Economics, Steady State

The "steady state" economy is rooted in the nineteenth-century economic theory of John Stuart Mill. Little used until after World War II, the idea is a foundational concept in sustainability science. It can be considered an intellectual fabric with strands from classical economics to neo-Malthusianism, including growth limits, ecological economics, and degrowth. Whether a steady state economy is desirable and achievable remains an unanswered question for sustainability science.

The "steady state" economy (also called the "stationary state" economy) is a 150-year-old economic concept that became central to debates over the meaning of sustainability or sustainable development in the twentieth century. There are several views on what the steady state actually would be, as well as on the process of economic and social change that might lead to it, and whether or not it is even a desirable vision of a sustainable society relevant for the twenty-first century. Many of the debates about the steady state economy are fundamentally the same as debates about sustainability in general.

The steady state concept is rooted in nineteenth-century classical economic theory and is most clearly formulated in a short section in John Stuart Mill's *Principles of Political Economy*. There has not been a clear development of Mill's thought into a modern vision of the steady state. Rather, there are multiple strands of intellectual development that sometimes, but not always, borrow from one another.

The idea comes up in standard economic theory and the neo-Malthusianism of the mid-twentieth century, the return to the ideas of the British scholar T. Robert Malthus that human populations tend to grow faster than food supplies, resulting in a population controlled by famine, disease, or conflict. Steady state economy is central to the Romanian-US economist Nicholas Georgescu-Roegen's application of the entropy law to economic processes and to the emergence of the limits-to-growth argument in the early 1970s. (Entropy is a concept taken from the sub-discipline of physics called thermodynamics. A basic definition of entropy is the process whereby energy moves from a state of being able to do work—a state of high organization termed "low entropy"—to a state of being unable to do work—a state of lower organization termed "high entropy." Entropy is roughly synonymous with lack of organization.) It is embraced by the US ecological economist Herman Daly and thus is basic to the development of the discipline of ecological economics. There are elements of the steady state within the sustainable development paradigm, and it leads logically to its most radical form, sustainable degrowth. Nonetheless, there remain unanswered questions as to how a steady state economy might be achieved, whether it is still relevant in today's economic environment, and whether it is a desirable part of the sustainability paradigm.

John Stuart Mill

John Stuart Mill introduced the idea of the steady state economy idea in 1848 in a section of Book IV of his *Principles of Political Economy*. The section "Of the Stationary State" was a reaction to the work of other classical economists such as Adam Smith and T. Robert Malthus. Mill questioned the imperative of progress by asking about the end of development and by asserting that "the increase in wealth is not boundless," an early expression of what would come to be known as the limits-to-growth argument.

Mill rejected the contention by other classical economists that the end of progress must result in dire or depressing consequences. He made several claims for the stationary state, first by not assuming that an increase in human population was inevitable. He did acknowledge

that if the population was always increasing, then economic growth was necessary to avoid degrading the poorest of those in society; he did not think that growth was required in order for the poor to share in the benefits of society, which they could and must do. He advocated instead a redistribution of wealth and shared access to the paths to decent income. His vision was that "the best state for human nature is that in which, while no one is poor, no one desires to be richer, nor has any reason to fear being thrust back by the efforts of others to push themselves forward."

So a stationary population and shared benefits of the economy (he called this "equality of fortunes") were central to Mill's stationary state. In today's terminology, he was essentially making a quality-of-life argument for the stationary state. A stationary population results in a population density that allows for solitude, "and solitude in the presence of natural beauty and grandeur, is the cradle of thoughts and aspirations which are not only good for the individual, but which society could ill do without." A stationary population, therefore, is necessary for a stationary state economy.

Mill also made the distinction between growth and development that would become important to twentieth-century proponents of the steady state economy, particularly Herman Daly. In Mill's words, "It is scarcely necessary to remark that a stationary condition of capital and population implies no stationary state of human improvement. There would be as much scope as ever for all kinds of mental culture, and moral and social progress."

