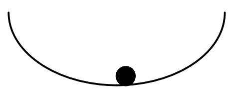
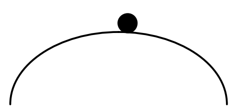
Chapter 1

Introduction: Reasons for Writing this Book, a Decision Theory Approach

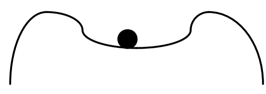
1.1. Introduction

The development of human infrastructure (energy, transport, communications, etc.) at a planetary level and the capability to work with large amounts of data has revealed the existence of limits with regard to both socio-technological and environmental developments. If the limits of technological development have proven to be of the saturation type, i.e., new technologies penetrate to replace the old, saturated ones, environmental evolution shows very clearly that this planet is all we've got. In our striving to master energies at the planetary level, which is not expected to happen in the foreseeable future, we are left with the hope that the environment will be resilient enough to absorb our errors due to our lack of knowledge and inability to accept our limits. Several decision reactions are possible:





'Whatever you do will change nothing' 'Anything you do will change everything'



'Certain things you do will push the system beyond stable equilibrium, others will not'

The perception of change in complex systems and, accordingly, the reaction, show bifurcation-like behaviour especially when one acquires an awareness of the limits (environmental, technological, social, etc.), Linear mentalities like 'whatever you do will change nothing' or 'anything you do will change everything' must be changed in more subtle ways of acting that take into account second-order effects which characterize the behaviour of complex systems. For instance, when building dams to protect against sea-level increase, we should consider the fact that the production of cement for dams represents a source of CO_2, which contributes to the rise in sea level.

During the Middle Ages, the indicator of welfare was the quantity of gold one possessed. Accordingly, the 'research programmes' of those days were aimed at changing everything to gold. Since the emergence of energy-availability limitations, the indicators have changed. Also, the increased complexity of interactions among the various systems (energy, population, economy, environment, etc.) has lead to the introduction of aggregated indicators. The planetary view we have today requires the consideration of the meteo-geographical conditions of each region and the normalization of the specific indicator values in order to make better comparisons. This suggests a personalization of new energy-supply technologies being implemented in various regions, taking into account not only the geographical conditions, but also the social ones, in order to achieve maximum efficiency.

Taking decisions for development has always been based on some type of representation of the process. Various models have served as tools to devise or justify decisions. The mathematics behind these models is usually linear. Since the behaviour of the processes involved is highly non-linear, the approximations made were valid for restricted areas and time intervals. These models were not able to predict the limits beyond which a discontinuous behaviour would occur in systems evolution. Decisions of the type 'quit financing a technology and enhance others' are common in the economy. Only in recent years, non-linear models based on non-linear mathematical tools have made possible the prediction of discontinuous decisions which occur when certain system parameters cross some limit. Although the mathematics involved is more complicated with respect to the linear one, the representation of systems evolution among limits is more straightforward.

Even if the limits are not accepted, they may sometimes be avoided or, in rare cases, crossed with the associated shocks. The capability to absorb shocks and still perform normally (resilience) measures the impact of our decisions for development on the environment, the economy, etc. Alternatively, accepting the limits opens the way to understanding the mutual interactions among the various systems, thus making it possible to change those limits in a sustainable symbiotic evolution.

Negotiating between energy and environmental concerns in development involves information which is not always available, and time constants that may be longer than what we have dealt with. The costs and financial measures implied may lead, for example, to capital accumulations which we are not prepared to control yet, lacking appropriate administrative structures, or may lead to unusually long payback times and the prospect of irreversibly damaging the environment. The present changes in energy generation, transmission, distribution and end-use systems, leading to more players in the market, have raised questions about the role of a regulator which would prevent chaos in the process and thus prevent shocks to the economy. Correlating global change with energy is one of the first projects to consider the interactions among various systems at a planetary scale, opening the way for closer international co-operation.

