SUSTAINABLE ECONOMIC SYSTEMS

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Contents

Summary

The first and second Industrial Revolutions are characterized by growth based on unsustainable economic systems: they are unsustainable because they are dissipative, open-cycle systems that also lead to structural and technological unemployment.

In order for an economic system to be sustainable, it must observe the laws of nature and adhere as closely as possible to the life cycles of products, materials and energy. This can be done by replacing the present disposable, quick-replacement culture with an optimal utilization culture, through the implementation of the principles of re-production and industrial ecology.

Such a revolution requires that goods become service-goods, and be designed with repair, reconditioning, re-use, recycle, and development/upgrading features, so that the concept of fruition will take over from that of consumption. Moreover, industries need to be organized and managed with the aim of producing a material and energetic metabolism, through sectoral and/or local integration with other industries.

This, in turn, requires the design and development of completely new goods and services to replace traditional ones, and consequently the establishment of new service and labor-intensive companies.

In conclusion, such a dematerialized, service economy tends to optimize the utilization of resources and energy by balancing the need for an increasing amount of such resources with the capacity to reproduce them and lengthen their useful life-span.

This transformation can only be achieved if all economic parties are capable of seeing the environment as an opportunity rather than a constraint, firstly improving all aspects of efficiency and then implementing the principle of functionality.

1. Introduction

For a long time now, industrial culture and practice have been based on the fast replacement and disposability of goods; on the increasing intensity of use and, as a consequence, on the increasing amount of waste and dissipation.

This culture has adopted mechanistic principles in the field of production, which has led to the creation of open-cycle economic systems, and as a result to their growing environmental impact.

The pursuit of sustainable development requires the radical transformation of economic scope and aims, together with the widespread adoption of totally new production and consumption principles; basically, production activities should be transformed so as to reduce the demand for energy and materials, and to reduce the burden on the environment.

This could be done by developing and promoting the practice of un-making and re-making, in a circular rather than a linear system.

Academics consider circular systems to be much more complicated to organize and manage. This complexity means that a greater number of variables need to be taken into account and requires a closer relationship between producers and consumers.

2. The Unsustainability of Present Economic Systems

2.1 Features and Limits of Open-cycle Economic Systems

The debate on, and the need for, a sustainable form of economic development have arisen mainly because all existing economic systems are open-cycle structures, so that the flow of energy and materials required to obtain a useful product does not involve the exchange of entropy with other systems, and as a consequence highly dissipative effluents are produced at all points during a product’s life cycle.

This means that productive activities have only partially imitated the behavior and principles of ecosystems: the evolution and self-regulation of the latter comes from their capacity to pump entropy out of the system, using solar energy and dissipative structures, whereas the former cannot regulate themselves. In other words, present economic systems cannot regulate their working and evolution in a metabolic manner as natural (eco) systems do.

Summing up, the most unusual feature of the economic system is that it has developed independently of the complex regulatory function of nature. The ability to access enormous quantities of low-entropy material within the geographical boundaries of the system has led the economy and human kind to ignore the fundamental constraints imposed on other species and ecosystems, namely that development can only occur within the limits of the high-quality solar input. This high degree of freedom has been both advantageous and disadvantageous. On the one hand, it has enabled the economy to develop highly complex, energy-intensive structures to support progressively more technological lifestyles. Some of this development has undoubtedly contributed towards improving the quality of life, at least for one section of the world's population. On the other hand, the cost to be paid is that of a worsening environmental crisis at all levels, involving both local and global ecosystems.

From the biophysical perspective, these effects are in part a sign that human ecology, in by-passing the regulation provided by the solar constraint, has also forsaken the advantage inherent in that constraint: i.e. the guarantee that the entropy associated with transformations in the system is exported from it: they are also a result of the wide availability of toxic materials whose mobility within the ecological system had previously been constrained by specific biophysical regulation.

2.2 The Earth's Carrying Capacity, Critical Load and Ecological Resilience as Benchmarks in Development

In order to explore the limitation of an ecosystem's capacity to sustain economic development, we need to consider the idea of the carrying capacity of a given habitat. In other words, each habitat can support a limited population of each individual species, and this is determined by the potential energy flow through each habitat. Conversely, the same limits can be defined in terms of critical loads.

