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A thermodynamic approach for emergence of globalisation

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Introduction

Despite the notion of the world community's transformation into a "global village", as introduced by Marshall McLuhan in 1960, globalisation remained unrecognized as an influential phenomenon until the 1980s, when it began to be conceptually addressed. Although the existence of globalisation has been demonstrated in empirical case studies, its definition still remains vague, elusive, and even contradictory. The lack of an essential definition has contributed, at least partially, to keep globalisation as a highly contested subject. Although the term is widespread in the last two decades' literature, the essential nature and meaning of globalisation continue to be inapprehensible, and its description is characterized by a collection of numerous adjectives and attributes. In the present debate there is no consensus as whether or not globalisation describes properly the nowadays changes in societies. Although the controversy surrounding the current globalisation debate is relatively recent, the globalisation process seems to have a long evolving history that has not been traced exactly to its origin.

Globalisation seems to present an apparent omnipotence, omnipresence (Steger, 2005), inexorability and inevitability amongst its attributes (Beck, 2000, p. 122); it preys on the most backward societies, ensures that poverty becomes perpetuated, makes material inequality even deeper, increases ecological degradation and is a carrier of violence, social injustice and insecurity for most of humanity (Scholte, 1996, p. 53; Hoogvelt, 2001; Black, 1999; Falk, 2000; Niskanke and Thorbecke, 2006). It may also be stated that globalisation puts an end to national states, promotes neoliberal ideology, increases and globalises financial capital and is found in transnational institutions and corporations, the new empire (Sklair, 2000; Anderson and Cavanagh, 2000; Riain, 2000). However, it can also be seen as an opportunity for less developed nations' progress, development and economic growth (World Bank, 2002; Ravallion, 2003). A variety of channels through which globalisation affects poverty have been recently discussed (Niskanke, 2010) and the effects of economic globalisation on income inequalities have been shown to be different in the short and long run (Sato and Fukushige, 2009). Regarding the relation between globalisation and income inequality, the so-called dimensions of globalisation seem to have different distributional consequences. In

fact, several differential impacts produced by economic, social and political globalisation have been characterized (Bergh and Nilsson, 2010).

The content given globalisation is contradictory, even though for others it is dialectic (Kellner, 2002). It is a material and concrete force, yet it is impersonal, ideological and rhetorical (Desai, 2001; Guillén, 2001; Hirsch and Fiss, 2000; Yeung, 2001; Hay and Rosamond, 2002; Steger, 2005). It is like a live organism (Sahtouris, 1998) but it does not have its own life (Yeung, 2002, p. 300). It is a new phenomenon but has always been around since Columbus and Magellan (Fazio, 2002). It explains everything and does not explain anything (Yeung, 2001; Watkins, 2002). It is the cause and it is the consequence (Yeung, 2002, p. 288). It determines everything; nothing is intentioned in it, everything is chaotic and anarchic (Lewis, 1996). It is phenomenon having universal scope; more than half the developing countries have not been globalised (A.T. Kearning/Foreign Policy, 2004; Pizano, 2002, p. 14). It is time-space distancing (Giddens, 1990, p. 64); it is time-space compression (Harvey, 1989; 2000). It is the hegemonic communication between nations; it is the end of nation states (Held et al., 1999; Berger, 2000). It is the end of history (Fukuyama, 1992); it is the end of geography (Läidi, 1997). It strengthens democracy (Munck, 2002); it inhibits democracy (Hardt, 2001). It consumes the most backward nations (Falk, 2000); it represents an opportunity for their economic growth (World Bank, 2002; Ravallion, 2003). It is the inevitable path towards prosperity and economic success; it is the cause of poverty and inequity (Basu, 2005). It is a civilising entity; it is destructive (Guillén, 2001). It is integration, competition and individualism; it is differentiation, cooperation and solidarity (Luhmann, 1984; Welge and Borhoff, 1999). It is a process of geographic dimensions; it has economic, political, cultural and social dimensions (Garay, 2000; Yeung, 2002). It is an inevitable and natural biological evolutionary process which began when humans landed on all the continents several millennia ago (Sahtouris, 1998); it is an invented system, it has nothing inevitable and natural about it, its place and date of birth is Breton Woods, US, July 1944 (The Siena Declaration, 1998).

A phenomenon having discursive versatility and causal wealth and attribute diversity and heterogeneity at the same time becomes a very attractive object to be tackled by biology and within the context of evolutionary economics. An attempt is not being made to introduce a particular definition of globalisation but rather just to contribute towards enriching debate about it. Globalisation is shown as being a characteristic or property inherent in self-organising and self-transforming complex social systems.

The economy during the first half of the 20th century, which was very much influenced by Samuelson (1947), assigned a predominant role to mathematics. Relatively few economists have taken Marshall's (1898b) proposal seriously, that of understanding economic subjects' behaviour from the point of view of biology. Marshall has said that mathematics is very useful for understanding simple problems; however, complex problems cannot be understood through mathematics and, much less so, the dynamics of equilibrium. Bearing Marshall's message in mind, it is proposed analysing globalisation as being a self-organised phenomenon lying outside processes of equilibrium. Biological reflection is a central piece of such approach. Understanding globalisation as a historical social phenomenon arising from the evolutionary transition from nature to society, might contribute to see globalisation itself neither good nor bad.

1. Globalisation: neither a definition nor a theory

The definition of globalisation continues being incomprehensible, elusive, vague and, on occasions, even chaotic and redundant (Yeung, 2002, p. 287; Rosenberg, 2000). Held *et al.*, (1999; 2000; Hirst and Thompson, 1996; 1999) have demonstrated the existence of globalisation in careful empirical case studies. Nevertheless, no definition agreed by consensus has yet been reached. Giddens (2000, 2001) considered that globalisation is not just economic but also political, technological and cultural; in his opinion, the topic of globalisation has been globalised during a period of intense and dramatic changes into a world where uncertainty is ostensible. Debate is not centred on existence of globalisation but rather on its nature. Beck (2000, p. 11) has emphasised globalisation's multidimensional nature, economic aspects being just part of its spheres. Therborn (2001, p. 449) has stressed the interaction of economic, socio-political, cultural and ecological aspects, concluding, therefore, that one should talk of globalisations and not just globalisation.

