Sustainability and Dissipative Systems

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Abstract. *The paper is concerned on the important issues of the causal or structural relations between the sustainability of the whole Universe and the dissipative systems in our bubble of Universe. Based on the gap between the general entropy velocity and the entropy velocity inside the dissipative systems, a taxonomic criterion for identifying the classes of dissipative systems is captured and operated. In this context, the correlation between the entropic sustainability and the dissipative systems is examined and concluded. The paper argues for the necessity (in the logic order) to pass from the optimal rationality to the sustainability rationality, based on the entropy conclusions and predictions (in the matter, three types of social rationality are identified and logically characterized*[*]*. In addition, the paper analyzes the arguments to assert that the complementary environment of a done dissipative system is complementary only in a relative way. This relativity is examined from the perspective of the Prigogine's principle of the minimum production of entropy (for the mentioned principle, the paper aims to provide a sui-generis demonstration), by proposing the concept of the minimum entropic gradient as anchor of the entropic interaction in the Universe. All these results or observations could be used by other researchers to apply them to the economic systems which are, of course, dissipative systems.*

Key words: dissipative systems; entropy; sustainability; rationality.

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JEL Classification: B41, Q01, Q57

1. Extracting a sustainability criterion in a dissipative univers

The presence of a dissipative system could be, as result, identified simply by detection of the entropy acceleration in the Universe 1[(1)]. We want to try, further of our study, to propose a general typology of "available" dissipative systems, as potentialities and, on this base, to discuss some species of the impact of dissipative systems arising on the entropy acceleration inside the complementary environment of these dissipative systems.

1.1. A possible typology of the dissipative systems

The criterion we would want to propose in order to identify the possible classes of the dissipative systems will be the relative ratio between the entropy velocity inside the dissipative system and the natural entropy velocity (that is, λ_N [(2)]) in the Universe 0. Thus, if we will note with $\lambda_{\overline{N}}^{i}$ the entropy velocity inside the dissipative system "i", we can theoretically have the following situations:

a. dissipative systems of rank "-1"[(3)], with the condition: $\lambda_{\overline{N}}^{-1} > \lambda_N$ [(4)]. As it is already pointed out, such systems constitute a logical impossibility, because their arising would signify a low entropy "pumping" to the complementary environment, that would mean (to perform it) a low entropy consumption from…the complementary environment[(5)]. However, the arising of such dissipative systems is marked by the arising of an entropic heterogeneity but…of opposite sign. So, the dissipative systems of rank "-1" are impossible rather inside the today theoretical framework concerning the entropic phenomenon; we would say that the dissipative systems of rank "-1" are ambiguous dissipative systems or, better, observationally (that is, theoretically) contextualized dissipative systems[(6)];

b. dissipative systems of rank "0"[(7)], with the condition: $\lambda_{\overline{N}}^{0} = \lambda_N$. It is obvious that such dissipative systems are indiscernible from the complementary environment, because, as is pointed out before, the identifying of a dissipative systems is equivalent with detecting of an entropy acceleration in the global environment; but, the fact that no entropic heterogeneity appears is sufficient to know that no dissipative system is born in the Universe 0[(8)]; we will say that such dissipative systems are not authentic dissipative systems or, to maintain the above terminology, they are observationally (that is, theoretically) non-discernible dissipative systems[(9)];

c. dissipative systems of rank "1", with the condition $\lambda_{\overline{N}}^{1} < \lambda_N$. This category of dissipative systems is the first that introduces an "orthodox"[(10)] entropic heterogeneity in the Universe 0. As we understand, here could be identified two sub-categories of dissipative systems:

c.1) *dissipative systems of rank "*1α*"*, that is, of non-human type, with the condition $0 \leq \lambda_{\overline{N}}^{1\alpha} < \lambda_N$. We understand by this category those dissipative systems that appeared in the Universe 0 and that remain, essentially, natural. Although they constitute, of course, an entropic heterogeneity, this heterogeneity maintains the time arrow orientation but reduces its "scalar" inside the membrane of the dissipative system, paying the price, as showed above, of the global entropy velocity increasing. The "natural" dissipative systems are represented by any structures (mineral, vegetal, and animal(11)) appeared based on a certain causality (on this causality we do not discuss anything here; we would prefer to accept the hypothesis of spontaneity in arising of such an entropic heterogeneity);

c.2) *dissipative systems of rank* "1β", that is, of human type, with the condition $0 \leq \lambda_{\frac{1\beta}{N}} \leq \lambda_{\frac{1\alpha}{N}}$. The gap $\varepsilon_{\frac{1}{N}} = \lambda_{\frac{1\alpha}{N}} - \lambda_{\frac{1\beta}{N}}$ is greater as the sophistication level of the human society is greater (as result of arising of such social activities as: medical, economic, cognitive, artistic, political etc.). In the incipient development periods, this gap was very small, it being, at limit, null (in the case, for example, of very primitive human groups).

In an absolute similar way with that in which a superior limit of the light velocity was been postulated (by the special theory of relativity), it is possible to postulate here, for the case of the entropic theory of evolution, an inferior limit of the entropic velocity, namely: this velocity *is never negative*.

1.2. Dissipative systems and entropic sustainability

It is obvious that these categories of dissipative systems can simultaneously exist, and, historically, seems must be accepted even an evolution from the dissipative systems of rank "1α" to the dissipative systems of rank "1β". A question is arising here: there is, really, a necessary "evolution" from the dissipative systems of rank "1α" to the dissipative systems of rank "1β" or, rather, we only see a contingent evolution along this way(13), that is observed only in our corner of the Universe and/or only inside our temporal life? To put differently, once arisen an entropic heterogeneity in the Universe 0(14) will it necessarily follow the "way" of permanent and continuing reducing of the entropic velocity inside its membrane?(15). We opt for an intrinsic (that is, "natural") rationality of the generic Universe that, simply, creates its entropic heterogeneities in order to reach its "objective" – the thermal death; so, we accept, as being a necessity, the dissipative systems emergence, observed by intermediation of reducing the local entropy velocity, and, as result, of increasing the global entropy velocity(17).

We would now want to come back to the sub-typology of the dissipative systems of rank "1". We can observe that both the dissipative systems of rank "1α" and of rank "1β" can reach the same entropy velocity (that is, $\lambda_{\frac{1\alpha}{N}} = \lambda_{\frac{1\beta}{N}}$). This is not possible, accordingly to our previous considerations, than is the case of a single membrane for the two dissipative systems. Since such a situation is absurd, inside the logic of the present study, it results we have to accept a conceptual distinction between *interior* *membrane* and *exterior membrane*[18]. To put differently, from this point of view, could exist a class of dissipative systems that ensure the entropy conservation. We could say, in this case, that we have a class of entropic stationary dissipative systems[19]. This class can be populated with non-human dissipative systems (for instance, a population of vegetables or/ and animals as well as with human dissipative systems (for instance, an urban, or national or even world community), as well as with a combination of the two mentioned categories of dissipative systems (that is, with a mixed eco-system). In Figure 1 is synoptically indicated the configuration of the class called *mixed dissipative systems entropic stationary* (MDSES):

THE COMPLEMENTARY ENVIRONMENT

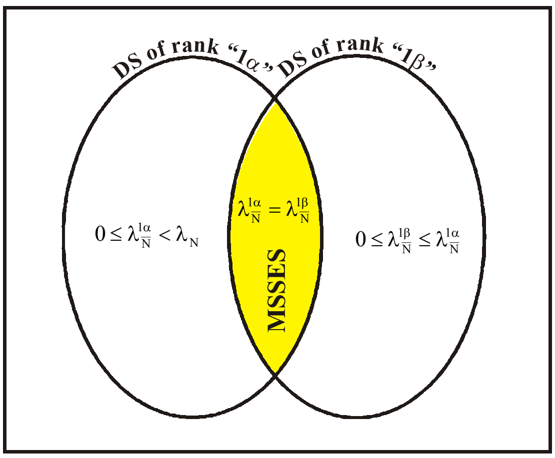

Figure 1. *Genesis of mixed dissipative systems entropic stationary*

In fact, that we must call as *sustainable systems*[20] addresses just this class of mixed dissipative systems (of human and non-human type) that are stationary from the entropic point of view [21]. But, really, the dissipative systems of rank "1α" could they constitute, by themselves, mixed dissipative systems entropic stationary[22] (that is, what we above called as sustainable systems)? Essentially, it is obvious that is possible. In other words, the genesis of the entropic sustainable systems does not necessarily require the presence of a dissipative system of rank "1β"; by the contrary, it requires the presence of a dissipative system of rank "1α". Terminologically, we prefer, however to make here a certain distinction.

