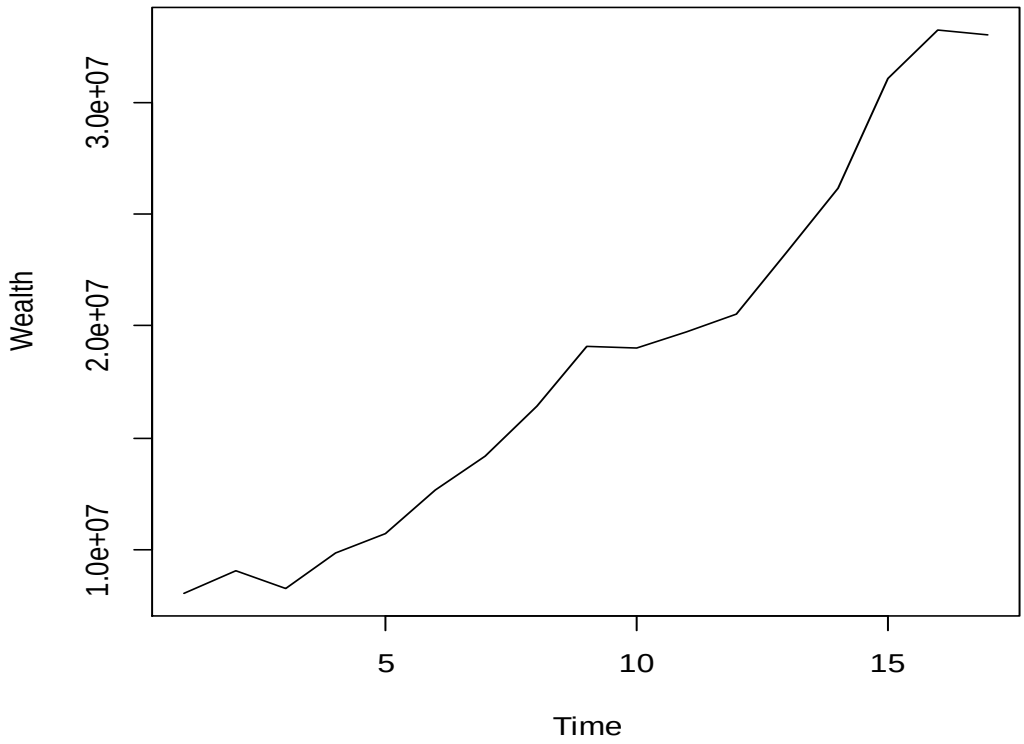


Figure 4.23: Wealth diffusion sample path for Mwalimu National SACCO management

Evidently, without a lot of updating, Mwalimu National SACCO management is expected to improve from the current lowest rationality level of 89.01% amongst all SACCO managements to just below 100% rationality. This underscores the principle of minimum guesswork implemented through the progressive reduction of q value from 80.7% in year 2005 to 46.8% in 2015 (table 4.44).

Table 4.44: Discrete time rationality values from wealth diffusion sample path of M. N. SACCO management including forecasts highlighted from year 2016 to year 2025

r	q	p	entropy	i	d	Rat	Year	UCR
0.8173	0.807	0.9424	0.1082	1	0	0.8393	2005	73.30%
0.8393	0.7731	0.9371	0.1424	1	0	0.8636		
0.8636	0.7392	0.9318	0.1787	0	1	0.6235		
0.6235	0.7053	0.9265	0.2168	1	0	0.6851		
0.6851	0.6714	0.9212	0.2568	1	0	0.749		
0.749	0.6375	0.9159	0.2986	1	0	0.8109		
0.8109	0.6036	0.9106	0.3422	1	0	0.8661		
0.8661	0.5697	0.9053	0.3875	0	1	0.5874		
0.5874	0.5358	0.9	0.4347	1	0	0.7051		
0.7051	0.5019	0.8947	0.4839	1	0	0.81		
0.81	0.468	0.8894	0.5351	1	0	**0.89**	2015	
0.8901	0.4341	0.8841	0.5886	1	0	0.9429	2016	
0.9429	0.4002	0.8788	0.6444	1	0	0.9731		
0.9731	0.3663	0.8735	0.7028	0	1	0.8785		
0.8785	0.3324	0.8682	0.764	1	0	0.9497		
0.9497	0.2985	0.8629	0.8283	1	0	0.982		
0.982	0.2646	0.8576	0.8962	1	0	0.9944		
0.9944	0.2307	0.8523	0.9681	1	0	0.9985		
0.9985	0.1968	0.847	1.0446	0	1	0.992		
0.992	0.1629	0.8417	1.1266	1	0	0.9984		
0.9984	0.129	0.8364	1.2154	1	0	0.9998		
0.9998	0.0951	0.8311	1.3127	1	0	**1**	2025	

Besides, the SACCO's entropy is expected to rise to 100%, the highest cited in this study. Of course the figure reads 1.3127 equal to 131.27% but this is not achievable given the proof in section 3.7.2. These discrete forecasts have been developed on assumptions that the 10 year trends in q, p, i and d will continue the same way for the next 10 years. Beyond 10 years forecasts will not be feasible. The period in magnitude to which data collected relates should be the same period forecasted for purposes of reliability (Hull, 2012). A summary of the entire process is shown in table 4.45.

Table 4.45: A summary of required and actual decisions rationalized

SACCO group	Required updating decision points (Rational decisions)			Simulated Actual decision points							
				Rational decisions		Irrational decisions					
	Inc	Dec	Total	Inc	Dec	*Inc	*Dec	Total	Error rate	Decision Fertility	%Decisions rationalized
All	8	3	11	8	3	7	0	18	0.2727	0.8333	0.6111
Females	7	2	9	7	2	6	0	15	0.2222	0.8667	0.6000
Males	9	4	13	9	4	7	0	20	0.3077	0.8000	0.6500
Unitas M	10	2	12	10	2	3	0	15	0.1667	0.8667	0.8000
Stima M	14	5	19	14	5	10	1	30	0.2632	0.8000	0.6333
Mwal. M	11	3	14	11	3	6	0	20	0.2143	0.8500	0.7000
U.Mgt	12	1	13	12	1	2	0	15	0.0769	0.9333	0.8667
S.Mgt	15	3	18	15	3	6	0	24	0.1667	0.8750	0.7500
M.Mgt	9	2	11	9	2	4	0	15	0.1818	0.8667	0.7333

*Inc and *Dec are wealth increases and decreases respectively generated from guesswork decisions. In psychology, excitement from wealth increase leads to irrational decisions just as anger does from wealth decrease. Decision fertility is the probability that a decision, rational or otherwise was beneficial to the decision maker. Figure 23 shows that in the current set up, holding prior knowledge r, prospects of wealth increase after irrational decision making and prospects of wealth increase after rational decision making constant, increasing i's from the current 8 to 14 would perfect financial decision making rationality. Conversely, increasing d's reduces rationality more highly.

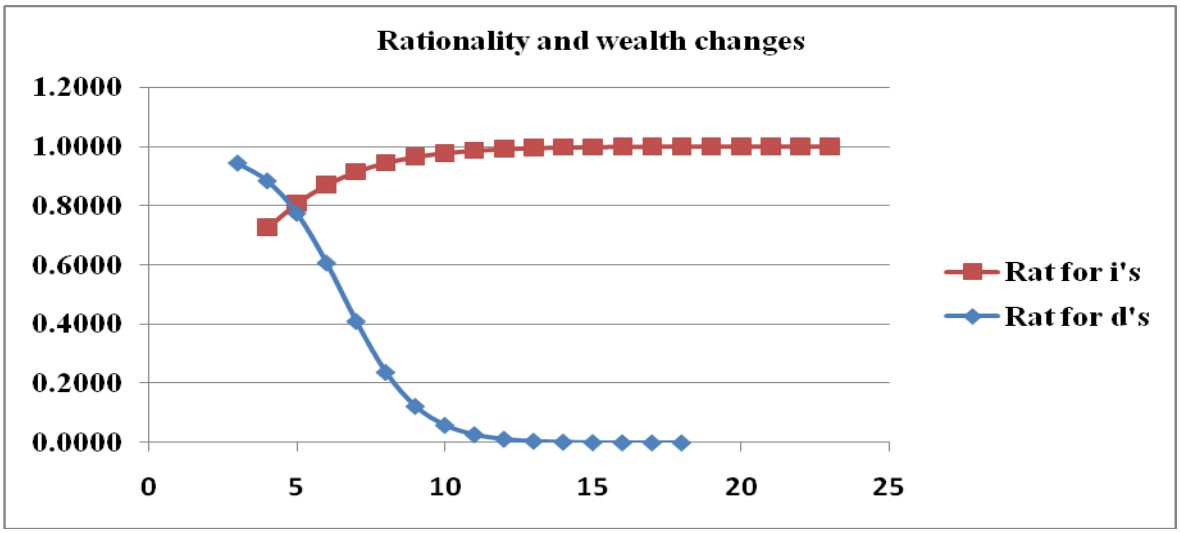


Figure 4.24: Rationality variation with number of increases and decreases for the entire SACCO fraternity

4.4.8 Continuous time rationality forecasting

This kind of forecasting, is supposed to project a rationality value at any time point by adjusting time intervals for both the deterministic and stochastic terms of equation 4.8 unlike that of binomial setting where the updating process is quantized. Continuous time process requires generation of continuous rationality diffusions. Table 4.46 shows prior knowledge, drift and volatility values needed to generate the required diffusions in the first three columns. The last highlighted column shows forecasted rationality values for year 2025. Their derivations have been computed according to equations 3.2 and 3.3.

Table 4.46: Prior knowledge, Ito-Bayesian drift and volatility for various SACCO groups

Group	Ito-Bayesian drift p.a.	Ito-Bayesian Volatility p.a.	Prior Rat.(2015)	Rat (2025)
All SACCOs	0.00502	0.02362	0.9689	0.9755
Females	0.00748	0.03057	0.9510	0.9543
Males	0.00697	0.02639	0.9539	0.9568
Unitas Members	0.00837	0.02892	0.9689	0.9713
Unitas Mgt	0.04485	0.06697	0.8755	0.9196
Stima Members	0.00821	0.02198	0.9792	0.9808
Stima Mgt	0.02631	0.04055	0.9415	0.9552
M. N. members	0.01342	0.03492	0.9827	0.9875
Mwalimu N. mgt	0.00589	0.02558	0.8901	0.8920

Table 4.46 has been generated by adjusting for different updating periods for each SACCO group to derive annual values. Starting from year 2016 to year 2025 Ito-Bayesian continuous time forecasting produces graphs that follow. Rationality forecasts are computed using interpolation.

$$\Gamma_f = \Gamma_{in} + \{\frac{\Gamma_c + \Gamma_{ic}}{1+\Gamma_{ic}}\}[1-\Gamma_{in}] \quad \text{...} (4.15)$$

Where:

Γ_f = rationality forecast for a given year

Γ_{in} = prior knowledge in this case for 2015

Γ_c =computed rationality for the required year using Ito-Bayesian algorithm

Γ_{ic} = computed rationality for the prior knowledge using Ito-Bayesian algorithm

Application of equation 4.10 generates rationality forecasts for year 2025 shown in table 4.46.

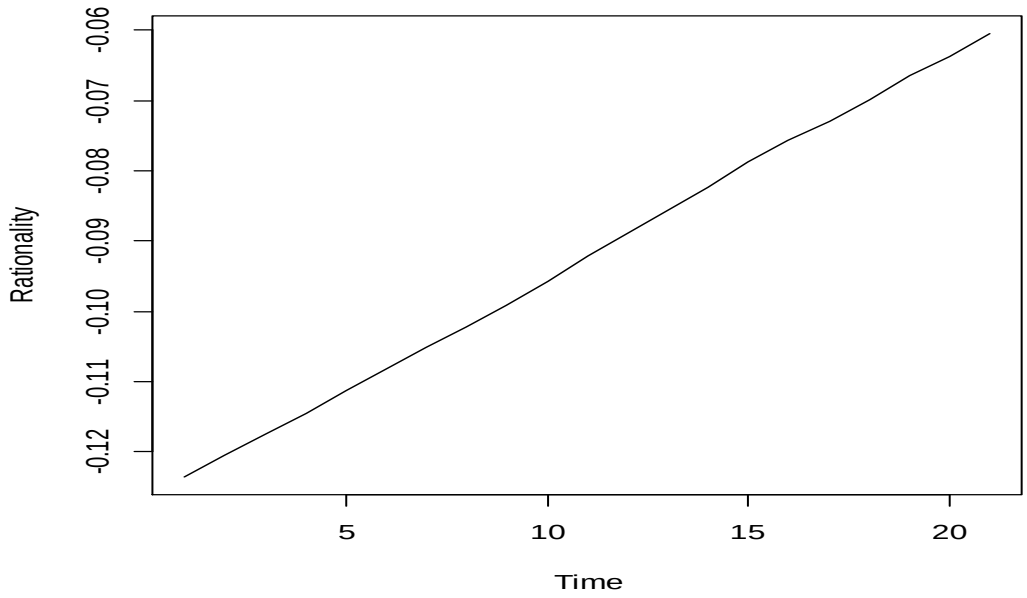


Figure 4.25: Ito-Bayesian rationality forecast curve for Mwalimu National SACCO management year 2025.

