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DEGROWTH AS A STRATEGY FOR THE SUSTAINABLE MANAGEMENT OF ECONOMIC DEVELOPMENT

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Abstract

The explosion of global financial crisis and its systemic consequences on real economy exceeding dramatically and rather reversing the established expectations about growth prospects have shifted the issue of sustainability of economic development at the top of public agenda. This paper aims to demonstrate degrowth as an effective policy response to the objective of sustaining standards of living, outlining a long term strategy restraining growth with environmental and social criteria. Relying on a System Dynamics model of the life cycle of national economic development followed by industrial economies it states the hypotheses that allow its extension into the new content of economic development identified as a global knowledge economy. Drawing on mental implications derived from the extended model structure it investigates the new pressures and limits encountered in growth. Accessing to interrelation and interaction of arising forces driving and inhibiting growth, concludes that an optimistic future lies on restraining growth with accepting higher environmental pressures and enabling a long term consideration of time in economic activity rather than on escalating growth with a perpetually heavier reliance on technology.

Key words

economic development, sustainability, knowledge economy, globalization, degrowth, system dynamics

Introduction. Dynamics of change in the path of Economic Development

Economic development in the context of industrialization is a complex social process incorporating the improvement of standards of living of a nation's population with sustained growth from a simple, low-income to a modern, high-income economy. Assuming that standards of living are determined by economic well-being, social welfare, quality of natural environment and population growth, the path of economic development followed may be considered as the outcome of the dynamic interaction of demographic, economic, social and environmental structures constituting its determinants.

In economic literature theories of cyclic behavior of growth are usually presented as descriptions of how assumed causes might produce observed fluctuations in economic activity (Forrester, J. W., 1977). Historically observed such cyclic modes include the 3-to-7 year business cycle, 15-to-25-year Kuznets cycle (intermediate), and 45-to-60-year Kondratieff cycle (long) (Forrester, J. W., 1977). At the heart of this discussion lies technological innovation. According to Schumpeter (1935) at the bottom of long wave fluctuations stand technological revolutions, as shown in the ability of long wave to bunch technological change embodying different technologies with its compatible infrastructure into specific time periods, being attributed to the structure of capital intensive economic sectors (Forrester, J. W., 1977). Technological revolutions provoking a paradigm shift in all sectors of economic activity correspond to a discrete techno-economic paradigm (Perez, 1983, 1985, Dosi, 1982). Periods of economic recession correspond to negative correlation of techno-economic paradigm with institutional environment while periods of economic development correspond to a positive correlation.

According to J. W. Forrester (1977) beyond the time span of the long wave lies the life cycle of economic development. Not being in fact a cycle since it might not be repetitive for any one civilization like the industrial it corresponds to the long term fluctuations resulting due to the passage of economic development through discrete stages of growth evolution, from rapid expansion to dissolution and degeneration (Forrester J. W., 1977, 1971, Forrester N., 1973). In particular three phases of the life cycle of economic development are identified (Forrester J. W., 1971, Forrester N., 1973):

- a. Growth phase, corresponding to the era of continuous exponential growth in population and standards of living.
- b. Transition phase from growth to equilibrium, characterized by the appearance of intense environmental and social pressures suppressing growth and retarding standards of living.
- c. Equilibrium phase, leading counter acting forces driving and inhibiting growth as well as standards of living to equilibrium.

Arguing that the peak of the long wave experienced in 60's coincided for first time with the transition region J. W. Forrester (1977) concludes that economic development is already deeply hooked in the transition region of its life cycle.

According to non-equilibrium Thermodynamics economic development in a historical perspective is a non-predictable process subject to social and environmental limitations, set by entropy, to material standards of living (Georgescu-Roegen, 1975, 1986). However for a well defined (discrete) period of its evolution, as the one determined by the dominance of the neoclassical pattern of growth (Solow, 1957, 1956) and under explicitly specified thermodynamic conditions (Katchalsky and Curran, 1965) that are valid at an approximation and for a limited time period, produced entropy may be considered constant (Georgescu-Roegen, 1975). The path of economic development corresponding to this period may be identified then, allowing the address of a policy response to the limits encountered and pressures arising in its future course, so that in the long term their intensity is lowered and the standards of living are sustained (Forrester N., 1973).

