

CHAPTER 10

HISTORY AND THEORY OF ECONOMIC GROWTH

10.1 The Remaining strategy

At the beginning of Chapter 8, the ecological damage caused by present-day economic activity was likened to health problems caused by smoking cigarettes. Three possible strategies were identified for counteracting this damage. One is to devise technologies for reducing the damage in individual cases (e.g., smokestack scrubbers), analogous to devising distinct medical treatments for emphysema, for lung cancer, and so on. A second strategy is to replace fossil fuel with clean energy as a way of breaking the link between economic production and ecological damage. This is analogous to replacing nicotine in cigarettes with less harmful ingredients.

These strategies were examined and found wanting in the two previous chapters. While both are capable of beneficial results, and should be implemented whenever possible, by themselves these strategies show little promise of restoring the biosphere to a healthy condition. Dysfunctional conditions such as global warming and ozone depletion result from disruption of natural feedback systems that keep crucial environmental variables in balance. Natural control systems of this sort cannot be repaired by specific technologies, to the discredit of the first strategy in question. Dys functionality in such circumstances, moreover, often results from uses in which fossil resources cannot be replaced by clean energy. In such case, the second strategy is not even applicable.

We come now to the remaining strategy mentioned in Chapter 8. This final strategy boils down to cutting back on the sheer volume of human energy-consumption that is primarily responsible for the widespread damage humanity has inflicted on the biosphere. Taking the analogy with nicotine consumption one step further, this is akin to curtailing the use of addictive tobacco products. In one way or another, we shall be

occupied with this third strategy and its ramifications throughout the remainder of the present study.

Considered apart from context, this strategy seems obvious and relatively straightforward. If consuming overly much of a given item is causing problems, the obvious remedy is to curtail consumption. If the item in question happens to be energy, a countermeasure that comes immediately to mind is simply to cut back on use of energy. The straightforward solution to any problem of excess is to adopt alternatives that are not excessive.

As the comparison with tobacco-use suggests, however, solutions that seem straightforward in the abstract might turn out to be considerably more complex in practice. Like nicotine intake for the individual smoker, profligate use of energy can be addictive for a consumer society. Advising a society of consumers to cut back on its use of energy is comparable to advising an addicted smoker to cut back on nicotine intake. In both cases, the advice would probably be ignored. Even when the behavior in question is recognized as harmful, cutting back on consumption of an addictive substance is all too often a difficult matter.

The point of the analogy here is not that excessive consumption of energy is addictive in its own right. We are not addicted simply to using lots of energy. What makes our current pattern of energy use so difficult to reverse is the close correlation between energy use and economic production. As shown in Chapter 7, and as some economist have known all along, high levels of production are directly dependent upon correspondingly high levels of energy consumption. The addiction in question is a result of this dependency.¹

It is a monumental misfortune, both for the biosphere at large and for the societies it supports, that the high levels of energy use involved in economic production are also a major source of ecological destruction. It is additionally unfortunate that habits of

excessive energy use have become addictive for the societies concerned. The starkly unfavorable upshot is that human society must find a way of breaking its energy addiction in order to have any chance of staving off the fatal consequences of a collapsing biosphere.

As stated previously, the remaining strategy for counteracting the damage to our ecological support-system caused by expanding economic activity is to cut back significantly on the amounts of energy involved. The remaining strategy thus stands in direct opposition to conventional economic wisdom that social well-being requires continual economic growth. In an effort to determine why economists think that growth is essential to social well-being, let us look briefly at the history of the concept of economic growth.

10.2 Early history of the concept of economic growth

Our term ‘economy’ comes from the Greek οἰκονομία, which originally meant the art of household management. One of the first treatises on economics was the *Oeconomicus* by Xenophon (4th Century B.C.), a discourse concerned with specific skills such as furnishing houses, training servants, and procuring food. Economics in this original sense was not far removed from the subject designated (redundantly) ‘home economics’ in high school curricula of previous decades.