Globalisation implies the growth of supra-territorial relationships between countries for Scholte (2000), whilst Tomlinson (1999) has characterised such empirical condition as being complex interconnectivity, similar to that of a group of multivalent connections uniting our political, economic and environmental practices, experiences and destinies via the modern world. Globalisation thus implies de-territorialisation. Other authors have referred to globalisation as being a set of activities, policies and prescriptions laid down by the IMF, the World Bank, the WTO and FTAs tending to create a free global market for goods and services (Anderson and Cavanagh, 2000). The World Bank (World Bank Group) (2002) has stated that globalisation has favoured the struggle against poverty in more than 20 developing countries, even though it recognizes that in so doing it could have contributed towards increasing inequality.

Hans Köchler (2000), for example, has stated that the globalisation slogan constitutes a fresh phase in colonising the third world; this deals with ideological discourse about how to ensure economic progress in line with the model of North American democracy and conditions ruled by free market rules promoted by the WTO. Globalisation represents prescription for the whole world of the model of North American democracy supported by the imperial rule of the free market. Western institutions, such as free trade capitalism, technological rationalism, or liberal democracy, are becoming global. Nevertheless, there is debate about whether globalisation is the same as internationalisation, westernisation, Americanisation, McDonaldisation (Latouche, 1996; Ritzer, 1993) or market liberalisation. Globalisation has been also used to describe a wide spectrum of phenomena (Steger, 2007, p. 7) that possess little explanatory power and did not allow distinguishing between causes and effects. Some associate globalisation with the emergence of a political belief system that forms an ideological discourse sometimes called globalism (Steger, 2005). Globalisation has been thought of as an unprecedented time and space compression resulting from political, economic, and cultural changes, as well as powerful technological innovations (Castells, 1996-1998), Globalisation has been also perceived as a way of growing flows of capital, people and information taking place across space on a universal scale (Harvey, 1989; Ohmae, 1990).

A.T. Kearny/Foreign Policy (2004) proposed the globalisation index, including countries' levels of interdependence in terms of political relationships, technological integration, personal contacts and economic integration. This index's authors maintain that the most globalised countries have better income distribution. Such result would be valid for both developed and emergent economies. On the other hand, the KOF index of globalisation measures the main dimensions of globalisation (economic, social, and political) in addition to other sub-indices (Dreher et al., 2008). No consensus has been reached about the level of globalisation attained and its limits. However, some approximations for measuring economic globalisation have been advanced in terms of indicators for openness, connectedness and integration (Arribas et al., 2009).

Attempts at incorporating globalisation into the science of complexity were highlighted when constructing a theory of globalisation (i.e. the theory of non-linear dynamic complex systems) (Ormerod, 1998; Cole, 2002). Globalisation is an inherent attribute of all self-organising complex systems for Christian Fuchs (2003). He considered that relating self-organisation to globalisation (Rennstich, 2007) is a process which happens in society and is also present in nature (i.e. the more global a system, the greater the probability of its having higher complexity and a high level of interconnectivity between its component parts).

2. Metaphors and analogies

Metaphors and analogies regarding economics and biology are more than just centuries old. One only has to remember that Darwin alluded to Thomas Malthus and Adam Smith as being immediate sources of his inspiration when introducing the principle of natural selection to the biological world. It has already been stated that Marshall (1898a) proposed that biology and not mathematics was the auxiliary discipline for economics at the end of the 19th century; social phenomena could be better understood through biology than mathematics in his opinion. Metcalfe (2001) stressed that even though the concept of evolution is central to biology, this does not mean that it is exclusively a biological category. Evolution could happen in other domains. It is important to distinguish analogies from the principles inherent in physical nature which can be applied to biological, economic and social systems (Prigogine and Stengers, 1984; Georgescu-Roegen, 1971).

Many criticisms and objections have been made of using biological analogies, particularly regarding applying Darwinian Theory to economics and the social sciences in general. It has been argued that analogies from biology and physics only serve in identifying problems, but have not been appropriate in providing suitable answers (Saviotti and Metcalfe, 1991).

Another viewpoint states Darwinism's universality, the independence of its principles and its relevance for evolutionary economics (Hodgson, 2002; Knudsen, 2002). It has been said that Darwinism leads to a general theory of complex and open evolutionary systems, as well as proposing causal, accumulative and detailed explanations. Evolutionary economics has tended to appeal to the more relevant concepts of non-equilibrium thermodynamics. Such approach (Nelson and Winter, 1982; Nelson, 2002) goes against the founding postulates of conventional neoclassical economics. Geoffrey Hodgson (1993a; 1993b) and Michael Rothschild (1990) have stated that neoclassical economics is based on a metaphor taken from

Newtonian physics. Hicks and Samuelson's discussion regarding dynamics in economics concerned the pertinence of applying physics to economics. Contradicting Samuelson, Hicks stated that this was not possible.

Foster (2000) has criticised the biological analogy of natural selection regarding both its Darwinian and Lamarckian versions, stressing that Schumpeterian evolutionary thinking about economic evolution is compatible with an economic self-organising approach or perspective (Foster, 1997). Darwinian competitive selection is a secondary element in economic evolution as the primary force of evolution is born from the incessant generation of variety and novelty (Foster, 2000). The self-organising economic approach compatible with Schumpeterian intuitions highlights the concept of open system non-equilibrium thermodynamics (i.e. dissipative systems processing matter, energy and information).

Knudsen (2002) considered that Lamarckism and Darwinism share a common causal structure similar to that in economic evolutionary theory, even though the flow of information in Darwinism is unidirectional: from the genes (information) to the proteins (function) present in an organism's cells (i.e. from the replicators to the interactors). The Lamarckist view states that the replicators (genes) become modified due to information received from the interactors so that this modified state can then be transmitted to descendents. The set of encoded replicative instructions can be changed into habits and routines (genes) in economics, thereby allowing variations in intentionality to lead to rapider transformations than those resulting from Darwinian biological evolution (Knudsen, 2002).

Hodgson (1993a) resuscitated Marshall's metaphor (1898b) stating that economics is "a branch of biology broadly interpreted." Hodgson (1993b) thought that Marshall was more influenced by Spencer than Darwin. Really, Marshall never moved beyond a static, mechanistic paradigm, within a context of equilibrium (Hodgson, 1993b; Corning, 1996). Thorstein Veblen posed the following question in 1898. "Why is economics not an evolutionary science?" Economics should explain change before falling into the trap of static equilibrium in his opinion.

