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NEWS AND VIEWS

# Strengthening the threshold hypothesis: Economic and biophysical limits to growth

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ABSTRACT

This paper investigates the economic and biophysical limits to growth. The approach is based on the joint use of two instruments: an economic one (the Index of Sustainable Economic Welfare, ISEW) and an environmental one (the Ecological Footprint, EF). They seem to be quite different, but temporal analysis of divergence of EF from BIO (Biocapacity) and of ISEW from GDP (Gross Domestic Product) gives congruent information on the evolution of human systems.

## 1. Introduction

Economic growth is regarded as a basic element of modern society. Paradoxically, it is the ultimate aim of economic policy, seemingly the only criterion for judging the quality of government and the health of economic systems, while at the same time it is a prerequisite (initial condition) for government social and environmental spending, often considered as collateral.

The debate on the limits to growth continues. One important contribution in this field is the so called "threshold hypothesis", according to which "economic growth brings about an improvement in the quality of life but only up to a point beyond which, if there is more economic growth, the quality of life may begin to deteriorate" (Max-Neef, 1995, p.117). Since the System of National Accounts (SNA) fails to account for quality of life and the complexity of human activity in the biosphere, it is necessary to emphasize and improve diagnostic instruments that shift attention from merely economic parameters, such as consumption and GDP, to multidimensional objective measures.

Several physical-based methods offer an integrated approach to the study of man-made systems from the point of view of their sustainability. In the last few years, some supranational, national and even local organisations have used the results of research in the social and environmental fields (known as synthetic, integrated, composite, performance or sustainability indicators) as reference points for their policies.

In this paper we discuss some cases in which the importance of economic and biophysical limits to human activity is emphasized by joint use of two apparently independent indicators, outside the traditional economic framework: the Ecological Footprint (EF) and the Index of Sustainable Economic Welfare (ISEW).

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## 2. Alternatives to GDP: the Index of Sustainable Economic Welfare (ISEW) and the Genuine Progress Indicator (GPI)

The first idea of a possible revision of GDP as a measure of welfare perceived by people rather than wealth produced by a nation, was proposed by Nordhaus and Tobin (1972), who introduced the so called Measure of Economic Welfare (MEW). Taking consumption as an aggregate correlated with welfare, they proposed some corrections to the traditional SNA scheme and observed that the trend of MEW from 1929 to the 1980s was correlated with economic growth, as expressed by the GDP. Growth, not yet obsolete!, has therefore been the aim of economic policy for a long time. In other words, economists consider that in order to enjoy a higher level of welfare, the economic system must primarily increase in wealth.

Some doubts were expressed about the fact that the MEW framework did not consider environmental and social issues. Daly and Cobb (1989) proposed further revisions and introduced the Index of Sustainable Economic Welfare (ISEW). Starting again with consumption, they proposed some adjustments to allow for inequality of income distribution, environmental problems (such as pollution costs, long term environmental damage, depletion of non-renewable resources) and social issues (such as commuting costs, urbanization costs, public expenditure for health and education). Computations for different nations have shown that ISEW increases together with increasing GDP up to a point, beyond which it stagnates or even decreases, due to the environmental and social pressure of economic growth (Jackson and Marks, 1994; Jackson and Stymne, 1996; Stockhammer et al., 1997; Rosenberg and Oegema, 1995; Guenno and Tiezzi, 1998; Castañeda, 1999; Gil and Sleszynski, 2003). The Genuine Progress Indicator (GPI) is very similar to ISEW and shows the same trend as ISEW with respect to GDP (Anielski and Rowe, 1999; Lawn, 2003; Costanza et al., 2004)[1], because it considers the same items with few differences such as, for example, labour of volunteers and costs of crime. According to Lawn (2003, p.108) "the ISEW and GPI basically differ in name only".

## 3. A physical-based environmental accounting method: the Ecological Footprint

The Ecological Footprint (EF), developed by Wackernagel and Rees (1996) in the early 1990s, is usually considered an environmental sustainability indicator. In physical terms, EF is defined as the biologically productive area of the Earth's surface required to sustain a given population in a given lifestyle (Chambers et al., 2000). It provides a quantitative assessment of how much nature is necessary to provide the resources a population consumes (food, energy and materials) and to absorb the wastes produced. Its units are global hectares (gha) or hectares with the potential to produce usable biomass equal to the world's potential average of that year (Monfreda et al., 2004).