Geographical research on fuels along with scientific research on conversion technologies were one of the main reasons that led to the development of infrastructure, such as transport, telecommunications, etc., which in turn gave us the consciousness of, and the possibility to monitor, the influence of our activities on the environment.

The ability to perceive changes in the complex systems we interact with has influenced our ways of understanding and consequently modelling more complex behaviours. One should not forget that one of the first classes of models which show 'chaotic' behaviour was aimed at describing meteorological behaviour. (Lorenz, 1963)

1.1.1. Development in a limited environment

One of the basic concepts in non-linear behaviour is that the limit (separatrix, discontinuity) is seen not in the asymptotic way, as in linear theories, but as a drastic change in the behaviour of the system. The limits separate various basins of coherent (possibly linear) behaviour. Crossing the limits is the normal way of evolution for the system. As an example, our decisions for development are, frequently enough, to abandon a certain energy programme and intensify another, or are asymmetric, intensifying a programme with respect to others, as in the case of the nuclear energy in Italy and France. Such decisions may be seen as crossing various types of limits in the 'phase space' of the characteristic parameters of that system.

1.1.1.1. Social limits

When talking about social limits we have a spectrum of quantitative and qualitative parameters to consider. Population is the main quantitative one and in fact refers to two things: first, the purpose of the production in the economic system; second, one of the elements of the production. We must note that the projections we make assume a certain dynamic for the parameters influencing population evolution. The impact of fluctuation events like a Third World War or an epidemic of an unknown virulent disease without adequate medical technology (e.g. the plague in Europe in the Middle Ages) are not considered when making such projections.

On a different line, the economic interactions may be described with models that take into account the geometry of the process. Cities are seen as reactors of economic interactions where the agents are described with neutron physics models. It is shown that the dimension of a city depends on the intensity of the interactions, that the residents' saving profile occurs as a natural saturation process, and that specific indicators such as reaction cross-sections explain in a wider framework Zipf's 'one over income' power-law.

Another parameter which, although measurable, has a more qualitative aspect in the sense of describing socio-economic structuring and order is energy. Lately, the structuring of energy markets has been ongoing in different economies. This process is shown to have optimality as well as the potential to generate chaotic (deterministic chaos) behaviour in the penetration of privates into a contestable market, thus leading to a better explanation of the role of regulatory agencies.

1.1.1.2. Technological limits

The creation and penetration of technologies have been regarded from both economic and anthropologic viewpoints. Here, too, we encounter the type of non-linear behaviour in the dynamics of technology penetration in a given economy. This penetration of new technologies to replace the old, saturated ones is typical non-linear behaviour. The same applies to the shift of choice towards one technology although there existed two or more similar technologies in that field at the beginning. A good example is the video recording systems which started with both Beta and VHS; after a relatively short time the choice shifted to VHS although the other system was perfectly comparable from a technical point of view.

This non-linear behaviour in the dynamics of technology evolution shall be considered later in a more formalized way through a qualitative model. New technologies have been frequently issued in response to a perceived limit in development; they refocus the economy on different resources, some of which were totally unused up to that moment, having even a restructuring effect. Since we now have the perception of having reached the limits of the environment, a new wave of technologies is supposed to arrive, with a restructuring effect on the economies involved.

1.1.1.3. Environmental limits

Although certain limits in local ecosystems have been known for a long time, the planetary environment system is still too complex for us to assess (based on the relatively scarce amount of data we have), This is especially regarding the real importance, in the short and long term, of the limits we have presently identified.

It is certain that there is a strong correlation between the emissions of CO_2 (together with other gases) and the air temperature of the planet. Also it has been ascertained that the integrity of the ozone layer is perturbed by the presence of CFCs in the atmosphere. Butthe extent to which the earth may absorb these perturbations while maintaining conditions innocuous to humans is a thing we would not dare to find out, given our present capability to control the planet.