4.4.9Generating an Ito-Bayesian rationality curve

To forecast rationality through an Ito-Bayesian process, an equation with boundedness properties like equation 4.13 was developed. For few intervals of the equation, the function looks linear (figure4.24) but if more intervals are simulated, the function is perfectly convex to y-axis as shown figure 4.25.

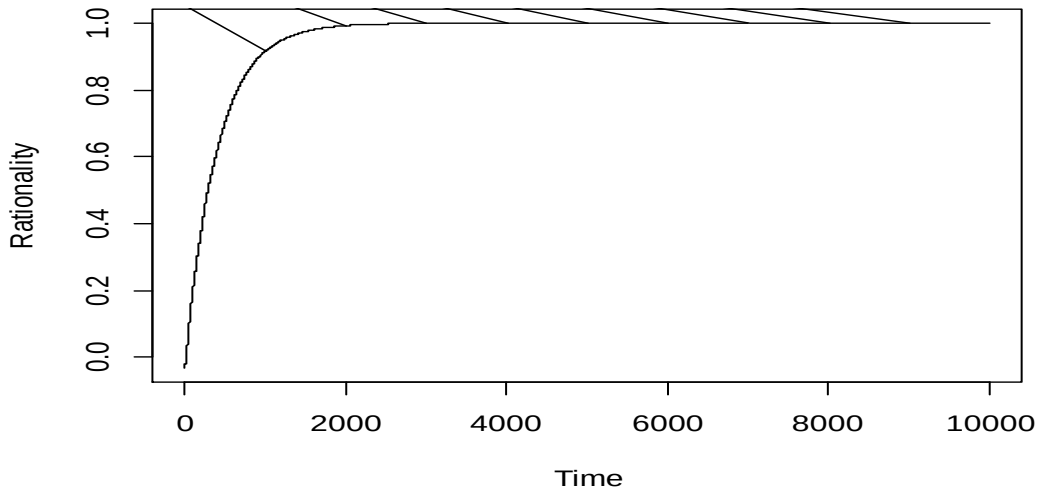


Figure 4.26: Ito-Bayesian rationality curve showing rationality boundedness

Notably, this graph is almost a straight line, but no, it is still concave like figure 4.25; only that the time interval is very small, displaying it as linear. A comparative look at Bayesian and Ito-Bayesian forecasts reveal wide variations. Using Bayesian forecasting, Stima SACCO members will actually decline in rationality as opposed to Ito-Bayesian forecasts which indicate a slight increase. This discrepancy needs further research. For now, the main purpose of Ito-Bayesian forecasts is theoretical. Moreover, since Ito-Bayesian diffusion forecasts are hinged on the assumption that volatility remains the same during the period; it does not reflect the learning aspect. For this reason backward iterated Bayesian rationalities are more realistic showing **Reflexive rationality** at 1.36% according to appendix 4. Here, the argument is for purposes of computation, Bayesian model presumes an initial value greater than zero; for in case it is zero, the updating process cannot take off. Yet, if this value was above zero, but zero by approximation of the four significant figures in use, this prior knowledge would be deemed insignificant. But the value of 1.36% cannot be approximated to zero. This means that at birth, and throughout decision making life of an economic agent there exist some rationality by reflex. This can be explained by a simple stimuli response to skin penetration by a sharp

object. The body responds by evacuating the body part affected; not because the individual is avoiding medication costs of treating the imminent injury, but to avoid discomfort as an end. On the other hand as indicated in appendix 5, there is a rationality of 0.61% above the highest achievable rationality level of 99.39% which can never be reached. This rationality type has been named **intrinsic irrationality**. From all the foregoing analysis and interpretations, further claims may be made as follows: rationality that can be learned is the difference of 100% and the sum of both intrinsic irrationality and reflexive rationality. For purposes of this study, this kind of rationality is named **Achievable rationality.** This is certainly less than **attainable rationality** which is the sum of achievable and intrinsic rationalities. These concepts for this proposed theory – Entropy-q Rationality Theory may be summarized in the figure 4.28.

4.5 Bridging standard finance and behavioural finance through rationality measure

Evidently, humans intend to be rational but only achieve so much of it. This study has attempted to determine how much rationality was operational and can be achieved. Part of the concern cited in the statement of the problem is to determine the amount of rationality at play in order to modify inadequate standard finance and classical economic theories. In appreciation of the fact that humans use heuristics (basic rules of thumb) to make decisions that they feel incapable to logically process, and what this study is calling irrational decision making, it remains to determine how much the SACCOs have been rational and what proportion of financial decisions taken in the last 10 years have been made through heuristics.

To this end, consider once more the number of times each group updated given the number of times it was capable of updating. By dividing the ten year period by the total number of ordinary decision and updating decision points the following table 4.47 for the entire SACCO fraternity was obtained. Entropy-q rationality model is a discrete model. It assumes that when an economic agent updates, he/she operates at that rationality level until the next update (discrete like binomial or Poisson distributions). For 18 decision points in 10 years, a total rationality value of 1x18 was possible.

Table 4.47: Entire SACCO member's rationality movement in 10 years to 2015

Interval	Rat (Y) against Intervals (X)
1	0.9216613
2	0.9522562
3	0.9708339
4	0.9348413
5	0.9587024
6	0.9736797
7	0.9830699
8	0.9889852
9	0.9773169
10	0.9548038
11	0.9689958
	10.5851464

However, the economic agent only updated in 11 of the intervals a total sum of 10.585 units. This means that the proportion of rational decisions made was 10.585/18 = 58.8%. It also by extension means that the rest of decisions made were predominantly done through heuristics at 41.2%. When a financial model assumes complete rationality of the financial decision maker, it is clear that a deviation of 41.2% cannot be wished away. With SACCOs contributing about 50% of Kenya GDP, it is clear that rationality level should be recognized as both a macro and microeconomic variable. The human resource manager's greatest task is to raise the updating points to 18, the highest possible. Similar workings done for the other groups yielded the results in table 4.48. This table shows that at least 50% of all financial decisions are rationally processed. If this was less than 50%, then there would not be any economic development. The challenge to the government is to raise this proportion higher for speedier economic growth, which may push rationality learning age ceiling beyond 67.27.

Table 4.48: SACCO groups' rationality averages in 10 years to 2015

Group	Update times	Total possible times	Total rat for the updates	Avg Rat
All SACCOs	11	18	10.5851	58.81%
Females	9	15	8.481	56.54%
Males	13	20	12.1281	60.64%
Unitas Members	12	15	11.4518	76.34%
Unitas Mgt	13	15	10.4382	69.59%
Stima Members	19	30	18.4762	61.59%
Stima Mgt	18	24	16.4418	68.51%
Mwalimu N. members	14	20	13.2353	66.18%
Mwalimu N. mgt	11	15	8.4302	56.20%

Quite a number of variables discussed so far relate to one another. Heuristics use rate refers to the proportion of financial decisions which are not rationalized. Instead, economic agents use heuristics to take decisions. This relationship is important to guide sensitivity analysis and ultimate policy. A summary of this relationship has been disclosed by table 4.49.

Table 4.49: Key variables summary for the SACCO groups including average rationality

	Entropy	Educ	Age	Indec	Updrate	drift	stddev	UCR	Avg Rat
All	0.1905	1.98	39.36	0.774	11	0.2508	0.3941	0.61	58.81%
Female	0.1658	1.931	39.9	0.834	9	0.2735	0.4047	0.60	56.54%
Male	0.2102	2.02	38.9	0.759	13	0.2335	0.3518	0.65	60.64%
U.mem	0.1563	1.28	38.4	0.911	12	0.2889	0.4604	0.80	76.34%
U.mgt	0.1105		30	0.735	13	0.2735	0.0903	0.87	69.59%
S.mem	0.2723	2.26	36.8	0.804	19	0.2814	0.2579	0.63	61.59%
S.mgt	0.5606		30.5	0.511	18	0.3208	0.2304	0.75	68.51%
M.mem	0.4562	3.19	41	0.77	14	0.1505	0.2330	0.70	66.18%

M.mgt	0.2974	38.7	0.671	11	0.154	0.1646	0.73	56.20%

UCR = update consistency rate; Avg Rat = Average rationality

4.6 Validation of average rationality values as the real rationality values

A summary of the SACCO members' decision process using a decision tree is as follows:

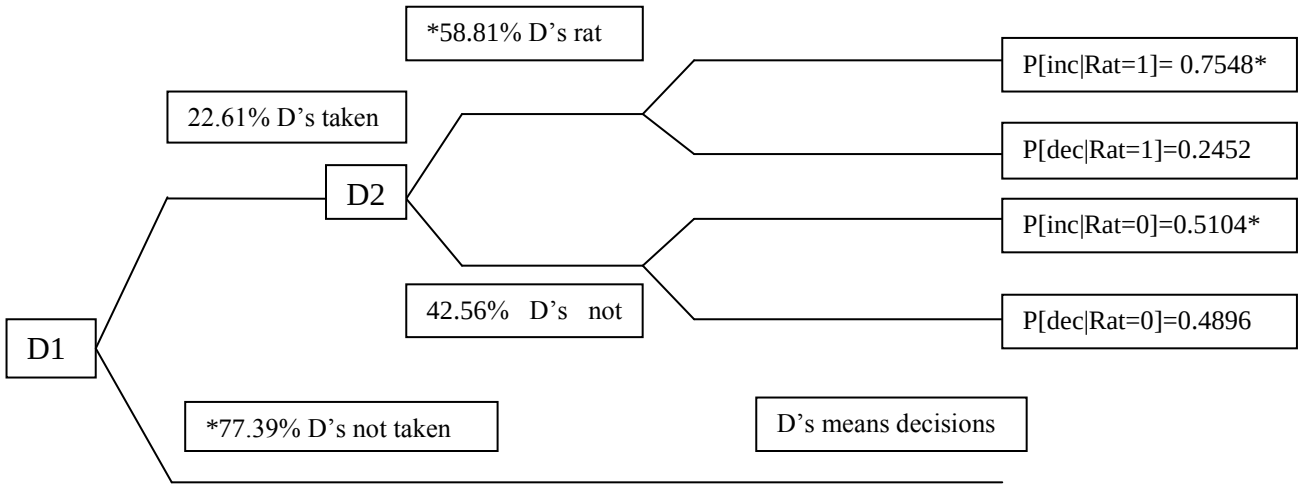


Figure 4.27: Decision tree for the SACCO member as at 2015 year end

Values *94.51%, 0.7548*, 0.5104* and *77.39 are obtained from table B in the appendix.

Equations 4.16 to 4.19 show various versions of Bayes theorem.

$$P(inc \mid Rat = 1) = \frac{P(inc \,\&\, Rat = 1)}{P(Rat = 1)} \quad \ldots\ldots (4.16)$$

$$P(Rat = 1 \mid inc) = \frac{P(inc \,\&\, Rat = 1)}{P(inc)} \quad \ldots\ldots (4.17)$$

$$P(Rat = 0 \mid inc) = \frac{P(Rat = 0 \,\&\, inc)}{P(inc)} \quad \ldots\ldots (4.18)$$

$$P(inc \mid Rat = 0) = \frac{P(inc \,\&\, Rat = 0)}{P(Rat = 0)} \quad \ldots\ldots (4.19)$$

From the above equations, it can be shown that:

$$P(inc) = P(inc \,\&\, Rat = 1) + P(inc \,\&\, Rat = 0) \quad \text{..... (4.20)}$$

When the values in the decision tree are plugged in, P (inc.) = 0.4336 + 0.2172 = 0.6508 when average rationality values are used. Reported values would overstate P(inc) to 0.7414. To prove average values as the applicable ones, compare Unitas and Stima SACCO reported values of 0.8576 & 0.9665 for Unitas 2005 & 2015 and 0.8800 & 0.9699 for Stima for the two years. Surprisingly Unitas recorded as asset turnover of (1.8/0.14) = 12.857 while Stima turned only (2.7/0.32) = 8.438 times within the same period even after reporting higher rationality values than Unitas in the entire 10 years! Hence Unitas members have been more rational all along at 76.34% compared to Stima's 61.59% with similar drift.