If we would consider the complementary environment in the Universe 1 as an anti-dissipative system[25], then we will say that any quasi-mixed dissipative system entropic stationary must be considered rather a *durable system*, while any mixed dissipative system entropic stationary must be considered properly a *sustainable system*. To put differently, the quasi-mixed dissipative systems entropic stationary cannot generate sustainable systems, properly speaking, that is, the sustainability must be always associated with the presence of the antropic factor. Why must we consider as justified such a terminological distinction proposal? To defend our proposal, we will say that the presence of the subjective (antropic) factor inside the DMSES could generate gaps (accidental or deliberatively) from the null velocity of the entropy, on short run, often cyclically but of permanent nature[27, 28], while in the case of the quasi-mixed dissipative systems entropic stationary, this phenomenon does not appear or, in the opposite case, it is singular (reaching of certain value of the entropic velocity will maintain sine die this value, destroying irrevocably the stationarity of the system). As result, the irreversible[29] feature of the state of the durability, compared with the reversible feature of the state of sustainability leads us to accept the above mentioned terminological distinction. To defend the utility of this terminological distinction we will say that we frequently meet expresses as "durable development" or "durable growth" related to the economic activity, that make these expresses, in the context discussed here, to be inadequate; we more correctly we believe must use expresses as "sustainable development" or "sustainable growth"[30].

2. Rationality and sustainability[31]

The above considerations on the concept of sustainability (more exactly, on the concept of mixed dissipative system entropic stationary) could be used to analyze the evolution of the human society rationality along the history.

It obvious that maintaining of the stationary state of the economic systems (more generally, of the social systems) accelerates the entropy increasing in the environment, because the mentioned maintaining implies a reducing (at limit, stopping) of the entropy increasing inside the economic stationary system, with the price of consuming of low entropy from the complementary environment. Let's note with $\Delta E(N) = d\gamma$ the natural increasing of the universal entropy, in the lack of any dissipative structures. The maintaining of the stationary state for the dissipative systems must counteract, locally, this general increasing of the entropy. To this end, the dissipative systems will take out from the environment a quantity of low entropy of size: $-d\gamma \times (1+\upsilon)$[32]. This is equivalent with "injecting" into the environment an equal quantity of high entropy, i.e. $\Delta R_C = d\gamma \times (1+\upsilon)$; this means that the total entropy of the complementary environment will increase with $\Delta E(R_C) = d\gamma \times (2+\upsilon)$. This rationality could be called *the rationality of first order* (the rationality of local stationarity). In turn, the rationality based on optimality (that is, on maximizing/minimizing, in one word, on optimizing, of the established objective in the framework of a system of restrictions) seems lead to a supplementary acceleration of the entropy, compared with the case of maintaining of the stationary state of the economic systems. Indeed, if it is needed to optimize an objective-function, then it is needed not only to maintain the entropy at the actual level (that is, to ensure a null acceleration for the local entropy increasing[33]) but it is needed that this velocity be decreased accordingly with the "ambition" of the optimizing. So, the dissipative system will need for an additional quantity of low entropy from the complementary environment, let's say: $d\varphi$. If we note with σ the low entropy needed to be consumed in order to obtain the comprehensive and methodological ability to perform the optimizing (projecting the objective-function, establishing the restrictions equations, identifying the technical tools to optimize etc.), then the increasing of the low entropy (compared with the stationary state) needed by the dissipative system to perform the rationality based on the optimality will be: $\Delta R_O = d\varphi \times (1+\sigma)$. So, the entropy in the complementary environment will increase, in the case of a dissipative system performing the rationality focused on the optimality, compared with the case of a dissipative system that follows a rationality based on the stationarity, with: $\Delta E(R_O) = d\lambda \times (2+\varepsilon) + d\varphi \times (1+\sigma)$. If it is noted: $d\varphi / d\gamma = \rho$, we have: $\Delta E(R_O) = d\gamma \times \times (2 + \upsilon + \rho + \rho \times \sigma)$. This rationality could be called *the rationality of second order* (i.e., rationality of local optimizing). In this situation, the entropy acceleration in the presence of dissipative systems having a rationality of second order, compared with the natural situation will be: $\Delta E(R_O - N) = d\gamma \times (1 + \upsilon + \rho + \rho \times \sigma) = \omega \times d\gamma$ (34), where with ϖ is noted the acceleration coefficient. The rationality based on the sustainability (that we will call *the rationality of third order*, that is, a rationality of local sustainability), accordingly to those above mentioned, is nothing else than a rationality of the stationarity also but, because it is "occurring" after the rationality of optimality, we called it as a rationality of third order. Properly speaking, it is probable that never occurred, really, a rationality of the stationarity in the mixed dissipative systems, because the genuine economic behavior is always based on certain optimizing criterion – for instance, the minimizing of the opportunity cost. It is obvious that, as the human society has became more complex, the optimization has became more complex itself, especially under the instrumental aspect, which led to iterative and cumulative accelerations of the global entropy. So, it is necessary to come back to a rationality comparable with the rationality of first order; thus, the coefficient σ does not work anymore (it is no needed anymore to know how could we perform the principle of the rationality of second order) and will be replaced by another coefficient, let's note with μ, that signifies the low entropy consumption from the environment, in order to know how must we perform a local circular economic process(35). This means that the expression $\upsilon + \mu$ (36) signifies the new added entropy inside the complementary environment, because, as showed before, the increasing of the neg-entropy inside the dissipative systems is the same with the increasing of the entropy outside the dissipative systems (ignoring, of course, the low entropy necessary to acquire the knowledge and practical skills for every type of rationality). So, the passing from the rationality model based on optimality to the rationality model based on sustainability will lead to a reducing of the global entropy acceleration with: $\Delta E(R_S - R_O) = \upsilon + \mu - \upsilon - \rho - \rho \times \sigma = \mu - \rho - -\rho \times \sigma < 0$ (37). We obtain that the "price" (on global entropy acceleration basis) paid by every type of rationality of the dissipative systems is described by the following order relation:

$$\Delta E(N) < \Delta E(R_C) < \Delta E(R_S) < \Delta E(R_O)$$

or, if we will note with R_0 the "natural rationality", we can write: $R_0 \succ R_I \succ R_{III} \succ R_{II}$, where the "$\succ$" signifies "is preferred[38], from the entropic point of view, to". But, as we know, the real history of the humanity followed another road of the rationality (Figure 2):

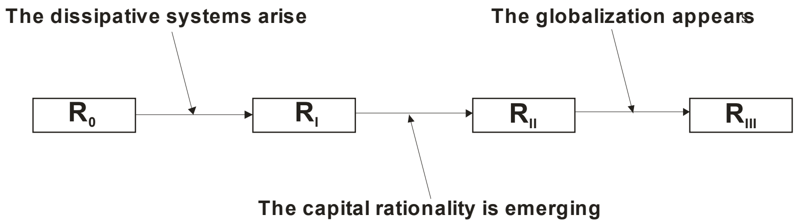

Figure 2. *Logic of social rationality models emerging*

Because R_0 is not relevant in the presence of the dissipative systems, we see that the humanity performs a "non-rational skip", inside the entropic logic point of view, from R_I to R_{II}, by ignoring the better rationality of R_{III} [39]. It is of hoping that the effectiveness and stringency of the problems put by the globalization process, as well as the epistemological progresses inside the sciences studying the fields where evolutionary processes occur (among them, probably, the pioneer is biology, followed by economics), will generate, for all the humanity, the necessity to choose the rationality of third order, that is the rationality based on local sustainability[40]. This way, the human dissipative system will deliberatively verify the principle of the minimum entropy production.