Mill's stationary state ideas were little used for nearly a century, until the post–World War II era.

Early Uses of the Concept

The theories of growth that dominated early twentieth-century neoclassical economics did not dispense with Mill's steady or stationary concepts, but the ideas were used in a technical sense, exemplified by the US economist Paul Samuelson's (1943) writings at midcentury. The stationary economy was considered as some kind of equilibrium condition that needed to be understood in terms of capital formation and depreciation, interest rates, and the business cycle. The steady state was in no sense a normative concept as used by Mill before and others afterward.

More significant to the emergence of the steady state economy idea was a neo-Malthusian concern for population growth in the post–World War II era. The US ecologist William Vogt (1948), the US conservationist Fairfield Osborn (1948), and others suggested that the Malthusian trap of geometric growth in population versus arithmetic growth in food supply was a model for understanding the changes facing the world after the cataclysm of World War II. The links between a steady state economy and a stationary population became accepted truths for the neo-Malthusians. As Vogt (1948, 284–288) said, "By excessive breeding and abuse of the land, mankind has backed itself into an ecological trap. . . . [U]nless, in short, man readjusts his way of living, in its fullest sense, to the imperatives imposed by the *limited* resources of his environment—we may as well give up all hope of continuing civilized life." Neo-Malthusian thinking continued into the 1960s, particularly in the writings of the US biologist Paul Ehrlich (1968).

Vogt, Osborn, and others planted the seeds that grew into several different but intertwined strains of steady state economics in the 1960s and 1970s. These included limits to growth, Georgescu-Roegen's application of entropy to economic processes, and Daly's explicit steady state economics.

The Limits-to-Growth Controversy

In the post–World War II era, the emphasis in the industrial nations of the world was to continue economic growth. The reconstruction of Western Europe and Japan, the development of the first Green Revolution, and the formation of the Organisation for Economic Co-operation and Development were all part of a growth-oriented public policy. The fears of the neo-Malthusians were addressed and rejected. In the United States, Resources for the Future (RFF) was founded to research the potential constraints on growth from resource scarcity. In a seminal work from RFF, the researchers Howard Barnett and Chandler Morse concluded that generally declining real prices of natural resources indicated the power of technological change and resource substitution to prevent any specific resource scarcity. "Advances in fundamental science have made it possible to take advantage of the uniformity of energy/matter—a uniformity that makes it feasible, without preassignable limit, to escape the quantitative constraints imposed by the character of the earth's crust" (1963, 11). Barnett and Morse's conclusions reflected the growing dominance of the neoclassical paradigm in the economics profession. In this perspective, the neo-Malthusians were characterized as being just as wrong as Malthus was in his predictions about population growth and food supply.

Yet in the 1960s, there were multiple challenges to the neoclassical model. For example, the US economist Kenneth Boulding used a space-age metaphor to express the idea of limits when he introduced the metaphor of the Earth as a spaceship. Boulding (1966) argued that the

standard model of an open economy (he called it a "cowboy" economy) failed to reflect the reality of the limits to the natural system within which the economy as a social system functions. His proposed alternative was a closed or "spaceman" economy where stocks are maintained but throughput (output or production) is minimized. Although Boulding did not call this a steady state economy, he clearly challenged the assumptions of the standard neoclassical growth model.

Despite the challenges by Boulding and others, Barnett and Morse expressed the dominant worldview in Western industrial societies until the publication in 1972 of *The Limits to Growth* (Meadows et al. 1972). This report on computer modeling of the "world system" was sponsored by the Club of Rome, an international group of private citizens brought together by the Italian industrialist Aurelio Peccei and the Scottish scientist Alexander King in 1968 to stimulate international thinking on long-term issues. The project they sponsored at the Massachusetts Institute of Technology developed a systems dynamic model of the world system to test the growth assumptions of the standard economic model.