Table 4.50: Relationship between wealth turnover, average and declared rationality

SACCO Group	Initial wealth (a)KES'000	current wealth (b)KES'000	Wealth Turnover (b)/(a)	Avg Rat	Declared Rat
All members	292.7	2,301	7.861	0.5881	0.8817
Female members	285.2	2,050	5.33	0.5654	0.8807
Male members	301.7	2603	8.628	0.6064	0.8825
Unitas Members	140	2,000	14.286	0.7634	0.9121
Unitas Mgt	827,386	9,286,191	11.22	0.6959	0.7263
Stima Members	320	2,667	8.334	0.6159	0.925
Stima Mgt	23,209	262,500	11.31	0.6851	0.8114
M.N. Members	350	2,167	6.19	0.6618	0.889
Mwalimu N. Mgt	8,073,526	32,500,000	4.026	0.5620	0.8471

Average wealth recorded and simulated for year 2015 was divided by initial wealth to generate wealth turnover in table 4.50. Average and declared rationality were correlated with wealth turnover. It was argued that the more rational an economic agent is, the more money they are able to make in the long run. Table 4.51 shows correlation results for average rationality, declared rationality and wealth turnover. Conspicuously, average

rationality has a correlation coefficient of 0.854 with wealth turnover, whereas declared rationality by respondents only correlates at -0.203. At the same time, average and declared rationality have a negative correlation (-0.203); suggestion average rationality is a superior estimator of actual rationality.

Table 4.51: Correlation between average, declared rationality and wealth turnover

Correlations

		wturn	declrat	avgrat
wturn	Pearson Correlation	1	-.175	.882**
	Sig. (2-tailed)		.652	.002
	N	9	9	9
declrat	Pearson Correlation	-.175	1	-.203
	Sig. (2-tailed)	.652		.601
	N	9	9	9
avgrat	Pearson Correlation	.882**	-.203	1
	Sig. (2-tailed)	.002	.601	
	N	9	9	9

**. Correlation is significant at the 0.01 level (2-tailed).

Table 4.52: Log regression output for the effect of real rationality on wealth turnover

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	21.057	2.574		8.180	.000
	ln(realrat)	27.494	5.542	.882	4.961	.002

a. Dependent Variable: Wturn

The sample regression function degenerates into:

Wealth turnover = 27.494*log (real rationality) + 21.057. When real rationality is made the subject of the formula, the equation reduces to:

Real rationality = exp {(Wealth turnover – 21.057)/27.494}. Substituting 1 for wealth turnover, we obtain a real rationality of 0.4822. That is, a SACCO member requires having upwards of 48.22% rationality level for wealth creation. Any one operating below this level is certainly a dependant within the SACCO fraternity. Meanwhile, table 4.50 underscores the effect of updating consistency rate, which is incorporated into the multiperiod Bayesian model to yield the overall model as:

$$\Gamma = \frac{crp^{i}(1-p)^{d}}{rp^{i}(1-p)^{d} + (1-r)q^{i}(1-q)^{d}} = \frac{0.5(0.7667)^{i}(0.2333)^{d}}{0.8182(0.7667)^{i}(0.2333)^{d} + 0.1818(0.4812)^{i}(0.5188)^{d}} \quad \text{..... (4.21)}$$

Where: Γ = Financial decision making rationality;

c = Updating consistency rate equal to 0.6111 for the entire SACCO members;

r = Prior probability of full knowledge about a financial decision;

p = Prospects of wealth increase after making a rational decision;

q = Prospects of wealth increase after making an irrational decision;

i = Number of wealth increases during the period in question; and

d = Number of wealth decreases during the period in question;

In the model, r, c, p and q are parameters while i, and d are variables.

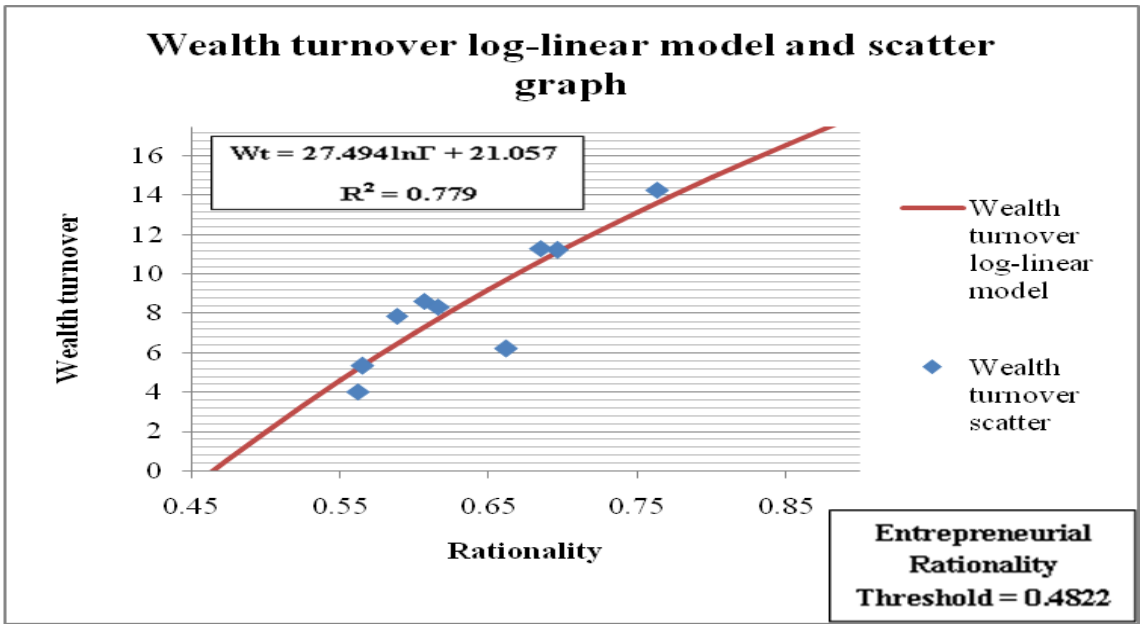


Figure 4.28: Psycho-social economic equation for Kenyan SACCOs

This is the ultimate validation of the model. Many a researcher is of the view that R^2 is usually abused; agreeably so. Quite often, interpretation of significance values is confused with model fit. It is quite possible to have a high R^2 value which becomes useless for prediction purposes; especially when data follows a non-linear model but a short interval of the same was used (Chin, 1998). In such a case, the model use for prediction is limited to interpolation and possibly small extensions at both ends.

What is encouraging about the model derived in relation to data points is that both visually and by Q-Q plots, the existing relationship is log-linear. In this case, the high R^2 = 0.779 and the adjusted R^2 =0.747 can safely be interpreted to contribute to the accuracy of prediction by extrapolation, for $R^2 > 0.6$ is substantially high for social sciences (Chin, 1998; Henseler, Dijkstra, Sarstedt, Ringle, Diamantopoulos, Straub, & Calantone, 2014). The line covers rationality values between 56% and 76%, giving room for reliable predictions 10percentage points on either ends, covering the entire SACCO working population . In summary, for any interval of time, this proposed entropy-q rationality theory states that financial decision making rationality is completely

determined by four factors: relative entropy of decision maker, updating consistency rate, the likelihood of making a rational decision in the immediate last transaction and wealth movement.

Table 4.53: Education, entropy and age for the SACCO members

Education	Entropy	Age
High School	0.120177	39.98
Diploma	0.00909	36.56
Bachelors	0.053374	40.47
Masters	0.614811	39.00
PhD	0.009912	47.00

A crucial finding was that entropy is not necessarily directly proportional to education as has been shown by the summary correlations table 4.53. Figure 4.27 and table 4.52 show that master's level of education has the highest entropy. This group has the highest financial rationality spatial thinking. This should inform both national education policy as well as firm's recruitment policy at a micro level. Surprisingly, doctorate degree holders do possess lower financial rationality entropies than high school leavers! Possibly they get so absolved in their pursuit of intellectual excellence that they forget to be money- minded, given that they possess lower utility of money. Diploma holders seem to be disgruntled; they operate at lower entropies than high school leavers as well. A master degree should be acquired early in life. Entropy rationality analysis is particularly important because it delves deeper into the individual's decision making patterns not just academic qualifications. However, group education level correlates highly with entropy showing that group dynamics influence decision making pattern greatly.

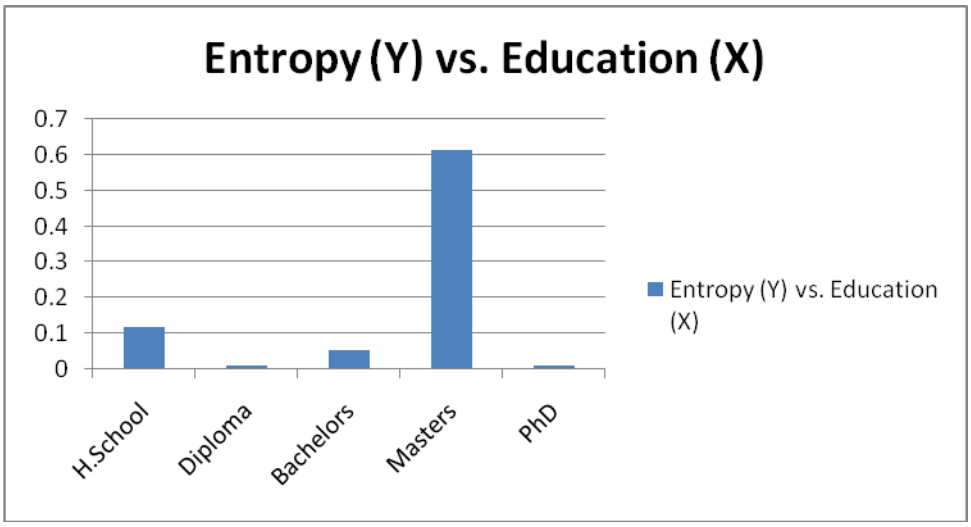


Figure 4.29: Relationship between entropy and education

4.7 Correlation analysis of independent and dependent variables

Table 4.54: Key variables summary correlations for the SACCO groups

Correlations

		Entrop	Educ	Age	Indec	Updra	Drift	stdde	UCR	AvgRat
Entropy	Pearson	1	.941**	-	-.707*	0.584	-	-	0.017	0.116
	Sig. (2-		0.005	0.692	0.033	0.099	0.71	0.445	0.966	0.766
	N	9	6	9	9	9	9	9	9	9
Educ	Pearson	.941**	1	0.481	-0.694	0.357	-	-	-0.19	-0.203
	Sig. (2-	0.005		0.334	0.126	0.487	0.026	0.015	0.717	0.7
	N	6	6	6	6	6	6	6	6	6
Age	Pearson	-0.154	0.481	1	0.592	-0.483	-	0.579	-0.63	-0.447
	Sig. (2-	0.692	0.334		0.093	0.188	0.104	0.102	0.071	0.228
	N	9	6	9	9	9	9	9	9	9
Indec	Pearson	-.707*	-0.69	0.592	1	-0.424	-	0.588	-0.19	0.067
	Sig. (2-	0.033	0.126	0.093		0.256	0.932	0.096	0.63	0.865
	N	9	6	9	9	9	9	9	9	9
Updrate	Pearson	0.584	0.357	-	-0.424	1	0.328	-0.35	0.142	0.342
	Sig. (2-	0.099	0.487	0.188	0.256		0.389	0.355	0.716	0.367
	N	9	6	9	9	9	9	9	9	9
Drift	Pearson	-0.145	-.864*	-	-0.034	0.328	1	0.278	0.097	0.346
	Sig. (2-	0.71	0.026	0.104	0.932	0.389		0.469	0.804	0.362
	N	9	6	9	9	9	9	9	9	9
stddev	Pearson	-0.293	-.898*	0.579	0.588	-0.35	0.278	1	-0.52	-0.079
	Sig. (2-	0.445	0.015	0.102	0.096	0.355	0.469		0.152	0.84
	N	9	6	9	9	9	9	9	9	9
UCR	Pearson	0.017	-0.19	-	-0.187	0.142	0.097	-0.52	1	.799**
	Sig. (2-	0.966	0.717	0.071	0.63	0.716	0.804	0.152		0.01
	N	9	6	9	9	9	9	9	9	9
AvgRat	Pearson	0.116	-0.2	-	0.067	0.342	0.346	-	.799**	1
	Sig. (2-	0.766	0.7	0.228	0.865	0.367	0.362	0.84	0.01	
	N	9	6	9	9	9	9	9	9	9

**. Correlation is significant at the 0.01 level (2-tailed). *. Correlation is significant at the 0.05 level (2-tailed).

It can be noted that more educated SACCO members are risk averse and also earn lower margins than the less educated at -0.898 and – 0.864 respectively, from table 4.53. This means that the fear of the unknown dominates SACCO members and justifies the higher risk higher return principle (Fama, 2011). There exists a fairly high negative correlation (-0.707) between indecision and entropy, interpreted to mean that entropy alone is a sufficient parameter to indicate financial decision making decisiveness at a correlation of 0.707. There exists a high correlation between entropy and education (0.941) but the correlation between real rationality and education is actually negative (-0.203). This discredits education as a measure whatsoever of financial decision making rationality and puts entropy at a cardinal position. But, as well it was noted that the correlation between entropy and real rationality was positive, though small (0.112). This means that entropy alone cannot determine real rationality. Other factors like updating rate and updating consistency rate come into play.