1.1.2. The perception of changes in complex systems

1.1.2.1. Perception of a complex process

The greenhouse (GH) effect is characterized by a large spectrum of time constants of the involved processes. Certain economic actions may produce an effect on temperature over decades; others may act continuously and screen the long-term tendency of the evolution. The perception of the interaction such as the one between human society and the planetary system is polarized by its high level of complexity.

At one end the interaction may be perceived as ‘do whatever you please; nothing will happen’ or, in other words, a totally absorbent (completely resilient) anthropo-planetary system. However big the shock induced to the system by a certain decision, it will not produce a loss of equilibrium. A physical representation would show the state point of the system inside an infinitely high potential well.

At the other end there is a perception of low resilience: ‘anything you do will ruin everything’. The physical representation of such a case shows the system’s state point on top of a potential hill: any shock will move it out of the equilibrium position.

Between these two extremes the interaction may be summed up as ‘certain things you do will push the system beyond stable equilibrium, others will not’. This involves a finite depth of the characteristic potential well; i.e., certain shocks may push the state point of the system out, either to non-equilibrium positions or to other equilibriums.

1.1.2.2. From simple to aggregate

The simplest method used for getting an image of the dynamics is to show the evolution of each indicator separately. Although this offers a good way to predict the future values of each indicator, it does not allow foreseeing the global system behaviour.

To characterize the interaction we have to start using combined/aggregated indicators. If, for example, in the hydro-dynamical systems we are very much accustomed to criterial numbers (Reynolds, Prandl, etc.) resulting as a combination of the system parameters (indicators), in the economical systems, although highly dynamic, the normally used characterization of the interactions is done by aggregated indicators resulting from the simple division of only pairs of the simple indicators (e.g. energy/capita, energy/GNP, CO_2 emissions/capita, CO_2 emissions/unit of energy, GNP/capita, etc.), We must note that the simple division indicators’ evolution is easy to verify intuitively; thus, even if there is no model that sustains the interpretation of the indicator related to data, one can use intuition to draw conclusions about the future behaviour of the economic system.

1.1.2.3. Rich and poor trigger second-order effects in labour or population migration

Nowadays, the problem under study is the difference between the specific behaviours of rich and poor economies. It includes the use of child labour, superseding of moral values, as well as migration of population (in and out of various areas) in relation to economic characteristics (e.g. infrastructure, GNP, etc.) of the respective areas.

Regarding the use of child labour, it has been shown that this is merely one of two equilibrium points in a bifurcation model on the use of adult labour versus the use of adult and child labour, depending on the family subsistence level.

Regarding migration, what is the potential gap that produces a variation of concentration (a flux) of persons from one area to another? With the political transitions we are witnessing, we shall consider that people are simply going from poor to rich areas. So the difference that is intensively perceived between the West and East or between the North and South is one of welfare/poverty.

Taking into account the welfare/poverty barrier between the West and East or the North and South, and the consequent migration of population from poor to rich areas, we may identify some non-linear behaviour like the one described below.

The infrastructure measures the efficiency with which an economy makes labour (active population) produce GNP, expressed as GNP/capita.

Increasing the population by immigration leads to an increase in the active population (labour), Over a certain saturation value of the infrastructure's efficiency the increase in population shall be greater than its capacity to produce GNP. So the GNP/capita will diminish, this being perceived as poverty. Thus, along with migration from poor to rich areas there is also an import of poverty into the rich economy.

In parallel, the investments of rich economies to create (or develop) infrastructures in either the East or South contributes to the increase in efficiency of those economies. Thus, the increase in efficiency will produce a greater GNP/capita, perceived as an import of welfare from the rich economy into the poor one.

If this perception is strong enough the outflow of population might reverse. These reversals may create cycles of immigration and emigration in initially poor regions where investments are being made to develop the infrastructure. An example is Italy where the emigration of the fifties was reversed in the mid-seventies, signalling that the infrastructures were set up and operational.