3. On relativity of the complementary environment concept

The subject announced in the title of this paragraph is of the most importance in order to a more analytical building of a "theory" concerning the causality implied in the "dissipative system – entropy" binomial, but in this study we only intend to enounce some possibilities for future analyses hoping, this way, certain reactions from the specialists in the matter, in order to generate a larger polemics that could be profitable, eventually, for the science generally.

As we mentioned, partially, previous as well, in the situation in which inside the Universe 0 simultaneously appear more many dissipative systems (of course, this set of dissipative systems can be constituted not only concomitantly but successively as well, of importance being that, at a given moment, inside the Universe 1 to exist more many such systems, of rank "1α" as well as of rank "1β"), the concept of complementary environment become, to so say, multi-relative (it anyhow was relative even in the situation of a single dissipative system, as showed before, and as the open reader can immediately observe). This means that, given a dissipative system, be A, another dissipative system, be B, will become a relative anti-dissipative complementary environment for A[41]. If so, a question could arise: how will develop the entropy inside the dissipative system B, given a certain development of the entropy inside the dissipative system A? To put differently, the question is: there is an entropic impact of a dissipative system on other dissipative system[42]. As we understand, to answer the above mentioned question, it is necessary to postulate that the dissipative systems "recognize" at the level of membrane (i.e., at its borders), the entropic gradient between themselves and the complementary environment[43]. Once this ability supposed, how really "choose" the dissipative systems to perform "the entropic change" (that is, to take out low entropy in exchange for high entropy)? Expressed like that, the question is: a certain dissipative system will "prefer" to perform the entropic exchange with the complementary environment (where, as it is clear, are included all the other contemporary dissipative systems) at the maximum or at the minimum level of the entropic gradient? Probably we must postulate, here, a principle similar with the principle of the minimum distance in physics[44], namely *the entropic exchange is performed always at the level of the minimum entropic gradient*[46]. This principle, once accepted, just generates the relativity of the complementary environment, and, on the other hand, generates, as well, a necessary matrix (here, the concept of "necessary" has its logical signification) of entropic interactions. This means that, if we would have a "map" of the entropic gradients in the Universe 1, we could exactly say (the informed reader will find here a pure laplaceanism) which entropic interactions will occur[47, 21]. So, the complementary environment cannot be defined than in the multi-relative way (in fact, we can say, "in a contextual way" and even, as it seems for us, rather "in a practical mode than in a theoretical one").

The "chain" of entropic interactions based on the choice of the minimum entropic gradient indicates a necessary acceleration of the global entropy in the Universe, namely an auto-catalytic acceleration: more many dissipative systems there are, more accelerated global entropy is. Moreover, more advanced the dissipative systems are (in the entropic sense, that is, lower the entropy velocity is inside them), greater the impact on the increasing of the global entropy velocity is. But, as we tried to show, the dissipative systems have a necessary propensity to entropically develop. So, we can to summarize as follows: a) any variation of the local entropy velocity is equivalent with an inverse variation of the complementary environment entropy velocity; b) the principle of choice of the minimum entropic gradient in order to perform the entropic exchange inter-dissipative systems supplementary accelerates the global entropy. But, the last supposition needs for a specific argumentation: suppose we are inside a Universe 1 where there are two dissipative systems, A, with the local entropy velocity λ_N^A, and B, with the local entropy velocity λ_N^B, so $\lambda_N^A < \lambda_N^B$. We will note the entropy velocity of the complementary environment, relative to the two dissipative systems, with $\lambda_C^{A,B}$ (the way of noting is aimed at to indicate the fact that the arising of the two dissipative systems led to an increasing of the entropy velocity inside the complementary environment – accordingly to all said far now – so $\lambda_C^{A,B} > \lambda_N$). Obviously, $\delta_A^B = \left|\lambda_N^A - \lambda_N^B\right| < \left|\lambda_N^A - \lambda_C^{A,B}\right| = \delta_C^N$ (where δ signifies the entropic gradient), so the entropic exchange aimed at to more reduce the entropic velocity inside the dissipative system A, will occur between A and B[48]. Taking into consideration the order relation between the local entropy velocity in the two dissipative systems, the entropic exchange will be materialized by taking out by the dissipative system A of a certain quantity of low entropy from the dissipative system B, and vice versa, by taking out by the dissipative system B of a certain quantity of high entropy from the dissipative system A. Now we see the basic significance of the choice criterion of the minimum entropic gradient: by this choice criterion is ensured a minimum transfer of low entropy from the dissipative system less entropic advanced to the dissipative system more entropic advanced. Indeed, it seems be enough obvious the fact that, in order to reach a certain differential of the local entropy velocity, the dissipative system A should consume more low entropy from the genuine complementary environment than it should consume from the dissipative system B[49].

Here is appearing a last question which we want to discuss in the study: is the principle of choice the minimum entropic gradient in order to perform the entropic exchange between the dissipative systems, really consistent with the prigoginean principle of the minimum entropy production? If we would take into consideration as argument the behavior of the natural systems (quasi-mixed systems by terminology used here), we should answer yes[45, 50].

Synoptically, we could represent the above considerations as in the Figure 3:

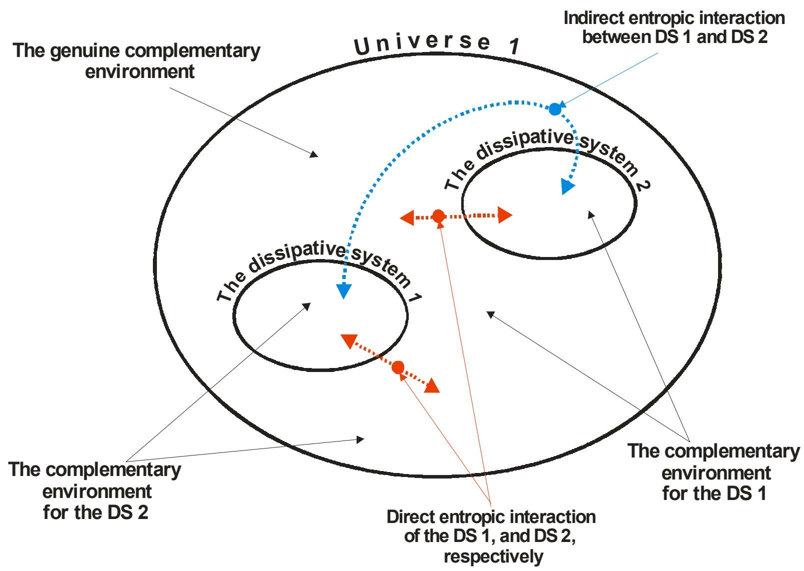

Figure 3. *The logic of direct/indirect entropic interactions*

We now will try to formalize the mechanism of the entropic interaction in a Universe 1 “endowed” with more than one dissipative system.

Suppose there are “n” dissipative systems, every having own[52] local entropy velocities, which verify the ordinal relation: $\lambda_N^1 < \lambda_N^2 < ... < \lambda_N^n$. Accordingly to the choice criterion of the entropic interaction (obviously, the principle of the minimum entropic gradient can be alternatively formulated as the principle of proximate entropic interaction), mentioned above, the entropic development of the “n” dissipative systems will necessarily implies as the dissipative system 1 must interact with the dissipative system 2, in order to take out low entropy from the last, the dissipative system 2 must interact with the dissipative system 3 in order to take out low entropy from the last, and so on. The dissipative system “n” will interact with the genuine complementary environment (that will be noted as a “n+1” system) in order to take out low entropy from the last. Let’s note with θ_j^i the quantity of low entropy transferred from the dissipative system “j” to the dissipative system “i”, and with κ_j^i [53] the consumption of low entropy inside the dissipative system “j” to realize the transfer of low entropy from the dissipative system “j” to the dissipative system “i”. The quantity of low entropy transferred from the dissipative system “j” to the dissipative system “i” is an increasing function depending on the entropic gradient[54], that is, $\theta_j^i = h(\delta_i^j)$ [55], where $h'_\delta > 0$. So, as a result of the interaction between the dissipative systems “i” and “j”, in the dissipative system “j” we have an “increasing” of low entropy of size: $dE_j^i = h(\delta_i^j) + \kappa_j^i$, j=i+1, for j=2,…, n+1, and i=1,2,3,…,n (we remember that, with “n+1”, it is noted the genuine complementary environment). If we note the rate of supplementary consumption of low entropy related to the transfer of low entropy as π, then: $dE_j^i = h(\delta_i^j) \times (1 + \pi_j^i)$[56]. As the entropic interaction between two dissipative systems[57] modified the local entropy velocities inside the two dissipative systems, we understand that the following interaction (between the dissipative system which “pumped” low entropy and the dissipative system which is in the entropic proximity – from the point of view of the entropic gradient) will suffer some modifications under the aspect of the quantity of low entropy needed for the entropic interaction. Let’s organize the complete process of the entropic interactions as in Table 1 (we will note with η a functional way, for instance, a multiplicative way, of the dependence of the variation of local entropy velocity in a dissipative system on the entropy increasing inside the dissipative system involved[58]).