4.8Relationship between findings, literature and other researchers' views

From table 4.42 it is apparent that updating consistency rate is correlated to real rationality at 80% with a 1% level of significance, construct with the highest correlation. This is consistent with Bayesian learning process as depicted by Bayesian decision model. These findings served to confirm the same. Manktelow (2012) described the same observation using the words "base rate neglect". When financial decision makers take decision without regard of up-to-date learning that has taken place in relation to evidence from data, they are said to have neglected the basis on which the current decision has to be made.

Bounded rationality theory (Simon, 1996) was perfectly obeyed and at two levels. One is that even with all consistency in updating; it was proved in chapter three that it is not possible to achieve complete rationality. Secondly, that due to inconsistency in updating by human economic agents, much lower rationality is achieved. But Conejo (2012) agreeably so opines that human irrationality is not necessarily negative. He reckons that human ability to be honest, to trust and to care about others are non-economic behaviours; yet they make us wonderfully human. The fact that humans find irrationality

beneficial is what causes consistent departure from rational action (Shiller, 1994). The principle of maximum entropy by Jaynes (1957) was found to be applicable within a limited range of up to p = 0.7267 where maximum rationality the SACCO members was achieved. Thereafter, any increment in entropy does actually decrease rationality rather than increase it. If financial decision makers would fairly quantify the desirable levels which irrational behaviour may be allowed to intervene during implementation of financial plans, the planning fallacy (Kahneman and Tversky, 1982) may be effectively alleviated. In view of the foregoing, these findings form a basis for formulation of risk management indices and several other metrics that can be of use not just by SACCO managements but also by other enterprises within the economy. Rational choice theory was confirmed inapplicable from the onset. Most respondents admitted to the fact that they neither do they collect all available information regarding a decision, nor do they possess all the ability required to process it. Like many other researchers who criticized the theory on this basis, this empirical finding is in their support. Modern portfolio theory rationality assumption was proved misleading.

These findings will also help increase self awareness of SACCO members decision making habits if this information is disseminated to them during education days for members normally offered by SACCO managements. Fragmented concepts like intrinsic irrationality, reflexive rationality, achievable rationality, attainable rationality and rational learning age limit by other researchers were successfully aggregated into a single theory with an accompanying model that derives requisite quantities. In all, however, it was discovered that variables relationship in this research were not linearly related; hence more investigation needs to be done to establish existing non-linear relationship for better understanding of the entropy rationality model. A diagrammatic summary of new key concepts added into the existing body of knowledge is shown in figure 4.28.

4.9 Summary of analysis and discussions

As predicted, operational values of p and q were related such that, $p > q$ for learning to take place (Glosten and Milgrom, 1985) and in fact, analytically, $q \leq 0.9202$ while $p \geq$

0.6321 for an economic agent to achieve the maximum entropy of unity. However the statistical distance between the two, that is entropy (which normally maximizes at 1), was decreasing with age thereby affecting the rate of learning over time as exemplified by (Agarwal, Driscoll, Gabaix and Laibson, 2016). He found out that word recall, matrix reasoning, spatial relations and pattern comparison abilities decline with age; what he termed as the decline of cognitive capital. By the principle of maximum entropy (Jaynes, 1957) SACCO members could update more and had better financial decision making potential. Moreover, individuals with high entropies could sustain high rationalities longer and over a bigger rage of p values.

The study stumbled on a complementary principle forming part of new knowledge and was termed the principle of minimum guesswork; that the quantity q has to be minimum for rationality to continue increasing. This principle seemed to override the principle of maximum entropy for there were instances where entropy could increase while rationality decreased unless the q value was reduced; the reason why the proposed theory was named entropy-q rationality theory. Naturally, q value increases with age as exemplified by data. A critical value of q = 0.18 was found to maximize rationality level over all ranges of p above 0.6321. Then, p values decreases with age. This means that entropy decreases with age. Findings further indicate that only Unitas management is on a rationality increasing trend. Other managements have already attained their upper bounds on assumption that q values and updating rates remain constant. Female members and Unitas members are at the apex while all other SACCO groups are on the anti-climax (table 4.29 and 4.31figures highlighted).

Incidentally, bounded rationality theory was proven analytically. As well, using geometric Brownian motion model, a new financial forecasting method was formulated and named: Stochastic Financial Forecasting. It was noted that entropy was not necessarily directly proportional to academic education at the individual level. This entropy concept is also used in portfolio diversification problem to alleviate the drawback of too few assets selection when mean-variance principle is applied. In

specific terms, PhD holders recorded an entropy equal to that of diploma holders (just about 1%), which was 12 times less than that of high school leavers. Masters degree holders had the highest entropy at 56%. This means that PhD holders get so absolved in their pursuit of knowledge that financial logics do not matter.

Further, from wealth diffusion sample paths produced, the ordinary decision points encountered were predominantly increases in wealth save for Stima members who had one of the ordinary updating points being a wealth decrease. This observation confirms that when SACCO members record wealth increases, they have no business learning from the increase to enhance their rationality levels. In fact, they get happy and forget. Happiness and anger invoke irrationality while sadness and fear invoke rationality. This is a piece for Kenyan Psychologists to determine appropriate measures. More surprising is the finding that 0.61% of rationality cannot be achieved; and was named intrinsic irrationality. As well, at least 1.36% of rationality is actually present at birth. That leaves rationality range within the open interval (0, 1) posting and asymptotic graph, while at 67.27 years of age, the average SACCO member stops learning.

Given that the Bayesian model is discrete, an Ito-Bayesian rationality diffusion algorithm was constructed for forecasting in continuous time. Human beings can only reduce their entropies with time, others factors held constant. For this reason SACCOs and other corporates alike can only increase their corporate entropy by way of employing younger, more knowledgeable and exposed employees. This new concept of enhancing financial decision making entropy was called Generational Entropy Substitution rate. Finally, Entropy Rationality Theory and Model were proposed. This theory has effectively apportioned the place for rational decisions and for irrational ones part of which was earlier in this document known as instrumental rationality. Appendix 3 shows extract tables of the model which can be used to determine a financial decision making rationality level given the initial level, p and q probabilities including desired increases and decreases in ODV.

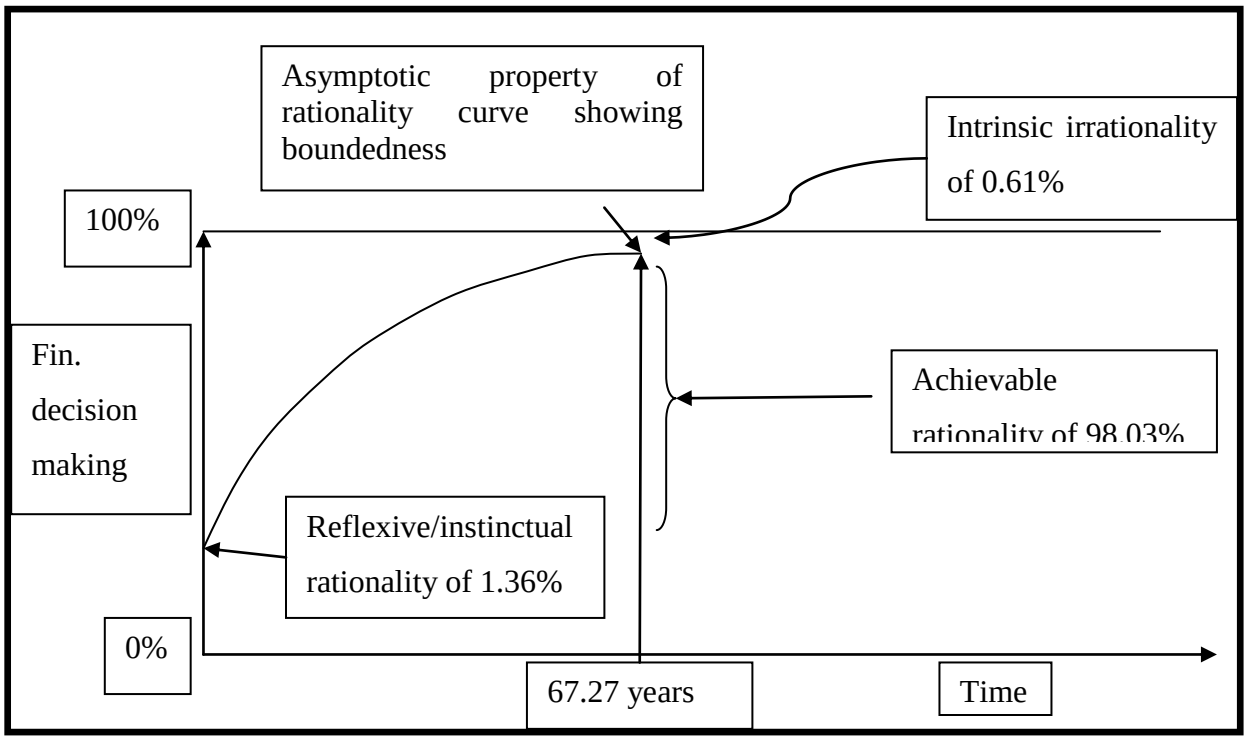


Figure4. 30: A summary of key concepts for the proposed Entropy-q Rationality Theory

CHAPTER FIVE

SUMMARY OF FINDINGS, CONCLUSION & RECOMMENDATIONS

5.1 Introduction

This research study set out to primarily establish the effect of choice determinants of financial decision making rationality, incidentally constructing a financial decision making rationality scale and hence determining measure the exercised level of decision rationalization by SACCO members and SACCO managements as economic agents as occasioned by incessant evidence of consistent departure of humans from complete rational decision making. Cardinal motivation for this arose from the fact that the most fundamental assumption in standard finance, classical and neo-classical economic theories is that humans act rationally all the time as economic decision makers (Fama, 2011). On the basis of findings, it was possible to determine whether the consistent deviation underlying economic decisions is significant or not. This measure was to undoubtedly establish interplay between standard finance and behavioural finance which primarily deals with the use of heuristics in financial decision making. Non-human resources do not learn. They depreciate with time and become obsolete. Human beings learn and keep expanding knowledge of the environment with time and with increase in challenges against their own existence on earth. This section reviews key research findings, general conclusion and major recommendations.

5.2. Summary of findings

5.2.1Effect of prior knowledge on financial decision making rationality

A high rationality level begets higher with learning. High prior knowledge increases the probability of making better quality decisions by a decision maker. The learning rate of a decision maker possessing low rationality levels is higher than that of one with higher levels of rationality other factors held constant. This is because the boundedness character of financial decision making rationality means diminishing marginal rationality. From data analysis as a 10 year period average, a unit prior knowledge (r) about a financial decision increased rationality level by 0.3540 of a unit. It can be seen

that Unitas SACCO members keep learning at a higher rate than their counterparts. Any employer would like to employ a person who is sensitive to firm's costs and revenues; who is able to understand why cost-cutting is a priority at specific times of the firm's life without belaboring much. Organizations are always on the lookout of people who can manage programmes cost effectively and efficiently not necessarily to be admitted and learn in the organization. In this case, they look for relevant experience by way of what other companies an individual has worked for. But human resource firms have not been able to come up with quantitative ways of determining the best person to employ. Initial level of rationality well quantified can gauge later learning and can then create a yardstick for comparing working environments offered by the employer for purposes of instituting appropriate interventions. On a macro level, a government would be more comfortable administering highly economically rational citizenry. This lightens the government's burden of public goods provisions creating time for higher development policy formulation and execution. From the foregoing discussion it is clear that prior knowledge is a determinant of financial decision making rationality.

5.2.2Effect of prospect of wealth increase after irrational decision making on financial decision making rationality.

Over the whole range of 0-1, any increase in q is detrimental to the decision maker's financial decision making rationality, reducing rationality by 0.5627 for every unit increase in q (for the 10 year period average). Empirically, it was established that it is better to increase entropy by reducing q than to increase it by increasing p for this particular group of SACCO cooperators. This is because q value determines the maximum rationality attainable by an economic agent. At some point any entropy increase may actually be detrimental to rationality. This happens when the local rationality maximum level has already been attained; in this case at 0.95, so that if q remains constant, the decision maker is better off retaining the operational p value. A q value above 0.9202 cannot maximize entropy to unity. It is the upper bound critical value. It is q value that determines the useful range of p value for purposes of enhancing financial decision making rationality. This observation gave birth to the principle of

minimum guesswork; overriding that of maximum entropy. The beauty of reducing q is that it more than substitutes the effort made to increase p. At no point does reduction of q become counter productive. In fact, regardless of p value above 0.6321, a q value of 0.18 maximizes rationality to almost unity throughout the range. At q levels of below 0.45. the rate of increase in rationality is a lot higher than at higher q levels. An important finding is that female SACCO members will have overtaken their male counterparts in the next ten years for they have a q reducing trend. Since reduction of q positively affects financial decision making rationality and vice versa, it is no doubt the most crucial determinant of financial decision making rationality.