Economics in this original sense seems at first to be quite different from the subject taught by economics professors in present-day colleges and universities. An obvious difference is that the “household” whose management is studied by economists today has been extended from the individual family to a more diffuse and extensive group of people. The sense of ‘home’ (Greek οἶκος) pertaining to contemporary economics is close to that figuring in our terms ‘homeland’ and ‘home state.’

Another difference is that when someone completes the required course of studies and becomes an economist today, that person is not thereby qualified to manage an actual economy. Xenophon's treatise in effect was a textbook of household management. By contrast, the skill of a trained economist today is not primarily one of practice but rather one of understanding the principles and dynamics by which economies operate.

There is one key respect, however, in which mainstream economics today retains continuity with its ancient Greek prototype. In both contexts, the mark of a successful economic regime is its ability to maintain a consistent pattern of growth. The goal of Xenophon's economics went beyond merely running the household efficiently on a daily basis. Another aspect of running a household successfully was being able to increase its wealth over an extended period (*Oeconomicus*, Chs. II, III, *passim*). A well-run household was one that kept on growing, while stagnation was a portent of impending failure.

The notion of what constitutes economic growth underwent considerable change between Xenophon's time and recent centuries. For Xenophon, growth was primarily a matter of increasing resources (living accommodations, provender, servants) by which the needs of a household could be met. There was no expectation that the household itself should produce these resources, only that resources made available externally (by farming, commerce, warfare, etc.) be brought into its service.

With the shift in focus from the domestic family to larger political organizations, however, functions of production and consumption began to merge within the context of a comprehensive system of interacting economic interests. Needed commodities might still be acquired from sources outside the system, either by exchange or by military action. But the items of value (precious metals, currency, crops) for which outside goods were exchanged, along with the resources by which standing armies were maintained, typically were produced within the system itself. Increasingly complex interactive

networks of this comprehensive sort presumably evolved into prototypes of our modern economic systems.

Once an economic system of this rudimentary sort has taken shape, it can be characterized with respect to the parties (rulers, merchants, workers, etc.) whose interests play significant roles within it. It can also be characterized with respect to the kinds of benefits (monetary wealth, land, tithes in kind) it brings to bear in serving those interests. Generally speaking, for an economic system to undergo growth is for it to gain added capacity to make such benefits available.

Although economics did not emerge as a discipline with a distinct subject matter until the latter half of the 18th century, historians have ventured to characterize earlier periods of economic activity in terms of more recent economic theories. According to one source (<http://www.univ.com/economy.php>), the ancient Roman economy was an agrarian system based on slave labor, geared to feeding its vast numbers of soldiers and citizens and, ultimately, to keeping its ruling class in power. Economic growth was a matter of acquiring additional territories for growing grain and additional forces of slaves to work them. Insofar as new territory was acquired by conquest, economic expansion led to increasing numbers of soldiers and administrators who needed to be fed. Once the Empire ran out of additional territory to conquer (around the 2nd century A.D.), it began a period of decline and of inevitable collapse.

A similar story can be told about the feudal period in Europe (<http://www.icpd.org/democracy/index.htm>). For centuries leading up to 1500, feudal economies were based on land, which typically was devoted to producing food through the labor of serfs. Economic production was aimed at serving the needs of the lord and his manor, leaving the serfs a bare minimum for daily subsistence. To the extent that economic growth was possible, it usually amounted to increasing productivity of the fields through minimal improvements in farming methods (e.g., replacement of oxen by

horses²) or to demanding larger tithes for use by the lords. Feudalism broke down with the rise of monetary economies, in part because paid workers proved more productive than bonded labor.

Increasing emphasis on money as a means of exchange led to what has come to be known as the “mercantile system,” prevalent in Europe from the 16th to the 18th century (<http://en.wikipedia.org/wiki/Mercantilism>). During this period, economic growth constituted increasing amounts of negotiable wealth at the disposal of a nation-state, usually in the form of currencies and the precious metals on which they were based. Growth was achieved by several methods, one of which was the exploitation or conquest of gold-rich territories in previously “unexplored” parts of the world (think of Cortez and his incursions into Mexico).