Another typical example is the south of Italy where, 20 years ago, emigration was the rule for workers of that area. Investments done by the government to create infrastructure has led to a slowdown, if not a stop, of emigration. Based on the ideas above we might expect an immigration to the south of Italy after a certain number of years. This may seem unbelievable to a 40-something-year-old Italian, but similarly the disintegration of communist-like structures would have seemed unbelievable to an Eastern European 20 years ago.

1.1.2.4. Implementation of new technologies

We also analyse the implementation of new technologies into an economy. This will lead to more complex aggregated parameters, but will lead to a simpler layout of the model which allows a better understanding of the occurrence of discontinuities.

This process has a dynamic characterized by the successive saturation of old technologies and emergence of new ones (Kondratiev cycles; see Grubler and Nowotny, 1990), This may be seen as a succession of hysteresis-type cycles chained in three-dimensional space (π,u,v),

The decision of allocating funds between two technologies in competition (or one and the other available technologies) is described with a Fokker–Planck equation whose stationary solution leads to a cusp catastrophe. The evolution of the system's trajectory may have a sudden discontinuity associated with the decision to abandon a project.

If one considers the production of technologies along with the production of other goods, it can be demonstrated that a similar relation to the Cobb–Douglas function may model the generation of technologies where instead of labour, one considers intelligence, and instead of production means, one takes research means. (Purica, 1988)

Moreover, the interplay between the production of GDP and the one of technologies is shown to be ruled by a Hénon 'strange attractor'. Also, the gain of information by the experimenter of technologies is measured in a Minkowski space by an associated Lorentz transformation. This is a measure of information resulting from applying multivalent modal logic and not the typical bivalent one.

1.1.3. Decisions for development

1.1.3.1. Models for development – linear versus non-linear

Looking at the papers of 20 years ago which tried to forecast development, one is struck by the linear behaviour suggested by those results, i.e., uphill with varying slopes. The first type of forecasting that involved some non-linearities was resource utilization. In this case after an initial slow increase, due to technology implementation followed a period of fast increase which ended in a saturation due to the depletion of the resource reservoir. Another area where saturation occurs is the penetration of technologies into the economy. This process was extensively described by Marchetti and Nakicenovic. The results gave the possibility to predict limits, although only saturation ones, which was a great difference from the former linear models.

Generalizations of these models (Gheorghe and Purica, 1979, UN-GPID Project; Ursu *et al.*, 1985) have shown that limits are due not merely to saturation but also to strong non-linear correlations among the system's control parameters, as seen in the example of the economic model described above. The interplay between aggregated parameters creates limits in the evolution which include the saturation ones but are not limited to them.

1.1.3.2. Avoid or cross the limits – system resilience

When limits may be predicted one is tempted, in the first instance, to avoid them. On second thought, after having estimated the shock to the economy, crossing certain limits may be a better decision. Thus, if the system's capability to absorb shocks is good enough, the decision will have to specify not only where to invest, but also when, in order to avoid certain limits or/and cross preselected ones.

The possibility of non-linear approaches to include the moment of time as an element of the decision is more similar to what we are faced with in day-to-day life, giving a higher predictability level for these models.

1.1.3.3. Sustainability – accepting the limits

Once the consciousness of the system's dynamics is created in a systematic way, showing how to control the evolution trajectory, another possibility occurs, representing an interaction of a superior level. It refers to the fact that by designing the parameters of a system, one may control the position and amplitude of the limits. Thus, the alternative of accepting the limits and trying to control them by influencing the parameters proves to be the best long-run decision. The one word which now, after the issue of the 1988 Brundtland Report (Our Common Future), describes this mentality is 'sustainability'. This approach might lead to better coping with the reality of climate and energy conversion pattern changes.

1.1.3.4. Indicators of sustainability

At this point, along with Pearce et al. we may say that sustainable development enters as a fundamentally different approach, shifting the focus from economic growth, as narrowly construed in traditional attitudes, to economic policy. It speaks of development rather than growth, of the quality of life rather than real incomes alone. That is, sustainable development makes it clear that the very antithesis of growth and the environment is not the issue.