Calculation of EF is based on the statistics of consumption and EF therefore increases with increasing consumption.

The counterpart of a country's EF is its Biocapacity (BIO). BIO represents the theoretical maximum resource capacity in a year (Monfreda et al., 2004). In other words it is the maximum supply of natural resources and ecological services that can be provided by an area. It can be used as a comparative term to reveal whether existing natural capital is sufficient to support human consumption patterns. A country with an EF higher than its BIO is in a state of ecological deficit and cannot meet the human demand for resources in a sustainable way. In contrast, if EF is less than BIO, the country is in a state of ecological surplus.

EF and BIO time series studies have been performed at local and global levels to monitor human dependence on the life-supporting services of natural capital and natural capital's ability to provide these services (Haberl et al., 2001; Lenzen and Murray, 2001; Wackernagel et al., 2004; WWF, 2004). The Global Footprint Network has been updating national EF and BIO time series since 1960.

## 4. ISEW (or GPI) and EF: economic and biophysical limits to growth

A crucial parameter in the calculation of GDP is consumption. It is also the basis on which EF is calculated: high consumption makes a high EF. It seems therefore that GDP and EF are correlated (Jorgenson and Burns, in press). Since EF represents the demand for natural capital that must be met in order to support a certain level of consumption, then it is a measure of environmental stress (Sutton and Costanza, 2002); increasing consumption causes increasing environmental pressure.

Consumption is also the main component in the calculation of ISEW. However, as we have seen, environmental pressure and damage reduce ISEW, more than offsetting, beyond a certain point, the benefits derived from consumption. At this point, ISEW stagnates or even decreases and an increasing gap is observed between GDP and ISEW, meaning that not all the wealth produced in a nation is translated into welfare. ISEW represents the *economic threshold* of growth.

The fact that finite availability of natural resources is a constraint to economic growth is also highlighted when EF and BIO are compared. BIO is the amount of natural capital that can be replaced annually in a sustainable way. In most high income countries, EF overshoots BIO (EF>BIO), a condition known as ecological deficit. Demand exceeding local supply can be met by importing BIO from outside the country (sometimes) and/or by liquidating the stocks for future generations. In general, BIO is constant or in slow decline everywhere, whereas EFs show increasing trends. This means that the general trend is shifting from surplus (abundance of resources) to deficit conditions (scarcity of resources). The point of transition from ecological surplus to ecological deficit, when the gap between GDP and ISEW is increasing, represents the *biophysical threshold* of growth.

For the purposes of sustainability, this biophysical threshold is critical with respect to the economic threshold. Farber et al. (2002), identify a "critical threshold" in the availability of ecosystem services as a limit beyond which non-linear

[1] For a complete view of time series analyses of ISEW and GPI, see also http://www.foe.co.uk/campaigns/sustainable_development/progress/international.html.