We note with ϖ a *global entropy increasing divisor* (GEID), which will be determined as a mathematical ratio between the total variation of the entropy in the case of the logical entropic interactions (based on the principle of minimum entropic gradient) and total variation of the entropy in the case of interactions between every dissipative system, on one hand, and the genuine complementary environment, on the other hand. So, formally, we have:

$$\varpi = \frac{\sum_{k=1}^{n} h\left(\delta_k^{k+1}\right)}{\sum_{k=1}^{n} h\left(\delta_C^{k}\right)}$$

It is immediately obvious that $\varpi \le 1$ [59], because the numerator will be less than the denominator, based on the fact that h is an increasing function on the entropic gradient.

For instance, if we consider the h of a multiplicative type, say $h = \psi \times \delta$, where ψ signifies a constant coefficient of low entropy transfer per capita of entropic gradient (so, the average transfer of low entropy generated by the entropic interaction) then we can write successively:

$$\sum_{k=1}^{n} h\left(\delta_k^{k+1}\right) = \psi \times \sum_{k=1}^{n} \delta_k^{k+1},$$

$$\sum_{k=1}^{n} h\left(\delta_C^{k}\right) = \psi \times \sum_{k=1}^{n} \delta_C^{k},$$

$$\delta_C^k = \chi_k \times \delta_k^{k+1},$$

where χ_k signifies a coefficient that links the entropic gradient generated by the entropic interaction between any pair of dissipative systems (based on the principle of minimum entropic gradient) to the entropic gradient generated by the entropic direct entropic interaction between any dissipative system and the complementary environment. The row series (χ_k), for $k \in N$ is real, infinity, and increasing, with $\chi_1 = 1$, and $\chi_k > 1$ for any $k = 2,3,...,n$.

Then, we can be written:

$$\varpi = \frac{\sum_{k=1}^{n} \delta_k^{k+1}}{\sum_{k=1}^{n} \chi_k \times \delta_k^{k+1}} \le 1 .$$

So, we obtained the conclusion that by "verifying" of the principle of minimum entropic gradient for choose the entropic interaction, is also verified the principle of the minimum entropy production, that clear indicates the consistence between the two mentioned principles[60]. This result could also be assessed as a sui-generis demonstration of the principle of minimum entropy production (which is a non-intuitive principle) based on a much more intuitive postulate[62] which requires that, always, the next entropic interaction occurs between those dissipative systems which have the minimum entropic gradient between.

Dissipative systems in interaction	The initial entropic gradient (before entropic interaction)	The entropic gradient alter the logically anterior entropic interaction[63] (based on the principle of minimum entropic gradient)	The total entropy variation in the case of direct interactions between every dissipative system and the genuine complementary environment	The total entropy variation in the case of logic entropic interaction (based on the principle of minimum entropic gradient)
$1 \leftarrow 2$ [64]	δ_2^1	-	$h(\delta_C^1)\times(1+\pi_1^C)$ [65]	$h[(\delta_1^2)\times(1+\pi_2^1)]$
$2 \leftarrow 3$	δ_3^2	$\delta_3^2 \times \{1+\eta\times[h(\delta_1^2)\times(1+\pi_2^1)]\}$ [66]	$h(\delta_C^2)\times(1+\pi_2^C)$	$h[(\delta_2^3)\times(1+\pi_3^2)]$
$3 \leftarrow 4$	δ_4^3	$\delta_4^3 \times \{1+\eta\times[h(\delta_3^2)\times(1+\pi_2^3)]\}$	$h(\delta_C^3)\times(1+\pi_3^C)$	$h[(\delta_4^3)\times(1+\pi_3^4)]$
. . .	. . .	. . .	. . .	. . .
$(n-1) \leftarrow n$	δ_n^{n-1}	$\delta_n^{n-1} \times \{1+\eta\times[h(\delta_{n-2}^{n-1})\times(1+\pi_{n-1}^{n-2})]\}$	$h(\delta_C^{n-1})\times(1+\pi_{n-1}^C)$	$h[(\delta_{n-1}^{n})\times(1+\pi_n^{n-1})]$
$n \leftarrow (n+1)$	δ_{n+1}^n	$\delta_{n+1}^n \times \{1+\eta\times[h(\delta_{n-1}^{n})\times(1+\pi_n^{n-1})]\}$	$h(\delta_C^n)\times(1+\pi_n^C)$	$h[(\delta_n^{n+1})\times(1+\pi_{n+1}^n)]$
Total of Universe[67]	-	-	$(1+\pi)\times\sum_{k=1}^{n} h(\delta_C^k)$	$(1+\pi)\times\sum_{k=1}^{n} h(\delta_k^{k+1})$

4. Some conclusions

The arising of the dissipative systems breaks the entropic symmetry of the Universe, leading to two generic structures: the dissipative system, on the one hand, and the complementary environment, on the other hand. This entropic heterogeneization generates a redistribution of the entropy "mass" and separates a low entropy (i.e., a superior degree of complexity) inside the membrane of the dissipative system, face to a high entropy (i.e., an inferior degree of complexity) inside the complementary environment. But the complexity increasing decreases the own (specific, depending on the process) time tact inside the dissipative system, that is, increases the entropy velocity (generates the entropy acceleration). *The principle of invariance of the global entropy velocity* (which is an effect of an implicit principle of invariance of the global entropy, and is based on the *principle of invariance of the total simplicity* of a dissipative system) is valid in the case of taking into a consideration of a simple redistribution of the entropy between the dissipative system and the complementary environment (that is, in the case of taking into a consideration only of the *compensation entropy*). The "birth" itself of the dissipative system requires a supplementary consumption of low entropy inside the complementary environment or (that is logical equivalent) requires a supplementary high entropy production inside the complementary environment, that is what we called *heterogeoization entropy*. Thus, between the two sub-structures of the Universe 1 (the dissipative system, and the complementary environment) appears not only a relative difference of the entropy velocity (because the inadequate measuring, with the clock time, of the two velocities[68]) but appears also an absolute difference in the entropy velocities. This absolute difference leads to the acceleration of the global entropy (for both the dissipative system and the complementary environment). This means that the process of dissipative systems[69] birth modifies, in fact, absolutely, the global entropy velocity.

Theoretically, three categories of dissipative systems could exist, of ranks, respectively: “-1”, “0”, and “1”. While the dissipative systems of rank “-1” are logically impossible, and those of rank “0” are observationally indiscernible (based on the accepted criterion of identification of the dissipative systems: the accelerating of the entropy inside the complementary environment of the involved dissipative system), in turn, the dissipative systems of rank “1” are those of theoretical and empirical interest. The partition of the dissipative systems of rank “1” into two sub-categories: dissipative systems of rank “1α” (non-human dissipative systems) and of rank “1β” (human dissipative systems) leads us to the concept of *mixed dissipative systems entropic stationary* (MDSES), which is a concept capable to generate many theoretical constructions on the entropic sustainability.