Some estimates have shown that nearly 40% of the Earth's net primary productivity (photosynthesis) is already being used by humankind, and this percentage is increasing. If we take this as an index of the human carrying capacity of the Earth, and assume that a growing economy could utilize 80% of photosynthetic output before destroying the functional integrity of the ecosphere, then we can see that the earth will soon reach this limit.

Other calculations, this time regarding the energy-based analysis of food production, also point towards a similar conclusion: they show that about 900 m^2 of cropland is needed to produce the average per capita food energy requirements (in the case of a year-crop). With an average growing season of only 180 days, each hectare of agricultural land will theoretically support about 5½ people. World population density currently stands at about three persons per arable hectare. Therefore, we are within less than one population doubling of the sunshine limit to growth, and under present conditions we will reach that limit in 35 years time.

These simple estimates make no allowance for such obvious uncertainties as accelerated resource degradation or technological advances, and of course this makes prediction uncertain. However, the data do provide reason enough to forecast absolute limits in a world of rising material expectations where the human population is increasing by 100 million people per year.

From other data we can see that the area of the Earth’s surface ecologically occupied by a typical industrial city or urban region will be at least an order of magnitude greater than that contained within the usual municipal boundaries or associated with the built-up area residents would normally identify as their home community.

The extraterritorial land requirements of such high-density settlements can be considered as appropriated carrying capacity. Together with the land it physically occupies, the land area functionally required to support a given city or urban region can be referred to as its true ecological footprint.

This analysis has some remarkable implications for inter-regional trade. If all human populations were able to live within their own regional carrying capacities (i.e. on the interest generated by natural capital within regional geographic boundaries), the net effect would be global sustainability.

However, the reality is that the populations of many regions and even whole nations already exceed their territorial carrying capacities and depend on trade for survival. Such regions are running an ecological deficit; in other words, their populations are “appropriating carrying capacity (sustainability) from elsewhere.”

Since the original carrying capacity is greatly altered by anthropogenic activities, the relations between economy and ecosystems cannot be simply ascertained by considering the carrying capacity; it is necessary to consider another two fundamental concepts: critical loads and ecological resilience.

The critical load concept has been defined as the level of exposure to one or more pollutants, below which significant harmful effects on specific elements do not occur, according to present knowledge.

In practice, critical loads are difficult to establish because: (a) in many situations knowledge is too limited to allow quantitative limits to be set, (b) the no-effect-level is so low for certain pollutants that it is close or equal to zero and (c) problems of scale arise both in terms of the dose (local sources or the large-scale supply of the pollutants) and of the response (individuals are harmed or die but are replaced by other individuals; flux alters but steady state does not).

Ecological resilience is a measure of the ability of a system to absorb changes. This means that a system that is unable to absorb the alterations must be considered unsustainable.

The main question is how changes in human welfare are connected to resource depletion and environmental degradation. It is clear that resilience is not something that can be observed directly, and so the possible indicators tend to measure the inputs involved in resilience, and the outputs that are affected by changes in resilience.

Green accounting, together with measurements of biodiversity, provide us with an initial answer.

In an agricultural system, for instance, variability in crop yields is considered to reflect the loss of resilience; when fluctuations in a specific area are high, the system is near to collapse.

This indicator may be one form of the "ecological footprint," typical of all ecosystems, even if it is very difficult to identify how technology, in the broad sense of the word, affects it.

3. Features of Sustainable Economic Systems

3.1 Closing the Cycle: Toward an Optimal Utilization Economy

The unsustainability of present "open-cycle" economic systems inevitably leads to the modification of all structures and trends within each economy in an attempt to minimize exploited resources and waste products. This entails "closing the loop": in other words, an optimal utilization economy is destined to replace the production-oriented, rapid-replacement system typical of such an open-cycle economy.

The optimal utilization economy means changing our way of viewing the problem of wealth production and the provision of human services; it emphasizes the shift in priority from the production of hardware to the optimization of an economic system designed to meet human needs. The performance of a system has to be measured not so much in terms of the volume flow at the point of sale as by the optimization of services to consumers.

Compared to the production-oriented, fast-replacement system, the optimal utilization economy involves transformation and service activities replacing extractive industries and base-material production, whereby sustainable product development becomes a vitally important issue.