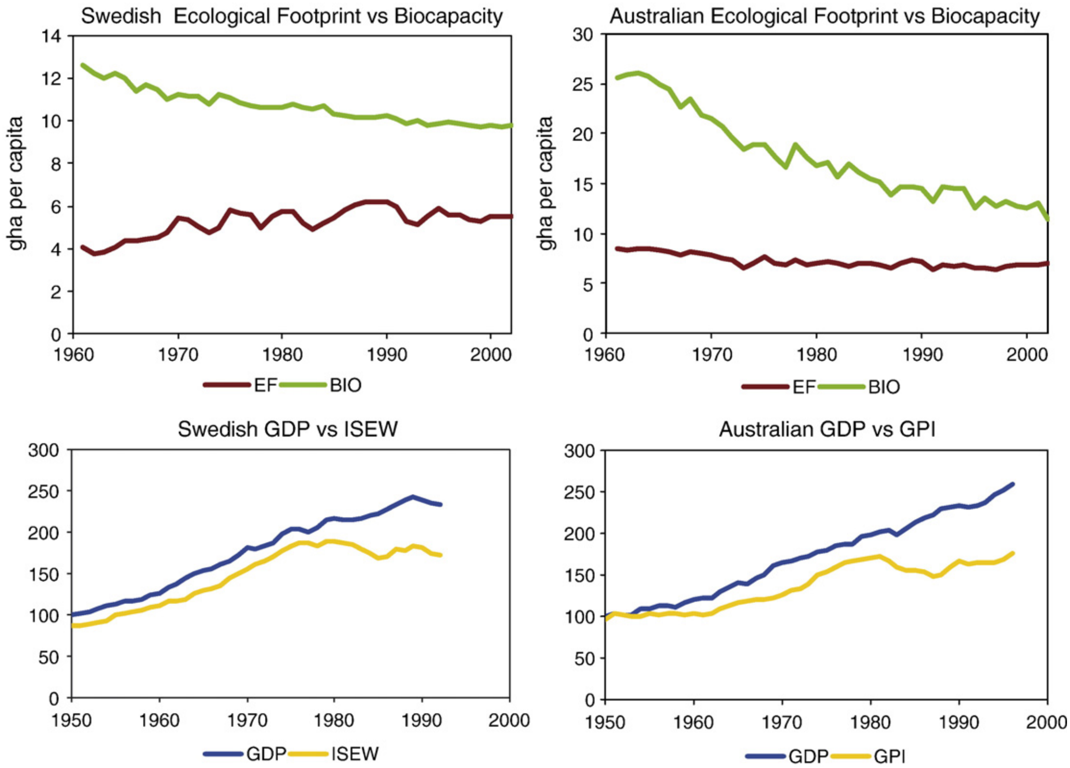


**Fig. 1 – (Top) Ecological Footprint vs Biocapacity for Sweden and Australia. Data from Global Footprint Network (2006). (Down) GDP and ISEW (or GPI) for Sweden and Australia. Data from Jackson and Stymne (1996), Hamilton (1999) and http://www.foe.co.uk/campaigns/sustainable_development/progress/international.html. (Swedish $GDP_{1950}=100$; Australian $GDP_{1950}=100$).**