Sustainable development accepts that what we have been calling 'economic growth' in the past has been measured by some very misleading indicators. The tendency has been to use a measure of gross national product (GNP) as the basis for economic growth calculations. If GNP increases that is economic growth. But GNP is constructed in a way that tends to divorce it from one of its underlying purposes: to indicate, broadly at least, the living standard of the population. If pollution damages health and, health care expenditures rise, that represents an increase in GNP – interpreted as a rise in the 'standard of living' – not as a decrease. If we use up natural resources then, that is capital depreciation, just as if we have machines we count their depreciation as a cost to the nation. Yet depreciation on man-made capital is a cost while depreciation of environmental capital is not recorded at all. (Pearce, Markandya, Barbier, 1990)

The message above is that from now on, along with man-made capital, the material and 'know-how', we will have to seriously take into account the environmental capital. Finding and implementing indicators to show the depreciation of the latter capital will not be an easy task. Implementing environmental standards will certainly mean important costs for all nations involved. These new concepts need to penetrate and spread into the various economies, so that they become a state of mind. Thus, there is a need to institutionalize them in the broader sense of the word.

The next chapter concentrates on describing the occurrence of institutional structures using the Brusselator model, where the reaction–diffusion is done with the memes of Richard Dawkins (1976), and showing that institutions occur as Benard–Taylor dynamic stabilities far from thermodynamic equilibrium, in the memespace. The evolution of institutional structures viewed from this perspective recalls Heraclitus's 'panta rhei' ('all things are in flux') model of the world dynamic.

We have been talking about cycles in economy. Considering the product cycles and their superposition onto the full economy cycles, one may introduce an interpretation based on the fact that the so-called 'velocity of rotation of money' is actually a frequency correlated to the oscillatory behaviour of the economy. Dividing general costs into production and transaction costs one may find a conservation law of the monetary mass, similar to that of energy, over the duration of an economic cycle. The associated equation for this process recalls the well-known Schrödinger equation in quantum physics. It is also shown that along with production functions there may be transition functions introduced for products, these being similar to potential and kinetic energy, respectively. Various other findings occur from such considerations related to the discrete (meaning not continuous) nature of economic activity in a finite resource environment.

Let's start now with an example of applying decision theory.

1.2. Why the Structure of This Book – a Decision Theory Approach

As decision theory has its own vocabulary that is not sufficiently popular among economists and physicists, we will try to introduce such models with an example below.

The example used is the one on the manner I used to decide on the structure of this book when I decided to put together ideas developed from various papers I had published in the last 25 years.

I was reasoning in the following way:

If I write this book it may be either:
a normal standard book (N) or,
a 'crazy' book (C)

I shall call these strategies (S_i)

After reading the book the reaction of the readers may be:
take an interest (I) or,
show politeness (P)

I shall call these outcomes (Q),

The consequences may be the following:

(Q_1) - I write a normal book and the readers take an interest, it means: "They consider me having a comparable expertise with other authors", or, shortly, experienced.

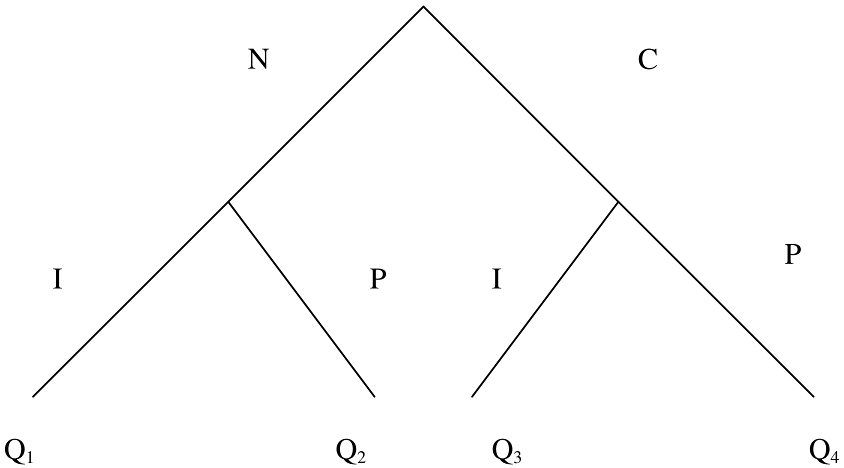
(Q_2) - I write a normal book and the readers show politeness, which means: "They consider me under the level".

