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Economic Rationality-based Entrepreneurial vs. Employee Orientations by Entropy, Updating and Error Rates Computing: Evidence of Kenyan Credit Unions

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Abstract: Unemployment is one of the greatest concerns of economies. Strong advocacy for entrepreneurship development by way of creating an enabling environment for funding entrepreneurs to start own businesses and training to ensure sustainability is an international objective. This paper contrasts financial decision making orientations for credit union entrepreneur members and credit union employee members of Unitas and Stima credit unions respectively who share the same return on assets. Three objectives were pursued. First was to establish that higher entropy does not necessarily result into a higher rationality level. Secondly, the paper set out to show that a low error rate is an important factor that leads to higher rationality levels, which results to better financial performance. Finally, it sought to establish that updating rate is critical to long run financial performance. A 9-point Likert longitudinal data for 2005 and 2015 was collected and converted into probabilities. Since the probabilities are subjective, cumulative prospect theory decision weights function was used to transform them into objective probabilities, and then fitted into a multi-period Bayesian rationality model. Unitas members with less than half the potential of Stima members and a lower rationality starting point catch up with Stima members within the 10 years. Stima's endowment of a lower updating period did not give it any advantage. The single all important factor is the updating rate, which worked in favour of Unitas credit union members. The paper recommends that entrepreneurial union members should be supported more by the government to accelerate wealth creation, hence job creation.

Keywords: entropy, updating rate, error rate, decision weights function, entropy-q rationality model

Introduction

Unemployment is probably the greatest economic concern in the world. Existing organizations and business enterprises are not sufficient avenues of providing employment, hence calling for more individuals to venture out and identify human needs requiring address; and produce goods and services to meet the needs, thereby creating employment through entrepreneurship. The International Labour Organization in 2011 lamented that only 23.5% of the youth in the world are employed, yet poorly so. Economic transformation of societies will hence require entrepreneurship (Salazar-Xirinachs, 2012). This creates broadly, two groups of people in the economic production arena. One comprising employees earning a living by being formally hired by assorted organizations and the other one entrepreneurs who establish and run own business enterprises.

To represent these groups are two credit unions; namely, Unitas and Stima, which happen to among the best performers in year 2012 (SASRA, 2013). Incidentally, one of the characteristics of the entrepreneurial group studied (Unitas) was that they were high school dropouts or graduates. These are therefore likely to be necessity entrepreneurs (Brewer and Gibson, 2014). A majority of Stima members studied are Kenya Power Limited employees. The entrepreneurial orientation is represented by Unitas while employee orientation by Stima credit unions respectively. Both groups share the same return on assets. This paper sought to provide evidence of these different economic decision making orientations and the accompanying rationality progression over a ten year period 2005 through 2015. Entropy-q rationality model was used to show that entrepreneurs' as opposed to employees' economic rationality is composed of different proportions of the component variables in the model, and that therefore these combinations can then be used to craft a recruitment criterion for employees and possibly a funding criterion for the entrepreneurs especially start-ups. The paradox examined is the perception that more educated individuals should be better wealth makers (Adcroft, Willis & Dhaliwal, 2004).In the foregoing sections, Bayesian decision and bounded rationality theories are reviewed; then the entropy-q rationality model is introduced. Methodology comprised derivation of updating and error rates computation, for ten year wealth movement diffusion.

Statement of the Problem and Objectives

McCloskey's (1990) question "if you're so smart, why aren't you rich?" features prominently in this paper. While many a scholars opine that education is the key to economic prosperity, may be not directly or rather not necessarily through entrepreneurship. However, it has been found out that a higher level of entrepreneurial activity was higher in more educated immigrants within the OECD countries than the less educated immigrants (Neupert & Baughn, 2013) agreeably so. But there is a caveat here. In the unpublished research conducted in 2016, it was found out that the potential of financial decision making ability of credit union members was positively correlated with relative entropy but negatively correlated with education. Surprisingly, education was highly correlated with relative entropy; where entropy is the difference in individual prospects of benefiting from rational financial decisions from prospects of benefitting from irrational decisions (Kirika, 2016). This means that there is substantial concurrence with McCloskey's question. If education is the key to entrepreneurial generated riches, then educated people should be the richest. This paper sought to provide evidence for this claim and to numerically establish what brings about this difference in wealth accumulation between the educated and the less educated. The problem is why does this difference exist? Why the paradox, that all nations are investing heavily in education; yet the highly educated do not create as much wealth as the low educated cadres? Is there a quantitative model that isolates specific determinants of financial decision making behaviour to explain this disparity?

