

REPLY

Georgescu-Roegen versus Solow/Stiglitz

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Daly is right to be concerned about our society's use of resources. Environmental degradation and the wasteful use of natural resources—or any resources, for that matter—are of concern.

Daly's tirade concerning our work seems motivated by two concerns: a lack of consistency with basic laws of physics, and the alleged implication that growth can continue unabated, without eventually facing constraints imposed by the limited supply of natural resources.

Part of the problem arises from a lack of understanding of the role of the kind of analytic models that we (and others) have formulated. They are intended to help us answer questions like, *for the intermediate run—for the next 50–60 years, is it possible that growth can be sustained? What does this possibility entail? We write down models as if they extend out to infinity, but no one takes these limits seriously—for one thing, an exponential increase in the population presents almost unimaginable problems of congestion on our limited planet.*

In this intermediate run, capital can substitute for natural resources—and this is true even though capital itself uses resources. More precise machines (made out of resources that are relatively abundant) can reduce wastage of resources that are relatively scarce. Technical change—some of which is the result of investments in

R&D, a form of capital—can reduce the amounts of physical capital and resources required to produce the unit of output—where output is measured not in physical units, but in the value of the services associated with it. To be sure, a pound of aluminum may continue to embody a pound of aluminum, but a 12-oz soda can today uses far less aluminum than a soda can of only a few years ago; and increased efficiency in production may imply less wastage of bauxite and less coal or oil to produce the energy used to make a pound of aluminum. Or consider the 'resources' that were required to run a regression only a half-century ago—pounds and pounds of heavy calculating machines replaced by mere ounces of a modern calculator.

Changes in technology also allow us to recycle resources more efficiently, so that the amount that is not 'recaptured' for future production may be reduced.

Perhaps the most important question is: Where does all of this lead us? Resources are scarce, and markets, when they function well, reflect that scarcity, economizing on the use of resources. There are important instances, especially where the environment and natural resources are concerned, where markets do not work well. There are, for instance, the classic problems posed by pollution externalities. When markets do not

work well, it is imperative that actions be taken to correct these market failures. No one, to our knowledge, is proposing repealing the laws of thermodynamics! Doing so would make as little sense as the act of one state legislature that thought that students' intellectual resources could

be economized by changing the value of π from the highly inconvenient 3.1416... to just 3.

In the end, we hope that we have made our essential points, using somewhat fewer trees and other resources than Daly did in his 15-page note.