The above considerations could lead us to a very important conclusion on the rationality dynamics of the human society: from the stationarity rationality to the optimality rationality, and, today, from the optimality rationality to the sustainability rationality. The principles of the entropy (theoretical argument) as well as the emergent challenges of the globalization process (pragmatic argument) lead to the necessity to reject the actual paradigm of optimality, and to take over the paradigm of the sustainability.

The entropic interaction occurs based on the principle of the minimum entropic gradient (if the number of dissipative systems in the Universe 1 is more than 1) and this principle is consistent with the principle of minimum entropy production, proposed by Prigogine, although this demonstration of consistence could be assessed as well as a proper demonstration of the principle of minimum entropy production.

At the same time, the above considerations and conclusions generate, in turn, o set of questions which here remained unanswered or, in the best case, without a decisive answer.

For our colleagues in the field of entropy theory or, larger, in the field of the economic epistemology, we think could be useful to enumerate some of these: a) is it for any importance the age[71] of the Universe 0, for the moment of arising of dissipative systems? How is exerted this influence (if any), from the point of view of the velocity and acceleration structures and dynamics?; b) is it possible a dissipative system which have a negative local entropy velocity, that is, which have an entropy decreasing[72]? What could be the signification of such a case, from the point of view of the time arrow?; c) is it of any importance if inside the Universe 0 appears a single dissipative system or many such dissipative systems appear? How influences this on the global entropy velocity?[(73)]; d) how "knows" a given dissipative system how much low entropy must take out from the complementary environment (or, indirectly, from other dissipative system, accordingly the principle of entropic interaction logics)? Except the dissipative systems of rank "1β" (in which case we could use the concept of a neg-entropic deliberative program), what can we say about the other cases?

Our considerations, proposed in this study (including the questions arisen by these considerations themselves) have not only an academical or philosophical (even metaphysic) signification. The globalization and its problems (generated or highlighted), that constitute pragmatic issues (involving the social practice), as well as, for Romania case, the process of integration into the European Union and, later, the process of integration in the euro area, indicate the necessity of these preoccupations on the "complementary environment" that is created by the human dissipative systems (for the moment in the under-moon world), that is on the artificial complementary environment (composed by the artefactual "objects" of the human society). Probably, the most important such artefactual "objects" are the social institutions. They constitute sui-generis principles, more exactly: they are replicas to the natural (i.e., entropic) principles, and, consequently, they should be analyzed from an entropic perspective as well[(74)].

Notes, comments, and bibliographical references

Notes

* The author has recently discovered a fourth type of such rationality, i.e. the rationality of viability, based on the logically vivid system concept and on moral presuppositions.

(1) It remains, of course, to be solved the crucial question of measuring (or, at least, of quantifying) the variation of the entropy velocity. We believe, however, that this question is rather a practical question than a theoretical one. Consequently, we put it into (Husserlian) parentheses.

(2) Remember that, by definition, : see our article *About some Entropic Aspects of Dissipative Systems*, Theoretical and Applied Economics, 2006, Volume 10(505), Issue 10(505), p. 33-40.

(3) The fact we note with "-1" the rank of such dissipative systems indicates, metaphorically, that they are (logically) impossible or, that is the same, they constitute an inverse heterogeneity in the Universe 0 (or, as remembered, this type of heterogeneity was been postulated and demonstrated as impossible). However, see further some suggestions to use this impossibility in order of a possible construction of a dynamic (more exactly, oscillatory) entropic model of the Universe.

(4) In all ordinal relations which are used to obtain the typology of the dissipative systems, we have in front of eyes both the compensation entropy and the heterogenization entropy.

(5) To be noted the fact that such dissipative systems could be formally described by the logical contradiction (that is, by a necessary contradiction).

(6) Here appears a logical problem that is of extreme interest. As the situation is before described, in the Universe 0 is arising, however, an entropic heterogeneity. But, the arising of an entropic heterogeneity is a token (even in the semiotic sense) for the assigned referential, that is, for the dissipative system. So, we cannot logically reject the fact that a dissipative system is born. The impasse is emerging, in our opinion, from the fact that we already "choose" what we understand as being a dissipative system (i.e., the "content" of a membrane that has a complexity degree higher than the "content" of the outside of the membrane), as well as, what we understand as being the complementary environment (the opposite situation). But, this choice is absolutely arbitrary or even…anthropomorphic. Indeed, a cognitive subject inside the complementary environment could believe that it is his own membrane (the same we ourselves observe, but from inside of that we call dissipative system) that separates a dissipative system, from where results that a dissipative system is a "content" that has an entropic velocity higher (i.e., a complexity degree smaller) than the "content" in outside of this membrane. Although we (which make this analysis) are, certainly, one of the two cognitive subjects, unfortunately we cannot say which of them we are; our structural position is indiscernible (in the lack of absolute framework of reference) related to the position of the alter ego. To put differently, are possible, simply, two theories concerning the entropic phenomenon: one that believes that the time arrow is indicated by the entropy increasing, and other that believes the contrary, that is, the time arrow is indicated by the entropy decreasing. We will come back to this problem, because it could be a starting point for the time arrow debates.

(7) The fact we note with "0" the rank of such dissipative systems indicates, metaphorically, that they do not constitute a heterogeneity in the Universe 0.

(8) It is easy to remark that the Universe 0 can be moved, from the methodological point of view. Thus, if at the moment t_0 a real (that is, of strictly positive rank) dissipative system arises, then we could consider that, in order to analyze the arising of a second real dissipative system (at the moment t_1, where $t_1 > t_0$, and the moments are measured with the clock time, that is, with the cosmological time), the Universe 1, generated by the arising of the first dissipative system, could be assimilated with a new Universe 0, with the condition, of course, that $\lambda_C^{\overline{N}} \equiv \lambda_N^{(1)}$, where $\lambda_N^{(1)}$ signifies the new "natural" entropy velocity, after the arising of the first real dissipative system.

(9) If, however, such dissipative systems would be observed (by intermediation of a certain entropic consequence, that is, by intermediation of a cognitive innovation), this means that our identification criterion for the dissipative systems arising in the Universe 0 is not working.

(10) In the sense that it establishes us in a privileged position face to our symmetric "companion" (observer or knowing subject), placed in the complementary environment. See, for details about the explanation paradigm based on the symmetric companion (the "twin earth"), the work of Hilary Putnam, *Rațiune, adevăr și istorie*, Editura Tehnică, București, 2005 (especially chapter 1).

(11) Any of the three mentioned examples (mineral, vegetal, and animal) must be considered, in the integral context of the study, as vivid systems examples(12).

(12) It seems be quite excessive to consider as vivid system any dissipative system, but we have for our "defense", two arguments: a) forming of the membrane (inherent to the entropic heterogeneity arising), as well as the maintaining, inside the membrane, of a entropy velocity less than outside the membrane (remember that this capacity is an auto-poietical capacity) constitutes the two basic conditions for a logically vivid system; we have here a *conceptual argument*; b) the formula of the equivalence between the vivid system and the dissipative system ensures an indisputable logical coherence, which is very difficult to be achieved in the lack of this equivalence; we have here a *methodological argument*.

(13) Which is valid, nota bene, only in the hypothesis of accepting the evolutionary doctrine on the species and, implicitly, of rejecting of the creationist doctrine in the matter.

(14) Remember that the Universe 0 is that Universe about we discretionary establish that it (logically and chronologically) is in the antecedent of a Universe (called Universe 1) where follows to appear an entropic heterogeneity (that is, a dissipative system or, as we pointed out before, a vivid system).

(15) It is easy to remark that the question could be formulated even in more radical terms, namely, if we should accept a "rationality" of the Universe 0, and if yes, in which way could we describe such a "rationality"? If we would accept such a rationality (we ignore the quotation marks, because we are discussing here just in anthropomorphic terms), then the Universe 0, certainly, would has as "target" the homogenization (so, the re-homogenization) of the Universe 1, because the basic principle of the evolution of the Universe is the principle of the road to thermodynamic equilibrium. In this context, it results not only that the arising of the authentic dissipative systems (i.e., of rank "1") constitutes an accident but, in addition, it results that the "improvement" of the accident (the entropy velocity reducing or achieving of a negative(16) entropy velocity inside the dissipative systems) constitutes a "second order accident", so forbidden as well by the principle of permanent increasing of the global entropy. However, we could develop a contrary demonstration as well: taking into account that the "target" of the generic Universe is to reach the thermodynamic equilibrium, the arising of the dissipative systems (and how much more so, their entropic development by decreasing of the entropy velocity inside the membrane) constitutes "vectors" just for the mentioned "target". So, if we would accept a sui-generis rationality of the Universe 0, then, inside this rationality, the arising of the dissipative systems constitutes "strategies" extremely efficient, because the dissipative systems accelerate the entropy (as explained before).