The results showed that the world system is characterized by resource constraints either in terms of availability of natural resources as inputs or of limits on the pollution-assimilative capacities of the natural environment. Growth then would inevitably lead to "overshoot and collapse." The authors argued that their findings necessitated an equilibrium state. "Thus the most basic definition of the state of global equilibrium is that population and capital are essentially stable, with the forces tending to increase or decrease them in a carefully controlled balance" (Meadows et al. 1972, 171).

Numerous neoclassical economists attacked the limits-to-growth findings, most often based on the contention that Meadows's team had ignored the role of prices in markets to stimulate technical innovation and input substitution (Cole et al. 1973). The book spawned a wide public debate about growth. For example, the American Academy of Arts and Sciences dedicated a whole issue of its journal *Daedalus* to the "No-Growth Society."

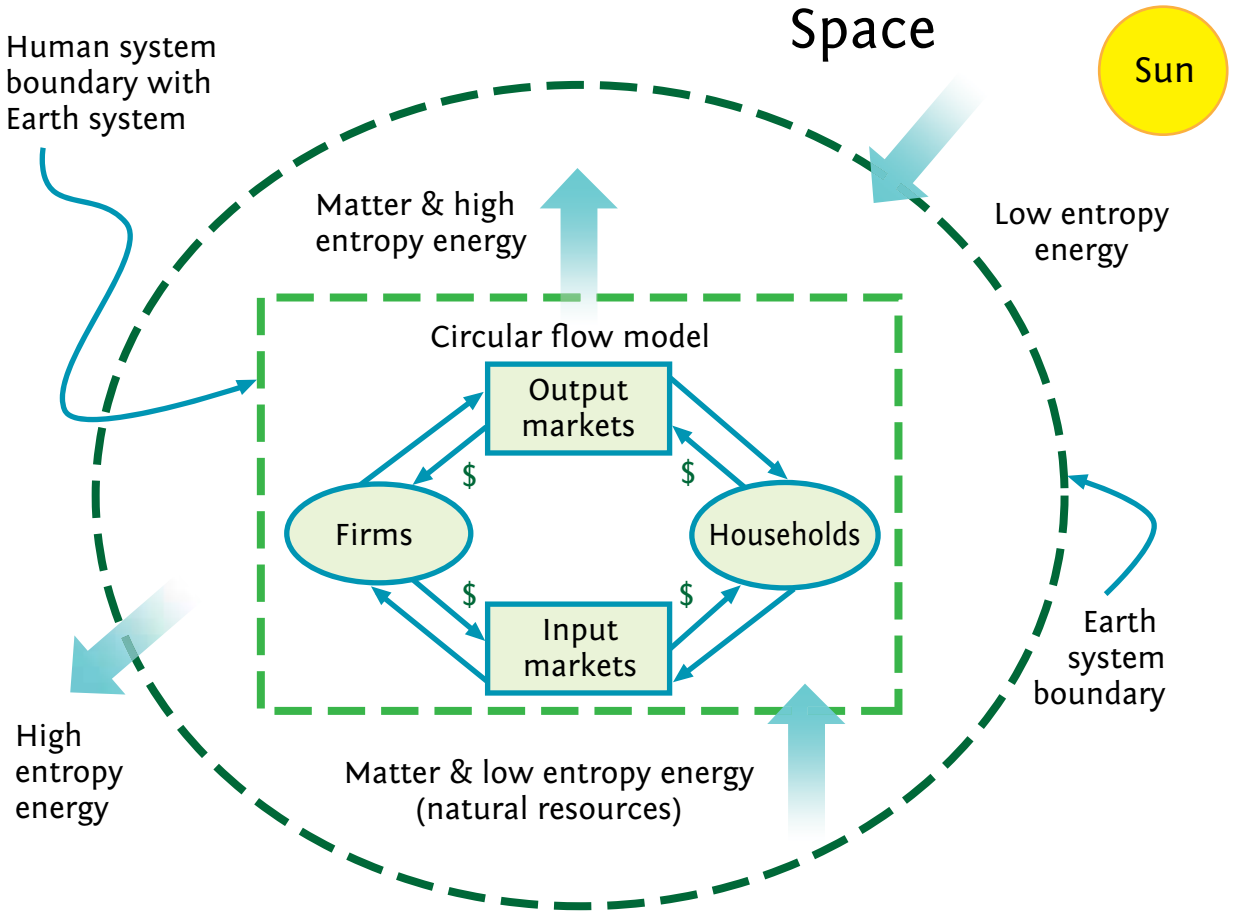
Concurrent with the limits-to-growth modeling effort, a few economists began to critique the growth models that had dominated their profession. Two are notable in the evolution of steady state economics: Nicholas Georgescu-Roegen and Herman Daly.