Approaches to studying the self-organisation of social systems in terms of evolution and co-evolution of species, genes or technologies (Maynard Smith, 1982; Kauffman, 1993; 1995) have recognised the risk that analogies and metaphors inspired by the inanimate physical world and the biological world (Mesjasz, 2002) may impede advances being made towards fundamental, more specific and systematic studies. The theory of biological evolution has also made use of mechanistic analogies. The notion of natural selection in the biological world has been considered, in its turn, to be a metaphor (Thompson, 2000; Hesse, 1974). Several authors have defended the scientific value of metaphor-based ideas (Lewis, 1996; Maasen, 1995; Hodgson, 2002) but have also insisted that they must go beyond the metaphor itself so that analysis can be systematic (Church, 1999).

3. The origins of natural selection and globalisation

The problems presented on trying to locate the historical origin of natural selection in the biological sphere and globalisation in the social and economic field are associated with the difficulties of theoretical conceptualisation. It is not known with any degree of certainty when natural selection began to act. The moment of its origin has changed frequently (Lima de Faría, 1983; 1988). Some Darwinists have stated that natural selection has acted on individual organisms in general (Lloyd, 1992) or functions or phenotypes (Mayr, 1997); others hold that it has acted on genotypes and genes (Williams, 1966; Dawkins, 1989) whilst others maintain that selection has always operated at molecular level (Eigen, 1971; Eigen and Shuster, 1979).

Swenson (2003) has stated that globalisation began when the earth was formed from a gaseous nebula 4.6 billion years ago. Moore and Lewis (1998) have stated that globalisation may be considered to be a natural process forming part of social evolution whose presence can be recognised during such early ages as four millennia ago during in ancient Assyria. Others hold that it began when humans set foot on all the continents several millennia ago (Sahtouris, 1998). Some people think that the phenomenon is more recent and began after the time of Columbus and Magellan. The starting point would be the great discoveries and the conquest of new territories after the second half of the 15th century (Fazio, 2002). The world system theorists estimate that it began with the capitalist system's expansion during the 16th century (Waters, 1995, pp. 2-4). Roland Robertson (1992; Fuchs, 2003) maintains that globalisation became intensified between 1870 and 1920. Some authors hold that globalisation was born during July 1944 at Breton Woods, USA (the Siena Declaration, 1998). Agnew (2001) has stated that contemporary globalisation had its origin in the Cold War's ideological geopolitics (Agnew & Carbridge, 1995). John Tomlinson (1999; Fuchs, 2003) and Manfred B. Steger (2003) have argued that globalisation made its most recent appearance during the 1970s; others prefer to think that it began at the beginning of the 1980s (Guillén, 2001).

4. Globalisation and natural selection

Darwinian Theory regarding biological evolution has been the object of intense debate during the last few decades. Natural selection has been the target of criticism, being more associated with a descriptive notion of evolutionary processes than with their fundamental explanation. Some critics have assumed that natural selection has been an abstract process of choice between alternative situations (Lima de Faría, 1983; 1988), independently of the universe's physical structure and that of the chosen organisms. Selection is resorted to each time that the basic mechanisms implicated in biological and social systems' architecture, functioning and evolution are ignored.

Progress beyond the analogy between natural selection and selection resulting from the process of competition has not been made in the case of economics. There is not empirical evidence showing that selection constitutes the basic mechanism of biological, economic and social evolution. Darwinism and its natural selection do not offer an explanation for the principles concerning the spontaneous thermodynamic ordering of living beings. Darwinian "fitness" and adaptation have also been questioned, the first because it is very difficult to quantify and the second due to its similarity with natural selection. The self-organisation

(Rycroft and Kash, 2004; Kauffman, 1993; 1995) of biological, social and economic systems presents itself as an alternative for understanding the nature of systems from their individual to planetary level.

There is no unified Darwinian theory, although there are many subjective (Lima de Faria, 1983; 1988) and contradictory approaches (Lima de Faria, 1983, p. 1024; Prothero, 1992; Lewontin, 1978; Witting, 2003; Mayr, 1978); something similar happens with globalisation. Every author has his/her own definition. In terms of its most outstanding attributes, globalisation has become analogous for natural selection. It has powerful omnipotent, omnipresent and universal properties "explaining" all economic, social, political or cultural events. Such mystification conspires against analysis of the driving forces of social and economic evolution from a historical point of view and contrasts with modern social thinking's classical foundations (Rosenberg, 2000, p. 2-3).

5. Globalisation as a self-organising complex system

Non-equilibrium thermodynamics can describe active structures' historical genesis (Prigogine, 2004; Prigogine and Stengers, 1984; Kauffman, 1993; 1995). Biological and social organisation implies forming structures which are very different to those of equilibrium which characterise the inanimate world. Complex, self-organising biological and social structures are born in open systems in which matter, energy and information are exchanged with their surroundings. The system is kept far-from-equilibrium and its dynamics corresponds to non-linear processes leading to their components' coherent interaction; new dissipative structures are born spontaneously in such conditions (Prigogine and Stengers, 1984).

Kauffman (1993; 1995) has proposed the spontaneous emergence of order in living systems and attributed a secondary role to natural selection concerning self-organising complex systems. Biological and social structures (as spontaneously produced phenomena in open systems and those very distant from equilibrium) are influenced by their surrounding environment, but also influence it in turn (Prigogine, 2004). Communities, nations and regions forming the global system behave as complex, open systems which are far-from-equilibrium. Interactions between subunits are non-linear (Heylighen, 2007). Globalisation must also be understood as being a complex self-organising system produced by social evolution (Rennstich, 2007).

5.1 The phenomenon of globalisation and the phenomenon of life

Globalisation is a collective distinctive characteristic of social complexity (i.e. the whole of the human species). Life is also a collective characteristic (Kauffman, 1993; 2000). The phenomenon of life, together with that of globalisation, has been defined in many different ways. Around 80 definitions have been proposed recently (International Workshop on Life, Pályi *et al.*, 2002; Zhuravlev and Avetisov, 2006). In practice, the end result has been to describe the constitutive elements instead of insisting on the search for an essential definition. Albert Lehninger (2000) has said that, "living organisms are composed of lifeless molecules," whilst Bohr (1933) stated that, "The existence of life must be considered as an elementary fact (or axiom) that cannot be explained, but must be taken as a starting point in biology."

