Basic 'Anti-Entropic' Physical-Economic Constraints

To state the most characteristic feature of a physical economy in the terms of approximation afforded by textbook thermodynamics, agree to define the *necessary* physical costs (input) of an economy's level of productivity (including administration), under the heading of "energy of the system," and to consider the not-wasted, remaining portion of output, as "free energy." "Energy of the system" includes both current new input, and the net replacement cost (in physical terms) of that portion of functionally significant physical capital, the which is stored within the economic process. The latter, stored, net (physical) capital investment, includes basic economic infrastructure, improvements in the physical-economic fertility of land, agriculture, industry, and a restricted portion of actively stored total services: in the form of education and health of the members of households, and science and technology potential of the labor force and enterprises.

Express these, in first approximation, in my own changes in definitions for the symbology for the terms which Karl Marx adopted from his British teachers. Let **V** signify input/output of the labor-force, **C** signify required materials input for the entire economy (functionally defined), **F** net (functional) physical capital, **d** necessary deductions for government and administration otherwise, **S** output in excess of *energy of the system,* and **S′** *free energy* (after deductions for both necessary administration and waste). Be reminded: read these symbols as defined here, not the Marxist reading. Prepare the way by describing the constraints to be examined, as follows.

The general constraints are:

1. The potential population-density of the economy (as a whole) shall not be decreased, and the demographic characteristics of the population as a whole shall be improved.

2. The inputs and outputs of the "market baskets," and of their contents, shall be increased in absolute (physical) terms, for households, for performance of infrastructure, for agriculture and related, for industry, for education, for health care, and for science and technology services. These increases shall be measured in market-baskets, also as contents of market-baskets, and in terms of *per-capita* (of labor-force), households, *per*-square-kilometer of land area.

3. The ratio of "free energy" to "energy of the system," so defined, shall not decrease, but the relative energy of the system (*per capita* of labor-force, *per* household, and *per* square kilometer) shall be increased through reinvestment of "free energy" generated.

These seemingly paradoxical requirements may then be expressed as:

Population-density (adjusted for demographic parameters):

$$|(F)\ P_1| \leq |(F)\ P_2|\ .$$

"Free Energy" Ratio:

$$\left[\frac{S'_1}{(V_1 + C_1)}\right] \leq \left[\frac{S'_2}{(V_2 + C_2)}\right] .$$

"Energy-Density" Ratio (*per-capita* of labor force):

$$\left[\frac{(V_1 + C_1)}{F_1}\right]_1 \geq \left[\frac{(V_2 + C_2)}{F_2}\right]_2 .$$

But, the physical content of market-baskets (M) for productive functions, *per capita,* for labor-force:

$$(M_v)_1 \leq (M_v)_2\ ,\quad (M_c)_1 \leq (M_c)_2\ .$$

This set of "market-basket" relations overlays a set of constraints defined in terms of divisions in output of employment of the total labor-force's operatives, letting **V** correspond to the operatives' ration of the total labor-force.* In this case:

$$\left(\frac{V}{C}\right)_1 \geq \left(\frac{V}{C}\right)_2\ ,\quad \left(\frac{S'}{V}\right)_1 \leq \left(\frac{S'}{V}\right)_2\ ,$$

and

$$\left(\frac{S'}{V + C}\right)_1 \leq \left(\frac{S'}{V + C}\right)_2 .$$

—*from "The Essential Role of 'Time-Reversal' in Mathematical Economics," Fidelio,* Winter 1996 (Vol. V, No. 4).

* See, *So, You Wish To Learn All About Economics?, passim.* [Footnote 8]

quality of development of the physical-economic investment by the society in scientific and technological potential of the new individual as a desired improvement in the physical-economic demographic characteristics of the population.

Consider some elements of basic economic infrastructure: transport, water, and energy. To the extent we can slow down the rate at which water, originating as rainfall, is emptied into the seas and oceans: in how many ways can the useful turnover of that water-flow be increased? Can we increase, thus, the effective amount of water available *per capita* and *per* square kilometer? How can we better manage forests, fields, and so forth, to increase and effectively maintain water-tables, streams, and create weather-systems which moderate weather and increase the amount of rainfall regenerated from evapo-

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