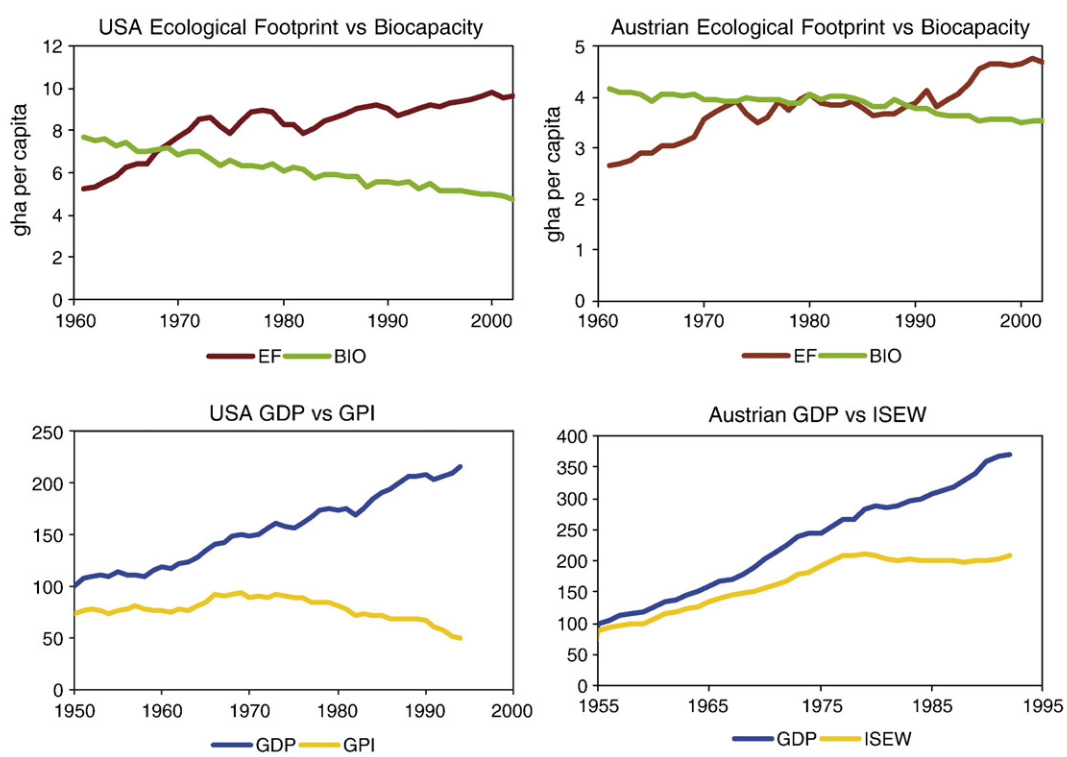


**Fig. 2 – (Top) Ecological Footprint vs Biocapacity for USA and Austria. Data from Global Footprint Network (2006). (Down) GDP and ISEW (or GPI) for USA and Austria. Data from Anielski and Rowe (1999), Stockhammer et al. (1997), and http://www.foe.co.uk/campaigns/sustainable_development/progress/international.html. (USA $GDP_{1950}=100$; Austrian $GDP_{1955}=100$).**

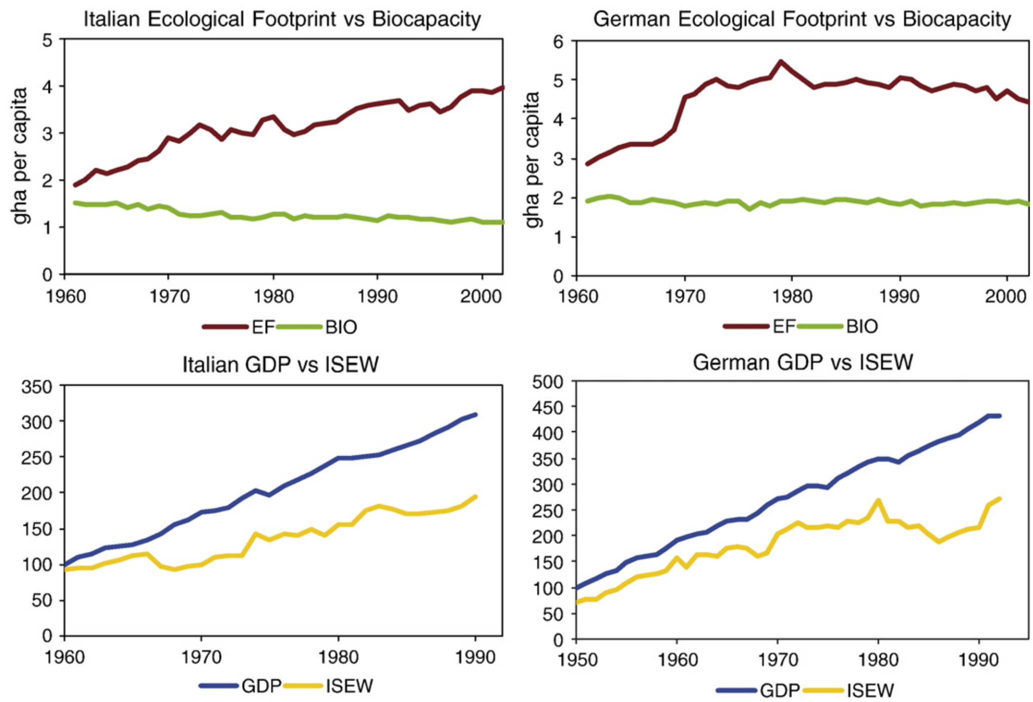


**Fig. 3 – (Top) Ecological Footprint vs Biocapacity for Italy and Germany. Data from Global Footprint Network (2006). (Down) GDP and ISEW for Italy and Germany. Data from Guenno and Tiezzi (1998), Diefenbacher (1994) and http://www.foe.co.uk/campaigns/sustainable_development/progress/international.html. (Italian $GDP_{1960}$ = 100; German $GDP_{1950}$ = 100).**

patterns, irreversible changes and catastrophes may occur, with major environmental and economic consequences.

The fact that EF has already overshot BIO in most western countries may therefore be a reason for the decrease in welfare measured by ISEW.