In general, necessity entrepreneurs possess limited cognitive decision making potential by reason of low end education achievement as compared to opportunistic or even the serial ones (Block and Koellinger, 2009). By implication, necessity entrepreneurs should accumulate the least wealth in the long run. In contrast, employees formally engaged acquire such status by reason of higher education achievement. Their private lives are expected to be a reflection of their enormous potential and endowment. Unfortunately, in the long run, these necessity entrepreneurs are likely to accrue more wealth than formal employees. Formal employees make more financial decisions mistakes than their low end counterparts (Kirika, 2016). A critical point here is that both necessity entrepreneurs and formal employees under consideration reside in the same city; and therefore can fairly access similar services and financial information. This shows existence of structural economic decision making setting unique to each group even if they share similar economic decision making rationality levels, such that necessity entrepreneurs accumulate more wealth in the long run. While the general objective was to distinguish these two financial decision making orientations; entrepreneurial and employment quantitatively, the three specific objectives pursued were as follows. First, to establish the effect of entropy, this is proportional to decision volume; on financial decision making rationality.

According to the law of maximum entropy, maximization of the overall entropy of the variables in question maximizes performance (Jaynes, 1957). Any business man starts one with a view of making profits perpetually. However, factors beyond control of the entrepreneur come into play in ordinary life like crop failure for the farmer or market failure for the merchandise enterprises leading to losses. On the part of the employee, medical bills for chronic diseases for example may alter the intended wealth trajectory in a certain period of wealth creation. These countable wealth decreases have been referred to as error rate. In this connection, the paper secondly, set out to determine the effect of error rate on financial decision making rationality. Finally, it has been observed that human beings do not regularly update their lessons (Manktelow, 2012) in their subsequent decision behaviour to secure more informed decisions. If a son, holding brief in shop keeping for his hospitalized father, requests the father how much of a particular stock should be ordered, the father cannot have solid ground to respond to the question. This is because he has not been around to track new customers and any new information. Any response given to the son will contain some base rate neglect. Base rate neglect is the opposite of updating rate. This takes us to the final objective; to establish the effect updating rate on financial decision making rationality, hence financial performance measured by wealth level.

Literature Review

Examination of economic decision making behaviour patterns requires a look at how humans process information. People make decisions on the basis of two sources of information: the objective external source and the internal source which usually combines cognitive and affective domains. They make mistakes often but never intend to make them (Jones, 1999). The fact that they make mistakes reveals that they are sometimes irrational implying that their rationality is bounded (Simon, 1996). To this end, a short digression into bounded rationality theory suffices.

Bounded Rationality Theory

This theory states that human beings economic rationality is never complete for two reasons: one, they possess limited cognitive processing ability even if all information relevant to a decision was available. Secondly, it is never possible to have all information pertinent to a decision all the time. So, humans make ‘satisficing’ (good enough) decisions instead of completely rational decisions (Simon, 1996). Often times, people take decisions without fully processing available information owing to time constraints yet the decision is urgent. This is against one of the assumptions of rational decision making model, that there is no cost or time constraint to a decision. Lots of empirical evidence exists on bounded rationality. It has been cited that sustainable supply chain management was hampered by bounded rationality on the part of managers (Roenhrich, Grosvold and Hoejmose, 2014). In a different scenario where real estate investments were examined, the more fundamental rationality assumption by neo-classical economics was rejected (Bruin and Flint-Hartle, 2003). It was found that investors are not completely rational. Again, in a study conducted in Germany, it was found that farmers do not immediately switch to new banks offering lower interest rates. This was partly attributed to migration charges and partly due to bounded rationality. Farmers underestimated financing costs by about 10 times (Musshoff and Hirschauer, 2011). In the light of this evidence, Bayesian decision theory has been used to construct a rationality measuring tool which was used in analyzing the data collected.