5.2.3 Effect of prospects of wealth increase after a rational decision on financial decision making rationality

In general, the higher the value of p, the higher the rationality level of an individual. But at some point, depending on values of prior knowledge, there may feature a **local rationality maximum**. In fact as of 2015, a unit increase in p reduced financial decision making rationality by 0.1196 of a unit (10 year period average). This necessitates reduction of p value up to a level that coincides with the maximum rationality. A p value of less than 0.6321, obtained by equating the relative entropy equation to unity and substituting the value of q by 0, cannot maximize rationality level. Female members of the SACCO fraternity are on an increasing mode of rationality.

Likewise, Unitas management members are on a high. All the other groups need to affect q and not p. Naturally, p value goes diminishing, while q increases with age. This leads to an overall decrease in entropy with age. Increasing their entropy by affecting p does not make things any better. This means that raising the prospects of gains after making rational decisions will not raise the rationality levels. In case increasing q is a natural occurrence, it means that the older people use more heuristics than younger SACCO members. This is a remarkable finding. Generational Entropy-q Substitution Rate for SACCO managements provides a way of raising entropy-q to improve managements' financial decision making quality progressively, which is not always

possible for SACCO members. It is apparent that entropy-q is more of a personality variable than an environmental one. The fact that p value affects financial rationality decision making qualifies it as a determinant of financial decision making rationality.

5.2.4 The intervening effect of wealth movement on determinants of rationality

This aspect brings about continuity of a decision making process. In its absence, the model would collapse into a single decision (a single period model). Greater importance of this variable is the fact that it links the observable dimension variable to the unobservable dimension variable. The only reason humans are interested in being rational (unobservable) in their financial decision making is to maximize their wealth (observable); but that human limitations stand on their way. This is the objective that gives the whole theory, the appropriate interpretation. SACCO members updated their rationality scale 11 times (updating decision points) in ten years occasioned by 8 wealth increases and 3 wealth decreases. However, 18 key financial decisions were made in the same period; on average two per year.

Most important is the interpretation that only in 11 of those decisions did they make reference to previous learning as they took subsequent decisions. This means they should have updated 18 times but only did this 11 times. The difference, 7 are referred to as ordinary decision points. At each of the 7 points decisions made never followed the logical process of gathering all available information, processing the information without bias and picking on the best alternative. This means heuristics were employed in taking the decisions. In general, SACCO members exercised 7 times irrational decisions and 11 times rational translating to 61.11% updating consistency rate during the period. However even the 11 rational decisions were not accorded 100% rationality as cited in table 4.47! They were accorded upwards of 95%. It is the product of 95% and 61.11% that gives about 58.81% to mean that SACCO members are rational 58.81% of the decisions or time in the last 10 years. From the foregoing argument, it means that the key intervention point is conversion of ordinary decision points into updating decision points. This would mean that if out of the 7 point one was converted into an updating

point, applying about 95% rationality, overall rationality would rise to 64.08% [(10.585 + 0.95)/18]. This means that progressive avoidance of heuristics would enhance rationality. If updating points were increased from 11 to 14, near 100% rationality would be realized holding other factors constant. Similar interpretations for each of the rest of the SACCO groups apply.

5.3. Conclusion

It is encouraging that choices made regarding the problem, causal variables and the models applied to explain the dependent variable did reflect the practice in financial decision making not just by the sample SACCO members but also by the general SACCO fraternity. Notable still is that the methodology used was able to slot all manner of decision making while the model accommodated both psychological dimension and standard financial theories compromised through the bounded rationality theory. In general, the higher the prior knowledge the higher the financial decision making rationality. But because of bounded rationality capped at unity, when prior knowledge nears 1 the gradient of the curve gets less and less approaching zero. High increases in rationality occur earlier in the curve, while later lower increases relate to lower cognitive capital (Agarwal, Driscoll, Gabaix and Laibson, 2016) when human beings approach senile dementia age. Prior knowledge level is therefore a determinant of financial decision making rationality. When this quantity is high, it means that the economic agent posts high wealth increases without putting in any logic into their decisions hence there is no motivation to be rational.

Part of the findings of this research study reveals that there is greater punishment for being irrational than there is reward for being rational. This is in line with the quote “if think education is expensive, try ignorance” (Bok, 2009). The initial use of the quote was literal. It is clear that the concept is wider; and in line of the principle of minimum guesswork. It is therefore important to seek to know how to go about a process that to shoot blanks, for this is detrimental. Normal expectation is that making rational decisions is directly proportional to increasing wealth. Prospects of increase in wealth

are high when a rational decision is made. However, this is not a guarantee since humans live in a stochastic world. While these prospects increase, it is important to note that from Bayes theorem, this can only happen if the joint probability of increasing gets higher. Assuming that the independent probabilities of increase or decrease are constant, such that what changes is the proportion of rational to irrational decisions, the latter has to reduce to post a higher prospect of increase than previously which means reducing q value. These principles are very much applicable and form the rationale for training.

Wealth movement variable links all financial decision making practice in the time dimension to the basic Bayesian mechanics of decision making in a single period. It is the variable that is expected to drive all types of interventions that this theory is likely to inform. It is therefore critical to choose properly the observable dimension variable as well as the observable dimension model. A deterministic observable dimension model would convert all analysis deterministic which would not reflect the true state of human kind decision making processes. In particular, this variable informs us that if SACCO members are a representative sample of Kenyans as justified previously in this study, then it means a Kenyan is only rational 58.81% of the time for the last 10 years. For purposes of forecasting, probably she will increase in rationality as data suggests but also is likely to decrease updating consistency so that the overall effect is likely to be lower in the next 10 years. However, the forecasting done in this study assumed that updating consistency rate remained constant.

5.4. Recommendations

Having established that prior knowledge is a determinant of rationality, it is important to optimize in selection of individuals for any task that entails financial decision making. Businesses and public sector alike are interested in making the best financial decisions for and on behalf of the firms and the public. On selection of SACCO employees, management should ensure to pick candidates with the highest prior knowledge. This will put their operations on an edge above other SACCOs which may not exercise the

same. For members, financial decision making advice should be sought from persons with high rationality levels and not just those highly educated. Given that Unitas SACCO members have been able to turn their seed value in 2005 14 times compared with their Stima counterparts who are more learned, this is a sure indicator that rationality measure is a superior measure. It was found out that wild guesses are detrimental to achievement for wealth maximization for the firm as well as the economy. Job mismatch, a common feature in employment practice should be alleviated. This causes the holder of the position make decisions which they are not trained to do resulting to guesses. SACCO managements should desist from selecting candidates on the basis of paper qualification convictions. At personal level, economic agents need to be trained to minimize financial decisions out of whims. To this end, SACCO members should actively engage respective managements during education days and from other sources to secure as much information as possible to assist them in make the right financial decisions. This will no doubt increase the general rationality levels of the masses thereby increasing overall productivity of the SACCO members and the Kenyan people by extension.

It is definite that prospects of wealth increase after a rational decision should be increased. However, this should happen only if the proportion of rational decisions taken is either increasing or remains constant otherwise increasing this probability will be counterproductive. For this reason the two should be emphasized together. Findings from the combined effect of the determinants showed that from the current position, both prospects of wealth increase after irrational and after rational decision making should be reduced for rationality to increase. SACCO managements have already reached their local rationality maximum, for any increase in p value is as of 2005 counterproductive. Both p and q values should therefore be reduced with a greater emphasis on reduction of q to set SACCO managements on a rationality increasing trend.

Wealth movement is the most important and sensitive variable. It guides all possible interventions in possible applications of this theory. Most importantly, this variable determines the proportion of rational decisions made per unit time. The simple average rate of use of heuristics by managements is 21.67% compared to 26. 67%. This means that in general, SACCO managements are more rational than their members as expected. From figure 4.23, it was clear that if SACCO members increase their wealth increase updating points from 8 to 14, they would achieve the maximum rationality level. They should also reduce their error rates to operate at a more desirable rationality level. This intervening variable was also instrumental in forecasting future rationality at specific time points. Having established that the chosen determinants are fit to estimate rationality levels under various conditions, this validates the related models in chapter 3 including a deterministic continuous model as shown in Table 5.1. Various forms of the model, the variables and parameters have been shown. The discrete time model can determine among others, indecision level (including decisiveness), irrationality level, updating period and consistency of updating. The continuous time model may be used to derive deterministic and stochastic rationality levels.

By adjusting the three key questions involving p, q and r, Entropy-q Rationality Theory can be applied to develop an education system. Most education systems are developed based on developmental psychology. By identifying human development times where education rationality is high, complex content to be learned may be slotted. Arising directly from this study, it was identified that there is dissonance within Mwalimu National SACCO members' with management's rationality structure. Where rationalities are so different between the agent and principle, agency conflict thrives. As well, this theory may be used to identify the dominant emotions when gains or losses are posted by economic agents. As noted before, fear and sadness promotes rational decision making while happiness and anger promotes irrationality.

Table 5.1: Summary of Entropy Rationality Model and related equations

Model application form	Symbolic function	Variables/parameters
Stochastic discrete time		Where Γ is financial decision making rationality; r is prior knowledge; p is the prospect of gain after a rational decision; q is prior knowledge; p is the prospect of gain after an irrational decision; r_D is the proportion of decisions made out of total encountered.
1. Overall model	$\Gamma_{(R)} = \frac{crp^i(1-p)^d}{rp^i(1-p)^d + (1-r)\mathrm{q}^i(1-q)^d}$	
2. Decisiveness	$\Gamma_{(D)} = \frac{r_D p^i(1-p)^d}{r_D p^i(1-p)^d + (1-r_D)\mathrm{q}^i(1-q)^d}$	
3. Irrationality	$\Gamma_{(IR)} = \Gamma_{(D)} - \Gamma_{(R)}$	$\Gamma_{(IR)}$ is irrationality level
4. Indecision	$\Gamma_{(IN)} = 1 - \Gamma_{(D)}$	$\Gamma_{(IN)}$ is indecision level
5. Updating period	$Updating\ period = \frac{n}{i+d}$	n is the number of months. The quantity measures time taken to update a block of financial
6. Updating Consistency Rate	$\Gamma_c = \frac{(i+d)_{calc}}{(i+d)_{real}}$	$(i+d)_{calc}$ is the actual iterated numbers; $(i+d)_{real}$ is fitting diffusion path numbers;
Stochastic continuous time	$\Gamma_t = \Gamma_{t-1} + \frac{1}{\mu\frac{1}{\Gamma_{t-1}}\Delta t + \sigma\frac{1}{\Gamma_{t-1}}\varepsilon\sqrt{\Delta t}}$	μ is the drift and σ is the variance of an Ito-Bayesian process. ϵ is a normally distributed random
Deterministic continuous time	$\Gamma = \begin{Bmatrix} 1 - a\exp bx^c, & \text{for all } 0 \le x \le SDA \\ kx(x+2SDA) + h, & k \le 0,\ \forall x \ge SDA \end{Bmatrix}$	a, b, c, k, and h are constants. SDA is senile dementia age

The fact that a range of updating rate of between 55% and 76% means that the difference can be bridged by increasing updating consistency rate. This indicates that the involved persons' businesses are not saturated if they can afford to make mistakes in financial decisions and still post profits. This aspect can be used by the government to structure tax incentives for various sectors in the economy. Employers should use entropy-q rationality theory in recruitment universities should be ranked using entropy changes in their customers, not just facilities which some of them do not use or if they do, it they are used for the unintended purpose. Finally, financial forecasting can be modified from deterministic to stochastic to reflect more realistic forecasts using geometric Brownian motion model. The model contains a stochastic term that includes standard deviation which can be used to calibrate interval estimates to establish desirable confidence limits. The same model can be used to modify the deterministic learning curve into a stochastic learning curve. In strategic human resource management, the finding that men rationalize one and a half times the decisions rationalized by women, by profiling decision volumes and sensitivity of decisions of various positions in an organization, management may do better staffing than previously by employing the concept of activity based staffing. Better still, these research findings can be used to calibrate the efficient market hypothesis on a numerical continuum. The government can use rationality measure to structure tax incentives and/or rebates as a better measure of tax progressivity.

5.5 Suggested areas for further research

Since correlations show that all the variables relationships are non-linear, researchers are called upon to investigate on an applicable continuous function. Infact, it was tempting to assume a quadratic relationship going by the shapes of the curves involved. However, a closer examination revealed that the relationship is not quadratic. This area needs further research to disclose more about the subsisting relationship between variables now that the model is new. The model is discrete; if an equivalent continuous model would be fitted, more analysis would be possible by exploiting differentiability

properties. Most new concepts discovered and named herein have not been tested by other researchers including the model itself. This research has many areas to inform in public policy formulation.