(16) We repeat, although probably with too much insistence, that this supposition is much too complicated to be discussed inside the limited ambitions of the present study, it implying difficult considerations on the inversion of the local time arrow, as the phenomenon is proposed by the entropy theory. It is possible that the special theory of relativity (which accepts only a positive values for the time, associated with the superior limit of the light velocity) be only a particular case of the evolution in the Universe, and, consequently, the entropy theory could develop this evolution theory including the negative values for the clock time, that is, the negative values for the entropy velocity. For the moment, we are acting in the same way as in the special theory of relativity, namely we postulate an inferior limit for the entropy velocity – this cannot be negative.

(17) Of course, if somehow the thermal death of the Universe is the God's target, then we

could remove the spontaneity from the arising of the dissipative systems and could transfer the "decision" to initiate and, then, to develop these systems, on the transcendent divinity; to be observed the fact that, if the divinity is immanent, then itself must be considered as the first dissipative system in the Universe 0 although, in this case, the problem of the spontaneity in arising of the dissipative systems is again resuscitated (it was been rejected only by postulating the transcendent nature of the divinity; it is true that such a resuscitating is opposable only to the arising of the first dissipative system, which is just the birth of the God himself). If we do not accept the hypothesis of the spontaneity in arising of the entropic heterogeneity called God, then we must (logically) accept a God of… the God and so on, ad infinitum (in addition, the perspective of a God of the God is a few impolite face the divinity which, many times, serve us, with kindness, as useful hypothesis in our cognitive works).

(18) In the same way, approximately, in which the European Union has a common commercial policy (for instance, a common external tariff) – that is, the exterior membrane but, at the same time, there are also national commercial regulations (especially non-tariff kind) – that is, interior membranes. Of course, in the biological world, such examples are much more abundant.

(19) It is, we hope, obvious the reason for which we do not call these dissipative systems as entropic static systems (because, between these systems and the complementary environment there is substance, energy and information exchange, that is, metabolism, so the mentioned dissipative systems are dynamic but not static).

(20) Although it is obviously the case of entropic sustainability, we are very doubt it is possible to talk with certain signification (scientific signification) on another category of sustainability, except the case of very punctual demarches, where the notion of sustainability is considered rather in a metaphorical sense (fiscal sustainability, social sustainability etc.)

(21) To be noted another important issue, here: the entropic gradient has not only a scalar but also an algebraic sign: the entropic exchange will occur so that the low entropy will "flow" from the system that has higher entropy to the system that has lower entropy, never inversely. This assertion must be, however, funded. Our argument is: we "have established" that the finality of the Universe 0 (so, of any possible Universe 1) is to reach the state of thermodynamic equilibrium. As the arising of the dissipative systems (far from equilibrium systems) accelerate this process, "results" that the dissipative systems arising is "rational". Now, if we would suppose that the entropic exchange, in the case of an entropic given gradient, would get so that from the higher entropy-system to the low entropy-system would flow the high entropy, then, accordingly the above mentioned, low entropy should be consumed in the higher entropy-system. In order to perform the entropic exchange; but, this will create high entropy in the system that just "delivered" high entropy, that would nullify, for instance (or would reduce, in any case), the entropic "gain" generated by the high entropy "export". This result is not consistent with the above mentioned rationality. As consequence, the entropic exchange will occure exactly in an inverse sense: the high entropy-system will "pump" low entropy to the low entropy-system, and this will consume supplementary low entropy in the high entropy-system. This time, the result is consistent with the "rationality" of the Universe.

(22) As is showed at *Notes, Comments and References*, no. (23), in order to ensure the terminology unity, we must talk, in this case,

about quasi-mixed dissipative systems entropic stationary (QMDSES), i.e., about sustainable natural eco-systems.

(23) Here appears an important problem: the membranetical differentiation: indeed, every dissipative system of rank "1" has a membrane face the complementary environment; for instance, a dissipative system of rank "1β" has a membrane (the same) that separates it from the complementary environment as well as from the dissipative systems of rank "1α" (we do not extend the discussion to more analytical distinctions, as those among different dissipative systems of rank "1β", although the anthropologists or the sociologists are discussing the important differences among different human communities, related to the natural environment – that is, related to the dissipative systems of rank "1α" – where there is a given proximate among the respective dissipative systems). In this case, we must admit that the membranes of the dissipative systems (no matter their rank) have certain capacities to recognize the rank (or, even the sub-rank, if we want to make more analytical differentiations based on sociological, anthropological, geographical, economical, cultural etc.) of a given dissipative system that interact with. Based on these recognizing capacities, the mixed dissipative systems are possible, as we talked about above[24].

(24) It is absolutely obvious that the analysis must be extended as well to the quasi-mixed systems (to call them so) which are formed among the dissipative systems of rank "1α": for instance, between the vegetable system and the animal system. There is, otherwise, a consecrated notion for such entropic interactions: the eco-systems, but the discussion must be developed, in our opinion, around the concept of entropy and of entropy velocity.

(25) The anti-dissipative system is the system which has he "quality" to have an entropic velocity greater than of the dissipative system entropic velocity (or, that is logically equivalent, the system which takes over the high entropy from the dissipative system and, simultaneously, transmits low entropy to the dissipative system). To be mentioned that this "definition" is valid only in the particular case in which we have in the Universe 1 a dissipative system only; at once of the second dissipative system, at least, is born, for any given dissipative system, the anti-dissipative system will be constituted by the genuine complementary environment and all the dissipative systems having an entropy velocity higher than the analyzed dissipative system (but, as we pointed out in the framework of discussion on the "rationality" of the Universe 1, all the dissipative systems tend to reduce their velocity) [26].

(26) How could we in this case, however, to highlight the complementary environment if the Universe 1 is densely populated with dissipative systems? We should consider, for every dissipative system, as outside environment, the all content that is not comprised by the membrane. But, taking into account the fact that, in the case of a high density of dissipative systems, the membranes have the capacity to recognize the other dissipative systems (and, of course, to recognize the genuine complementary environment), probably we should to distinguish (for every given dissipative system) between two categories of complementary environments: a) the dissipative complementary environment or the relative anti-dissipative complementary environment (the set of the other dissipative systems that have a higher entropy velocity than the analyzed system); b) the absolute anti-dissipative complementary environment (that remaining after the methodological separation of all the existing dissipative

systems). But, this generates the problem of the "communication" among the dissipative systems (to which we will shortly refer next).

(27) See, for instance, the paradigms of the economic growth, based, in majority of cases, on the hypothesis of cyclicity of economic activity. But, the cyclicity implies, by definition, variations of the complexity degree (for instance, of the organization degree or, that is the same, of the internal connectivity degree); these variations are directly "translated" into variations of the entropic velocity. The variation of the entropic velocity, in turn, destroys the stationarity of the dissipative system in the case.

(28) To be observed that the sustainable systems, as were defined here, immediately lead to the concept of the evolutionary economics which, in opposition with the neo-classical economics, accepts more than one equilibrium. By an analogy which cannot be too audacious, on could say that the durable systems are described by the neo-classical economics, and while the sustainable systems are described by the evolutionary economics. The link between the evolutionary economics and the entropy theory is obvious if we remember that the both theories admit the qualitative changes, that is, such changes which cannot be always described by the analytical (that is, of dynamic type) equations.

(29) For certain fine distinctions between the irrevocability and the irreversibility (in a statistical key, however) see Nicholas Georgescu-Roegen, *Legea Entropiei și Procesul Economic*, Editura Expert, București, 1996. But, for our discussion here, these distinctions are not indispensable.