In bibliography a structure generating the industrial pattern of economic development of a national economy, in the context of a typically industrialized economy (Canada), is a complex system defined along the principles of System Dynamics (Forrester J. W., 1968, Forrester N., 1973). This system being governed, in respect to its evolution, by the neoclassical growth pattern is representing a model of the life cycle of economic development. Simulating the process of economic development and assuming alternative operation hypotheses, it generates several different life cycle behavior modes, over a 250 - year period beginning in 1900. All these modes correspond to the pattern of industrialization since they all have in common as initial phase of this cycle the first 100 years of exponential growth of production and population realized and differ only after this period. The model behavior, i.e. the types of behavior of several model variables that depict economic development, is produced by the individual causal relationships between model variables that describe the mode of dynamic interaction of the determinants of economic development characterizing its operation. In this model pressures are caused endogenously by the interaction of growth of economic and demographic structures with social and environmental ones that are not ruled by the law of growth. When growth goes too far, the limits of the latter are approached

and acting through feedback loops on the former, erect obstacles to growth that threaten the material standards of living. In this respect, the assumed alternative hypotheses implying alternative interaction modes of the model's elements represent different development options each corresponding to a discrete set of limits that is likely to emerge in the path of economic development. The model generating endogenously the evolution of standards of living throughout the entire life cycle of economic development that corresponds to these assumptions, identifies as growth phase the period that lasts up to 2000, as transition phase from growth to equilibrium the period of the next 100 years, and as equilibrium phase the period beginning in 2100 and continuing beyond 2150.

In particular the model generates endogenously the pattern of industrialization observed during growth phase and is focused on changes likely to occur in the life cycle of economic development after the appearance in 1970's of the rising cost of non renewable natural resources and stagnation. Simulating the process of economic development, the model allowed for the exploration of the development options that, corresponding to the traditional pattern of industrialization, are open to industrialized economies in the transition phase and provided a preliminary basis for formulating a set of policy conclusions. Testing alternative strategies the findings indicated a degrowth strategy, in the context of planning a long term policy to restrain growth, as the most adequate policy response to address at end of the growth phase the sustainability problem arising for economic development. More specifically it was shown that the strategy of recycling natural resources lowering the intensity of pressures to growth, maintained high capital / labor ratios in the long run and succeeded to keep the material standards of living high for a longer period than the other available growth escalating policies. Providing an option for the entrance of the path of economic development into the transition phase of its life cycle, degrowth as defined in this context, was suggested as an alternative strategy for the sustainable management of economic development.

Since 1970's and the publication of the original model, the pattern of industrialization as it is argued below in section 1, has changed. Economic development embarked on a new course corresponding to a transition from the traditional industrial to a new post-industrial pattern identified as global knowledge based economy. The new pattern implying a new mode of interaction of the determinants of economic development is associated with a different set of pressures and limits to growth than those characterizing the traditional pattern of industrialization. Thus it is likely to lead to the generation of a new set of life – cycle behavior modes.

This paper aims to outline a degrowth strategy in contemporary conditions, assessing the sustainability of global knowledge economy in terms to identifying the pressures arising and the limits encountered. The address of this objective is structured in three sections as follows:

(i) A description of the dynamic structure of global knowledge economy in terms to its differentiation from industrial, in order to highlight the specific limits and the causes of the pressures accompanying currently the process of growth. Since the new content of economic development has evolved qualitatively from industrial, its structure may be described with an extension of the latter. Such an extension, implying an alteration of the assumptions underlying the original model, involves the formulation of the changes realised in the structures determining the path of economic development into new hypotheses imposed to its operation.

(ii) An identification of nature and intensity of the pressures expected to arise opposing growth, as a consequence of the new model structure for the purpose of relating the new content of economic development with the life – cycle phase it is associated. Depending on the magnitude and the structure of these pressures, the new content may correspond to the growth phase of a new life cycle of economic development, or in distinction, it may be considered inherent with the transition phase of the industrial development life cycle. In the first case the optimal policy response should target enforcement of growth while in the second, as it will be shown that is the case, to planning of degrowth.

(iii) The address of a degrowth strategy in the context of indentifying the leverage points of intervening into the extended model of the life – cycle of economic development: the policies that intervening in the model's operation are likely to shift its behavior into a mode compatible with transition phase, thus accomplish the sustainable management of economic development.

