Occupy the Financial Niche – Saturation and Crisis (discontinuous decisions)

Ionut PURICA, PhD
Hyperion University Bucharest; puricai@yahoo.com

Abstract: The model presented is proposing an approach that could verify the nonlinear behaviour during a crisis, such that to quantify and predict potential discontinuous behaviour. In this case, the crisis behaviour associated with financial funds reallocation among various credit instruments, described as memes with the sense of Dawkins, is shown to be of discontinuous nature stemming from a logistic penetration in the financial behaviour niche. Actually the logistic penetration is typical in creating cyclic behaviour of economic structures as shown by Marchetti and others from IIASA. A Fokker-Planck equation description results in a stationary solution having a bifurcation like solution with evolution trajectories on a 'cusp' type catastrophe that may describe discontinuous decision behaviour.

Key words: nonlinear models, decision, financial crisis, meme

JEL classification: C3, C61, C62, D7, D87.

Acknowledgements: warm thanks to Prof. Ali Bayard from ECOMOD and to Prof.Giuseppe Furlan from ICTP

1. Social Reality and Collective Behaviour

In a paper from the '80-ties, Marchetti was identifying the spread out of ideas (e.g. technological innovation) as possessing biological properties such as mutation, selection and diffusion. He was concentrating on the most obvious of the three mechanisms i.e. diffusion, identifying logistic penetration and waves of economic behaviour in different domains such as energy. Earlier on Dawkins has developed the notion of meme as a concept that presents biological properties such as reaction, diffusion, mutation, selection, etc. Fashion, as well as other types of behaviour, is described by using this concept.

It occurred to me that several credit memes with the sense of Dawkins are penetrating the niche of the financial instruments portfolio evolving in a logistic way i.e. slowly at the beginning, then bursting to finally saturate. The decision to allocate money to the newly penetrating financial meme may be described by a Fokker-Planck equation whose stationary solution is showing nonlinear behaviour. This model may describe the discontinuous decision to abandon a certain type of credit and allocate the money to the rest of the portfolio. The parameters driving this decision are: cost of risk (potentially measured by e.g. spread or volatility) and benefit (measured by e.g. interest).

2. Dynamics of Memes

The movement of ideas and principles among the members of a collectivity creates a dynamic where socio-cultural niches are formed as described by Popper (1973). To look deeper into the dynamic we will consider the memes introduced by Dawkins (the 'virus-like sentences', in Douglas Hofstadter's terminology) that describe the basic conceptual framework for such an analysis. (Purica, 1988)

There exists a certain intercorrelation of memes in a society that reacts and diffuses among the individuals. If looking at the financial world one may see it meets the typical criteria described above for a niche where the various financial instruments coexist as financial

memes and have a specific dynamics. In what follows we will analyze the way financial memes penetrate and occupy the niche. We must underline that the fact that a given meme species is having a larger part of the niche (call it financial market) depends of the perception by the decision makers of the potential advantage of the instrument. Moreover, it is important to stress that the decision to extend the use of a given instrument is based on perception that feeds from the creation of a collective effect.

The penetration of new financial instruments is done slowly at the beginning and then accelerated, to saturate toward the end. This is typically described by a logistic function. One may notice that this type of behaviour has been shown to describe technology penetration in niches associated to technologies. Marchetti, Nakichenovich, as well as other researchers from IIASA in Laxemburg have extensively done research on the logistic penetration of technologies with important results on the process understanding.

We may note that Marchetti is making an attempt to analyze the evolution of credit taking from banks that identifies some features of the same behaviour, but without identifying the general cause of such behaviour, which is related to decision makers behaviour in the situation of financial institutions. This is where we are bringing some added value in introducing the memes as defined above and describing the discontinuous decision to enhance or abandon money allocation to a given meme.

The logistic behaviour is perceived in the case of financial instruments as moments of crisis when a given instrument after having occupied a large portion of the market (niche) saturates i.e. falls fast.

The data from the previous crises and from the 2007 one are showing the same type of behaviour obviously in relation to different instruments. As we have shown in the beginning of our analysis it seems there are periods of repeated penetration and decrease of some financial meme. See Figure 2 below.

