

THE ENTROPY THEORY IMPLICATIONS IN BEHAVIOURAL FINANCE

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I. Introduction

A short look over the last decade capital markets' evolutions allows us to see that the multiple financial crisis which have shaken the financial system, could be hardly explained using the traditional models where the rational investors determine the asset prices to reflect the net present value of the generated cash-flows. In these conditions, one could include psychology (as methodology and results) as a solution in order to identify the potential causes of the financial crisis, the transmitting and contagions channels, and also to formulate some efficient ways to reduce their outcomes. As Statman [1999,p. 19] said: "...some believe that the behavioural finances introduced the psychology in Finance but psychology never been outside the finance. Even if the behavioural models are different they are all based on psychology".

A large number of researchers centred their papers on the impact investor's psychology has over the capital markets' evolutions. In their seminal work, Tversky si Kahneman [1974] investigate the main heuristics used in incertitude conditions :representatives, availability, adjustability and anchoring. Despite the potential use of the heuristics as a probability valuator for uncertain events they can also generate some important systematic judgement biases. Kahneman and Riepe[1998] are focusing their paper on the preferences and expectation biases which the financial consultants should know in order to be able to formulate recommendations to avoid them or their effects (*systematic rationing errors*:

overconfidence, optimism, exaggerated reactions to events and others, *preference errors* :non-linear probability valuation, value function, the games form and attractiveness ; *using buying price as a referential: narrow framing , short and long term vision; accepting the consequence of the own decisions: the omission and engagement regret, risk assumption regret*). In his book Shefrin [2000] extensively presents a sum of biases induced by heuristics (representatively bias, the law of small numbers, overconfidence, anchoring and adjustment, conservatism, ambiguity aversion, emotions and knowledge) and also frame dependence (loss aversion, mental accounting, emotional aspects, auto control, regret, money illusion). Also the main heuristics and the biases they generate are present in: Hirshleifer [2001] (proposes an detailed and unified version for the most known biases in the context of the investor's psychology and asset valuation); Goldberg and Nitzsch [2001](define heuristics as information processing mechanisms used in order to determine a quick response, not necessary optimal, with reduce effort and divide them in two main categories: heuristics to reduce complexity and euristics for quick judgement); Barberis and Thaler [2003](describe main biases involved in the creation of investors' preferences and opinions), (Altman[2006], Ko,K.,J, Huang,Z.[2006], Peterson[2007].

Despite the development of the behavioural theories, in the last decades, the potentially boundless set of psychological biases that theorist can use to build the imagine of the investors attitude and their decisional system make

this imagine incomplete (Chan, Frankel and Kothari [2002]).In this context since information is the reduction of entropy and all human activities are essentially entropy processes, it is natural to understand human psychology and market patterns from the viewpoint of entropy theory.

The paper has four parts and the first one presents the informational entropy. The second one creates the connexion between entropy theory and the main features of the investors' behaviour on the contemporary capital market and in the third one we are trying to validate some of the capital market patterns using this theory. Fourth part concludes.

II. The entropy theory of information

The informational entropy measures the incertitude associated with a random variable or in other words the medium informational content the receptor loses when does not know the value of the random variable (Shannon[1948]).

The value of information is a probability function with the following proprieties:

- the informational value of two events is higher than the informational value of each of them;
- if the two events are independent one from another, their information value could be written as the sum of the two events' informational values;
- the informational value of any event is non-negative.

The only mathematic function which satisfies all this proprieties and which represents the level of incertitude (when a signal appears the incertitude decreases, as a result of the information), is:

$$H(P) = -\log_b P \tag{1}$$

where b is a positive constant.

Let X be an random event with n discrete states: $x_1, x_2, x_3, \dots, x_n$, each with probability $p_1, p_2, p_3, \dots, p_n$. One could say that the informational value of X is the

average of the each state's informational values.

$$H(X) = -\sum_{j=1}^n p_j \log(p_j)$$

If the probability is 1 then $-\log P=0$ because the value of the known information is zero. When probability approaches to zero the value of the information increases because the less people know it the more valuable is the information.