1 The new content of economic development

As demonstrated by the emergence of a new global pattern of production and trade (Saeed, 1998, High Level Group chaired by Wim Kok, 2004), as argued by bibliographical sources (Brinkley, 2006) and as grounded on the adopted public policies (European Council, 2000, European Commission, 2000) the content of economic development has been differentiated. Its new content is determined by the

emergence of a new techno-economic paradigm based on ICT technologies that corresponds to a new industrial revolution (Perez, 1983, 1985, Jessua, 2006). Altering the patterns of technological change and growth leads to a post-industrial or knowledge society (Ritzer, 2007).

As it is evidenced (Saeed, 1998) the comparative advantage shifted from traditional rule to knowledge intensive outputs, inaugurating knowledge economy as a key driver and determinant of change, across the OECD countries (Brinkley, 2006). In particular raw material processing and heavy manufacturing shifted from industrial to developing (low cost) countries with the former turning their focus in production towards high value added products and services (Saeed, 1998, EU, 2007). New technologies increasing the ability to store, share and analysis knowledge, allowed globally acting economic agents, to exploit its properties, as it is a renewable and not depleted by use economic good, in gaining competitive advantage (Brinkley, 2006). Exploitation has been achieved by building with innovation, integrated international production chains (as R&D facilities) in industrialized countries that create new products produced in assembly plants in developing countries and then shipped back in the former countries, for added value in knowledge (Brinkley, 2006). More specifically Saeed (1998) drawing on UNCTAD data, found:

(a) The fractional growth rates, for the period 1975 – 1990, while being higher for the developing countries, they remain insignificant in absolute terms compared to those of the industrialized countries. Irrespective of the high fractional growth rates in the developing countries the absolute amount of their production as well as its cumulative growth, continue to be small compared with the rates in the industrialized countries.

(b) The composition of the production output for the two categories of economies is different. Industrialized economies have moved to producing a larger share of services and goods with high value-added content, while developing economies continue to concentrate on production and manufacturing with low value added content.

(c) Worker productivity in manufacturing for a sampling of country groups belonging both to the industrialized and the developing categories, measured in terms of value added per worker, is consistently lower in the developing countries than the industrialized ones.

(d) Trade flows have almost doubled over the period 1980-1990. This increase is accompanied however by a worsening of the terms of trade for the developing countries.

(e) The composition and the growth of trade flows between a sampling of industrialized trade blocks (U.S.A., E.U., Asian developed countries) and developing regions (South Asia, ASEAN, China), shows a growing tendency to transfer environmental costs to the countries with lower economic and political muscle.

In respect to the current global division of labor and the pattern of production these findings suggest that developing countries are specializing in the production of products with a high resource content and low added value in a competitive market scale while industrialized countries are specializing in the production of products with low resource content and high added value content in a monopolistic scale (Saeed, 1998). As stated by the Kok Report (High Level Group chaired by Wim Kok, 2004) in every aspect of contemporary economy, at the heart of value added is knowledge.

In respect to the overall implications of this pattern of production specialization on natural resource base and environment these findings indicate that the burden from production processes on natural resource base and environment, is now reallocated, distributed unevenly being heavier in developing countries than the industrialized ones (Saeed, 1998).

2 The structure of Global Knowledge Economy

Extending the original model of the life cycle of economic development so that it may represent the new content of economic development involves the identification of the major qualitative changes realized in the fundamentals determining its path and their formulation as new hypotheses for the operation of the underlying system. These changes have resulted as outcome of the policies applied on economic structures, in the direction of overcoming the limits to growth raised in the industrial content of economic development. As such major policies having a significant impact on the path of economic development are identified (a) the globalization of money and capital markets and (b) the knowledge economy.

a. The emergence of globalization, technically facilitated with the innovations introduced by the new pattern of technological change, is due to the public policies adopted worldwide in line with “Washington consensus”, targeting liberalization and deregulation of money and capital markets and leading to an institutional reform (Williamson, 1989). Globalization serves for the diffusion and establishment of knowledge economy (Fisher, 2007), by:

1. Extending the domain of development from a national to a global dimension, that allows global economies of scale.

2. Facilitating higher and accelerated leverage rates of capital that lead to a substantial increase of the capital intensity (in the model capital to labor ratio) of production processes. The resulting increase of capital inflow in global economy, in comparison with national protected economies, satisfies a crucial financial requirement for the acceleration of technological change. In particular it allows up grading of knowledge capital vis-à-vis physical (productive) capital in the content of capital (in the original model the capital consists of a knowledge and a physical content). The required finance for capital investment is now much higher since it is now primarily directed towards knowledge capital, in the form of education, research and development, being more expensive than the input required for the formation of physical capital (Forrester, 1973, Strange, 1996).