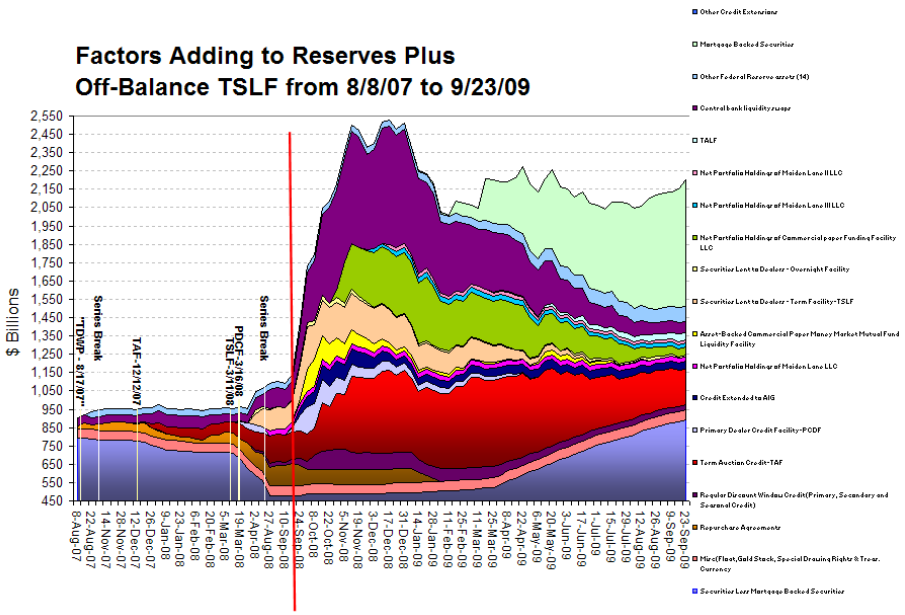

Figure 1. Evolution of various financial instruments in 2007-2008, Source: IAES Conference, Boston oct.2009. A typical logistic behaviour is seen in the niche of financial instruments used, described as memes, showing increase in the sum allocated to some instruments as they occupy larger parts of the financial market to diminish after saturation and switching to other financial memes.

But in the world of today, planning the development of financial systems means having to take into account a large and intricate pattern of various indicators not only

connected with economical aspects, but also with the political, sociological, environmental, etc.

The good fitting of the statistical data by the logistic function is only providing the financial planner with a method to predict the evolution of financial instruments penetration in the future. It does not show how to change and control such an evolution.

The table 1 and associated figure 2, show such penetration related to the evolution of the subprime financial instruments and show their position in the allocation of assets evolution in the US during 1999-2007. This is given in the table 1 below that summarizes the average collateral composition for of 742 Security Asset Backed CDO deals originated between 1999-2007:

Table 1. Average Principal Allocations by Asset-Class. The abbreviations stand for: REL – residential equity loan (includes all RSMB less than prime), RSMB – residential securities mortgage-backed (by prime borrowers), CSMB – commercial securities mortgage backed, other OSAB – other securities asset-backed (including auto-loans, credit-cards, etc.). Source: Lehman Live and Barnatt-Hart (2009)

Year Originating	Deals	REL	RSMB	CSMB	CDO	OSAB
1999	1	0%	14%	9%	3%	74%
2000	16	5%	1%	2%	12%	80%
2001	28	7%	6%	8%	18%	61%
2002	47	16%	6%	7%	8%	63%
2003	44	29%	14%	3%	18%	37%
2004	101	35%	14%	6%	17%	28%
2005	153	37%	16%	10%	11%	25%
2006	217	33%	16%	7%	9%	35%
2007	135	36%	12%	8%	14%	29%

One thing to mention is that we have purposefully slightly changed the names of the instruments from the usual literature ones. This is done specifically to make the reader get out of the interpretation reflexes created by seeing the same names and pay more attention to the fact that more information is taken out of the same data by using the approach we describe here. It is in fact a question of memes perception that we try to change[1].