Bayesian Decision Theory and Cumulative Prospect Theory

Also known as the probability of causes (Hume, 2003), Bayes theorem determines the probability of an event A was a consequence of finite one of the events B_1, B_2, B_3… B_n. This applies for a single time period process. Further, this process can be aggregated for multiple time periods; which has been used to derive rationality levels that accord with bounded rationality theory discussed previously. On the basis of Bayes theorem, Bayesian decision theory and model derive. Besides, the same breadth of logic gives birth to Bayesian statistics which is considered more accurate than the conventional frequentist statistics (Murphy and Longo, 2009). Analysis by Bayesian decision theory entails two dimensions: observable variable dimension and the unobservable variable dimension (Bolstad, 2010). In this case, the observable variable dimension is wealth while the unobservable dimension is the rationality level that generated the wealth. While it is possible to analyze any finite number of prior activities, only two possibilities were envisaged. Either wealth increases or decreases (binomial). This setting leads to equation 1.

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

Where, Γ = current economic rationality

c = updating consistency rate – the ratio of updating to total decision points
r = prior probability of making a rational decision
p = prospects of wealth increase after a rational economic decision
q = prospects of wealth increase after an irrational economic decision
i = number of wealth increases observed
d = number of wealth deceases observed

Entropy, Updating Rate and Error Rate

This refers to the distance (scalar) between two probability distributions also known as Kullback-Leibler’s divergence. According to the maximum entropy principle, the highest entropy generates the highest productivity as represented in equation 2.

$$D(q \Vert p) = \sum_{x \in \chi} q(x) \ln \frac{q(x)}{p(x)} = I_{(q)} p \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(2)}$$

In this case, high rationality level is generated by individuals with high entropies. But not just entropy, two individuals with same entropies may generate different rationality levels other factors held constant. This difference emanates from different q- values. Recall that q represents prospects of posting a wealth increase after making an irrational decision. This is equivalent to expecting gain from illogical decisions like gambling. This q-value is inversely proportional to entropy, so that higher the q-value, lower the entropy level. The composite effect brings about the quantity entropy-q, which means the quotient of entropy with q-value in equation 3.

$$q\ln(q/p)+(1-q)\ln\{(1-q)/(1-p)\} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. (3)$$

Unfortunately, most empirical studies involving Bayesian analysis suffer from validity issues by reason of use of subjective probabilities. This problem has been adequately addressed through the use of decision weights function from cumulative prospect theory by Kahnemann and Tversky (1992). Part of economics definition, from which finance branches, is that it 'examines that part of individual and social action most closely connected with the attainment and use of material well being (Marshall, 1890). The individual possesses two components with regard to economic decisions; the rational and irrational component. The rational component forms the foundation of classical and neo-classical economics, while the irrational component forms the basis of behavioural economics or behavioural finance. The irrational component derives from human biases owed to the affective domain. To transform subjective probabilities into objective ones from whose analysis objective findings may emerge, the decision weights function is used. This is a single parameter model, where the parameter δ is the level of individual optimism measured by the Life Orientation Test – Revised (Scheier, 1994) as shown in equation 4.

Methodology

A 9-point Likert Longitudinal data for 2005 and 2015 collected from Unitas and Stima credit unions within Nairobi metropolitan was converted into probabilities by deducting 1 from each score to make the observations continuous by including the 0-1 interval which would have been excluded and would have caused distortion in analysis. The scores were then interpolated within the [0, 1] probability interval. These probabilities were subjective, so they were transformed into objective probabilities by processing through the decision weights function equation 4 (Kahneman & Tversky, 1992).

$$p_s = \frac{{p_o}^{\delta}}{\left\{ {p_o}^{\delta} + (1-p_o)^{\delta} \right\}^{1/\delta}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots. (4),$$

Where p_s = subjective probability

p_o = objective probability

δ = coefficient of optimism

Using iteration method on an excel spreadsheet; the minimum number of i and d were obtained which preserve continuity. The model is discrete, therefore not differentiable. Definitely, higher rationality levels generate superior economic decisions to lower rationality levels. Let us also recall that the super-ordinate goal of an individual is to maximize their economic welfare, whose primary measure is return on assets. Other measures like return on sales usually apply especially in balance sheet presentation. Devoid of mistakes or misfortunes in business, these return measures yield exponential assets or wealth increases throughout over time as shown in figure 1.