Nicholas Georgescu-Roegen and Herman Daly

The two late-twentieth-century economists most closely associated with the idea of a steady state economy were Nicholas Georgescu-Roegen and Herman Daly. Georgescu-Roegen was a Romanian mathematician and economist whose contributions set the stage for a full development of the steady state economy idea. He argued that economists had limited their analysis in the traditional circular flow model of the economy and ignored the obvious fact that economic processes take place in a larger biophysical realm. The boundaries between the economy and the "material world" are relevant to understanding fundamental economic processes. (See figure 1 on page 81). His profound contribution was to make clear the relevance of the laws of thermodynamics to economics processes, particularly the second law, or entropy law. Once people saw economic processes as essentially ones that converted low-entropy energy to high-entropy energy, they understood that growth had to be limited. Production and consumption of goods and services inevitably lead to the conversion of low-entropy energy to high-entropy energy—a process that physicists assure us cannot continue indefinitely.

Placing the economy within this larger system, which both neoclassical and Marxist economists had failed to do, changed the understanding of what was possible. The economy was constrained by the laws of physics, and those laws could no longer be ignored. Georgescu-Roegen's approach challenged the basic understanding of capital in economic growth models, which treated natural and manufactured capital as substitutes with few or no limits on the degree the economy could replace natural capital with manufactured capital. A prime example of this is the Cobb-Douglas production function, a central analytical tool in the neoclassical canon, which makes

Figure 1. Expansion of Economists' Circular Flow Model Implicit in the Work of Nicholas Georgescu-Roegen



Source: Adapted from Daly (1980, 20), fig. I.2.

There are biophysical constraints on the economy. The boundaries between the economy and the "material world"—the world's oceans, forests, atmosphere, etc.—are relevant to understanding fundamental economic processes, which are, essentially, activities that convert low-entropy energy to high-entropy energy. Sustainability requires that the economy function in ways that account for the biophysical constraints imposed by the larger system within which it is nested.

explicit this fungibility of different types of capital. The price system stimulates technical improvements in the efficiency of manufactured capital, allowing it to replace natural resources in the production function. Georgescu-Roegen's argument was that more often than not, natural capital and manufactured capital complement each other. Furthermore, because production inevitably transforms low-entropy energy, the most basic form of natural capital, growth must be limited. His magnum opus was *The Entropy Law and the Economic Process,* a book more appreciated outside of the discipline of economics than within it (Daly 1995).

Georgescu-Roegen did not embrace the term *steady state economy* in his writings. That became the domain of his student, Herman Daly. Daly studied with Georgescu-Roegen at Vanderbilt University, but later their visions of the appropriate way to think of the possible end states diverged. Daly became the central proponent of the steady state economy, while Georgescu-Roegen questioned it on the same basis that he questioned the growth paradigm of neoclassical economists.