The evolution of the allocations in table 1 is also shown in the figure 2, below:

[1] The literature names are: (REL) HEL – home equity loan (includes all RMBS less than prime), (RSMB) RMBS – residential mortgage-backed securities (by prime borrowers), (CSMB) CMBS – commercial mortgage backed securities, (OSAB) other ABS – other asset-backed securities (including auto-loans, credit-cards, etc.).

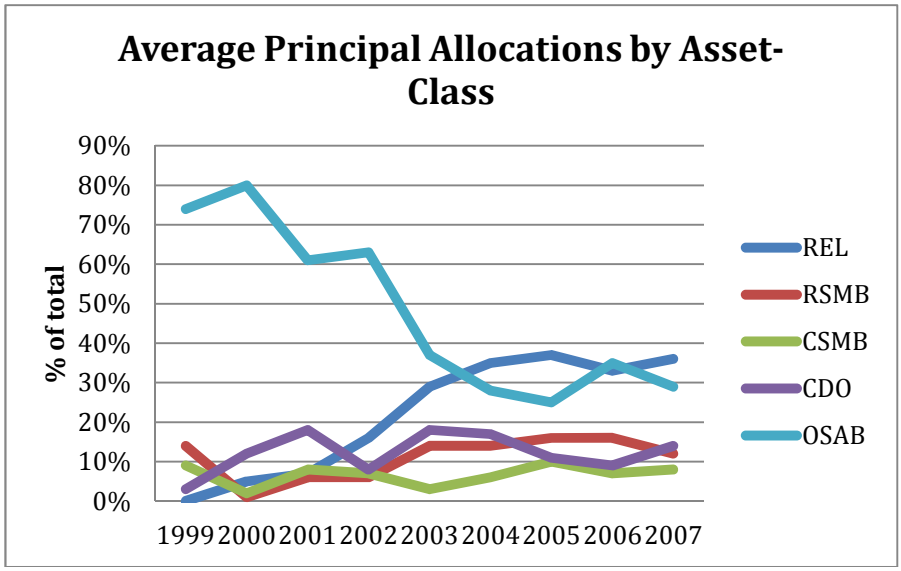

Figure 2. Source: Author calculations based on Lehman Live data in table 1. above.

We are concentrating now on the REL – representing the subprimes. One may see that the evolution in this niche of financial instruments shows a typical case as decribed above, of logistic penetration of an instrument, REL, to the detriment of another, previously dominant one OSAB.

The following figure (3) represents the two instruments and the respective logistic functions resulting from a logistic regression on the two sets of data.

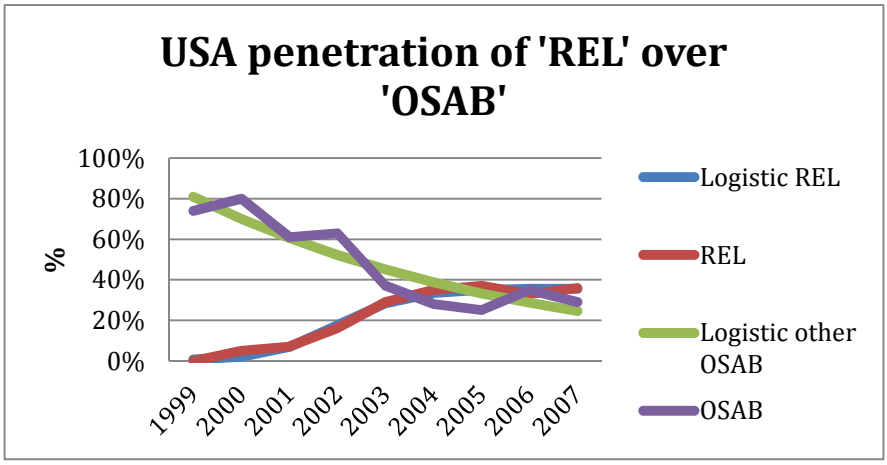

Figure 3. Source: Author calculations based on Lehman Live data

The set of logistic function is presented below:

For REL:

Logistic
REL

a = 263.5
b = 1.388
c = 0.3554

REL=c/(1+a*exp(-b*x))

For OSAB

Logistic OSAB
a = 8.11
b = -0.158
c = 8.5
OSAB=c/(1+a*exp(-b*x))

As seen from the description of the logistic penetration we have here a case of a slow at the beginning, then fast, followed by saturation, penetration of a new financial instrument in the financial niche. This follows a 'sigmoid' curve and takes the niche away from the previous dominant instrument that decays, also following a logistic curve. It is a process described by Marchetti, Nakicenovic, Pry, as well as others having studied this type of process in various domains (niches).