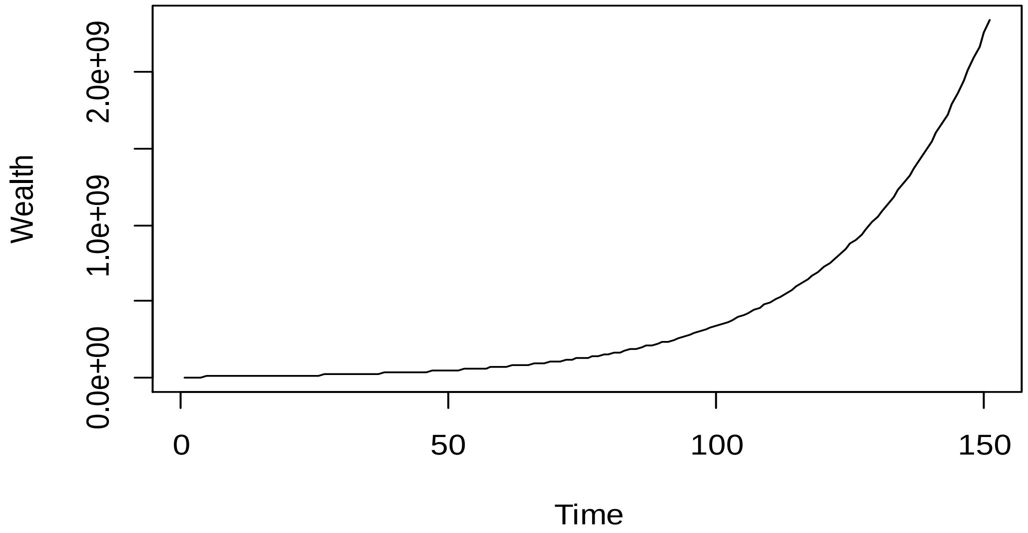

Figure 1: Idealistic wealth increases over time

However, this is idealistic. In reality, businesses and individuals alike, experience assorted shocks in the ordinary business of life to post highs and lows over time. This is the real picture depicted in figure 2 & 3 and summarized in table 1 on the consecutive rows of number of increases and decreases, where i's representing increases is accompanied by a number of d's. This figure 1 shows an initial level (W_o shown on table 1) of wealth on the basis of which the next level is generated exhibiting the Markov property as is used in financial accounting. That every subsequent financial period's income depends on the immediate previous level of capital; fits pretty much with Markov property. Figures 2 and 3 show a projection of wealth in 2015 for Unitas and Stima members per individual, including the increases and decreases shown in table 1.The graph is generated by simulation using the R-statistical software. From these two figures 2 and 3, a wealth level of Ksh2, 050,000 and Ksh2, 900,000 average per member for Unitas and Stima respectively. Then from table 1, initial wealth levels were Ksh140, 000 and Ksh340, 000 for Unitas and Stima respectively. Finally, simple workings of the number of times each member has turned the original value gives 2,000,000/140,000 = 14.286 times and 2,667,000/340,000 = 8.334 times for a Unitas member and Stima member respectively.

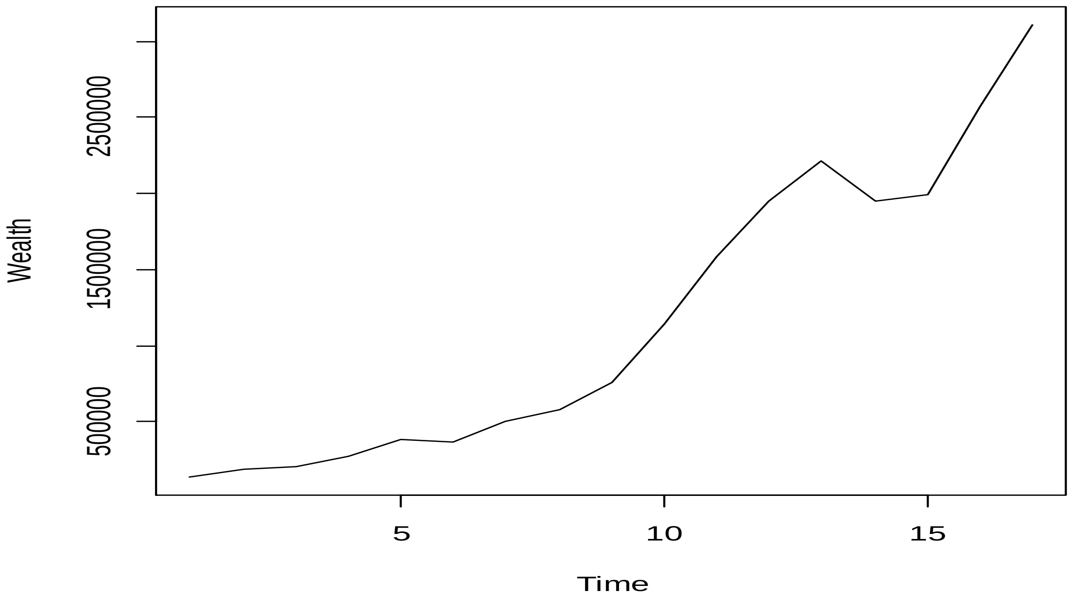

Figure 2: Average Unitas members' wealth projection by 2015 (time 15) using initial wealth in 2005 (time 0)