Daly wrote more forcefully and in more detail on the steady state than anyone else. The idea first showed in his 1968 article, "On Economics as a Life Science." He used biological and ecological analogies to posit a more complete model of the economic process, showing clearly the influence of his mentor, Georgescu-Roegen. Daly's writings on the steady state economy demonstrate a breadth and depth of scholarship both within economics and beyond its narrow disciplinary confines. Ecology, physics, ethics, and evolutionary biology were all brought to bear on the problems of defining the steady state economy. For him, the idea was part of a Kuhnian paradigm shift that was essential for economics to remain relevant as a discipline. The US historian and philosopher Thomas Kuhn (1970) argued that

science progresses when the prevailing paradigm in a discipline no longer functions to adequately explain observations by scientists. This necessitates development of a new paradigm, a change that Daly saw to be needed in economics.

For Daly, the need for a steady state economy came from two conflicting ideas. First, the neoclassical growth paradigm assumed that "good" (*welfare* in economist's terminology) comes from both an increase in capital, especially manufactured capital (a stock), and from an increase in income produced with that capital (a flow). Second (which reflects his desire to ground economics in biophysical realities), the Earth "approximates a steady-state open system" and thus nature imposes "an inescapable general scarcity" (Daly 1980, 17, 19). These two ideas represented an irreconcilable internal contradiction in neoclassical economics, demanding a new paradigm—the steady state economy.

The steady state would of necessity have a constant stock of capital and a constant population. But this alone was not sufficient. The capital stock must be durable so that there is a low rate of throughput in the system, an idea similar to Boulding's spaceship economy metaphor. Here Daly showed his grounding in the Georgescu-Roegen concern for the relevance of entropy to the economic process. Daly acknowledged that the limits on throughput can occur on the input side (scarcity of resources) or on the output side (limited capacity for the environment to assimilate used matter and energy).

The obvious problem of this system is that those least well off materially cannot be offered higher incomes through growth, the idea of the growth paradigm being that a rising tide lifts all boats. Physical wealth would be a zero-sum game. This means that "the important issue of the steady state will be distribution, not production" (Daly 1980, 21).

Harking back to Mill again, Daly emphasized the need to see economic well-being as rooted in development rather than growth. There is perhaps no stronger critique of the neoclassical paradigm than when he says, "Paradoxically, growth economics has been both too materialistic and not materialistic enough. In ignoring the ultimate means and the laws of thermodynamics, it has been insufficiently materialistic. In ignoring the Ultimate End and ethics, it has been too materialistic" (1980, 10). This idea that we can still develop even when there is no more growth is the most important feature of the steady state economy. In this, Daly reflected the thinking of Mill. Yet the possibility of development without growth challenged one of the central tenets of neoclassical economic theory—that well-being (welfare) is measured by willingness to pay for goods and services, and that there is no limit to human desires for additional consumption. Daly rejected the idea that for humans more is always preferred over less.

Daly clearly drew on Georgescu-Roegen by direct reference and in the fundamental importance to his arguments of the finite nature of resources, particularly low-entropy energy. Georgescu-Roegen, however, did not embrace the steady state economy. He came to believe that the entropy law makes even the steady state unachievable and calls it a "topical mirage." He pondered, "Perhaps the destiny of man is to have a short, but fiery, exciting and extravagant life rather than a long, uneventful and vegetative existence. Let other species—the amoebas, for example—which have no spiritual ambitions inherit an earth still bathed in plenty of sunshine" (Georgescu-Roegen 1975, 379).

For many, the steady state economy is related to the principles of sustainable development from the Brundtland Report, the title commonly given to the final report of the World Commission on Environment and Development (1987). While some used the term "sustainable development," others referred to "sustainable growth." Daly called "sustainable growth" an oxymoron, arguing that growth is not sustainable because it implies increase in capital stock, population, or both. The steady state economy sits in the middle between growth models, with the optimism of neoclassical or sustainable growth on one side and the pessimism of Georgescu-Roegen on the other. We thus have three fundamentally different views of what is possible and desirable, reflecting multiple tensions around ideas of growth.

Is the Concept Still Relevant?