We have shown in our analysis that the process of logistic penetration is actually also happening in the niche of financial instruments that is at the basis of financial systems' operation.

This represents just an experimental assertion, a very important and necessary one, but not a consistent theory, which would provide the criteria and the means for deciding and influencing the evolution of financial systems.

We are trying to provide a means to fill this gap by analysing the case of funds allocation, measured in monetary units, for the intensification of one or the other of two financial instruments in competition, with the imposed or wished variations of the external parameters represented by indicators of benefits and costs of risk control. This way, development decisions may be taken to avoid sudden, unprepared and large discontinuities resulting in impacts that may affect the evolution of the financial programmes.

3. Description of the Model

The main ideas, which have led to the construction of the model are presented extensively in Gheorghe and Purica (1979), Ursu, Gheorghe, Vamanu and Purica (1985), Purica (1991) and Purica (2010). We will only mention that based on the logistic penetration, a Fokker Planck equation is determined for the decision process to allocate funds to a given financial instrument (meme) in competition with the others. The stationary solution of this equation shows a behaviour that can be represented as a trajectory evolving on a cusp type catastrophe having as control parameters the benefits (u) and the costs of risk control (v) (see figures 4 and 5). Close to the edge of the fold, described by the limit curve value v=SQRT(4u^3/27), a small change in the perception of the parameters may trigger a sudden change of behaviour associated to the decision to abandon financing a given financial instrument i.e. 'a financial crisis'.

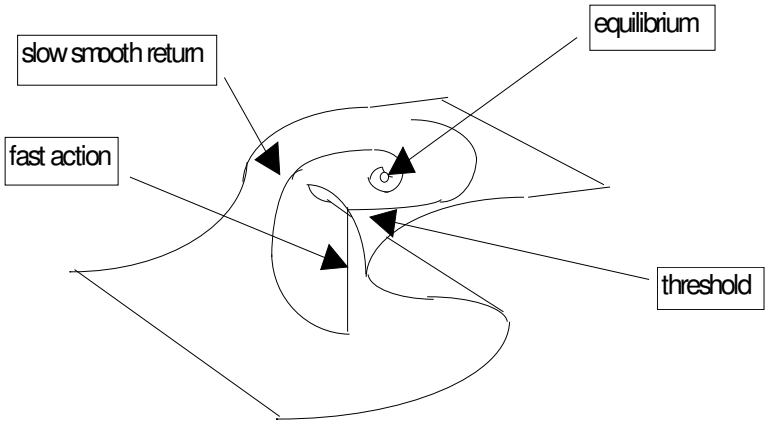

Fig. 4. A flow of trajectories on the cusp fold – potential crisis behaviour Source: done by the Author

The critical border is not crossed if the benefits of the first instruments are increased by, for example, finding new applications for it that are of interest to the society.

In the case of the subprime instruments considered above the trajectory on the cusp surface, as compared to the limit of discontinuity, is depicted in the figure 5 where the limit curve value is v=SQRT(4u^3/27)=2.96 while the value of v_r=POWER(u^2/16*27,1/3) associated to u on the decision trajectory is 2.95, which is a good indication that the evolution trajectory has gone beyond the limit requesting a discontinuous decision to abandon allocating money to this instrument