(30) See also our study, *Surse sustenabile de finanțare – aspecte de metodologie generală*, published in Oeconomica, no. 3/2006, where some more analytical considerations in the matter are offered.

(31) This part of the study is inspired and adapted (including some effective takings over) from our previous study *Modelul entropic al procesului economic*, published in Oeconomica, no. 2/2006. The concepts and notations used in the mentioned study were been modified or specified, to be consistent and coherent with the goal, terminology and logics aimed at in the present study.

(32) Accordingly the Nicholas Georgescu-Roegen's analysis, in the above mentioned *The Entropy Law and the Economic Process*, in the margin of discussion on the Maxwell's demon, it seems that the information needed by the dissipative structures in order to "know" how much low entropy must they take out from the environment to maintain their stationarity, implies a new quantity of low entropy to be consumed from the environment (see also the Loschmidt's argument). This supplementary low entropy consumption was been added by intermediation of our coefficient υ.

(33) It is easy to remark that null entropy acceleration is equivalent with an invariance of the entropy velocity.

(34) Using of the word acceleration can be justified as follows: the difference between the entropy change in the case of presence of dissipative structures and the entropy change in the case of lack of dissipative structures, give us a change of the change of the entropy, which leads us to the concept of acceleration (if we would use the continuing type of differential equations, we would have the second derivative of the entropy related to the time, so the acceleration).

(35) Here is arising a problem: once the dissipative system functioned inside the rationality of second order, the afferent low entropy for the σ was been already consumed (that is, was been "pumped", into the complementary environment, a quantity of high entropy of "size": $d\gamma \times \rho \times \sigma$. This increasing of the entropy will never be

"recuperated". The significance of the symbolic reasoning is only that, *from now further*, the global entropy increasing generated by the maintaining of the knowledge necessary to perform the principle of the rationality of the second order will not occur anymore (obviously, the "forgetting" of the knowledge and skills to optimize an objective-function in the framework of certain given restrictions, cannot create "neg-entropy", that is, low entropy, although the attainment of this knowledge and skills created high entropy before; so, we have not here a symmetrical behavior concerning the passing among the rationalities types, from the point of view of entropy dynamics, which is perfectly consistent, of course, with the condition of non-positivity of the entropy velocity).

(36) We deliberatively avoid saying we have to minimize the expression: $\upsilon + \mu$, because we have the steady conviction that the rationality based on the sustainability should be independent on any attempt to optimize. However, it is very difficult to non-equivocally demonstrate the fact that the rationality based on sustainability is independent on any optimization criterion (and this demonstration should constitutes a challenge for all the experts in the matter). To be mentioned, at the same time, that in the present study as well as in other studies, of other authors, on this subject (see, for instance, the principle of minimum entropy production, pointed out by Prigogine) some optimization principles are still applied. The nature itself seems to have any obvious reticence face to optimizations (at least as trend, should not say we that the road of the Universe to the thermodynamic equilibrium could be assessed as an optimizing principle?). Despite these controversial aspects, we "feel" that the sustainability should be assessed by other principles than the optimizing principles or, at limit, by principles based on… other way to understand the optimizing process.

(37) It is obvious that: $\mu < \sigma$, because the necessary knowledge to ensure a circular economic process is smaller than the necessary knowledge to ensure an optimizing of the economic process. As result,

$$\Delta E(R_S - R_O) = \sigma - \phi - \rho - \rho \times \sigma =$$
$$= -\rho - \sigma \times (1 + \rho) - \phi < 0$$

because $\rho > 0$ and $\phi > 0$.

(38) It is impossible do not feel the anthropomorphic discomfort of this signification. Probably, the most appropriate explanation, that is, in a more conformity with the general context of present discussion, would be the following signification "generates an entropic acceleration less than".

(39) As many analysts in the matter suggest, it seems that the capitalist type of economic paradigm generated this "non-rational skip"; today, as we are seeing on the globalization problems and on economic integration processes, is emerging a necessary "back-skip" of rationality, inside the entropic perspective, namely from R_{II} to R_{III}. The locution "back-skip" should be considered from the logical point of view, because, from R_{II} the R_{III} ordinal point of view, R_{III} is „before" R_{II}. But the locution is inappropriate from the historical point of view because, under this aspect, R_{III} is „after" R_{II}.

(40) From the macrocosmic point of view, the humanity "disposes of" a limited environment for the human (or mixed) dissipative system which is based, for the moment, on the rationality of second order: the mother-planet. As consequence, the entropic acceleration in the environment of its dissipative system is incomparable greater than it would be if the technological contact of the humanity with the cosmic space (i.e., with low entropy resources) would be larger (obviously, an enlargement of the dissipative system of the humanity, that is, a relative reduction of the entropic acceleration in the new environment is not impossible in the future; the question is, if

this future is enough proximate so the humanity continue to perform the rationality of second order).

(41) It is clear that "A" and "B" are interchangeable, without the reasoning be modified, although, as we will see, it is possible to become necessary that the membranes of the dissipative systems be endowed with the ability to recognize the entropic gradient between involved dissipative systems and the complementary environment (of course, in this last complementary environment will be included other dissipative systems having different entropy velocity, as well).

(42) We take into account only the case of "contemporary" dissipative systems. The alternative case, where the dissipative systems are not contemporary can be logically derived from the first case because any dissipative system marks the complementary environment with an "entropic trace"; this entropic trace will influence the new non-contemporary dissipative system under the aspect of the entropy level and velocity (the Universe is brought to "zero" again and again).

(43) Among the "functions" of the demon which substitutes, here, the Maxwell's demon, will be, obviously, that of "calculation" this entropic gradient between the dissipative system and its genuine complementary environment (or between the involved dissipative system and other dissipative systems).

(44) As it is known, for instance, the light always follows the minimum distance between two points (generally, the minimum distance between two points is the way which follows the geodesic generated by the space-time curvature, as is indicated by the non-Euclidian geometries and the general theory of relativity, respectively). But, as showed before, the dissipative systems generate, on their turn, a sui-generis "entropic curvature", although in another sense than in the physical space-time. More exactly, the dissipative systems generate "geodesics" which indicate that the entropic interaction will occurre between the dissipative systems having the minimum entropic gradient (this principle is verified, as well, in the particular case in which inside the Universe 1 there is a single dissipative system: indeed, in this case, there is a single entropic gradient – between the dissipative system and the anti-dissipative complementary homogeneous genuine environment – so, it is the minimum entropic gradient)[45].

(45) For the case of the economic dissipative systems (obviously, mixed dissipative systems) there could be defined specific gradients (that is, difference of "potential") (see, for a proposal in the matter, based on inertial considerations on the economic process, the author's book, *Fenomenul inerțial în procesul economic*, Editura Economică, București, 2001 – for instance, p. 99).

(46) The principle is otherwise suggested by our under-moon experience (and, until the opposite evidence, we should consider this experience as valid for the entire Universe, so should make a translation, under the sanction of the popperian falsiability, from the contingent to necessary) concerning, for instance, the trophic chain in the genuine nature: the carnivorous animals, which are on the peak of this trophic chain, do not take out the low entropy directly from the vegetable environment, but they "prefer" to do this indirectly, by consuming the herbivorous animals. But this means that the entropic exchange "choice" is made based on the principle of minimum entropic gradient.

(47) Of course, this enthusiasm for the determinism should be substantially moderated by the fact that, instrumentally, for the moment it is impossible to quantify these entropic gradients. To be observed that, epistemologically, we exactly have here the same problem which has arisen in economics, in the matter of the cardinal utility (fortunately, in the last case, we have,

however, the "solution" of recurs to the ordinal utility theory, which is generating, in its turn, so much inconsistence between the predictions and their actualizations).

(48) Logically, once at least two dissipative systems appeared in the Universe 1, do not anymore occurs direct entropic exchanges with the genuine complementary environment, but only between the two dissipative systems, based on the choice principle of the minimum entropic gradient. It is obvious, at the same time, that the indirect entropic exchange occurs between the two dissipative systems, and then, based on the same principle of the minimum entropic gradient, the dissipative system having the entropy velocity nearer the entropy velocity of the genuine complementary environment, will perform the direct entropic exchange with the complementary environment.