b. Knowledge economy represents the new pattern of growth. Growth in the neoclassical growth model (Solow, 1957, 1956) is generated by combining physical capital with unskilled (and low cost) labor. The endogenous growth theory (Romer, 1986) modified the Solow growth model, shifting the focus away from the physical capital towards knowledge, as the key source of economic growth. The new growth theory emphasized on human capital and on Research and Development, as sources of knowledge and therefore economic growth (Lucas, 1993). In contrast to traditional growth theory the new growth theories are dynamic in nature and emphasize the role of knowledge (Audretsch, 2004). The heavier reliance of growth on technological change up grades its role as the most significant production input and restructures production processes and trade flows, as follows:

1. It corresponds to a higher level of capital intensity of production processes that allows the emergence of a new more capital intensive technology. New technology aims to improve, per unit of output, the effectiveness of non renewable natural resources in both respects (i) decreasing their inflow as production inputs and (ii) reducing emissions to environment.

2. It reorders, as to their importance in production processes (i) the factors of production (capital versus labor, knowledge versus natural resources) and (ii) the determinants of economic development (economic versus all the others).

3. It shifts comparative advantage towards knowledge intensive outputs.

These fundamental changes in the structures determining the path of economic development may be formulated in the following new hypotheses governing now the system’s operation:

(a) Increase of the capital intensity of production processes

(b) Extension of the domain of development from national to a global scale

(c) Decrease of the natural resource content, per unit of output, inversely related with the increase of capital intensity of production processes (as the capital intensity is rising the natural resource content of capital intensive output is declining). This hypothesis alters the corresponding one of the original model, stating that the natural resource content of output is independent from the capital intensity of the production processes being a constant variable taking discrete values (since the original model does not include an emissions sector, a hypothesis about reduction of emissions is omitted) (Forrester, 1973).

3 The limits encountered and the pressures arising in the Global Knowledge Economy

The adoption of new hypotheses into the original model imposes new restrictions to its operation that represent new pressures to its growth. Their appearance is related with the impact of economic and demographic growth, according to the knowledge economy pattern, on social and environmental determinants. Its consequences acting through model's feedback loops on the former generate endogenously forces that counteract its growth and question the sustainability of standards of living in the long term. The magnitude of the arising threats depends on the structure of these pressures and the available growth policies to address them. Since standards of living are directly depended on the new model structure their sustainability may be induced by a closer examination of the nature of the pressures raised along the new pattern of economic development.

As it is demonstrated by the structure of the extended model, global knowledge economy aims to escalate growth by addressing the environmental pressures raised in the industrial content of economic development. In particular the objective to overcome physical frontiers is intended to be served by substituting with a new advanced capital intensive technology for the already overwhelmed carrying capacity of the environment. The production of such a technology implying accelerated technological change has as a crucial requirement for its financing a radical increase at the level of capital intensity of production processes coming to terms with global economies of scale. This shift in the direction of growth escalating policies introduces new limits to growth and has major implications on the structure of the accompanying pressures, restricting the policy options available so far for their management.

3.1 The nature and structure of pressures to growth

As stated by Cimoli, Dosi, and Stiglitz (2008), the great transformation leading from traditional, mostly rural, economies to economies driven by industrial activities and nowadays also advanced services entailed a major process of accumulation of knowledge and capabilities. During the growth phase, the golden era of industrialization, technological progress increasing productivity of labor enlarged carrying capacity of the environment and allowed the growth of economic determinant to accelerate, offsetting the growth of the demographic one and leading the standards of living to an exponential increase for a growing population (Forrester, N., 1973, Forrester, J. W., 1973). In the early stage of industrialization technological progress, addressing environmental pressure (as seen in treating food shortage and in making less attractive land habitable) relieved social pressure as well (Forrester, J. W., 1973). As industrialization was advancing population density increased and urbanization was spread (Forrester, J. W., 1973). The orientation of technology towards a more complex infrastructure in order to address environmental pressure, i.e. higher buildings and more concentrated transportation systems, led to a more complex superstructure, i.e. more complex intermediation of communication with radio and TV, more complex political processes and deepening specialization of work, that raised rather than relieved