The steady state economy concept, in any of its manifestations, is fundamentally opposed to the dominant paradigm in contemporary economic thinking. The normative

application of the neoclassical mode is sometimes referred to as neoliberalism. While there are multiple debates within the neoliberal school of economics, its general normative approach favors freer trade among nations, flexible labor markets, freer migration, global financial integration to enhance capital flows, and intellectual property protections. The underlying assumption of this school is that economic growth is the solution to poverty, unemployment, and income inequality, captured in the aphorism "a rising tide lifts all boats."

This viewpoint is evident in the responses to the global financial crises in the first decade of the twenty-first century. National fiscal and monetary policies as well as global trade policies continued to focus on stimulating overall economic growth as measured by traditional metrics like real (inflation-adjusted) gross domestic product per capita. Public policy was clearly dominated by this approach, and few politicians at local or national levels embraced the steady state economy idea. This might bring into question whether the steady state concept is still relevant in a world recovering from a global recession in the business cycle nearly as large as the Great Depression following 1929.

Advocates of the steady state economy argue for a paradigm shift in economics. They reject many of the underlying assumptions of the neoliberal economic thinking and make different assumptions. Three of the important assumptions follow:

- There are biophysical constraints on the economy that must be recognized. (See figure 1 on page 81.) Economic growth as reflected in material throughput therefore cannot continue indefinitely.
- Inequalities in the distribution of income, wealth, and other benefits of economic production are relevant to human well-being, and therefore distributional questions cannot be ignored by advocating for more growth. Utilitarianism is not accepted to be an ethically acceptable approach to measuring welfare changes.
- Human well-being is not just a function of money income, and all values are not captured by individual willingness to pay for goods or services.

It is clear that these assumptions about normative elements of economic theory have not penetrated mainstream economic thinking and were not part of the public policy response to global economic stresses at the beginning of the twenty-first century. A paradigm shift has not occurred yet in economics. There are, however, signs of growing debate among economists that suggest that elements of the steady state economy may well be relevant for the new century.

The normative assumptions of the steady state vision show up in surprising places, indicating that elements of the concept continue to shape debates about economic policy. For example, the idea of biophysical limits on economic activity has taken hold with one of the world's largest traders in currency, Tullett Prebon. The research director for the firm, Tim Morgan, argues that there is a need for a new kind of economics he calls "exponential economics" to identify "key drivers of society and the economy." He says, "The first of these key drivers is that the economy is an energy equation. Society as we know it today is a product of the use of extraneous energy to leverage the limited capabilities of human labor. The leveraging effect of abundant extraneous energy alone permits the earth to support a population of almost seven billion people" (2010, 2). This is not an explicit reference to Georgescu-Roegen, but it reflects the same kind of thinking. Morgan identifies energy return on energy invested as a potentially important measure of the biophysical constraints on the economy (2010, 33).

These biophysical limits have an effect on distributional questions as well, which is the second assumption where steady state advocates differ from advocates of conventional economics. We can see in the growing policy debate around climate change response that distribution of consumption matters. The researcher Shoibal Chakravarty and his colleagues (2009) place climate change response as an issue of distribution and therefore one that cannot be solved by growth. They argue that the requirements of carbon emission reductions should not be allocated on the basis of nation-states but rather based on the distribution of one billion high emitters, individuals who are responsible through their personal lifestyles for the largest emissions and are located in nations around the world.

More significantly, the 2011 United Nations Human Development Report made explicit the links between sustainability and equity in distribution. An innovation in the Human Development Index (HDI) for 2011 was the inclusion of an inequality-adjusted HDI, for the first time recognizing in this metric that distribution of income matters for well-being. This contradicted the utilitarian assumptions of welfare analysis in neoclassical economics and reflects a growing acceptance of this part of the steady state economy paradigm challenge to the dominant paradigm.