Zhuravlev and Avetisov (2006) have combined life's manifestations (attributes or properties) into three groups: a state, a structure and a process. The difficulty presented when one tries to break down the attributes and seek their dynamic interactions can be recognised from such triptych vision. In the case of life actually present in the biosphere, this is seen as being a specific state of matter, commonly called the living state. Even though the essence of live matter is not clear, Zhuravlev and Avetisov (2006) suspect that it is related to the excited state of organic molecules and their assemblies. Understanding living matter refers to complex molecular systems' physics and chemistry and concerns the question about the events leading to the transition from the inanimate state to the living state. According to Prigogine (1977; 2004), new states are originated far-from-equilibrium in matter acquiring properties such as "communication," "perception" and "memory", these being typical of living systems.

In the structural and functional sense, life on Earth is represented by a specific hierarchical system called the living system, composed of self-reproducing agents (Zhuravlev and Avetisov, 2006). The phenomenon of life is comprehensible from individual organisms (and their cells) up to the level of a global ecosystem where the individual agents interact to organise more complex systems having different hierarchical levels. The tendency towards hierarchical structures is very obvious in the phenomenon of life (McShea and Changizi, 2003). The whole of the system is, at the same time, fragmented and integral. Life on Earth is a global phenomenon; it is thus composed of a series of hierarchically organised subsystems (Oltvai and Barabais, 2002) such as molecules, genes, biochemical networks, cells, tissue, individuals, communities and ecosystems.

Life on Earth has also been understood as being a specific process, the living process (Zhuravlev and Avetisov, 2006). Self-reproducing agents evolve within a context of uncertainty by producing genetic diversity. Dynamic and informational content, alongside the exchange of matter and energy, is also inherent to the living process. Andrade (2000) emphasised W. H. Zurek's proposal (1989) as he understood biological systems as being cognitive systems. Additionally, cognitive systems and living systems can be assumed to be collectors, processors and users of information.

5. 2 Globalisation as a state of social matter

Globalisation can be assumed to be a state characteristic of "social matter." It is the result of multidimensional interactions happening between individual agents, communities, nations and regions through codes of international, transnational and global interaction. The phenomenon of globalisation emerged as a less complex, less global, more local state of social matter. Regarding the state of social matter (human biology), such phenomenon is the result of social agents' cognitive "excitation" leading to approaches enabling collective learning and the accumulation of information and knowledge (Devezas and Modelsky, 2003). Such state of humanity is maintained through agents' interactions in which matter, energy and information/knowledge are exchanged at all hierarchical levels. Globalisation is the organisation of social matter, humanity, at planetary level. Social matter is living matter which has moved from the biological (living) state to the social state.

The notion of state is usually associated with the essential description of a system's components. To understand the phenomenon of life, one must differentiate between individual agents (which are relative passengers due to their ephemeral nature) and lasting populations or species containing them, to which they contribute towards forming, to which they belong. The allusion to the generic phenomenon of life on the face of the Earth has an abstract meaning, but the ecosystem relationships sustaining species have a concrete meaning, even though not all of them are related with the same intensity. Such characteristics do not contradict the conceptualisation of life as being a planetary phenomenon. Following a similar line of logic, the social matter represented by individual social agents is ephemeral whilst the communities and nations sheltering them last and are those which, in addition to maintaining their cohesion and internal coherence, contribute towards the structuring and functioning of the phenomenon of globalisation.

5. 3 Globalisation as a structure and a system

Globalisation in terms of a hierarchical systemic phenomenon is the result of an interconnection which open subsystems establish with their surroundings, in far-from-equilibrium conditions. Globalisation (as a hierarchical systemic structure) is interconnected to individual agents, local communities, nations and regions with differing degrees of intensity. It is thus necessary to turn to the concept of system to understand globalisation. Systems, especially autopoietic, self-organising and self-sustainable ones, present attributes which only appear when seen from a systemic global perspective (Maturana and Mpodozis, 1992).

Human societies' hierarchical structure has not been clearly established. Several levels of organization have been identified such as the family, the clan, the town, the national state (McShea and Changizi, 2003). There is a species of subsystem succession which includes (in order of growing complexity) individual agents, families and communities (urban and rural) within the framework of nations, continuing with communities of nations (regions) up to global level. Subsystems contain others in such hierarchical logic, making fractal arrangements and establishing horizontal and vertical interactions (McShea, 2001; Oltavai and Barabási, 2002).

Subsystems have heterogeneity in space and time in the phenomenon of globalisation and also generate diffuse frontiers, especially in their form and in some of their dimensions, determined by their internal elements' activity and parameters and their interactions with their surroundings (Prigogine *et al.*, 1972; Prigogine and Lefever, 1975). Each community, at whatever level, is simply a component or fragment of a globalised subsystem. Put another way, it is a population of interrelated individuals (economically, socially, politically and culturally) responding or reacting as a whole (community, nation or region) to the effects of the external environment, to their interconnectivity with other subsystems, as well as to their internal logic.

A society may be considered as being a network of subsystems which, in their dialectic interaction and dynamics, assure the maintenance of unity, cohesion and continuity through space and time, within certain not necessarily physical boundaries or limits (Fuchs, 2003). Analysing globalisation should show how the different hierarchical levels are spatially

interconnected. Fuchs (2003) has suggested that a global society and national societies may be found in the social space, as well as other transnational collective actors. Seen in this way, the global thus becomes a planetary-scale social space (Swenson, 1997).

5.3.1 What is national and what is global

Global structural sense is radiated at all levels, even though with variable intensity in different dimensions, latitudes and moments. There are trends towards globalisation at all levels, in communities, nations and in regions. Nations have a global sense regarding the local communities which they contain. That which is local constitutes the global whole; it is a condition of its existence. Globalisation is made up of local organisms (communities, national states) where the set of their interactions and interconnections supports growing globalisation. In spite of its asymmetries, fragmentations, exclusions, heterogeneities and inequalities, the phenomenon has planetary characteristics.