Figs. 1–3 show comparisons of GDP and ISEW (or GPI, when ISEW is not available) and of EF and BIO for different countries. Three different cases are illustrated. Note that this analysis is based on a heterogeneous data set. EF and BIO figures are quite homogeneous because they are all calculated by the Global Footprint Network using the same procedure. ISEW (and GPI) calculations are performed by different authors who obtained information from different national databases, and published in different journals or within books. In any case, all the information should be interpreted focusing on the trends, that seem quite remarkable, rather than on the single data items.

- Sweden and Australia (Fig. 1): both have an ecological surplus (BIO>EF) due mainly to vast environmental heritages and low population densities (BIO). ISEW stagnated after 1980 in both cases, probably due to decreasing ecological surpluses. The transition from surplus to deficit will occur in a few years time, but an environmental margin for further development still exists. Note the crucial difference between the distribution of BIO and its effective enjoyment by the population. In fact, population is concentrated in a small part of national territory and BIO is often inaccessible. In practical terms, this reduces the BIO that can be linked to EF, also reducing the surplus shown in Fig. 1. Governments should plan future development of the economic system, taking this “environmental advantage” into consideration and preserving it from depletion indefinitely.
- USA and Austria (Fig. 2): ecological overshoot occurred in 1965–1970 (USA) and 1980–1985 (Austria). Curiously, these periods coincided with stagnation of ISEW for Austria and a decrease in GPI in USA. Is it a coincidence? The EF and BIO reveal the different magnitude of the problem in the two countries, as reflected in the gap between GDP and ISEW (GPI). It emerges clearly that environmental conditions, or in other words the availability of natural capital, are crucial elements of economic systems, even if they are ignored by economic accounting systems. Unsustainable demands for energy, materials and ecosystem services have dangerous consequences. Demand can be made sustainable by implementing appropriate policies that acknowledge the existence of extra-economic factors.
- Italy and Germany (Fig. 3): these are doubtful cases. Overshoot probably occurred before 1960 and both are in ecological deficit, but the economic threshold was deferred: in Italy the first shock came at the end of the 1960s and Germany experienced a decrease in welfare in 1980. The increase in environmental pressure matches a growing gap between GDP and ISEW. Three main elements are evident: a) the EF trend describes increasing consumption during the 1960s and subsequent quasi-stabilization; b) the biocapacity is lower than in other countries; c) the consequent import of missing biocapacity from other less developed countries is supported by the economic power of European countries. This means that a low but increasing GDP-ISEW gap is now maintained by accumulating environmental debt towards other countries or generations. This condition sounds a warning for future development because of the intrinsic fragility of these systems and their dependence on environmental variables (just think of the global problem of raw materials and energy supply).

## 5. Conclusion

The main result of this study is confirmation of the complementary and nonsubstitutable nature of economic, ecological–economic and environmental measures of human behaviour. Modern society, especially in the western world, is experiencing increasing environmental pressure (as EF demonstrates) and decreasing environmental sustainability (as EF *versus* BIO demonstrates) in the name of economic growth (measured by GDP). The increase in economic wealth often results in worse, not better, conditions for people because the welfare related to a given GDP is "polluted" and diminished by environmental stress and social pressures (as ISEW demonstrates). This paper shows that the joint use of different instruments is important for several reasons:

- it transcends the traditional short-sighted reductionist view of the economic system as a self-sufficient closed system in which households and firms are linked by flows of products and income;
- it promotes implementation of new economic scenarios and related legislative measures, inspired by the results of the kinds of analysis discussed, that in turn promote further scientific research in the environmental and social fields;
- it brings attention back to the biophysical foundation of all human systems.

These economic and biophysical thresholds of growth should be understood as natural long term limits to human activity. For sustainable well being in the long run they are stronger than mere economic "break-even points", based on parameters such as feasibility, profits and prices.

Calculation of the GDP is an inevitably complicated procedure useful for quantifying national economic performance. However, additional new instruments can give policy makers a truer picture of the world. By breaking up the calculation, these indicators also show whether and to what extent deteriorating welfare depends on environmental issues. Time series analysis reveals the intensity of problems and shows how far a nation or region is from economic, social and environmental sustainability.

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