(Q_3) - I write a 'crazy' book and the readers take an interest, it means: "They consider me inspired"

(Q_4) - I write a crazy book and the readers show politeness: "They consider me crazy.

I had represented these alternatives in a decision tree:

Strategies \ Outcomes	I(A1)	P(A2)
S_1(N)	Q_1	Q_2
S_2(C)	Q_3	Q_4



Please note that the outcomes and the consequences are exclusive and complete and we shall call the assembly of such consequences a variable.

The second step was to try to order the consequences using my performance to be able to decide what strategy I will adopt.

As we like to use functions I had associated with my performance a function V, called value function that associates real numbers to consequences:

$$V(Q_j) \rightarrow number$$

I postulated that when I prefer Q_j to Q_k, then $V(Q_j) > V(Q_k)$ and that when the occurrence of Q_j or Q_k is indifferent to me, then $V(Q_j) = V(Q_k)$, I also considered that the relative value of the consequences is unique up to a linear increasing transformation

$$V(Qj) = aV(Qj) + b.$$

I may establish the following order of performance:

I prefer first to be considered with experience (Q_1), if not, to be inspired, if not, to be considered myself crazy and lastly to be considered under the level.

$$V(Q1)>V(Q3)>V(Q4),V(Q2)$$

In the following step I shall try to associate the same kind of numbers to assess the possibility (P) that a given consequence occurs when I choose a given strategy.

$$P(Qj/Sk) = Pkj.$$

I construct the matrix:

	Q_1	Q_2	Q_3	Q_4
S_1	P_{11}	P_{12}	P_{13}	P_{14}
S_2	P_{21}	P_{22}	P_{23}	P_{24}

Because when I choose the strategy S_1 only one of the consequences may occur, the numbers can satisfy:

$$S_j P_{j1} = 1$$

And, similarly when S_2 is chosen:

$$S_j P_{j2} = 1$$

No conditions are imposed on the column, but:

$$S_k (S_j P_{jk}) = 2$$

Up to now I have no possibility to associate numbers to P_{jk}.

Before trying to do this, please remark that we can simplify, a little, my problem if we notice that in this case each strategy consists in one action to be done:

write a normal book - $A_1 = S_1$

write a 'crazy' book - $A_2 = S_2$

Each consequence is associated to one couple (A_i,O_k) where O_k is an outcome:

$$Q_1 = (A_1,O_1);\ Q_2 = (A_2,O_2)$$
$$Q_3 = (A_2,O_1);\ Q4 = (A_2,O_2)$$

We easily see that when S_1 is adopted or the identical action A_1, it is not possible that $Q_3 = (A_2,O_1)$ or that $Q_4 = (A_2,O_2)$, Thus it is reasonable to put:

$$P(O_3/S_1) = P(O_4/S_1) = 0$$

Equally, if S_2=A_2 is adopted:

$$P(O_1/S_1) = P(O_2/S_2) = 0$$

Now the previous matrix reads:

	$Q_1 = (A_!,O_1)$	$Q_2 = (A_1,O_2)$	$Q_3 = (A_2,O_1)$	$Q_4 = (A_2,O_2)$
$S_1 = A_1$	$P(Q_1/S_1)$	$P(Q_2/S_2)$	0	0
$S_2 = A_2$	0	0	$P(Q_3/S_2)$	$P(Q_4/S_2)$

Collapsing the matrix above we have the matrix of action and outcomes:

	O_1	O_2
A_1	$P(O_1/A_1)$	$P(O_2/A_1)$
A_2	$P(O_1/A_2)$	$P(O_2/A_2)$

The numbers $P(Q_j/S_k)$ or $P(O_j/A_k)$ are like the probabilities because they are considered 0 when the consequence is impossible and 1 when we are sure that only the Q_j consequences will occur after action A_k is done.