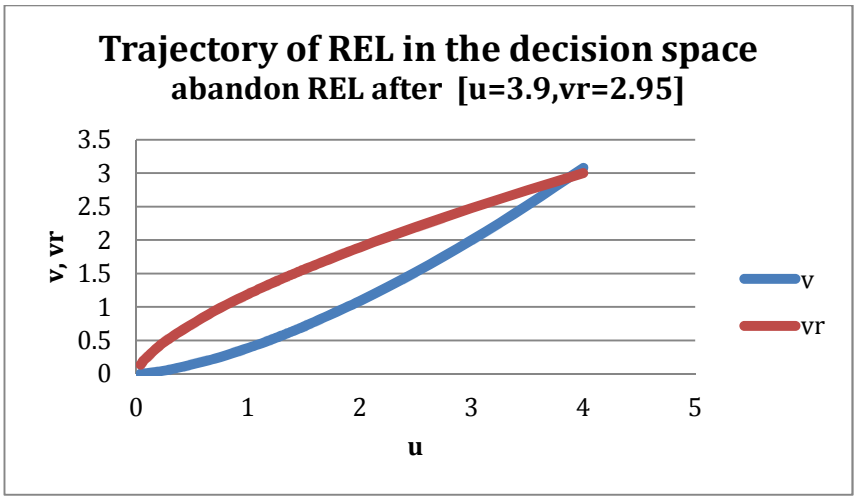

Figure 5. REL trajectory in the decision parameters' space Source author's calculations

The above is another example where numbers that are having a meaning, given by a nonlinear model, may have a greater prediction capacity than the usual linear models we are accustomed with. Of course, the image of a decision trajectory controlled by benefits and cost of risk evolving in a space having various types of limits (possibly moving limits) that may or may not be crossed with associated consequences, is a much better way to visualize this type of behaviour.

4. Conclusions: Beyond resilience – decisions for safety

The question arises of what are the amplitude and frequencies of such shock like efforts, which the nation's economy can still absorb and sustain without being completely perturbed.

We have here the very definition of resilience as given by Haefele (1977). But our model goes beyond that by first being able to discern between the amplitudes of shocks and their frequencies of occurrence, thus giving a limit on amplitude – transferred funds – a limit on frequency, and a limit on the total number of shocks. When any of these are reached, the economy is drastically perturbed.

By extending the mechanical analogy we may define a fatigue limit, measured by the number of cyclic shocks (funds reallocation) an economy can sustain before becoming completely exhausted and being forced to change its whole development in order to recover.

Combined amplitude and frequency effects of shocks may be accommodated within our model.

Another feature of this approach is the possibility to predict the arrival of shocks and, based on their predicted amplitude, to decide the most appropriate variations of the control parameters in order to avoid the shock or to mitigate its consequences if it is accepted.

Being able to make such decisions gives the financial system's planner the possibility to optimize the social effort for financial development, thus contributing to an increase in the nation's economic, social and ecological safety.

5. References

[1] Barnett-Hart, A. K. (2009) The Story of the CDO Market Meltdown: An Empirical Analysis, Harvard College, Cambridge, Massachusetts.

[2] Gheorghe A. and Purica I. (1979). *Decision Behaviour in Energy Development Program.* Preprint, University of Bucharest, Division of System Study, The University Press, Bucharest.

[3] Haefele W. (1977). On Energy Demand. *IAEA General Conference, Vienna*.[give page numbers]

[4] Haken H. (1975). Co-operative Phenomena in Systems far from Thermal Equilibrium and in Non-Physical Systems. *Rev. 01 Mod. Phys.* 47(1).

[5] Marchetti C. and Nakicenovic N. (1978). The Dynamics of Energy Systems and the Logistic Substitution Model. *IIASA* AR-78-18.

[6] Peterka V. (1977). Macro-dynamics of Technological Change: Market Penetration by New Technologies. *IIASA* RR-11-22.

[7] Purica I. (1988). Creativity, intelligence and synergetic processes in the development of science. *Scientometrics* 13(1–2):11–24.

[8] Purica I.(1991). Synergetic application of complex ordered processes. *Proceedings of ENEA Workshops on Non-linear Systems*, vol.3. Maino G.(ed) *Simulation of Non-linear Systems in Physics*. World Scientific Publishing, Singapore, 1991.

[9] Purica I.(2010). Nonlinear Models for Economic Decision Processes, Imperial College Press, London, ISBN 9781848164277.

[10] Ursu I., Gheorghe A., Vamanu D., Purica I. (1985), Socio-economic risk in development of energy systems, Risk Analysis 5(4).