The basis for building up such an economy is constituted by a new notion of value.

At present, the only notion of value in use is "production value"; in a sustainable economy the notion of "utilization value" must be introduced and developed at all levels.

A short definition of "utilization value" may help understand the significant difference between the two notions: "utilization value": the utility gained from a stock of products and services during their lifetime, regardless of the fact that they are paid for or not.

The cost of creating an optimal utilization economy varies with the technical complexity of the goods. In some cases, the cost of expanding a product's life-span will be lower than that of producing a new one, while in other cases it will be higher. Therefore, all economic sectors should be reorganized in order to optimize the utilization of all resources.

A closed-cycle economic system needs special activities to be established and developed: these must be capable of performing specific functions connected to the life-span optimization (development/upgrading, re-use, reconditioning, repair, recycling) of products, to the management of the flow of energy and materials, to technical assistance to different forms of cleaner production, and to the creation of direct and indirect employment opportunities. Such objectives might be achieved by the creation of new industrial and service enterprises, somewhat different in nature from those present within the existing economic system.

These new activities are to be characterized by smaller-scale, labor- and skill-intensive work units.

Mobile goods such as cars, ships and aircraft, with easily exchangeable components, are ideally suited to small workshops which can be located according to prevailing needs, conditions and demand. Buildings and other immobile systems with exchangeable components require both on-site intervention and workshop activities. Immobile systems such as sewers or railway tracks are ideal candidates for mobile reconditioning units that can perform repairs and renovations *in situ*.

It should be pointed out that components that become obsolescent as a result of leaps in technology would best be recycled in order to recover the base materials, rather than being reconditioned.

This new approach to economic systems will lead to a so-called “service economy,” which is not the same as the traditional “service sector” although it is based on the concept of replacing production and manufacturing with services selling “functions and utilizations” rather than goods.

Such an economic system begs the question of income level, income distribution and lifestyles.

Since the new goods and services are to have very different characteristics/performance from present ones, and companies are to have very different economic features, and since the cost of resources could not be the same as it is now, it is difficult to imagine that anything will really change in socioeconomic terms: of course the needs of present and future generations will be satisfied, but in a new way.

It is feasible that a modification of the structure and cost of inputs, and consequently of outputs, will lead to a reduction in the overall level of income (at least during the transition phase), but it is also true that the economic importance of the various goods and services would be very different from what they are now.

In other words, the economic and social hierarchy of goods and services is bound to dramatically change. To get a clearer grasp of this idea, we simply have to think about the fact that the increased duration of consumer durables will reduce their economic incidence on the average available income of each family, since the price paid for them will be amortized over a greater number of years, and the cost for their optimal utilization will be lower overall than the cost of maintenance is now; this is also a consequence of the considerable improvement in service activities.

The possible changes in income levels worldwide are difficult to foresee, as no sound theoretical or empirical analyses are currently available in economic literature.

Income reduction and increasingly unbalanced income distribution would need to be offset by special social policy instruments adopted at the national and local levels.

It goes without saying that the type, degree and quality of development must be measured using special resource, environmental, economic and social indicators (such as the Human Development Index), together with a structural resource/environmental accounting system (such as Green National Accounts).

Furthermore, the question has to be asked as to whether the prices of all goods and services in a sustainable economic system are environmentally-correct?

The internalization of present and future externalities cannot be accurately calculated due mainly to the considerably uncertain nature of the type and level of such costs, and because there are no objective criteria for assigning them proportionally to the respective economic and environmental incidence of each good and service. Consequently, in the present situation there cannot be environmentally "correct" prices, but only environmentally "corrected" prices.

If environmental factors and resource finiteness are to lead to the global transformation of economic activities and systems, in the pursuit of sustainability, this should be done by firstly modifying the basic criteria pertaining to their overall performance, so as to absorb and amortize any additional costs; and secondly, by introducing and promoting the criterion of functionality of inputs and outputs, so as to make the adoption of the optimal utilization paradigm both possible and advantageous.

In this sense, the new prices will be the consequence of such a profound transformation process, and they will comply with both the fruition costs (in the sustainable model of development, these would replace production costs) and with the economic features and importance of goods and services.

This means that these prices could be considered "sustainable" as the "result of the combined effort and investment in the pursuit of sustainability."

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Biographical Sketch

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