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APPENDICES

Appendix 1: Bayesian backward iterated rationalities indicating rationality value at birth

year	r	q	p	entropy	i	d	Rat
0yrs	**0.0136**	0.2664	0.8553	0.8801	1	0	0.0027
	0.0027	0.2722	0.8529	0.8528	1	0	0.0085
	0.0085	0.278	0.8505	0.8261	0	1	0.0254
	0.0254	0.2838	0.8481	0.8000	1	0	0.0722
	0.0722	0.2896	0.8457	0.7744	1	0	0.1852
	0.1852	0.2954	0.8433	0.7494	1	0	0.0481
	0.0481	0.3012	0.8409	0.7249	1	0	0.0114
	0.0114	0.3070	0.8385	0.7009	0	1	0.0305
	0.0304	0.3128	0.8361	0.6775	0	1	0.0773
9yrs	0.0773	0.3186	0.8337	0.6545	1	0	0.1798
	0.1798	0.3244	0.8313	0.6321	1	0	0.3597
	0.3597	0.3302	0.8289	0.6102	1	0	0.5851
	0.5851	0.3360	0.8265	0.5887	1	0	0.7762
	0.7762	0.3418	0.8241	0.5677	0	1	0.4810
	0.481	0.3476	0.8217	0.5472	1	0	0.6866
	0.6866	0.3534	0.8193	0.5272	1	0	0.8355
	0.8355	0.3592	0.8169	0.5076	1	0	0.9203
	0.9202	0.3650	0.8145	0.4884	1	0	0.9626
	0.9626	0.3708	0.8121	0.4697	0	1	0.8849
	0.8849	0.3766	0.8097	0.4514	0	1	0.7012
19yrs	0.7013	0.3824	0.8073	0.4336	1	0	0.6073
	0.4228	0.3882	0.8049	0.4161	1	0	0.6030
	0.603	0.3940	0.8025	0.3991	1	0	0.7557
	0.7557	0.3998	0.8001	0.3825	1	0	0.8609
	0.8609	0.4056	0.7977	0.3663	0	1	0.6781
	0.6782	0.4114	0.7953	0.3505	1	0	0.8029
	0.8029	0.4172	0.7929	0.3351	1	0	0.8856
	0.8856	0.4230	0.7905	0.3201	1	0	0.9353
	0.9353	0.4288	0.7881	0.3054	1	0	0.9637
	0.9637	0.4346	0.7857	0.2912	0	1	0.9096
	0.9097	0.4404	0.7833	0.2773	0	1	0.7960
29yrs	0.7961	0.4462	0.7809	0.2638	1	0	0.8723

Appendix 2: Discrete time rationality updating age limit by SACCO members for the entire group

	r	q	p	entropy	i	d	Rat
	0.8723	0.452	0.8	0.3	1	0	0.9217
	0.9217	0.4578	0.8	0.2	1	0	0.9523
	0.9523	0.4636	0.8	0.2	1	0	0.9708
	0.9708	0.4694	0.8	0.2	0	1	0.9348
	0.9348	0.4752	0.8	0.2	1	0	0.9587
	0.9587	0.481	0.8	0.2	1	0	0.9737
	0.9737	0.4868	0.8	0.2	1	0	0.9831
	0.9831	0.4926	0.8	0.2	1	0	0.989
	0.989	0.4984	0.8	0.2	0	1	0.9773
	0.9773	0.5042	0.8	0.1	0	1	0.9548
39yrs	0.9548	0.51	0.8	0.1	1	0	0.969
	0.969	0.5158	0.8	0.1	1	0	0.9785
	0.9785	0.5216	0.7	0.1	1	0	0.985
	0.985	0.5274	0.7	0.1	1	0	0.9893
	0.9893	0.5332	0.7	0.1	0	1	0.9807
	0.9807	0.539	0.7	0.1	1	0	0.9859
	0.9859	0.5448	0.7	0.1	1	0	0.9896
	0.9896	0.5506	0.7	0.1	1	0	0.9922
	0.9922	0.5564	0.7	0.1	1	0	0.9941
	0.9941	0.5622	0.7	0.1	0	1	0.9903
	0.9903	0.568	0.7	0.1	0	1	0.9846
49yrs	0.9846	0.5738	0.7	0.1	1	0	0.9878

	r	q	p	entropy	i	d	Rat
	0.9878	0.5796	0.7	0.0492	1	0	0.9903
	0.9903	0.5854	0.7	0.0438	1	0	0.9921
	0.9921	0.5912	0.7	0.0388	1	0	0.9935
	0.9935	0.597	0.7	0.034	0	1	0.9907
	0.9907	0.6028	0.7	0.0296	1	0	0.9922
	0.9922	0.6086	0.7	0.0254	1	0	0.9933
	0.9933	0.6144	0.7	0.0216	1	0	0.9942
	0.9942	0.6202	0.7	0.0181	1	0	0.995
	0.995	0.626	0.7	0.0149	0	1	0.9936
	0.9936	0.6318	0.7	0.012	0	1	0.992
59yrs	0.992	0.6376	0.7	0.0095	1	0	0.9927
	0.9927	0.6434	0.7	0.0072	1	0	0.9933
	0.9933	0.6492	0.7	0.0052	1	0	0.9938
	0.9938	0.655	0.7	0.0036	1	0	0.9941
	0.9941	0.6608	0.7	0.0023	0	1	0.9935
	0.9935	0.6666	0.7	0.0012	1	0	0.9937
	0.9937	0.6724	0.7	0.0005	1	0	0.9939
	0.9939	0.6782	0.7	0.0001	1	0	0.9939
	0.9939	0.684	0.7	0	1	0	0.9939
	0.9939	0.6898	0.7	0.0002	0	1	0.9941
	0.9941	0.6956	0.7	0.0007	0	1	0.9944
69yrs	0.9944	0.7014	0.7	0.0016	1	0	0.9942

A simple calculation of the age limit gives **67.27** years at the entropy of zero. Past this point all increases convert into decreases such that the process becomes meaningless. This interprets to mean that a rationality level of 0.61% (100%-99.39%) above 99.39% can never be reached. This value has been named **intrinsic irrationality**.

Appendix 3: Entropy-q Rationality Table

Entropy-q Rationality Model Table (extract) for i= 1-20 and d = 1-3
Γ = ar/{ar +(1-r)b}; a = p^i(1-p)^d ; b=q^i(1-q)^d ; Updating Consistency of 100%

p or	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
d	1	1	1	1	1	1	1	1	1
i=1	0.09	0.16	0.21	0.24	0.25	0.24	0.21	0.16	0.09
2	0.009	0.032	0.063	0.096	0.125	0.144	0.147	0.128	0.081
3	0.0009	0.0064	0.0189	0.0384	0.0625	0.0864	0.1029	0.1024	0.0729
4	0.00009	0.00128	0.00567	0.01536	0.03125	0.05184	0.07203	0.08192	0.06561
5	9E-06	0.000256	0.001701	**0.006144**	0.015625	0.031104	**0.050421**	0.065536	0.059049
6	9E-07	5.12E-05	0.00051	0.002458	0.007813	0.018662	0.035295	0.052429	0.053144
7	9E-08	1.02E-05	0.000153	0.000983	0.003906	0.011197	0.024706	0.041943	0.04783
8	9E-09	2.05E-06	4.59E-05	0.000393	0.001953	0.006718	0.017294	0.033554	0.043047
9	9E-10	4.1E-07	1.38E-05	0.000157	0.000977	0.004031	0.012106	0.026844	0.038742
10	9E-11	8.19E-08	4.13E-06	6.29E-05	0.000488	0.002419	0.008474	0.021475	0.034868
11	9E-12	1.64E-08	1.24E-06	2.52E-05	0.000244	0.001451	0.005932	0.01718	0.031381
12	9E-13	3.28E-09	3.72E-07	1.01E-05	0.000122	0.000871	0.004152	0.013744	0.028243
13	9E-14	6.55E-10	1.12E-07	4.03E-06	6.1E-05	0.000522	0.002907	0.010995	0.025419
14	9E-15	1.31E-10	3.35E-08	1.61E-06	3.05E-05	0.000313	0.002035	0.008796	0.022877
15	9E-16	2.62E-11	1E-08	6.44E-07	1.53E-05	0.000188	0.001424	0.007037	0.020589
16	9E-17	5.24E-12	3.01E-09	2.58E-07	7.63E-06	0.000113	0.000997	0.005629	0.01853
17	9E-18	1.05E-12	9.04E-10	1.03E-07	3.81E-06	6.77E-05	0.000698	0.004504	0.016677
18	9E-19	2.1E-13	2.71E-10	4.12E-08	1.91E-06	4.06E-05	0.000489	0.003603	0.015009
19	9E-20	4.19E-14	8.14E-11	1.65E-08	9.54E-07	2.44E-05	0.000342	0.002882	0.013509
20	9E-21	8.39E-15	2.44E-11	6.6E-09	4.77E-07	1.46E-05	0.000239	0.002306	0.012158
d	2	2	2	2	2	2	2	2	2
i=1	0.081	0.128	0.147	0.144	0.125	0.096	0.063	0.032	0.009
2	0.0081	0.0256	0.0441	0.0576	0.0625	0.0576	0.0441	0.0256	0.0081
3	0.00081	0.00512	0.01323	0.02304	0.03125	0.03456	0.03087	0.02048	0.00729
4	0.000081	0.001024	0.003969	0.009216	0.015625	0.020736	0.021609	0.016384	0.006561
5	8.1E-06	0.000205	0.001191	0.003686	0.007813	0.012442	0.015126	0.013107	0.005905
6	8.1E-07	4.1E-05	0.000357	0.001475	0.003906	0.007465	0.010588	0.010486	0.005314
7	8.1E-08	8.19E-06	0.000107	0.00059	0.001953	0.004479	0.007412	0.008389	0.004783
8	8.1E-09	1.64E-06	3.21E-05	0.000236	0.000977	0.002687	0.005188	0.006711	0.004305
9	8.1E-10	3.28E-07	9.64E-06	9.44E-05	0.000488	0.001612	0.003632	0.005369	0.003874
10	8.1E-11	6.55E-08	2.89E-06	3.77E-05	0.000244	0.000967	0.002542	0.004295	0.003487
11	8.1E-12	1.31E-08	8.68E-07	1.51E-05	0.000122	0.00058	0.00178	0.003436	0.003138
12	8.1E-13	2.62E-09	2.6E-07	6.04E-06	6.1E-05	0.000348	0.001246	0.002749	0.002824
13	8.1E-14	5.24E-10	7.81E-08	2.42E-06	3.05E-05	0.000209	0.000872	0.002199	0.002542
14	8.1E-15	1.05E-10	2.34E-08	9.66E-07	1.53E-05	0.000125	0.00061	0.001759	0.002288

15	8.1E-16	2.1E-11	7.03E-09	3.87E-07	7.63E-06	7.52E-05	0.000427	0.001407	0.002059
16	8.1E-17	4.19E-12	2.11E-09	1.55E-07	3.81E-06	4.51E-05	0.000299	0.001126	0.001853
17	8.1E-18	8.39E-13	6.33E-10	6.18E-08	1.91E-06	2.71E-05	0.000209	0.000901	0.001668
18	8.1E-19	1.68E-13	1.9E-10	2.47E-08	9.54E-07	1.62E-05	0.000147	0.000721	0.001501
19	8.1E-20	3.36E-14	5.7E-11	9.9E-09	4.77E-07	9.75E-06	0.000103	0.000576	0.001351
20	8.1E-21	6.71E-15	1.71E-11	3.96E-09	2.38E-07	5.85E-06	7.18E-05	0.000461	0.001216
d	3	3	3	3	3	3	3	3	3
i=1	0.0729	0.1024	0.1029	0.0864	0.0625	0.0384	0.0189	0.0064	0.0009
2	0.00729	0.02048	0.03087	0.03456	0.03125	0.02304	0.01323	0.00512	0.00081
3	0.000729	0.004096	0.009261	0.013824	0.015625	0.013824	0.009261	0.004096	0.000729
4	7.29E-05	0.000819	0.002778	0.00553	0.007813	0.008294	0.006483	0.003277	0.000656
5	7.29E-06	0.000164	0.000833		0.003906	0.004977	0.004538	0.002621	0.00059
6	7.29E-07	3.28E-05	0.00025	0.000885	0.001953	0.002986	0.003177	0.002097	0.000531
7	7.29E-08	6.55E-06	7.5E-05	0.000354	0.000977	0.001792	0.002224	0.001678	0.000478
8	7.29E-09	1.31E-06	2.25E-05	0.000142	0.000488	0.001075	0.001556	0.001342	0.00043
9	7.29E-10	2.62E-07	6.75E-06	5.66E-05	0.000244	0.000645	0.00109	0.001074	0.000387
10	7.29E-11	5.24E-08	2.03E-06	2.26E-05	0.000122	0.000387	0.000763	0.000859	0.000349
11	7.29E-12	1.05E-08	6.08E-07	9.06E-06	6.1E-05	0.000232	0.000534	0.000687	0.000314
12	7.29E-13	2.1E-09	1.82E-07	3.62E-06	3.05E-05	0.000139	0.000374	0.00055	0.000282
13	7.29E-14	4.19E-10	5.47E-08	1.45E-06	1.53E-05	8.36E-05	0.000262	0.00044	0.000254
14	7.29E-15	8.39E-11	1.64E-08	5.8E-07	7.63E-06	5.02E-05	0.000183	0.000352	0.000229
15	7.29E-16	1.68E-11	4.92E-09	2.32E-07	3.81E-06	3.01E-05	0.000128	0.000281	0.000206
16	7.29E-17	3.36E-12	1.48E-09	9.28E-08	1.91E-06	1.81E-05	8.97E-05	0.000225	0.000185
17	7.29E-18	6.71E-13	4.43E-10	3.71E-08	9.54E-07	1.08E-05	6.28E-05	0.00018	0.000167
18	7.29E-19	1.34E-13	1.33E-10	1.48E-08	4.77E-07	6.5E-06	4.4E-05	0.000144	0.00015
19	7.29E-20	2.68E-14	3.99E-11	5.94E-09	2.38E-07	3.9E-06	3.08E-05	0.000115	0.000135
20	7.29E-21	5.37E-15	1.2E-11	2.37E-09	1.19E-07	2.34E-06	2.15E-05	9.22E-05	0.000122