Unlike Unitas members, Stima members recorded 30 decisions within the 10 years. This is twice as much as Unitas; displaying enormous potential. This number of decisions is also supported by the slightly more than twice entropy of the Stima members.

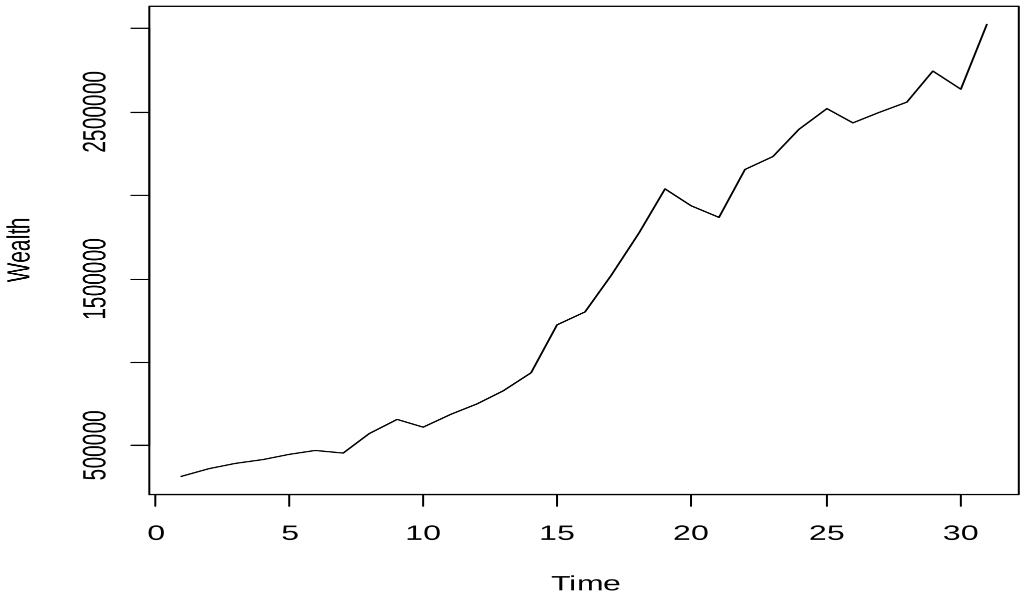

Figure 3: Average Stima members' wealth projection by 2015 (time 30) using initial wealth in 2005 (time 0)

The summary of findings is shown in table 1. From this table, rationalities of both groups get to the same point of declared rationality values of 0.9669 and 0.9693 by year 2015 from an original of 0.8576 and 0.88 for Unitas and Stima respectively. However, the potential of Unitas in terms of entropy is slightly less than half of that of Stima. Ten years later, Unitas members who are entrepreneurs catch up with Stima members who are employees in formal employment by virtue of having acquired tertially level education. Update time is then computed using equation 5 and which yields 10 months and 6.316 months respectively for Unitas and Stima members respectively. This means that within the 10 year period, Stima members updated after every 6.316 months while Unitas members, by reason of low level of education, took 10 months to update their learning of economic decision making in the lives.

$$\text{Update time} = \frac{120}{i+d} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(5)}$$

Table 1: A summary of Unitas and Stima credit unions' entropy-q, update rate and error rates