As its name suggests, the mercantile system was based on trade. Another means of gaining wealth was for a nation to maintain a positive balance of trade with other nations. Governments would attempt to foster growth by discouraging imports (money leaving the country) and encouraging exports. Imports were discouraged by imposing tariffs. Exports were encouraged by granting monopolies intended to make favored merchants more competitive in foreign markets. This enabled monopoly-holders like the Dutch East Indian Company and the Hudson’s Bay Company to manipulate prices in hopes of eliminating competition from other countries. Once a company’s monopoly became international, it could raise prices and reap profit from its original investment.

In this competition among nations for foreign markets, the stakes were high enough to lead frequently to armed conflict. Several wars between England and the Netherlands in the 17th century were precipitated by mercantilist ambitions. So too, in large part, was the American Revolution. As dedicated markets for British goods, and as sources of raw materials, the American colonies were compelled to trade only with England, and on English terms. This arrangement the increasingly prosperous colonists

found increasingly intolerable. A result of the revolution was that the U.S.A. soon became a formidable trading power in its own right, as witnessed by the infamous “Triangular Trade” of the late 18th century (slaves from West Africa to the Caribbean, sugar from there to New England, and rum from New England to West Africa). The wealth brought to New England by this commerce helped lay the basis for 19th century American capitalism (http://en.wikipedia.org/wiki/Triangular_trade).

Given its emphasis on production of goods for export and on price manipulation, the mercantilist system did not favor the working population. Local consumption was not a factor in economic prosperity, with the consequence that laborers and farmers generally lived on a level of bare subsistence (<http://en.wikipedia.org/wiki/Mercantilism>). As in the previous period of feudalism, the people primarily responsible for economic growth received few of its benefits. The main beneficiaries of mercantilism were the trading companies and the governments that supported their operations.

10.3 Adam Smith’s theory of economic growth

Adam Smith’s *The Wealth of Nations* is usually considered to be the founding work of modern economics.³ Considerable portions of this work are spent rebutting the policies of mercantilism, with its emphasis on the importance of accumulating bullion. For nations operating under mercantilist principles, gold and silver had inherent value and served as media of foreign trade. In Smith’s view,⁴ by contrast, bullion had the status of other commodities with value varying according to supply and demand.

Another line of criticism is directed against the mercantilist assumption that commerce is a zero-sum game (i.e., that every commercial transaction has a winner and a loser). As pointed out previously, this assumption was a factor in the trade wars that troubled Europe during the 16th and 17th centuries. Smith’s position was that all parties benefit from well-informed transactions when freely undertaken.⁵ If Portugal is better at

making wine and England at producing cloth, then each country should be able to benefit by purchasing the other's goods.

A more radical divergence from mercantilism was Smith's view that economic prosperity should benefit society as a whole. According to mercantilist ideology, the working classes had no rightful expectation of leisure time, education, or extra money to buy more than bare necessities. Such amenities were the prerogative of financiers and merchants who brought wealth into the nation's coffers. The role of working people was to produce goods for the consumption of others, rather than themselves to enjoy the goods produced.

Smith's rebuttal amounted to a fundamental rethinking of the mechanisms by which economies operate. By nature, he believed, human beings tend to act for personal gain. Although this may not be a good thing generally, in the context of a free and well-ordered economy self-interested action can work for the general well-being. If producers and consumers are able to choose freely what they sell and buy, the marketplace will distribute goods at prices that are beneficial to the entire community.