But, I had no reason to put any $P(O_j/A_k) = 1$, which means I was not sure that if I did an action e.g. A_2, it will be surely followed by outcome e.g. O_2.

On the other hand I am sure that after action A_1, one and only one of the O_1 or O_2 will follow and this was the reason I considered $P(O_1/A_1) + P(O_2/A_1) = 1$.

Any name may be used for these numbers but, they have the properties of the Kolmogorov's axiomatic definition of the probability.

I shall use the same name and I will consider $P(O_j/A_k)$ as a conditional probability of the occurrence of O_j, when I knew that A_k was done.

> "Probability in and by itself is neither a desirable nor an undesirable thing. However, when related to relative values of consequences, we see it in a different perspective. For example, under a specific strategy, one would like to have a high probability (near 1) for attaining the most desirable consequences and, respectively, a low probability (near 0) for

> attaining the least desirable consequences. Since there is a fixed amount of probability, namely 1, that, is distributed over the consequences for each strategy" (P.C.Fishburn, Decision and Value Theory, 1964),

This way, our probability concept is nearer to the de Bayes probability definition than to the Laplace probability definition.

I will remind the two below:

- Laplace, Théorie analytique des probabilités, Paris 1st ed.1812

> "La théorie des probabilités consiste a réduire tous les événements qui peuvent avoir lieu dans une circonstance donnée, a un certain nombre des cas également possibles, c'est a dire tels que nous soyons également indécis sur leur existence et a déterminer parmi ces cas, le nombre de ceux qui sont favorables a l'événement dont on cherche la probabilité. Le rapport de ce nombre a celui de touts les cas possibles, est la mesure de cette probabilité, qui n'est donc qu'une fraction dont le numérateur est le nombre de cas favorables et dont le dénominateur est celui des touts le cas possibles."

- T. de Bayes (1763), An essay towards solving a problem in the doctrine of chance. Phyl Trans.Royal Soc.Vol.53, p.370.

> "5. A probability of any event is the ratio between the value at which an expectation depending on the happening of the event ought to be computed, and the value of the thing expected upon its happening.
> 6. By chance I mean the same as probability."

Coming back to my problem, it consisted, in fact, of choosing one of the two strategies of action; supposing I knew the conditional probabilities and the relative value function.

It is reasonable to use the mathematical expectation to compare the strategies:

$$E(S_k) = E(A_k) = \Sigma_k P(Q_j/S_k), V(Q_j)$$

I prefer the strategy having a higher expectation value. So, when:

$$E(S_1)>E(S_2) \text{ or } E(S_1)-E(S_2)>0$$

I will prefer S_1.

My capacity to use this criterion is limited by my knowledge about the conditional probabilities and/or relative value function.

Fortunately, such criterion needs not the knowledge of figures for all the conditional probabilities and/or for all values of the relative value function.

We have:

$$E(S_1) - E(S_2) = \Sigma_{j=1,t} P_{1j}V_j - \Sigma_{j = 1,t} P_{2j}V_j = \Sigma_{j = 1,t} (P_{1j} - P_{2j})V_j$$

If we remember the Abel identity:

$$\Sigma_{j = 1,n} a_j b_j = \Sigma_{k = 1, k - 1}(\Sigma_{j = 1, k}(\Sigma_{j = 1, k} a_j)(b_k - b_{k+1}) + (\Sigma_{j = 1,n} a_j)b_n$$

And use it to transform the previous equation:

$$E(S_1) - E(S_2) = \Sigma_{k = 1, n - 1} \Sigma_{j = 1, k}(P_{1j} - P_{2j}) (V_k - V_{k + 1})$$

we see that any information in (P_{ij}) imposes conditions to (V_k) to have a dominance of one of these strategies.