Considering globalisation's planetary nature is unavoidable as part of an evolutionary analysis. The phenomenon of globalisation is not something exogenous to national and regional subsystems; these are a constituent part of the global phenomenon in the sense that they form part of planetary interconnectivity. Nations (and regional blocks) per se are manifestations of globalisation events, growing interconnectivity between individual agents, communities and localities, not only in the geographical-physical sense but in the social and historical sense. Globalisation may be seen from the planetary dimension, but is present at all levels. The notion of globalisation covers the national level in the sense that that which is national (in its hierarchical concept) establishes close interconnections between individuals, local communities, to form a national system having greater complexity transcending and covering that which is local without abolishing it. For example, national institutions coexist side by side with other more local ones, as well as national interconnectivity in multiple orders. The national system removes citizens from their local dimension, their communities, to install them in a more global national temporal-spatial dimension, preserving their original dimension. In this sense, and as part of the same hierarchical logic, the global system presupposes the existence of their national components, their subsystems.

The emergence of more complex social systems does not imply the disappearance of the less complex systems making them up, or mean that all the less complex components must be included with the same intensity in a more global system. In terms of interconnectivity and feed-back, nations participate as nodes in varied complex networks. Humanity is organised into a growing worldwide interactive multidimensional network (Cao, 2007; Rycroft and Kash, 2004). Such complex networks are characterised by non-linearity, unpredictability and permanent changes accompanying the formation and making up of their nodes and interconnections.

Localities also behave as complex social subsystems having other more or less complex subsystems as their surroundings. There is a flow of matter, energy and information/knowledge (embodied in human talent or codes, technology and culture) between these subsystems. Local communities, nations, behave as open far-from-equilibrium systems (at all hierarchical levels), whilst the planetary global system is essentially a closed system (and, to a certain extent, is self-contained and self-referred); even

though it receives energy from solar and stellar radiation, it hardly exchanges matter with its surroundings. There is no absolute global system exhibiting the behaviour of an open far-from-equilibrium system exercising total coordination as the global system is an essentially closed system. In effect, there are national (local) subsystems which are articulated (even though unequally) for approaching a coordinated global system. National (local) subsystems have the inherent characteristics of open thermodynamic systems in the sense of being permeable to the flow of matter, energy and information, as well as remaining far-from-equilibrium.

5.3.2 Complex systems and globalisation

Complex systems are characterised by enormous heterogeneity and variety in their components and how these are organised or connected in complicated metabolic interactive networks, into hierarchies and multiple time-space scales (Carlson, and Doyle, 2002). The sciences of complexity understand living and social organisms as being self-organising and adaptive systems, acting through decentralised, non-linear, non-deterministic and constant flow far-from-equilibrium processes. The causal successions of self-organising complex systems present truly complex articulations of feed-back loops and circuits, allowing them to evolve, adapt and respond to challenges (Ormerod, 1998; Cole, 2002; Maturana, 1980). Changes in organised complexity result from the spontaneous birth of new structures, connections and forms of behaviour characteristic of open far-from-equilibrium systems (Capra, 1996, p.85). Irreversibility, directionality in time and historicity can be added to these characteristics (Urry, 2005; Depew and Weber, 1988, p. 333).

It can also be assumed that complex systems are particularly tolerant or robust regarding constrictions or perturbations of a certain magnitude and are thus highly optimised, but not in terms of equilibrium (Carlson and Doyle, 2002). This means that complexity is exemplified here by highly structured and interconnected networks or configurations resulting from deliberate engineered design or evolution; this does not exclude fragility or susceptibility regarding variety- and innovation-carrying internal or environmental fluctuation, perturbation or instability or even extinction and collapse. Nevertheless, if globalisation as an evolutionary process includes and is characteristic of the emergence of a highly structured, hierarchised and complex system then such process must have an inherent determined robustness, tolerance or buffering capacity regarding onslaughts and challenges in all its dimensions.

5.3.3 Structural and systemic formalities

Understanding globalisation in terms of structure and system incorporates formal demands. Hugo Fazio (2002) has stressed the difficulties which emerge when trying to approach globalisation due to the angle from which it is seen being very different: structure, state, process or moment. Regarding systemic analysis, it is argued that the notion of system presupposes the existence of structures in which the system's units/components maintain interactions in a defined way. The systemic foundation of globalisation is represented by growing interaction or interconnection between national and regional subsystems, as well as between the components within them, even though its heterogeneity, asymmetry and

variable intensity could suggest that globalisation as a system does not imply complete and extended interdependence, frank reciprocity.

National subsystems are a condition for the existence of the phenomenon of globalisation. Nevertheless, some authors have assumed that globalisation can only be understood as system, if the national scope in all their dynamics is set aside (Fazio, 2002). The inequalities and heterogeneities presented in globalisation are used as an argument against a systemic notion, given that it is not unusual for systems to become associated with synchronic behaviour and it is implicitly assumed to be an organismic and functional whole tending towards equilibrium (Fazio, 2002). Octavio Ianni (1999; cited by Fazio, 2002) has shown that system dysfunction, imbalance and disequilibrium tend to be objects of correction or suppression. In such case, preserving equilibrium is being sought, thereby negating the potentialities of open and far-from-equilibrium systems.

It has been argued that globalisation is not a system because it has not been consolidated at planetary scale and its intensity and orientation are very different in different parts of the globe (Fazio, 2002). This fact does not invalidate a systemic approach. It is true that subsystems are diverse but this does not detract from the existence of a global system. Subsystems (as components of a global system) are diverse in their different dimensions. Their interconnections' intensity, form and orientation are equally diverse. Political contingency, uncertainty, unexpected happenings, unpredictability, revolutions, institutions, fluctuations inherent in open far-from-equilibrium systems change the phenomenon's directionality, mould or create new orders, accelerate and decelerate some of this particular phenomenon's manifestations. The human agency plays a role having transcendental importance in such local or global systemic scale fluctuations. The notion of open and far-from-equilibrium system is incompatible with the generalisation, uniqueness and homogenisation attributed to the experiences observed in the phenomenon of globalisation by some authors.

In formal definitions, structure is associated with a system formed by articulated and coherent events where each component depends on others. This functional coordination does not contradict its non-equilibrium condition. On the contrary, it is one of the conditions for generating order. Globalisation is linked to transnational practices and expressions in multiple dimensions (economic, social, political, cultural), tending towards world-widening in all its manifestations. Capitalism thus plays a determining role in strengthening and bolstering the structural notion of the phenomenon and more recent globalising tendencies (Fazio, 2002).