The HDI itself is part of a larger effort to develop alternative metrics of economic well-being from those that have dominated the standard economic theory. The assumption of the neoclassical model is that well-being is largely a function of consumption and that money income is a reasonable metric for economic progress. Therefore, real gross domestic product per capita is a reasonable measure of economic progress. Inherent in the steady state economy paradigm is a challenge to this assumption, but here too there is an

increasingly broader acceptance of the challenge to money income as a comprehensive measure of well-being, both among economists and policy makers. A good example is the report commissioned by the government of France on alternative metrics of progress. The authors say, "What we measure affects what we do; and if our measurements are flawed, decisions may be distorted. . . . [W]e often draw inferences about what are good policies by looking at what policies have promoted economic growth; but if our metrics of performance are flawed, so too may be the inferences we draw" (Stiglitz, Sen, and Fitoussi 2009, 8).

Although there has not been a complete paradigm shift toward acceptance of the idea of the steady state economy, the idea both in whole and in part continues to challenge mainstream thinking. The concept stakes out an intellectual space between the optimists, neoliberal (neoclassical) advocates for continued growth, and pessimists like Georgescu-Roegen. The most recent manifestation of the steady state concept is the sustainable degrowth movement, which provokes a number of questions about the steady state concept at its core.

Growth, Degrowth, and Resolved Problems

The steady state economy idea challenges the growth paradigm of the standard economic model. As long as natural resources are abundant, seemingly unlimited growth offers more for everyone. Growth allows societies to make everyone materially better off without having to address difficult issues of income or wealth distribution. As humanity fills the planet, however, biophysical limits appear to the advocates of the steady state economy to constrain future growth. Therefore, the steady state economy is the alternative paradigm that may be sustainable.

Several fundamental questions remain with the idea. At what levels of economic activity and population size should the steady state occur? For optimists, the answer is some future level beyond which we need not worry in the present. For others, particularly those in the European degrowth movement, the rich nations of the world are already beyond a level that could be sustainable as a steady state (see, e.g., Martinez-Alier et al. 2002; Kallis 2011.) The degrowth movement reflects a Georgescu-Roegen–like belief that society has already overshot the biophysical limits of the Earth and is trending toward collapse. These opposed perspectives give widely different answers to a stark question: Should there be more humans at lower levels of consumption for a longer period of time or fewer humans at higher levels of consumption for a shorter period of time?

Even if there were agreement either globally or at a smaller geographic scale that the steady state economy was desirable, there are many technical questions to be answered. These are similar to the questions that neoclassical growth theory addresses within the growth paradigm.

- What level of income and wealth inequality is necessary or tolerable in the steady state? How do policies about distribution affect production and consumption behaviors?
- How do different age structures in a population affect the functioning of the economy?
- What social welfare rules will be possible in the attempt to reach and maintain the steady state?
- What are the capital investment needs of the steady state and what policies will assure that they are met? This applies for all capital types—manufactured, human, natural, and social/cultural.
- What metrics of human well-being will facilitate achieving and maintaining the steady state economy?
- Are people willing to accept constraints on behavior necessary to achieve and maintain the steady state economy?
- Can one part of the steady state economy grow, necessitating that some other part decreases?
- Is the steady state sustainable in some meaningful way, or was Georgescu-Roegen correct in believing that the steady state is not any more possible than growth?

The assumption of the need for a steady state economy is that the current generation of humans has as an ethical or a moral obligation to future humans and perhaps to nonhuman species. Inherent in almost any definition of sustainability is the idea that there is an intergenerational imperative that we leave the future no worse off in terms of its ability to meet its needs. If the steady state economy is a necessary constraint on unsustainable growth in order to allow the future to meets its needs, the steady state economy becomes an article of trust for the present generation. We must trust that if the steady state is accomplished at some level that would be sustainable for the indefinite future, future generations will share in the commitment to pass that state on to those who follow them in their future. It is essentially a reciprocal intergenerational bargain. How might we be assured that those who follow us would accept that bargain?