social pressures Forrester, J. W., 1973, Forrester, N., 1971). From now on each new wave of progress, changing the nature of work, enlarging the technocratic base of society and introducing new communication principals advances complexity in social processes and raises pressures on the structures of existing social formations and relationships pushing them to innovation. The actual outlet for increasing social pressures was provided in an earlier stage by migration and conquering new geographical area (Forrester, J. W., 1973) and later by policy responses aiming to control in the short and medium term the pace of technological progress through regulating growth rate. These policies leading to the institutions of New Deal in US and to the rule of law and social justice in post war Europe relieved social pressures for a long period, assuring high standards of living. The acceleration or retardation of technological change, within the limits of capital intensity of production processes in industrial era, in order to be addressed successfully environmental or social pressures respectively, were fully available policy options. In other words growth policies were not confronted with any restriction or dilemmas in choosing the kind of pressures that will address.

By the end of growth phase the limits of carrying capacity have been reached (Forrester, J. W., 1973) and the existing labor saving technology cannot counter match any more the impact of environmental pressures on growth, since increasing labor productivity does not suffice for lowering or reversing environmental burden. Escalation of growth requires now in addition to labor saving a new type of technology directed towards improvement of the efficiency of natural resources so that excess of the already existing burden is minimized. Even more, technology has to be upgraded in respect to the other production factors, since growth relies now fundamentally on its capacity to overcome environmental pressures. The new advanced more capital intensive technology as well as the inauguration of technology as the “locomotive” of growth alters radically the level of capital intensiveness required in the production processes (Forrester, N., 1973). This requirement is imposed due to the shift of dominance implied in the content of capital, from physical (productive) to the knowledge one (Forrester, N., 1973). The latter being more expensive than the former (Forrester, N., 1973) demands for its formation a different level of financing radically higher than the one corresponding to the industrial pattern, implying a fundamental increase of capital inflow in production processes. The resulting structural differentiation of economic determinant alters the pattern of economic development and leads to global knowledge economy succeeding industrial. The address of environmental pressures with heavier reliance on advanced capital intensive technology, instead of restraining growth, introduces new pressures in three dimensions:

1. Raises rather than relieves social pressures:
 - the goal of steadily accelerated technological change implies radical and accentuating increase in capital inflow and a decrease of labor inflow, as seen in the rising role of capital versus labor
 - the diffusion of information technology in all aspects of social and economic activities, changing the nature of work with increasing specialization, enlarging the technocratic base of society with demanding a stronger political control for its governance and advancing even more the intermediation of communication with New Media, up scales complexity and destabilizes social cohesion, as seen in arising crime, fear, conflict and role of Media.
2. Increases in the long run environmental pressures as removing per unit of output physical barriers to growth allows escalation of growth rates and increase of natural resource extraction and emissions in total economy, as seen in climate change.
3. Is ethically dubious as it intensifies the inequality in the standards of living between, developed and developing nations, and, living and coming generations as seen in rising role of technology versus natural resources and in shifting of environmental burden to developing nations and to future generations (Fiddaman, 2007).

3.2 The limits to growth encountered in Global Knowledge Economy

According to Forrester (1961), two kinds of bounds may limit in the long term growth process in industrial economic systems. An upper one, erected with the depletion of available non renewable natural resources and a lower one, emerging at least with zero economic activity. However, as shown by the historical experience resulting from global economic crisis of 1929 and the two world wars, the lower limit may be erected in medium term, earlier than approaching the upper limit. The emergence of lower limits originated by the intensity of social pressures to growth led to the regulation of the industrial pattern of economic development. Global knowledge economy introduces new limits to growth process in the following two respects:

1. The strategic shift of growth policies focus to the address of environmental pressures and the choice as policy instrument for achieving this goal of an even heavier reliance on technology as implied by the global knowledge economy pattern indicates a programmatic preferential selection between environmental and social pressures. This selection signaling a departure from the pursuit of growth in the industrial era denotes that growth escalating policies are no more capable, changing their mix, to address in the long run both barriers to growth so that global economic system is brought to equilibrium with carrying capacity of environment. The policy option of regulating in the medium term the pace of technological change so that social pressures are relieved is now being eliminated, since it is contradicted with the goal of accelerating the rate of capital inflow increase faster than the rate of generating environmental pressures, as otherwise the environmental burden will overcome growth. This restriction of alternatives, as seen in the eclipse of full employment and social welfare policies as well as in drawing back the scope of improving the standards of living for populations of developing countries and for future generations highlights the obligatory acceptance of high social pressures in growth policies. As besides entrepreneurship there are no other policy instruments available to control social pressures it is likely that they will arise in a magnitude surpassing any manifestation of stress realized during the industrial era. The locking of growth policies on addressing environmental pressures will erect in the long run the social barriers that will pose an upper limit to growth in the process of economic development.