7.29E-11 = 7.29 x 10^{-11}; 9.28E-08 = 9.28 x 10^{-8} etc

Example: The finance manager has instructed the human resource officer to hire only persons with an updating period of six months. A prospective employee increases productivity five times in three years and has p and q values of 0.7 and 0.4 respectively. Given that at the hiring time point the person rationalizes his decisions at a rate of 60%, find the expected rationalization rate at the end of a three year contract period, assuming an updating consistency rate of 100%.

Solution:

$\Gamma = ar/\{ar +(1-r)b\}$

From the table, $a = p_{(5,1)} = 0.050421$; $b = q_{(5,1)} = 0.006144$ and $r = 0.6$

Plugging in a and b values yields an expected rationality level of **0.9249**

Appendix 4: **Raw Data Summary** Table A

	No. of obs. ((1)	Avg Age (2)	Educ Level index (3)	LOT-R score/ 24 (4)	Initial Rat (5)	Current Rat (6)	Indecision rate r_d =2005 (7)	Indecision rate r_d 2015 (8)	Pr(Inc| Rat=0) 2005 (9)	Pr(Inc| Rat=0) 2015 (10)	Pr(Inc| Rat=1) 2005 (11)	Pr(Inc| Rat=1) 2015 (12)	Drift (13)	Std Dev (14)	Wo (Sh'000) Avg (15)
Mwalimu	**91**	41.0	3.19	16.92	0.6250	0.8887	0.6011	0.6025	0.4069	0.4208	0.7177	0.6667	0.1505	0.2330	350
Female	44	41.4	3.28	17.11	0.6686	0.8977	0.6161	0.6399	0.4215	0.5727	0.6964	0.6802	0.1298	0.2943	350
Male	47	40.6	3.11	16.74	0.5851	0.8803	0.5878	0.5692	0.3936	0.4149	0.7367	0.6543	0.1699	0.1883	350
Mgt	**16**	38.7		17.25	0.6438	0.7031	0.5938	0.5313	0.6328	0.4141	0.7969	0.7188	**0.1540**	**0.1646**	**8,073,526**
Stima:	**47**	36.8	2.26	16.73	0.7083	0.8587	0.6750	0.6306	0.4028	0.4755	0.6833	0.6333	0.2814	0.2579	320
Female	15	38.0	2.33	16.07	0.6583	0.8583	0.7333	0.6667	0.4250	0.4250	0.6750	0.5833	0.3703	0.1052	320
Male	32	36.2	2.23	17.07	0.7333	0.8589	0.6458	0.6125	0.3917	0.5000	0.6875	0.6583	0.2577	0.2987	320
Mgt	**14**	30.5		17.25	0.5417	0.7857	0.4479	0.4375	0.4327	0.5000	0.7788	0.7946	**0.3208**	**0.2304**	**23,209**
Unitas:	**133**	38.4	1.28	17.29	0.6808	0.8471	0.6505	0.7464	0.4691	0.5013	0.6506	0.6601	0.2889	0.46036	140
Female	66	38.8	1.27	17.52	0.6862	0.8484	0.6402	0.7883	0.5756	0.5387	0.6463	0.6438	0.3341	0.48781	140
Male	67	38.0	1.3	17.07	0.6795	0.8432	0.3750	0.7045	0.3843	0.4727	0.6203	0.6297	0.2536	0.43771	140
Mgt	**16**	30		17.25	0.4643	0.7232	0.6583	0.5750	0.5625	0.5268	0.6833	0.7109	**0.2735**	**0.09034**	**827,386**
Age:	**3**	22	2	18.33	0.5000	0.8750	0.1250	1.0000	0.4167	0.6667	0.6667	0.8333			
	15	27	2.08	13.87	0.5469	0.8047	0.7031	0.6016	0.3750	0.4643	0.5893	0.5982			
	35	32	1.79	17.49	0.7386	0.8144	0.6581	0.6894	0.3788	0.5000	0.6667	0.6970			
	47	37	1.74	17.4	0.7324	0.8869	0.7143	0.7645	0.5219	0.5500	0.6612	0.6285			
	35	42	1.91	17.34	0.6679	0.9036	0.5735	0.6464	0.3250	0.4393	0.6821	0.6357			
	30	47	2.46	17.27	0.6595	0.8060	0.6042	0.6125	0.5750	0.4917	0.6466	0.5345			
	17	52	2.24	16.82	0.8089	0.8677	0.6397	0.6764	0.3456	0.2794	0.7059	0.7279			
	5	57	2	17.4	0.8750	0.9000	0.7	0.7	0.35	0.35	0.4	0.4			
Gender:															
Female	125	39.9	1.931	17.08	0.6936	0.8552	0.6642	0.7128	0.4760	0.4481	0.6628	0.6417	0.2735	0.4047	241.7
Male	146	38.9	2.02	17.18	0.7009	0.8495	0.6179	0.646	0.3952	0.4813	0.6611	0.6418	0.2335	0.3518	241.7
SACCOS Overall	317	39.4	1.98	17.13	0.6978	0.852	0.6382	0.6754	0.4296	0.4674	0.6618	0.6418	0.2508	0.3941	241.7

Appendix 4: Raw Data Summary TableA

Notes to table A:

1. Column (3) indicating education index ranks as 1 for High School or below, 2, for Diploma, 3 for Bachelors degree, 4, for Masters degree and 5 for PhD qualification. The index is the weighted average for every group.
2. Column (4) indicates optimism/pessimism levels of respondents measured by the Life Orientation Test – Revised (Scheier, 1994). This measure is important in transforming subjective probabilities to objective probabilities in seeking objective conclusions. The measure has been used to formulate the operational data summary table 4.2.
3. Column (5) shows subjective prior probabilities of making a rational decision in 2005 (r) as one of the three independent variables while column (6) shows the subjective posterior probabilities of making a rational decision in 2015 i.e. after learning for 10 years. Colum (6) will directly affect financial decision making rationality.
4. Columns (7) and (8) show indecision levels of economic agents for 2005 and 2015. It may be noted the economic agents generally grow indecisive with age hence economic shrewdness decline with age.
5. Columns (9) and (10) for years 2005 and 2015 respectively show the level of belief in luck in respondents otherwise hereinafter referred to as the level of guesswork financial in decision taking.
6. Columns (11) and (12) for years 2005 and 2015 respectively shows the level of belief of an agent that a rational decision is beneficial.
7. Columns (13) shows the average rate of increase of assets assumed to follow and Ito process, while column (14) indicates the inherent volatility in the process as measured by standard deviation
8. Column (15) shows the initial monetary assets level as at end of 2005 ignoring inflation effects.

Appendix 5: Operational data summary Table B

	No. of obs. (1)	Avg Age (2)	Educ Level index (3)	Delta (4)	Initial Rat (5)	Current Rat (6)	Indecision rate $r_{d=2005}$ (7)	Indecision rate r_{d} 2015 (8)	Pr(Inc| Rat=0) 2005 (9)	Pr(Inc| Rat=0) 2015 (10)	Pr(Inc| Rat=1) 2005 (11)	Pr(Inc| Rat=1) 2015 (12)	Drift (13)	Std Dev (14)	Wo (Sh'000) Avg
Mwalimu	**91**	41.0	3.19	0.634	0.7971	0.9808	0.7681	0.7698	0.4540	0.4796	0.8884	0.8483	0.1505	0.2330	350
Female	44	41.4	3.28	0.633	0.8450	0.9836	0.7875	0.8151	0.4817	0.7314	0.8711	0.8562	0.1298	0.2943	350
Male	47	40.6	3.11	0.634	0.7472	0.9781	0.7499	0.7255	0.4294	0.4688	0.9031	0.8296	0.1699	0.1883	350
Mgt	**16**	38.7		0.633	0.8173	0.8769	0.7329	0.6707	0.8070	0.4681	0.9424	0.8891	**0.1540**	**0.1646**	**8,073,526**
Stima:	**47**	36.8	2.26	0.634	0.8800	0.9699	0.8505	0.8036	0.4464	0.5778	0.8584	0.8061	0.2814	0.2579	320
Female	15	38.0	2.33	0.636	0.8321	0.9700	0.8993	0.8407	0.4859	0.4859	0.8489	0.7429	0.3703	0.1052	320
Male	32	36.2	2.23	0.633	0.9012	0.9708	0.8215	0.7832	0.4265	0.6205	0.8631	0.8347	0.2577	0.2987	320
Mgt	**14**	30.5		0.633	0.6866	0.9361	0.5301	0.5111	0.5021	0.6205	0.9319	0.9411	**0.3208**	**0.2304**	**23,209**
Unitas:	**133**	38.4	1.28	0.632	0.8576	0.9665	0.8274	0.9113	0.5686	0.6237	0.8275	0.8374	0.2889	0.46036	140
Female	66	38.8	1.27	0.632	0.8627	0.9670	0.8162	0.9380	0.7365	0.6831	0.8229	0.8202	0.3341	0.48781	140
Male	67	38.0	1.3	0.633	0.8556	0.9646	0.3956	0.8781	0.4128	0.5740	0.7926	0.8035	0.2536	0.43771	140
Mgt	**16**	30		0.633	0.5592	0.8934	0.8347	0.7346	0.7171	0.6637	0.8582	0.8835	**0.2735**	**0.09034**	**827,386**
Age:	**3**	22	2	0.629	0.6246	0.9774	0.0486	0.9999	0.4759	0.8465	0.8465	0.9615			
	15	27	2.08	0.644	0.6832	0.9420	0.8690	0.7590	0.3900	0.5493	0.7430	0.7546			
	35	32	1.79	0.632	0.9058	0.9811	0.8352	0.8656	0.4031	0.6215	0.8440	0.8724			
	47	37	1.74	0.632	0.9012	0.9806	0.8870	0.9234	0.6570	0.7000	0.8385	0.8031			
	35	42	1.91	0.632	0.8452	0.9854	0.7336	0.8230	0.3250	0.5152	0.8589	0.8112			
	30	47	2.46	0.632	0.8367	0.9476	0.7740	0.7842	0.7360	0.6076	0.6466	0.6767			
	17	52	2.24	0.634	0.9483	0.9738	0.8139	0.8519	0.3413	0.2289	0.8786	0.8965			
	5	57	2	0.632	0.9768	0.9845	0.8750	0.8750	0.3501	0.3501	0.4428	0.4428			
Gender:															
Female	125	39.9	1.931	0.633	0.8142	0.9471	0.7817	0.8341	0.5242	0.4811	0.7802	0.7553	0.2735	0.4047	241.7
Male	146	38.9	2.02	0.633	0.8211	0.9438	0.7247	0.7591	0.4229	0.5311	0.7771	0.7544	0.2335	0.3518	241.7
SACCOS Overall	317	39.4	1.98	0.633	0.8182	0.9451	0.7505	0.7739	0.452	0.5104	0.7785	0.7548	0.2508	0.3941	241.7

Notes to table B:

1. Column (4) is a transformation of column (4) of table 4.1 to obtain parameter delta using the equation

$$\delta = 0.69 - \{\text{LOT(R)} / 24\} * 0.08$$

, for the equation: $p_s = \frac{{p_o}^{\delta}}{\left\{ {p_o}^{\delta} + (1 - p_o)^{\delta} \right\}^{1/\delta}}$, where p_o and p_s are objective and subjective probabilities respectively (Kahneman and Tversky, 1992).