5.4 Globalisation as a process

In terms of process, the phenomenon of globalisation is a historic reality of the human species and thus constitutes a social evolutionary process. Globalisation can also be seen as a manifestation of a multidimensional cascade of world-wide evolutionary processes from the perspective of the changes articulating the world system (Devezas and Modelsky, 2003). The phenomenon of globalisation seems to be the systemic consequence of an evolutionary and irreversible process in which creating complexity and order is inherent in open far-from-

equilibrium social systems. Such social system of the human species is a “world system” in Devezas and Modelski’s words (2003).

The notion of process does not only imply the general ability for evolving but also the interconnections and interactions which different hierarchical systems sustain within their surroundings. Such interactions would include the transformations which a system’s constituent agents (at all levels of hierarchical organisation) produce on their surroundings and the mutations or variations which systems experience, primarily as a response to their internal dynamics and logic, as well as variations constituting responses to interaction with their surroundings. Regarding their autonomy and the exercise of their active role in evolution, systems vary and create innovations in their multiple dimensions, some of which may eventually show Lamarckian hereditary characteristics (Knudsen, 2002) (“replicators”: habits and routines, institutions, norms, identities, cultures). Put another way, “interactors”, individuals and firms (for example, in the economic dimension) exhibit degrees of freedom concerning “replicators” (habits, routines) which could become modified as a result of developing “interactors” and their interactions.

Globalisation’s systemic agents (individuals, communities, nations, regions) thus experience transmutations intimately related to generating tremendous multidimensional variety which will interact or be put to test in an environment formed by other subsystems. As happens with the phenomenon of life, it is worth asking whether the direction in which evolution and the development of globalisation is advancing is accidental or whether, on the contrary, it obeys an inexorable trajectory. Alternatively, it deals with an event whose actual scenario is the most probable one (even though other realities are not just probable but could be made possible by the active intervention of a human agency).

5.4.1 Thermodynamic approaches to globalisation

Globalisation behaves as a self-organising hierarchical complex system which undergoes constant change without presenting structural and immovable systemic stability. It deals then with an evolutionary process creating newer and greater complexity and instability, innovative evolutionary dynamics, generating self-organisation and hierarchy, whose thermodynamic properties are not restricted to just the setting of nature but are also extended to human society at all its levels (Corning, 1995; Kay, 2000).

The concepts of non-linearity, instability and fluctuations have moved from the realm of chemical kinetics to social “kinetics.” Prigogine (2004; 1976) has called the order generated by the state of non-equilibrium “order by fluctuation.” This refers to the order resulting from fluctuation in any of a system’s dimensions. Instead of disappearing in such endogenous dynamics, fluctuation increases its magnitude within the system and surpasses the critical threshold of stability. The global order which can be observed at all levels of human organisational hierarchy comes from the instability caused by economic, social, political or cultural fluctuations which (in their development) have surpassed previously existent states’ critical stability thresholds. Complex systems experience deep transformations and adopt distinct behaviour thereby affecting changes in their spatially and temporally organised functional structure (Prigogine, *et al.*, 1972; Prigogine and Lefever, 1975).

Dissipative structures in human societies are sources of self-organisation (Kauffman, 1993; 1995; 2000). They cannot be isolated from their surroundings as these are sources of matter, energy and information, and isolation will move them inexorably around the realm of equilibrium where disorganisation and inertia are the norm. Globalisation is characterised by its great complexity and the rapid flow of information and knowledge between subsystems, in spite of the evident asymmetries, inequalities and heterogeneities (World Bank, 2002; Ravallion, 2004; Almansa, 2000).

By contrast with the far-from-equilibrium world, equilibrium's analytical considerations refer to a homeostatic world in which fluctuations are buffered or absorbed by the system itself. No fluctuation can become a source of variation and innovation in such circumstances (Prigogine, 1980; Prigogine and Stengers, 1984; Gunaratne, 2004). If the phenomenon of globalisation runs along the paths of equilibrium then its evolution will be absent and the construction of increasingly complex and coherent systems and subsystems will become excluded.

Non-linear interaction networks constructed amongst component units within subsystems, and through them, incorporating feedback loops contributing towards sustaining metabolic routes and networks in non-equilibrium thereby strengthening and broadening them due to their catalytic and self-catalytic nature (Kay, 2000; Maturana, 1980; Varela, 1981), are not exclusive to living systems.

Information and knowledge flow through these networks constituting "energetic" potentials favouring constructing complexity on being "dissipated." Even though information and knowledge can be reused, the incessant generation of new information and new knowledge implies that they will be rapidly replaced through practical application. Subsystems having greater cognitive potential will tend to transfer more knowledge within them and towards those subsystems having less potential.

Dissipative structures are the result of irreversible processes (Prigogine, 1980; 2004). The second law of thermodynamics concerns the distinction between reversible and irreversible processes. Entropy produced by real world physical events can only be positive or zero. Such result is a direct consequence of processes' irreversibility and has become a universal law of macroscopic evolution. However, it should be stressed that evolution and irreversibility are associated with the disappearance of initial conditions and dissolving structures within the framework of the concept of equilibrium, whilst they are related to the emergence of order and growing complexity in far-from-equilibrium biological and social systems (Prigogine, 2004; Kauffman, 1993; 1995).

The phenomenon of life results from irreversible processes and, in turn, induces new irreversible processes. Irreversibility generates irreversibility (Prigogine, 2004). Such conclusion is also valid for social systems. Considerations relating to the concept of irreversible processes are thus not alien to the phenomenon of globalisation. Irreversible processes become more relevant when dealing with biological and social phenomena corresponding to temporal evolutions where the past and future are assigned different roles (Prigogine, 1980). Time flows in a single direction in such evolutionary and historic sense,

from past to future. Globalisation is a process which does not escape the inexorable arrow of time present in biological evolution and in physics. Globalisation is clearly a consequence of the presence of irreversible processes within the sphere of social systems. As happens with the phenomenon of life, and extending Prigogine's intuitions (2004) about biological phenomena to globalisation, it can be stated that the rupture of symmetry present in globalisation is a manifestation of the universal arrow of time; globalisation is irreversible and induces greater globalisation and irreversibility.