2. The goal of accelerating technological change at a perpetually increasing pace demanding a continuous increase of the capital inflow in global economic system is now critically depended upon a steadily increasing rate of capital leverage. The fulfillment of this requirement is conditioned upon the perpetual deepening of (financial) globalization and in particular the capacity of financial system to execute efficiently this role which is now, for this purpose, significantly up graded in respect to the past. The new role of financial system comprises (i) the redirection of financial flows from productive investments in a national scale to knowledge ones in a global scale (ii) the finance of economic development in domains that were previously funded by state budgets and (iii) the facilitation of capital intensiveness increase in production processes. These tasks involve attraction and leverage of capital in a huge and accentuating scale entailing large volatility and liquidity in financial markets and demanding new more complex financial instruments for their management. The difficulty in their evaluation and in controlling their diffusion in conjunction with the lack of any interstate regulation of financial markets and the reduction of national rules to minimum standards while contributes in achieving high rates of capital leverage in the short term is threatening in the medium term this objective, as it may lead to structural imbalances between supply and demand of financial capital. Since any option of global governance is ruled out by the current status of globalization (Habermas, 1998) a failure of financial system to serve this objective, boosting protectionist attitudes that may result to retardation or reverse of globalization process and to de-leverage of capital, is likely to erect in the medium term obstacles in accelerating technological change, that will retard, stop or reverse growth rates, as seen in current global economic crisis. As accelerating technological change is fragmented by the growth (GNP) rate, since the rate of increase in financing technological change may not exceed in the long run growth rate (Fiddaman, 2007), the heavier reliance of growth policies on the performance of a non - regulated financial system in order to serve accelerating technological change, as implied by global knowledge economy, is likely to raise in the medium term a

lower limit to economic activity.

3.3 Global Knowledge Economy and life cycle of Economic Development

The necessity to choose the kind of pressure that will be addressed and the restriction of alternatives for growth policies characterizing global knowledge economy indicate that trade-offs are developed in the growth process where choice was unnecessary during the growth phase of the life cycle of economic development (Forrester, 1973). In particular the breakdown of unity of the pursuits of growth policies in addressing economic development, as reflected in the choice of environmental versus social pressures, has as a consequence the appearance of trade-offs between previously unified policy goals as between (i) population growth and the quality of life (ii) total production and per capita production and (ii) present and future high standards of living (Forrester, N., 1973). Escalation of growth, pushing in the long term the burden of limiting growth from environmental to social pressures and being in the medium term critically dependant on the performance of financial system, appears as a one way policy choice aiming to sustain growth rather than an option among others available aiming to improve standards of living. Global knowledge economy is not addressing more effectively the limits to growth but it is rather raising the cost of confining them in the future with an even more advanced and expensive technology (Forrester, J. W., 1973). Thus it is not generating a new life cycle of economic development being now at its growth phase but it marks the entrance of economic development into the transition phase of the industrial life cycle. The path of economic development has to be directed from growth to a controlled degrowth so that the intensity of pressures is lowered and the standards of living are sustained.

4 Planning a degrowth strategy for the sustainable management of economic development

A degrowth strategy aims to regulate the structure of global knowledge economy, so that growth is gradually restrained and standards of living are sustained. In technical System Dynamics terms this aim pertains to transition of the extended system of the life cycle of economic development from growth into a growth restraining mode of operation (Forrester, 1973). Transition involves the adoption in system's operation of a development strategy that intervening with the right policies in the causes provoking excess environmental and social pressures controls their intensity, attaining sustainability of the standards of living. The discovery of these causes, that may lie back in time and located in other parts of the system than those expected, requires identification of the sensitive influential or leverage points through which the behavior of the system can be improved in the desired direction (Forrester, J. W., 1971). Due to system complexity such an intervention in the context of altering the corresponding control variable, may not be guided only by intuition and judgment but has to be evaluated as a system's operation hypothesis in respect to the mode of behavior produced (Forrester, J. W., 1971). However the address of the subject of this paper is focused on mental implications deriving from the extended model structure on the grounds of economic theory and is avoiding as possible interference with the complex technical issues encountered. Thus, policy recommendations proposed herein for the sustainable management of economic development serve as suggested hypotheses subject to evaluation for their contribution in sustaining the standards of living once model's mathematical equations have been defined and simulations have been performed rather than tested alternatives that may be used deliberately in policy planning.