Credit Union Group	Unitas Members (necessity entrepreneurs)	Unitas Mgt (SACCO employees)	Stima Members (company employees)	Stima Mgt (SACCO employees)
r	0.8576	0.5592	0.88	0.6866
q	0.5962	0.6904	0.5121	0.5613
p	0.8325	0.8709	0.8323	0.9365
entropy	0.1563	0.1105	0.2723	0.5606
Number of increases (i)	10	12	14	15
Number of decreases (d)	2	1	5	3
Declared rationality in 2005 (a)	0.8576	0.5592	0.8800	0.6866
Declared rationality in 2015 (b)	0.9665	0.8934	0.9699	0.9361
Declared period rationality (avg) (c)	0.9543	0.8029	0.9724	0.9134
Return rate	0.2889	0.2735	0.2814	0.3208
Standard deviation	0.4604	0.0903	0.2579	0.2304
Net worth (W_o Sh'000) in 2005	**140**	**827,386**	**320**	**23,209**
Net worth (W_o Sh'000) in 2015	**2000**	**9,283,271**	**2,667**	**262,494**
Update time = 120/(i+d)	10	9.231	6.316	6.667
Error rate = d/(i+d)	0.1667	0.1667	0.2632	0.2
Update rate (d)	0.8	0.8667	0.6333	0.75
Real rationality for the period (c)x(d)	**0.7634**	**0.6959**	**0.6158**	**0.6851**
Wealth (net worth) turnover	**14.286times**	**11.22times**	**8.334times**	**11.31times**

Most surprising was that out of the 12 updates recorded by Unitas members, only 2 were wealth decreases; an error rate of 16.67%. In contrast, out of the 19 updates recorded by Stima members, 5 of them led to the process error rate of 26.32%. Coupled with this is the updating rate. From table 1, Unitas updating rate stands at 0.8 while that of their Stima counterparts is 0.63. This means that Unitas members make reference to previous learning 80% of the time while Stima members do so 63.3% of the time. Unitas members are more alert compared to Stima members. Paraphrased, the levels of guess work in financial decision making are 20% and 36.7% for Unitas and Stima members respectively. Error rate and Updating rate led to Unitas members' rationality level to increase at a higher rate, almost catching up with Stima members' rationality level by 2015 despite the enormous potential of Stima members expressed in entropy terms. The effect of updating rate results in real rationality levels of 76.34% and 61.58% for Unitas and Stima members respectively. Noting that Stima members had a higher average of declared rationality of 0.9724 compared to 0.9543 for Unitas, it means that updating rate bears such a devastating effect.

The long and short of it is that employees are more laid back in their financial decision making decisions. This practice is observed in behaviours like not bargaining for public transport fares, making high cost house hold consumer goods that match their social class seeking to be more esteemed by their peers among others. Employees have more time to attend the gym and conclude the work day with a drink in favorite joints.

These tendencies predispose the employee to higher irrational consumption and investment behaviour unlike their entrepreneurial friends in Unitas credit union. Unitas members who are self employed care a lot about all the resources at their disposal for survival. They close shop at upwards of 9.00 pm, are more price sensitive than Stima members, plan their off-duties properly to ensure their small businesses do not lose their customers, care less about their social class and are therefore able to save more money in the long run compared to Stima members. This has made this class of people create more jobs sustainably than formally employed individuals. Self employed people are less financially included. This goes a long way inculcating good saving habits. In the meantime, the formally employed are inclined to betting habits and over rely on loans, leading to debt vicious cycles. This is, in the long run, likely to turn them into dependants especially where drug addiction is involved. The government should give the entrepreneurial group the required attention.

Conclusion

It is common place to assume that education leads to acquisition of formidable potential for wealth creation hence a better position in social stratification. This study has however revealed that the grave assumption is only one of several determinants and that it may not be the most crucial. While high entropy endows the individual a high potential for wealth creation, it must be accompanied by other ingredients of updating rate and error rates favourably. While error rate may at times be uncontrollable by the individual, updating rate is purely an individual’s effort and which, from this study, emerged as the most critical. Unitas members are necessity entrepreneurs who seek to eke a living from small and medium business enterprises. They are very careful not to engage in financial decisions detrimental to their survival. For example a green grocer must wake up very early to get to the market to secure purchases at wholesale prices and back to their premises probably in the estates in good time to display merchandise for customers. This daily profit is what the grocer survives on. This is typical of a Unitas SACCO member, who possesses an entrepreneurial orientation and who in the long run outperformed the formal employee in wealth creation. On the other hand, The Stima SACCO member – formally employed, who justifiably claims that they invested in education early in life can afford to wake up late, get to their work station late, and somewhat still receive their salary intact come month end. This habit breeds complacency which leads to making many financial decisions which are not well thought out. For instance, this employee may secure a loan to buy expensive smart phones and other gadgets in the comfort of their loan ability by reason of job security. This is the employee orientation which results in underperformance in wealth creation in the long run.

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