Smith describes this tendency of the unfettered market in terms of the now-famous metaphor of the "invisible hand."⁶ As he puts it in *The Wealth of Nations* (Bk. IV, Ch. II), when a man conducts his business with the motive of personal gain he is "led by an invisible hand to promote an end which was no part of his intention." That end, we are given to understand, is an optimal distribution of economic goods across all levels of society. With respect to the relationship between landlord and laborer in particular, he remarks (in *The Theory of Moral Sentiments*⁷, IV, I, 10) that, although the owner seeks only to gratify his own desires, he is "led by an invisible hand to make nearly the same distribution" of necessities among the poor as would have resulted if all parties had been allotted equal portions of land. Rightly or wrongly, this rationale was used by subsequent economists to justify modern free-market capitalism.

For the invisible hand to operate in this manner, it is necessary that the producers of economic goods function in the role of consumers as well. In the mercantile system, Smith observes (*The Wealth of Nations*, Bk. IV, Ch. VIII), “the interest of the consumer is almost constantly sacrificed to that of the producer.” Smith, on the other hand, considers it “self-evident” that “(c)onsumption is the sole end and purpose of all production” (ibid.). His most consequential departure from mercantilism may have been his account of growth in which expansion of consumption is necessary for an expanding economy.

Smith’s account of economic growth begins in the first chapter of his book with a discussion of the division of labor. When a complex productive task can be broken down into simple components, and each member of a work force assigned a specific subtask, production can be achieved more efficiently and cheaply than when each member is directly responsible for the finished product. Smith’s own example is the production of pins, which at that point involved a considerable number of distinct operations. By his estimate, a single worker would have had difficulty making 20 pins a day, which would have amounted to less than 200 pins for a ten person work force. When each person specializes in a particular operation, however, the same work force could produce close to 48,000 pins a day. (Bk. I, Ch. I).

Division of labor thus enables the production of larger numbers of goods that can be sold at cheaper prices. Yet unless there is ample demand for his goods on the market, no manufacturer will be motivated to expand his productive capacity. To make this point, Smith changes his example from pins to nails (Bk. I, Ch. III). Consider a nail-maker who produces one thousand nails a day and works three hundred days a year. If the nail-maker lives in one of “the remote and inland parts of the Highlands of Scotland,” the market for nails might be so small that only one day of a year’s labor would turn out

to be profitable. The resulting constraint is summed up in the title of Chapter III (Bk. I): “The Division of Labor is limited by the Extent of the Market.”

Large markets are required to absorb the large volumes of goods made possible by division of labor. This means that the class of consumers has to be expanded beyond the elite few who benefited from the mercantile system. Expansion of the consumer class is enabled in part by lower prices resulting from the cheaper production of goods by specialized labor. Another factor is the ability of factory owners to share profits more generously with a productive work force. A combination of these two factors brought consumer goods within reach of the common wage-earner. The upshot is that workers responsible for producing goods joined the ranks of consumers by whom those goods are purchased (<http://www.hrc.wmin.ac.uk/theory-mathematicsofdesire2.html>).

Division of labor increases labor productivity. Increased productivity leads to higher wages. Higher labor-income swells the consumer market. With an expanded market comes a demand for more consumer products. This demand then is met with further increases in productivity, resulting in part from more efficient division of labor, and so forth. Working together, this set of dynamics constitutes a positive feedback loop (section 3.5). Set off by a tendency toward worker specialization, increased productivity leads to yet higher productivity, improved worker income leads to yet higher income, and larger markets lead to yet larger markets.

This, in a nutshell, is Adam Smith’s theory of economic expansion. Although the upward spiral can be joined at various point, his view seems to be that the cycle is driven primarily by increases in consumption. Thus his dictum, quoted earlier, that consumption is the sole end and purpose of production. In line with our characterization of earlier theories in section 10.2, we may say that, for Adam Smith, economic growth amounts to an increase in consumption, which benefits all sectors of the economic community.