5.4.2 Uniformisation and homogenisation

Globalisation is associated with nations' uniformisation and homogenisation in all their spheres (i.e. with the extinction of heterogeneity and variety). It thus follows that isolation will be the better alternative to avoid falling into uniformity. Such proposal ignores the fact that a social system at any of its levels of organisation requires matter, energy and information from outside it. Its local operation is not possible without global interaction. The surroundings does not necessarily determine or impose a type of particular complexity. The inevitable opening could constitute an opportunity for liberating the system from its limited local framework regarding the possibilities of creating complexity. In the cultural context, the movement of ideas across traditional cultural borders is not a new phenomenon, except that now those cultural flows show a higher speed and scope (Kim and Bhawuk, 2008). Some concerns have been raised regarding threats to collective identity as well as concerns about cultural homogenization. On the contrary, it has been emphasized that the enhanced intercultural contacts offer new opportunities and possibilities (Kim and Bhawuk, 2008).

Determination coexists with the supply of possibilities in the surroundings; there is space for dependence and interdependence. National systems are not a representation of a "global" environment because numerous national "species" coexist in spite of it being stated that there is a determinant and homogenising "global" environment. Social systems decide the management of flows of matter, energy and information in their relationship with the surroundings through their cognitive activity (Andrade, 2002; Ángel-Rodríguez, 2004). Globalisation is not a homogenising force as the empirical evidence indicates that national societies continue, even though in a differentially, generating variety and complexity.

Regarding biological evolution, it has been suggested (Brooks, 2001; Brooks and Willy, 1988) that the emergence of order and complexity in an organism is the result of the interaction between self-organised subsystems (intrinsic factors) and equally organised and complex external surrounding environment (extrinsic factors), each having its own rules of behaviour. Globalisation would imply that more complex and developed social systems impose conditions on less developed ones, making them more complex and globalised, without necessarily compromising their identity or autopoietic autonomy and their ability to evolve.

Within the context of the evolutionary process of relationships between systems having differential development accenting their complexity, and taking Woese (2002) as an analogy, simple and modular economic systems (i.e. hardly interconnected internally, not very complex or robust) may be exposed to their components becoming easily displaced by

foreign components or modules from the exterior, thereby becoming a driving force in their evolution. They will thus be more connected with the exterior than their interior during early stages of their evolution; they will become exposed, before having obtained their own “genetic” identity, to this being imposed on them from outside, from other innovation-exporting systems. Their evolution as backward and hardly differentiated systems will tend to mainly take place through components (“genetic”, economic, political, cultural, technological, informational, and cognitive) from the exterior, obviously in asymmetric conditions of innovation interchange. In spite of such apparent tendency towards homogenisation in favour of more developed and complex systems, many arguments tend to demonstrate that the process of globalisation does not lead to convergence and homogenisation but it is rather a dialectic process of unequal and heterogeneous development which, even though coordinated, also fragments and, even more so, produces divergent results and contrary effects in some cases (Giddens, 1991, pp.21-22; Giddens, 2000, pp. 30-31).

Globalisation has distinct effect on each nation and such process is not necessarily convergent, nor is it equitable (Keohane and Nye, 2000, p. 76). Garrett (1998) has refuted the simplistic vision of convergence and homogenisation. The empirical evidence supports the assertion that the process of globalisation preserves national specificities (Guillén, 2001; Zelizer, 1999). Cole (2002) maintains that heterogeneity prevails over homogeneity in spontaneous self-organisation. If this were not, then that which is global would put an end to the structural support enabling its existence. The whole cannot finish with its constituent parts. Globalisation and localisation can be read as two sides of the same coin (Cole, 2002). It may be added that codes of interaction between national subsystems tend to become homogenised, as happens with living organisms’ molecular logic (Lehninger, 2000). Subsystems tend to preserve their internal national identity during this process. In other words, there may be convergence in the logic of global interactions (Heylighen, 2007), but divergence or “speciation” in subsystems.

5.4.3 Generating variety

Examining the economic, social, political and cultural history of humanity leads to the inevitable conclusion that wherever one’s gaze is directed, fluctuations, instability and evolution are observed, thereby generating diversity and variety and a general tendency towards self-organisation, complexisation and the emergence of a new order. So that the process of globalisation in non-equilibrium is considered as being a self-organising system, it must be considered as a whole, a unit, where all coherence present in the relationships between its open subsystems is internal to it. Not just accidental spontaneous change but rather the intervention of human agency must be taken into account in this process of systemic growth of complexity and hierarchisation, purposeful action. A self-organising approach to the process of globalisation thus seems to be more compatible with a historical evolutionary description of humanity than with a reductionist and mechanical neo-Darwinist approach supported by the human analogy of natural selection, be it social or economic.

Reflection about thermodynamic systems within the framework of evolutionary economic theory does not constitute an analogy, as emphasised by Metcalfe (1998), but rather

resolution dynamics operating when variety is generated in any type of dissipative system. Self-organisation is not a simple analogy (Foster, 2000), but rather one of dissipative systems' properties which is manifest in different ways according to the context (Foster, 1997). The transfer of matter, energy and information during the globalisation process incorporates changes between the global phenomenon's constituent subsystems. Globalisation's evolutionary nature is due to variety or "speciation" being exhibited (before convergence) in the social organisation and in opportunities for cooperation and interchange. The continued generating of variety in subsystemic and global interconnections breaks the causal Darwinian relationship between selection and variety being generated (Foster, 2000). The role of competitive Darwinian selection between different connections thus becomes secondary within such context. Following Foster's line of thought, the engine for economic evolution and globalisation is born from variety and innovation in systems and their articulations, including information production, transfer and processing. Technological innovation is characterised by materialised self-organising processes in firms and other innovative agents (Biggiero, 2001). The greatest evidence of self-organisation can be seen in the increase in inter-organisational collaborative activities such as joint-ventures, consortiums and strategic alliances (Richter, 1994; Rycroft and Kash, 2004).