(49) We could discuss here about a kind of entropic "productivity", defined as the quantity of low entropy needed to increase with a given magnitude the entropic differential between two dissipative systems (or between a dissipative system and the complementary environment, in the case in which in the Universe 1 there is a single dissipative system). So, the principle of the minimum entropic gradient to choose the entropic interaction could be expressed also in the form (logically equivalent) as: the principle of maximum productivity to vary the entropic gradient. Here, as we think, a suggestion for the economists involved in the global factor productivity question, could be find: maybe, beside the Solow residual, we should consider another residual (with a negative sign) generated by the entropic processes in the economic activities; so, we will have not only a global factor productivity but a total factor productivity also.

(50) For instance, in the case of economic systems, the arising of the specialization, based on the productive advantage (absolute or relative), that led to the economic exchange, pushes the commercial flows to follow specific "geodesics" that are generated by the economic development degree. In this sense, we could say (remaining, of course, that this assertion be developed in a more complete and coherent way) that the economic flows (of merchandises or of production factors) follow a kind of minimum gradient of the economic development (this degree could be measured by the competitiveness, productivity, opportunity etc. (51)

(51) It is possible that more talented analysts find, here, some suggestions to replace the actual criteria of the national specialization (absolute or relative advantage, endowment with production factors, the average level of the national productivity, the niches etc.) by a more general criterion: the…economic geodesic. A preliminary approach in the matter can be seen, as above already mentioned, in the author's book, *The Inertial Phenomenon and the Economic Process*, Politică Publishing House, Bucharest, 2001, p. 99.

(52) To be mentioned that in the following demonstration we use the clock, inappropriate time, because otherwise (by using the own time, assigned to the entropic process and dependent on it), as the reader which followed us far now can immediately observe, we have not differences of relative velocity, at the level of the set of considered dissipative systems.

(53) Obviously, $\kappa = f(\theta)$ but, for the moment, the features of this functionally dependence will be ignored.

(54) This direct dependence is not arbitrary, but it is the logical implication of the anterior postulate concerning the fact that the dissipative system "choose" to transfer a minimum of low entropy to reach the "target" of reducing of the local entropy velocity. As the entropic gradient is maximum when the dissipative system interacts with the genuine complementary

environment (and when, of course, it should take out a maximum of low entropy), the above mathematical conclusion is obviously.

(55) To simplify, we could consider this dependence, quantified by h, be uniform (that is, independent on the dissipative system). This means that h is not specified distinctively on the pair "i,j".

(56) We will suppose, in addition, that the entropic interaction between any two dissipative systems (based on the principle of minimum entropic gradient) does not modifies, by itself, the initial ordinal relation among the local entropy velocities for the "n" dissipative systems (even if a variation of the relative local entropic velocities occurred, these variations maintain the initial ordinal relation among the entropic velocities). This is a simplifying hypothesis which does not change the validity of the reasoning.

(57) The hypothesis that the dissipative systems interact two by two, while the other dissipative systems "wait" to be finished the actual interaction in order to "see" which is the new map of the minimum entropic gradients, is quite simple. It is most probable (we do not understand here by the concept "probable" nothing related to the theory of probabilities, but we consider the mentioned concept in its "civil" signification) that the dissipative systems interact in the network way. But, this last hypothesis requires analytical developments which are not intended by this study.

(58) For simplicity, we could consider that this dependence, measured by η, is uniform (independent on the dissipative systems).

(59) It is easy to observe that $\varpi = 1$ is verified only in the particular case in which in the Universe 1 there is a single dissipative system.

(60) We could ask, of course, why the Universe does not block the arising of the dissipative systems (In fact, of importance is to block the arising of the first dissipative system), and it only "strives" to verify the principle of entropic interaction based on the minimum entropic gradient, that leads to minimizing the entropy production, after the arising of the dissipative systems. This solution is, evidently, less efficient, and the rationality that we have cognitively projected on the Universe 0 has to suffer. But, as we repeatedly showed along the study, the arising of the first dissipative system is the result of a spontaneous "act" to appear an entropic heterogeneity. If we accept this "non-rational" spontaneity, then the arising of the second dissipative system (and the rule could be applied, ad infinitum) is logically necessary, just to verify the principle of minimum entropy production. After the arising of the first dissipative system the Universe 1 behaves "rational" (In fact, of importance is to block the arising of the first dissipative system.)[61].

(61) From reasons of terminology unity, we could say that, in the context of spontaneously arising of the first entropic heterogeneity (that is, of arising of the first dissipative system), the Universe 0 behaves a-rational (not non-rational).

(62) To be not forgotten that, epistemologically, the comprehensiveness requires the intuition, while the knowledge simply requires the rationality (logical demonstration). But, essential is that the intuitivity be ensured in the premises (as we proceeded, by postulating of the minimum entropic gradient as choice criterion for the entropy interaction, see also[46], and[50]), so, the demonstration or argumentation could be simply transferred to a logical automat.

(63) We don't know if the logic order coincides with the chronological order (accordingly the clock time, it must exist such a correspondence; for the moment, we do not need for the own time of the dissipative systems).

(64) The graphical arrows indicate, here, the sense of low entropy flow.

(65) It is sufficient to measure the succesive increase of the entropy in the genuine complementary environment.

(66) It is sufficient to measure the entropy variation only inside the "entropic donor" dissipative system.

(67) To simplify the calculus, we could accept the invariance for π_j^i, that is, $\pi_j^i = \pi$, for any „i" and „j".

(68) While, by measuring with appropriate clocks (based on the own time tact of every such structures), we have a verification of invariance of entropy velocity principle.

(69) Logically, the arising of the dissipative systems is equivalent with the entropic "improvement" of the dissipative systems, under the aspect of entropy deceleration compared with the actual global entropy velocity, because the impact on the heterogenization entropy is the same in the both cases(70). Here, it could be developed a nice theorem of invariance, similar, from the certain points of view, with the Miller-Modigliani invariance in the investment financing field.

(70) It is worthy of note that a dissipative system could be in the following "entropic situations": a) entropy velocity inside its membrane is equal with the global entropic velocity (that is, we have not variations of the entropy velocity related to the entropy velocity in the complementary environment); b) the entropy velocity decreases under the global entropy velocity (we have a low entropy consumption from the complementary environment, of heterogeneization entropy type, in order to ensure this velocity differential); c) the entropy velocity become zero, the system become stationary from the entropic point of view (we have a low entropy consumption from the complementary environment, of heterogeneization entropy type, in order to ensure that stagnation of the entropy velocity); d) the entropy velocity become negative, that is, the system increases its complexity degree (not only that we have a low entropy consumption from the complementary environment in order to perform this "target", but also appears the delicate problem of the time arrow (The question of the time arrow is here put, of course, from the perspective of the clock time, that is, from an inappropriate time).

(71) It is easy to remark that the age of the Universe 0 is linked to the degree of the entropization of the Universe 0 (the Universe is "Universe 0" for any new dissipative system). A supplementary question is here: really, is there the chance (please, do not see any allusion to the theory of probabilities, here) of arising of the dissipative systems dependent on the entropization degree of the Universe (that is, is this arising "catalyzed" by the entropization degree) or it is independent on it? This question is of great importance for the entire our discussion.

(72) To be observed that here it intervenes the important distinction between the non-human dissipative systems (which "walk" until a null entropy velocity, in principle), and the human dissipative systems (which, especially by the social construction, seems to reduce the entropy, so, seems to reach negative entropy velocities). Curiously, from the perspective of the clock time, does not appeared, far now, any existential anxiety about the time arrow inversion. It is possible, however, that the above fact implies not only logical considerations, but psychological aspects as well.

(73) Here we only outlined an answer just by our demonstration about the principle of minimum entropy production principle. We mention, however, the question since we believe it could generate new developments and simplifications of the entropy theory.

(74) It is well understood, of course, that the thermodynamic sense of the entropy must be completed by an informational one or even by an institutional one (in context, the above mentioned concept of complexity could help to "translate" the concept of entropy from a sense into another).