It should be noted in passing that there is nothing in Smith's account suggesting that economic growth can continue indefinitely. Growth could be curtailed by government policies attempting to enhance profits or to hold down wages, such as the creation of monopolies or an excessive taxation of income (Bk. I, Ch. IX). Given his view on the importance of land as a source of food and revenue (Bk. V, Ch. III), moreover, along with the obvious fact that land is limited, Smith may well have realized that economic growth is constrained ultimately by environmental factors.⁸

10.4 Classic growth theory following Adam Smith

Beginning with Adam Smith, the development of classical economic theory continues with the work of Thomas Malthus, David Ricardo, and John Stuart Mill. All three shared Smith's belief in private property, in competition, and in markets free from government supervision. They also shared his confidence in the public benefit to be derived from the pursuit of private gain, which Smith epitomized in his metaphor of the Invisible Hand.

Malthus is best known for his book *An Essay on the Principle of Population*, published in 1798, in which he points out the dangers of unchecked population growth. In briefest form, the problem he anticipated is that, while food supply would increase arithmetically at best, population would grow geometrically. The result would be mass starvation which, along with war, crime, and epidemics, would reduce human population to sustainable levels. Malthus's concern with the effects of overpopulation contributed to the reputation of economics as "the dismal science."

Adam Smith had argued that expanding consumer markets led to increased production and higher wages, which in turn would result in yet further consumption. For this positive feedback effect to continue, Malthus pointed out, the work force would have to remain more or less fully employed. But population increase tends to result in

underemployment. Another problem with Smith's doctrine, according to Malthus, had to do with what has come to be known as the "law of diminishing returns."

In point of fact, Malthus and Ricardo arrived at this principle independently (<http://cepa.newschool.edu/het/profiles/ricardo.htm>). As applies to production systems with variable inputs and outputs, the general idea is that increasing inputs leads to progressively smaller additional (so-called marginal) outputs. A simple example has to do with increasing the amount of seed applied to a fixed piece of land. If one pound of seed per acre yields one hundred pounds of produce, it would be unreasonable to expect that each time the amount of seed is doubled the amount of produce would double as well. At some stage the acreage would become overplanted, and the produce returned from additional plantings would begin to diminish.

With regard to Smith's agrarian-based production system, Malthus observed that increasing population would increase the supply of labor. But inasmuch as productivity depends upon both labor and land (a fixed quantity), continual increase in supply of labor will not lead to continuously increasing levels of productivity. In this case, diminishing returns show up as diminishing supplies of food in proportion to an increasingly hungry population.

In various publications from 1815 to 1821, Ricardo extended the principle of diminishing returns to other factors involved in land productivity. One factor is the amount of capital applied per laborer. Up to a point, return on capital will increase with amount of capital expended. But bringing more capital to bear, other things being equal, requires bringing more land under cultivation. Given limitations in fertile land available, this leads to cultivation of progressively less productive land, and accordingly to decreasing returns on capital.

Another factor is technological progress in farm equipment. On one hand, improvements in technology can make a given piece of land more productive and thus

allow for more growth. On the other hand, Ricardo realized, introduction of labor-saving machinery tends to reduce employment. While this does not automatically decrease returns on capital, it leads to a decrease in consumer spending which Adam Smith conjectured must increase for economic growth to occur.

As a result of Ricardo's work, the model economy studied by theoretical economists provided roles for three classes of participants. One is that of workers who spend most of their wages on necessities and whose income is under constant threat of erosion by pressure from the other classes. Another is the class of landowners who, inasmuch as they follow the principle of self-interest, spend most of their revenue on luxuries. Third are the capitalists, who tend to reinvest their profits in hopes of increasingly higher rates of return. This opened the door to "class-warfare" theoreticians like Karl Marx, who (in the *Communist Manifesto* of 1848) focused on the conflict between the capitalists and the working class.

The way this plays out historically, according to Marx, is for capitalists to pay their workers subsistence wages while retaining for themselves as much profit as the market allows. In sociological terms, this amounts to powerful (capital) interests exercising force and fraud in taking advantage of the weak (workers). In economic terms, it amounts to undercutting the purchasing power of the consumer on whom Adam Smith's dynamics of growth was based. In Marx's view, the fatal flaw of capitalist economies is their internal contradiction between improving technological efficiency, which drives up profits, and declining purchasing power of the so-called proletariat, who consume the products of an expanding economy.