Mark W. ANDERSON
The University of Maine

See also Community; Education, Higher; Energy Efficiency; Global Trade; Natural Capital; Population; Progress; Values

Further Reading

Barnett, Harold J., & Morse, Chandler. (1963). *Scarcity and growth: The economics of natural resource availability.* Baltimore: Johns Hopkins University Press.

Boulding, Kenneth. (1966). The economics of the coming spaceship Earth. In Herman Daly (Ed.), *Economics, ecology, ethics: Essays toward a steady-state economy.* San Francisco: W. H. Freeman.

Boulding, Kenneth. (1973). The shadow of the stationary state. *Daedalus*, *102*(4), 89–101.

Chakravarty, Shoibal, et al. (2009). Sharing global CO_2 emission reduction among one billion high emitters. *Proceedings of the National Academy of Sciences*, *106*(29), 11884–11888.

Cole, H. S. D.; Freeman, Christopher; Jahoda, Mari; & Pavitt, K. L. R. (1973). *Thinking about the future: A critique of the limits to growth.* London: Chatto & Windus.

Daly, Herman E. (1968). On economics as a life science. *Journal of Political Economy*, *76*, 392–406.

Daly, Herman E. (1980). Introduction to *Essays toward a steady-state economy*. In Herman Daly (Ed.), *Economics, ecology, ethics: Essays toward a steady-state economy.* San Francisco: W. H. Freeman. Retrieved August 14, 2012, from http://josiah.berkeley.edu/2008Spring/ER291/Readings/3.19-4.01/ValuingTheEarth_Daly_Intro.pdf

Daly, Herman E. (1995). On Nicholas Georgescu-Roegen's contributions to economics: An obituary essay. *Ecological Economics*, *13*, 149–154.

Daly, Herman E., & Cobb, John B., Jr. (1989). *For the common good: Redirecting the economy toward community, the environment, and a sustainable future.* Boston: Beacon Press.

Ehrlich, Paul. (1968). *The population bomb.* New York: Ballantine Books.

Georgescu-Roegen, Nicholas. (1971). *The entropy law and the economic process.* Cambridge, MA: Harvard University Press.

Georgescu-Roegen, Nicholas. (1975). Energy and economic myths. *Southern Economic Journal*, *41*, 347–381.

Kallis, Georgos. (2011). In defence of degrowth. *Ecological Economics*, *70*, 873–880.

Kuhn, Thomas. (1970). *The structure of scientific revolutions.* Chicago: University of Chicago Press.

Layard, Richard. (2005). *Happiness: Lessons from a new science.* New York: Penguin.

Martinez-Alier, Joan, et al. (2002). Sustainable degrowth: Mapping the context, criticisms, and future prospects of an emergent paradigm. *Ecological Economics*, *69*, 1741–1747.

Meadows, Donella H.; Meadows, Dennis L.; Randers, Jorgen; & Behrens, William W., III. (1972). *The limits to growth.* New York: Universe Books.

Mill, John Stuart. (1848). Of the stationary state. *Principles of political economy—Book IV.*

Morgan, Tim. (2010). End-Game: The denouement of exponentials. *Strategy Insights, Issue Six.* London: Tullett Prebon.

Osborn, Fairfield. (1948). *Our plundered planet*. Boston: Little, Brown.

Ropke, Inge. (2004). The early modern history of ecological economics. *Ecological Economics*, *50*, 293–314.

Samuelson, Paul A. (1943). Dynamics, statics, and the stationary state. *The Review of Economics and Statistics*, *25*(1), 56–68.

Stiglitz, Joseph E.; Sen, Amartya; & Fitoussi, Jean-Paul. (2009). Report by the Commission on the measurement of economic performance and social progress. Retrieved November 28, 2011, from www.stiglitz-sen-fitoussi.fr

Vogt, William. (1948). *Road to survival.* New York: Sloane Associates.

World Commission on Environment and Development (WCED). (1987). *Our common future*. New York: Oxford University Press.