In the case of my problem an order of preference was established among different outcomes.

We rewrite the matrix taking into account the outcomes order of preference:

	Q_1	Q_3	Q_4	Q_2
$S_1 = A_1$	P_{11}	0	0	P_{12}
$S_2 = A_2$	0	P_{21}	P_{22}	0

When we consider, in the Abel identity, the V_k in the ordered chain, all V_k-V_{k+1} are positive. It is easy to see that the coefficient (V_k-V_{k+1}) is obtained by forming into the matrix the partial sum by adding in rows the left term, and then taking the column differences.

	Q_1	Q_3	Q_4	Q_2
$S_1 = A_1$	P_{11}	P_{11}	P_{11}	$P_{12} + P_{11} = 1$
$S_2 = A_2$	0	P_{21}	$P_{21} + P_{22} = 1$	$P_{21} + P_{22} = 1$
	P_{11}	$P_{11} - P_{21}$	$P_{11} - 1$	0

The conditions to have a positive sign for the expectations' values, meaning to prefer S_1 strategy, are:

$$P_{11} > 0$$

$$P_{11}\text{-}P_{21} > 0 \qquad P_{11} > P_{21}$$

$$P_{11}\text{-}1 > 0 \qquad P_{11} > 1$$

Since every P must be less or equal to 1:

$$P_{11} = 1 \quad and \quad P_{21} < P_{11}$$

The conditions for having a negative sign, which means preferring strategy S_2, are:

$$P_{11} < 0$$

$$P_{11}\text{-}P_{21} < 0 \qquad P_{11} < P_{21}$$

$$P_{11}\text{-}1 < 0 \qquad P_{11} < 1$$

From the first and last relations we have:

$$P_{11} = 0$$

while the second relation gives:

$$P_{21} > 0$$

Now, to be able to make a decision I must have the information on P_{11}.

Looking at the literature in the field of econophysics I assume that all authors are more experienced in the topic than I am.

With this information I put:

$$P_{11} = 0$$

and:

$$E(S_1)\text{-}E(S_2) < 0 \quad E(S_1) < E(S_2)$$

This means I had to choose the second strategy or the second action:

$$A_2 = \text{'Write a 'crazy' book'}$$

And what you will read follows this conclusion.

References

Brundtland H., (1988), *Our Common Future*, UN Report.

Dawkins R. (1976), *The Selfish Gene*, Oxford University Press.

Fishburn P.C., (1964), *Decision and Value Theory*, John Wiley & Sons, New York.

Gheorghe A., Purica I., (1979), *Decisions for Development in Energy Systems*, UN-GPID Project papers.

Grubler A., Nowotny H. (1990), *Towards the Fifth Kondratiev Upswing: Elements of an Emerging New Growth Phase and Possible Development Trajectories*, International Journal of Technological Management **5**(4):431–471.

Laplace, (1812), *Théorie analytique des probabilités*, Paris.

Lorenz, E. (1963), *Deterministic Nonperiodic Flow*, Journal of Atmospheric Sciences, **357**, 130–141.

Pearce D., Markandya A., Barbier E., (1990), *Blue Print for a Green Economy*, Earthscan Publications Ltd., London.

Purica I. (1988), *Creativity, Intelligence and Synergetic Processes in the Development of Science*. Scientometrics **13**(1–2): 11–24.

de Bayes, T. (1763), *An essay towards solving a problem in the doctrine of chance*. Phyl Trans.Royal Soc., **53**, 370.

Ursu I., Purica I., *et.al*., (1985), *Risk Analysis*, vol. 5, nr.4.