2. Columns (5) to (12) with the exclusion of column (6) , indicate transformed subjective probabilities into objective probabilities;
3. Column (6) indicates financial decision making rationality using objective posterior probabilities (2015).
   Financial decision making rationality = Pr[Rat=1](1) + Pr[Rat=0](0) e.g. for Mwalimu, 0.9808(1) + (1-0.9808)(0) = 0.9808.
4. All other columns remain the same as in table A.

Appendix 6: DATA COLLECTION QUESTIONNAIRE FOR THE SACCO MEMBER 15A

The purpose of this questionnaire is to collect data to assist the researcher complete an academic course. You are humbly requested to fill it and submit it back earliest possible. You are promised that all the information provided will be treated confidentially. **Kindly be as honest as possible. DO NOT WRITE YOUR NAME** anywhere. There is possibility that the researcher can guide you to use the questionnaire for your personal decisions appraisal. Feel free to contact 0722-276580.

PART A: BIODATA

1. Kindly indicate your age bracket (in years) by ticking in the appropriate box

20 – 24	25 – 29	30 – 34	35 – 39	40 – 44	45 – 49	50 – 54	55 – 59	60 and above

2. Indicate your gender as appropriate by ticking Male Female
3. Are you formally employed or self employed ? Tick appropriately.
4. If in formal employment indicate your job group
5. Kindly indicate your level of education in the appropriate box

High School	Diploma	Bachelors Degree	Masters Degree	Doctorate (PhD)

PART B: SELF PERCEPTION

Please answer the following questions about yourself by indicating the extent of your agreement using the following scale; indicate as appropriate in the box at the end of each question.

[0]= strongly disagree [1] = disagree [2] = neutral [3] = agree [4] = strongly agree

6. When I am not sure of things to come, I usually expect the best
7. It is easy for me to relax
8. If I sense something can go wrong with me, it will go wrong
9. I am always expecting good things about my future
10. I enjoy my friends a lot
11. It is important for me to keep busy
12. It is very unlikely that things to go my way

13. I do not get upset too easily ☐

14. It is difficult for good things to happen to me ☐

15. Overall, I expect good things to happen to me than bad ☐

PART C: FINANCIAL DECISION MAKING

16. Prior knowledge

a) Level of information

i) In 2005, I used to make financial decisions only after collecting **sufficient information** about them (tick appropriately in the boxes labelled 1, 2, 3, to show your extent of agreement/disagreement).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) In 2005 I always ensured to **learn** for my mistakes in financial decision making (tick appropriately).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

b) Decision urgency

i) In 2005, all my financial decisions were normally **urgent**

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) In 2005, all my financial decisions were **important**

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

c) Cognitive style

i) In 2005, I was usually influenced more by **logic** than **values** in my financial decision making (tick appropriately)

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) In 2005, I was mainly driven more by **fairness** than **compassion** in my financial decision making (tick appropriately)

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6		8	9

d) Incidental affect

In 2005, my **mood** determined whether or not I will think through before taking a financial decision (tick as appropriate)

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

17. Prospects of wealth increase after irrational decision making

a) Integral affect

i) In 2005, the **history** of a product and my **attitude** when I saw it determined whether or not I will buy it. (tick appropriately)

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) In 2015 the **history** of a product and my **attitude** when I saw it determined whether or not I would buy it. (tick appropriately)

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

b) Locus of control

i) In 2005, I believed that becoming a success was a matter of **hard work**; luck had nothing to do with success.

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) Unfortunately, in 2005, my financial decision making **quality did not count** in my economic success no matter how well thought out the decisions were.

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

iii) In 2015, I believed that becoming a success was a matter of **hard work**; luck had nothing to do with success.

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

iv) Unfortunately, in 2015, my financial decision making **quality did not count** in my economic success no matter how well thought out the decisions were.

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

18. Prospects of wealth increase after rational decision making

a) Rational choice benefits

i) I always **recorded wealth increase in 2005**from analyzing information before making financial decisions (tick as appropriate).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) My life was **more organized in 2005** for making well thought out financial decisions

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

iii) I always **recorded wealth increase in 2015**from analyzing information before making financial decisions (tick as appropriate).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

iv) My life was **more organized in 2015** for making well thought out financial decisions

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

b) Rational choice costs

Reasoning out my financial decisions in 2005 was such **a bother** (tick as appropriate)

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

i) I **always suffered financial loss** in 2005for analyzing information too much before making a financial decision (tick as appropriate)

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) Reasoning out my financial decisions in 2015 was such **a bother** (tick as appropriate)

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

iii) I **always suffered financial loss** in 2015for analyzing information too much before making a financial decision (tick as appropriate)

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

c) Self efficacy

i) In 2005, I **felt able** to achieve most of the financial goals I was had set for myself (tick as appropriate).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) When faced with financial decision making difficulty in 2005, I was **certain to overcome** (tick as appropriate).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

iii) In 2015, I **felt able** to achieve most of the financial goals I was had set for myself (tick as appropriate).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

iv) When faced with financial decision making difficulty in 2015, I was **certain to overcome** (tick as appropriate).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

19. Financial decision making rationality

a) Likelihood of making a reasoned out decision

i) In 2015 I always believed **I could get all the information** needed about a financial decision (tick appropriately).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) In 2015 I always ensured to **collect all the available information** about a financial decision before processing it (tick appropriately).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

iii) In 2015, I used to make financial decisions only after **logically processing available information** about them (tick appropriately).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

b) Likely hood of not making a reasoned out decision

i) In 2015 I never **bothered to collect information** about a financial decision before processing it (tick appropriately).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) In 2015, I never **used to process information** about financial decisions before taking them (tick appropriately).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

20. Kindly estimate your assets monetary value including the value of education acquired in each of the following years, to the nearest thousands.

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Ksh											

Appendix7: DATA COLLECTION QUESTIONNAIRE FOR THE SACCO MANAGEMENT STAFF 15B

The purpose of this questionnaire is to collect data to assist the researcher complete an academic course. You are humbly requested to fill it and submit it back earliest possible. You are promised that all the information you will provide will be treated confidentially. **Kindly be as honest as possible. DO NOT WRITE YOUR NAME** anywhere. There is possibility that the researcher can guide you to use the questionnaire for your personal decisions appraisal. Feel free to contact 0722-276580.

PART A: BIODATA

1. Kindly indicate your age bracket (in years) by ticking in the appropriate box

20 – 24	25 – 29	30 – 34	35 – 39	40 – 44	45 – 49	50 – 54	55 – 59	60 and above

2. Indicate your gender as appropriate by ticking | Male | Female |
3. Categorize your official management rank as: (tick as appropriate)

Top level	Middle Level	Lower Level

PART B: SELF PERCEPTION

Please answer the following questions about yourself by indicating the extent of your agreement using the following scale; indicate as appropriate in the box at the end of each question.

[0]= strongly disagree [1] = disagree [2]= neutral [3]= agree [4]= strongly agree

4. When I am not sure of things to come, I usually expect the best ☐
5. It is easy for me to relax ☐
6. If I sense something can go wrong with me, it will gone wrong ☐
7. I am always expecting good things about my future ☐
8. I enjoy my friends a lot ☐
9. It is important for me to keep busy ☐

10. It is very unlikely that things to go my way ☐
11. I do not get upset too easily ☐
12. It is difficult for good things to happening to me ☐
13. Overall, I expect good things to happen to me than bad ☐

PART C: FINANCIAL DECISION MAKING

14. Prior knowledge

a) Level of information

i) In 2005, the SACCO management used to make financial decisions only after collecting **sufficient information** about them (tick appropriately in the boxes labelled 1, 2, 3, to show your extent of agreement/disagreement).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) In 2005, the SACCO management used to always ensure to **learn** for past mistakes in financial decision making (tick appropriately).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

b) Decision urgency

i) In 2005, all the SACCO's financial decisions were normally **urgent**

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) In 2005, all the SACCO's financial decisions were **important**

Strongly	Disagree	Moderately	Mildly	undecided	Mildly	Moderately	Agree	Strongly

disagree		disagree	disagree		agree	agree		agree
1	2	3	4	5	6	7	8	9

c) Cognitive style

i) In 2005, the SACCO management used to be influenced more by **logic** than **values** in its financial decision making (tick appropriately)

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) In 2005, the SACCO management was mainly driven more by **fairness** than **compassion** in my financial decision making (tick appropriately)

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6		8	9

d) Incidental affect

In 2005, the SACCO's **mood** determined whether or not it would think through before taking financial decisions (tick as appropriate)

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

15. Prospects of wealth increase after irrational decision making

a) Integral affect

i) In 2005, the **history** of a product and the SACCO management's **attitude** towards it determined whether or not it would buy it. (tick appropriately)

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) In 2015, the **history** of a product and the SACCO management's **attitude** towards it determined whether or not it would buy it. (tick appropriately)

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

b) Locus of control

i) In 2005, the SACCO management believed that becoming a success was a matter of **hard work**; luck had nothing to do with corporate success.

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) Unfortunately, in 2005, the SACCO's financial decision making **quality did not count** in the SACCO's economic success no matter how well thought out the decisions were.

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

iii) In 2015, the SACCO management believed that becoming a corporate success was a matter of **hard work**; luck had nothing to do with success.

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

iv) Unfortunately, in 2015, the SACCO's financial decision making **quality did not count** in the SACCO's economic success no matter how well thought out the decisions were.

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

16. Prospects of wealth increase after rational decision making

a) Rational choice benefits

i) The SACCO always **recorded wealth increase** in 2005from analyzing information before making financial decisions (tick as appropriate).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) The SACCO's financial state was **more organized** in 2005 for making well thought out financial decisions

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

iii) The SACCO **always recorded wealth increase** in 2015from analyzing information before making financial decisions (tick as appropriate).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

iv) The SACCO's financial state was **more organized** in 2015 for making well thought out financial decisions

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

a) Rational choice costs

i) Thinking through financial decisions in 2005 was such **a bother** to the SACCO management (tick as appropriate)

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) The SACCO management **always suffered** in 2005for analyzing information too much before making a financial decision (tick as appropriate)

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

iii) Thinking through financial decisions in 2015 was such **a bother** for the SACCO management(tick as appropriate)

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

iv) The SACCO management **always suffered** in 2015for analyzing information too much before making a financial decision (tick as appropriate)

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

c) Self efficacy

i) In 2005, the SACCO **felt able** to achieve most of the financial goals I was had set for itself (tick as appropriate).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) When faced with financial decision making difficulty in 2005, the SACCO was **certain to overcome them** (tick as appropriate).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

iii) In 2015, the SACCO **felt able** to achieve most of the financial goals I was had

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

set for myself (tick as appropriate).

iv) When faced with financial decision making difficulty in 2015, the SACCO was **certain to overcome them** (tick as appropriate).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

15. Financial decision making rationality

a) Likelihood of making a reasoned out decision

i) In 2015 the SACCO management always believed **it could get all the information** needed about a financial decision (tick appropriately).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) In 2015 the SACCO management always ensured to **collect all the available information** about a financial decision before processing it (tick appropriately).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

iii) In 2015, the SACCO management used to make financial decisions only after **logically processing available information** about them (tick appropriately).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

b) Likely hood of not making a reasoned out decision

i) In 2015 the SACCO management never **bothered to collect information** about a financial decision before processing it (tick appropriately).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

ii) In 2015, the SACCO management never **used to process information** about financial decisions before taking them (tick appropriately).

Strongly disagree	Disagree	Moderately disagree	Mildly disagree	undecided	Mildly agree	Moderately agree	Agree	Strongly agree
1	2	3	4	5	6	7	8	9

PART D: RETURN ON ASSETS SCHEDULE

18. List the total assets amount for year 2005 and the subsequent retained earnings for years 2006 through 2015 for your SACCO (secondary data).

	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total assets											
Retained earnings											

Appendix 8: Wealth forecast algorithm in R statistical package

```
Wt.1  <-  0
DeltaWt <- 0
DeltaWtlooper <- 0
timee <- 80
inters <- 10000
for(t in 1:timee)
{
Wt.1[1] = 8073526
DeltaWtlooper <- 0
for( k in 1:inters)
{
DeltaWtlooper[k] <- 0.25*0.149*Wt.1[t] + 0.5*0.1646*Wt.1[t]* rnorm(1,0,1)
}

DeltaWt[t] <- mean(DeltaWtlooper)



Wt.1[t+1] <- Wt.1[t] + DeltaWt[t]

}
plot(1:(timee+1),(Wt.1), type="l", xlab="Time", ylab="Wealth")

#Wealth at time t`
Wt.1[52]
```