The policies appearing to respond to this aim are the following:

1. Acceptance of high environmental pressure in the process of economic development that may act as a physical channel to limit growth through growth regulating policies (gradual degrowth) (Forrester, J. W., 1973). The physical restriction of growth reduces physically environmental pressure and enables its address with labor intensive policies that relieve social pressure by lowering labor productivity and stabilizing capital intensiveness of production processes. A policy serving this objective is recycling natural resources (Forrester, N. 1971): relieving physically environmental pressure (by reducing non renewable natural resource extraction rate) relieves social pressure as well (by lowering labor productivity in capital intensive sectors of economic activity).

2. Enabling a long term consideration of time in economic activity triggered with the introduction of ethical corporate governance, environmental and social criteria into the operation of markets and especially financial markets. Financial markets may serve these objectives with new instruments and practices that reflect a shift of their scope from short to long term considerations of performance so that short term growth is retarded in exchange for achieving a long term benefit in the financial ethical, environmental and social dimension of realized investments. These investments contribute in the long term in relieving environmental and social pressures and in the short and medium term in reducing excess volatility and liquidity of financial markets as well as in regaining the value of time. Eurosif, the European Social Investment Forum aiming to address sustainability through financial markets with promoting sustainable investments (SRI) in the fields of asset management and venture capital serves, since 2000, as an example of the policies that may be adopted or subsidized in this direction (Eurosif, 2006, 2007).

3. Redirection of the stance towards technology. The direction of technological advance as designated by global knowledge economy seems to reverse the trend dominating its past trajectory recorded in increasing demands on the environment (Forrester, J. W., 1973). Its new mandate is presented as opposing this trend aiming to radically decrease these demands. However, a technology that successfully decreases demands on the environment may not alter or worsen the sustainability prospects of economic development. On the one hand, because the use of this technology might lead total environmental burden to exceed cumulatively the currently existing one harming irrecoverably the well being of future generations if growth is not restricted since it will allow higher growth rates. On the other hand, because it might contribute to the rise of social pressure up to a point without precedent in industrial era, since it has as a prerequisite the accelerating pace of capital intensiveness increase of production processes and as a consequence the advancement of complexity and the intensification of inequality in the standards of living between developed and developing nations. Given that environmental and social limits have already been reached and since technology of either type, labor saving or natural resource efficiency improving, remains highly capital intensive and centralized in its structure, any change in the dimensions of its design (i.e. with the inclusion of social parameters), may not serve at the present moment as an efficient response to the demand for sustainable standards of living, even one serving a systemic change. The stabilization of technological advance at its current level (Forrester, J. W., 1973) focuses efforts to address pressures on physical control of their magnitude through growth regulation routes.

Conclusion

Regulating global knowledge economy structure with the recommended policies leads to a pattern of economic development associated with lower consumption and production standards. The degrowth process implied in this transition controlling the intensity of environmental and social pressures is capable to sustain the standards of living for a longer term period than the one corresponding to global knowledge economy growth escalating policies. This process of restraining growth is distinct from the one evolving nowadays due to global economic crisis. The latter imposed obligatorily, due to resulting de-

leverage of capital, is driven to serve structural adjustment towards global knowledge economy, as seen in massive low cost financing of private financial debt at the expense of state budgets, rather than respond to the deeper located causes driving this crisis, lying on the environmental and social consequences of adopted growth pattern.

On mental grounds adopted in this paper, a degrowth strategy in the context of restraining growth with environmental and social criteria appears as a more effective and less costly response, in the long term, to the objective of sustainable management of economic development, than growth escalating policies in the context of global knowledge economy with a perpetually heavier reliance on technological advance. Further work is required towards verifying technically, in a System Dynamics context, the plausibility of these conclusions.

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