

**Tribute to Nicholas Georgescu-Roegen**

**on his 85th Birthday**

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Nicholas Georgescu-Roegen is a great mathematical economist. Each time I go to consult one of his books--which is done often--I notice that Georgescu comes there on the shelf right next to Gauss. And I think there is something proper in this.

For Georgescu-Roegen is more than a mathematical economist. He is as well a humane, deep, and wise philosopher. It was a regret of the great Joseph Schumpeter, a regret that he carried to his grave, that his proposed collaboration with the young Georgescu-Roegen on a definitive economic treatise could not take place because of Nicholas's patriotic urge to return to the pre-war Romania that had nursed his genius. It was not only Schumpeter's loss, it was a loss to the budding science of political economy.

My own first contact with the Master came in Schumpeter's famed Harvard Ec 11 seminar: I was a beginning graduate student fresh from the Chicago of Frank Knight, Jacob Viner, and Henry Schultz. Georgescu was a young god who walked and talked and joked with such gods as Wassily Leontief, Joseph Schumpeter, Gottfried Haberler, Edwin Bidwell Wilson (Willard Gibbs's last protégé and polymath in his own right), and Nicky Kaldor (visiting Rockefeller fellow from the LSE). The stately Frank Taussig, dean and éminence gris of American economics, turned to Georgescu and Wilson for

adjudication when the young Milton Friedman wrote for the Quarterly Journal of Economics his maiden article criticizing the venerable A. C. Pigou of Cambridge. [Score 1 to 1: Pigou was not wrong; Friedman's generalization was of value in its own right.]

For this issue of a mathematical journal dedicated to the 85th birthday of Nicholas Georgescu-Roegen, it is permissible for me to neglect his fertile contributions to economic history and political development, in favor of a few mathematical topics that his work has resolved. Even here, I shall be forced to ignore his contributions to statistical theory; and also his mathematical resolution of deep production-function processes.

1. Consumer demand theory. When interested at 21 in the mathematics of consumer demand theory, my mind was blown away by the first diagram in Georgescu's 1936 QJE article (p. 145 in his 1966 collected papers). For the first time I sensed the nature of the integrability conditions problem that Pareto had grappled with, only to be gently criticized by the great geometer Vito Volterra. R.G.D. Allen and J.R. Hicks were in need of Georgescu-Roegen's deep understanding of Pfaffian differential expressions. Connoisseurs appreciated Georgescu-Roegen even if the common run of economists failed to appreciate the tour de force.

2. Topology and separable independence. Gerard Debreu is properly praised for applying abstract topology to the problem of additive separability-- as when you act to maximize a total utility that is the sum of one-variable functions of your respective consumptions of tea, cloth, and ballets  $\sum_1^3 f_i(x_i)$ ; or when you invest to maximize the Laplacian moral expectation  $\sum_1^2 P_j U(M_j)$ , where

$P_j$  is the probability of your ending with  $M_j$  of money. Debreu deserves his notice. But it is a matter of reproach to our profession that Georgescu-Roegen's earlier article in the 1954 Southern Economic Journal, has not received its proper due. For there he dealt definitively with the deeper problem of the 2-good case's topology.

3. The economy as an hourglass rather than a pendulum. As long as the words "entropy" and "economics" are remembered, the name of Nicholas Georgescu-Roegen will be remembered and honored. In one apt gestalt he changed our way of looking at the universe.

Classical economics, whether mainstream or otherwise, takes for its logo the image of a pendulum, one that oscillates forever in steady-state equilibrium. So to speak, the First Law of Thermodynamics reigns in the primers and monographs of economics. The Clausius-Boltzmann-Georgescu Second Law is brought home to us by Georgescu's pithy insistence that economic life is essentially an hourglass and not an undamped pendulum. As the sands fall irreversibly into the lower chamber, the entropy of the world increases. As industrial America taps the rich mines of concentrated natural resources, dissipating to everywhere the copper seams of the Mesabi range, entropy remorselessly increases.

One does not have to slavishly worship classical physics to the exclusion of evolutionary biology. Nor need one ape the precise formalisms of Clausius-Gibbs phenomenological thermodynamics. Before Georgescu economists would describe Ricardo's steady state by

$$Q = F(L, T, K.) = C + dk/dt$$

$(L, T, K, dk/dt) = (\bar{L}, \bar{T}, \bar{K}, 0) =$  (labor, land, capital, zero investment)

But once Ricardo remembers that the cost of getting a unit of copper from his exhaustible mines rises as the integral of past mined copper rises, we end up with

$$C + \frac{dk}{dt} + x = F(L, T, K, \int_{-\infty}^t x(t') dt')$$

Now, with  $\partial F[Y_1, Y_2, Y_3, Y_4] / \partial Y_4 < 0$ , Georgescu-Roegen demonstrates that no positive stationary state is possible.

A simple truth? Yes, simple after untruth and truth were separated for us by sage reason.

To Nicholas Georgescu-Roegen I lead the chorus:

Hail Master! Hail Sage!

*Paul A Samuelson*