5.4.5 Historical transitions for nature and society

Globalisation may be understood as being a transition from biological evolution to social evolution; life is thus the result of the transition from chemical evolution to biological evolution. Following this line of thought, globalisation has inherited the transformation of matter, energy and information from biology (its preceding stage) in the same way that biology inherited attributes of development from the inanimate world, in spite of the notable difference observed between the cell's chemical composition (even the most simple one) and that of its inanimate environment (Zhuravlev and Avetisov, 2006). Complexity, active adaptation, and hierarchical organisation at multiple levels took place during the period of transition from chemical evolution to biological evolution (Zhuravlev and Avetisov, 2006). Such attributes of biological evolution were in turn inherited by globalisation. Other attributes appeared during the transition from biological evolution to social evolution which have been reflected in an intensification of the production and flow of information and knowledge, as well as their indissoluble support (collective processes of learning and other institutions). That which is social presupposes the existence of that which is biological with all its material and informational elements. The human species on the planet cannot just be seen as a biological assembly. Its task goes far beyond that. It supports a complex social system consisting of many interdependent units of behaviour which interact so that collective behaviour can emerge on several hierarchical scales up to the formation of the entire global system (Devezas and Modelski, 2003; Modelski, 2007).

Seen from the viewpoint of self-organising hierarchies, the space for living organisms emerged from the self-organisation of inanimate matter, whilst living matter in its self-organisation of superior order generated the social space (Fusch, 2003). Following this sequence of transitions, life's environment is the inanimate state which preceded it as well as life itself which is represented in individual agents, species and ecosystems. The inanimate world did not cease to exist when life emerged. In fact, many inanimate components were not included in living organisms whilst only very small percentages of

others were included. Globalisation's open systems also have their surroundings in that which came before them: the inanimate world, biological ecosystems, as well as that which is social, represented by individual systems, local, national and regional organisations. It can thus be stated that the transition from local to global evolution did not imply that local elements should disappear. It is more appropriate to refer to globalisation as a self-sustainable system than a self-reproducible one as in effect they are the ephemeral units or individual components of the system reproducing them whilst the whole phenomenon lasts.

Social evolution's sustainability is compatible with historical transitions' diversity. Devezas and Modelski (2003) have stressed the most recent facts regarding social evolution which might be indicative of the beginning of a possible common (global) organisation for the whole human species of a modern world system characterised by the emergence of a global level of interactions and institutions (Modelski, 2007; Heylighen, 2007). World social evolution will thus consist of a cascade of evolutionary processes at all levels of the human species' hierarchical organisation and not just by predetermined simple, unique trajectories. The complete description of the construction of a world system will correspond to a millenarian process of learning made up of four phases (ancient, classical, modern and postmodern) (Devezas and Modelski, 2003; Modelski, 1999: 2000). Devezas and Modelski's analysis (2003) has suggested that the emergence of such world system may already be 80% complete and could soon be moving into its consolidation phase. This would suggest (without prejudicing the human agency's historic role) that the basis for constructing a world system would be ready by now and that it is very improbable that there would be a drastic reconstruction or modification of the general lines of contemporary world order.

6. Conclusions

In spite of globalisation having been one of the most widely discussed and referred to topics in recent economic, social and political literature, there is no consensual definition. A reading of the phenomenon has been proposed here in terms of a state, structure and process, within the context of evolving self-organising complex systems.

Globalisation is a characteristic state of "social matter," originating multidimensional interactions between individual agents, communities, nations and regions through institutional codes articulating international, transnational and global dynamics. It has already been stressed how open system non-equilibrium thermodynamics contribute towards describing the historical genesis of active biological and social structures (Prigogine, 2004; Prigogine and Stengers, 1984; Kauffman, 1993; 1995). Globalisation is an open and complex, hierarchical and self-organising system, having no end to its evolutionary history, lacking structural and systemic stability.

Globalisation is the result of far-from-equilibrium subsystems' interconnection being opened up and maintained with their surroundings. Globalisation incorporates coherent relationships between a system's units (individual agents, nations, regions). Such processes take place in a far-from-equilibrium milieu.

The order of global dimension characterising all levels of human organisational hierarchy comes from instability deriving from economic, social, political or cultural fluctuations

which have gone beyond critical stability thresholds for previously existing states during their development. Such dynamics become transformed into greater perturbations bearing new states, new order, new stability which, in turn, become the starting point for future instability. There is no space for equilibrating forces in such processes (Prigogine, 2004).

Globalisation is a collective characteristic of social complexity (i.e. of the whole human species on the face of the planet Earth). Understanding globalisation implies dealing with the difficulties inherent in complex systems which cannot be approached in terms of a brief essential definition. The empirical evidence has shown that national societies will continue to generate variety and complexity. Globalisation must thus not be understood as a uniformising and homogenising event for nations.

Humanity's economic, social, political and cultural history shows that an advance has been made towards a world immersed in fluctuations, instability, evolution, thereby generating diversity and variety. Consequently, the self-organising approach to globalisation seems to be more compatible with a social, economic and cultural evolutionary description of humanity than the neo-Darwinist reductionist and mechanical approach based on the human analogy of natural, social or economic selection. Within the framework of planetary evolution in terms of its physical, chemical and biological orders, it is thought that globalisation corresponds to a transition from biological evolution to social evolution in the same way that it has been proposed in a very documented way that life comes from the transition from chemical evolution to biological evolution. It has also been stated in this chapter that the open subsystems constituting globalisation also preserve the reality from which they come as well as their surroundings: the inanimate world, biological ecosystems and that which is social, expressed in individuals and organisations' behaviour (at local, national and regional levels).

The approach proposed in this chapter has shown that simplistic affirmations about globalisation have no grounding (from those who defend it because it is "good" and from those detracting from it because "it is not good"). It is neither the one nor the other. Complex systems are with us. They are not good or evil in themselves and the observer's opinion and actuation in the system is nothing more than one of the components of self-organisation processes.

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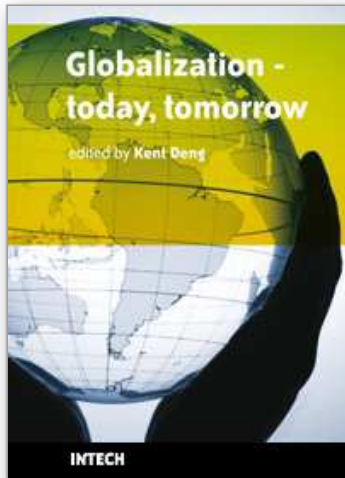
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