Even if the access to information is free the user does not always know to understand it and use it.. According to Shannon[1948] the information quantity someone receive could be written as the sent quantity minus the average value of the conditional entropy.

$$R = H(x) - H_y(x) \tag{3}$$

The conditional entropy measures the ambiguity average of the received signal and represents a quantitative estimator for the informational asymmetry .If x and y are independent $H_y(x) = H(x)$ and $R=0$. No information can be transmitted between two independent objects. The deeper is relation between the receiver and the sender the larger amount of information is transferred. The informational entropy theory offers a useful method to quantify the informational asymmetry and shows that the cost of obtaining information is positively correlated with the information's value in opposition with the former opinion which assumes the quantitative side of the informational asymmetry determined in an exogenous way.

III. The entropy law's influence in investor's behavioural pattern

Closed systems have by definition maximum entropy because by entropy law it is easier for a system to disintegrate than to maintain its structure. That is why it is very important to genetically code the main information

and knowledge into heuristics principles in order to reduce the cost of learning. The entropy law influences these heuristics and we will try to present below some of these influences:

1. Conservatism

Humans have the tendency to answer conservatively at any new information and they need a long period of time to adjust the risk aptitude to the new information.

This heuristics is strongly connected with the adjustment and anchoring (as a result of these two heuristics the high individual probability events' conjunction is overestimated and the low individual probability event's disjunction is underestimated).

All these three proprieties could be considered a result of the informational theory. From education 3 one could notice that the receipted information is equal with the send information minus the conditional entropy. The last one decrease when the individual general knowledge regarding the subject increases.

Conservatism and anchoring reflect the gradually decrease of the conditional entropy in the information's receptor.

2. Framing

The individual reaction towards the information usually depends from the way we understand and frame it in a certain importance category.

This category will determine the response's nature and the amplitude at the received signal. One could ask why we are doing this. A potential answer could be offered starting from the Gibbs's inequality:

$$-\sum_{j=1}^n p_j \log(p_j) \leq -\sum_{j=1}^n q_j \log(p_j) \quad (4)$$

Correct only if $q_j = p_j$ and $1 \leq j \leq n$

The left side represents the average uncertainty associated with the event and the right side the uncertainty we associate to the event.

This concept could be also connected to the entropy law because when the access to information increases and the information is correctly framed the new information are easier processed and used leading to a reduction in the conditional entropy, which in this case could be assimilated with some corrections with the difference between the two parts of the inequality.

3. Herd behaviour

The lack of some own experiences regarding the events makes us often in the position of using others experiences and relate to their decisions, in order to reduce the cost of learning. Usually repeating others experiences is almost impossible because the informal and motivational context which lead to this decisions does not exist. This heuristic will reduce the informational entropy because the response to the information is not the one generated by the limited power of the received signal but a copied reaction, starting from what a specialised user will do.

The danger of a wrong choice in the decisional referential exist, case in which the entropy will increase, but usually the effect is in the entropy and informational asymmetry reduction.

4. Overconfidence and optimism

Starting with the most far away moments in history the individual decisions, no matter of their kind, were influenced by overconfidence and optimism. Without them the humanity would not probably survived during the ages.

From the entropy law point of view any biological system as a non-equilibrium system is permanently confronted with a continuous dissipation process. In the absence of the overconfidence and optimism the necessary efforts done in order to

maintain a non-equilibrium system would be unbearable.

5. Goals

The investment behaviour, similar with other behaviours could be considered as oriented to the investor's financial and non-financial goals.

If for economic agents the unique goal is profit maximization for the individual investors the motivational palette is increased including also: the social preferences, equity, altruism, revenge, social status seeking or survival.

The way we understand and use the information is usually connected or determined by our goals because our reactions toward the same signal could be extremely different depending on what are our desires and goals.

From the presented analysis one could notice that some of the patterns which lead to a certain decision (for instance: conservatism, adjustment and anchoring) reflect the constraint induced by the psychics law. Others as framing, herd behaviour or goals seeking are mental attitudes which help us

processing better the information. Still others as overconfidence or optimism are mental attitudes which help us to survive the constant dissipation process endured by all non-equilibrium systems.

IV. Conclusions

Even if the Newtonian laws and mechanisms have been dominant even in the thinking of social sciences for many years life processes are thermodynamic processes instead of mechanical processes.

Finance is a very distinct subject in social science with the main advantage the vast amount of available data offered by the financial markets. These allow us to test better various hypotheses comparing with other fields. This work shows how problems in finance, a data driven and highly technical subject, stimulate researches in much broader areas.

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