The summary work of classical economic theory was John Stuart Mill's *Principles of Political Economy*. Although Mill is best known outside economics for his more broadly philosophical works, *Utilitarianism* and *On Liberty*, his *Principles* remained the most widely used textbook in economics for some 40 years after its

publication in 1848. In this treatise, Mill synthesized and expanded upon the contributions of Smith and Ricardo to the theory of free markets, and added original work of his own on taxation, foreign trade, and the distribution of income.

Like other classical economists before him, Mill was an outspoken advocate of the market system (http://en.wikipedia.org/wiki/John_Stuart_Mill). In the Preface to the first edition of the *Principles*, he expressed hope that its contents would impress themselves “strongly on the minds of men of the world and of legislatures.” This is comparable in intent to a desire that the ethical prescriptions laid out in his philosophical works actually be adopted by human society generally. In retrospect, it is not clear that a full-scale implementation of the dictates of either *Utilitarianism* or the *Principles* would have had a more salutary effect overall than that of Marx’s economic philosophy. Further consideration of Mill’s influence is set aside for Chapter 14.

10.5 Neoclassical growth models

The transition from classical to neoclassical economics began late in the 19th century. A brief story of the transition might focus on a variety of themes. One theme concerns the basis of economic value. In classical economics, a product’s value was thought to depend mainly on the costs of producing it (http://en.wikipedia.org/wiki/Neoclassical_economics). The neoclassical approach, on the other hand, tends to locate a product’s value in its perceived “utility” to a potential consumer. Utility here boils down to benefits the consumer receives from its use—roughly the sense of the term in ethical utilitarianism.

Another theme is the emergence of a highly abstract conception of the individual consumer. According to this conception, individuals maximize utilities in much the manner that firms maximize profits. As with firms, individuals have preferences among possible outcomes of their economic activity that can be optimized on a rational basis.

The sense is that economic behavior is governed by innate mechanisms operating according to the principles of Bentham's hedonic calculus.⁹ As Thorstein Veblen (an early critic of the neoclassical school¹⁰) put it, the "hedonistic conception of man" in question "is that of a lightning calculator of pleasures and pains."

A third transitional theme was an attempt to make economics "scientific" in the manner of physical science. In this context, a discipline was deemed scientific to the extent that its subject matter could be formalized in mathematical terms, enabling it to proceed on an axiomatic basis. An integral part of this approach was the above-mentioned conception of an individual consumer's preference being guided by algorithmic calculations of pleasures and pains. Other axioms brought into play as this approach developed have to do with the interplay between supply and demand, and with various factors influencing return on capital.

The cause of mathematical economics was advanced by the work of John Maynard Keynes, who began his career as a mathematician. His *A Treatise on Probability* (1921) has been touted as no less original than his towering economic work, *The General Theory of Employment, Interest, and Money* (1936).¹¹ A key theme of *The General Theory* is that mass unemployment cannot be explained by high wages or high prices alone, although both tend to weaken demand and hence decrease sales and jobs. In Keynes's view, unemployment is a function primarily of aggregate demand, which is demand on the part of consumers, investors, and governmental bodies alike. The general idea is that sales and jobs fluctuate with changes in aggregate demand: high demand leads to general prosperity, low demand to depression and unemployment.

Keynes thus followed classical economics in associating economic vitality with consumer activity. However, he departed from the laissez-faire doctrines of Smith and his followers in advocating governmental intervention to sustain market equilibrium. Because of its contribution to aggregate demand, government can and should act as a

counterpoise to vacillating business cycles. When the economy is depressed, government should encourage private investment and expand its own expenditures, even if this leads to budget deficits. When the economy is flourishing, on the other hand, government should reign in its expenditures and in the process make up its budget losses. The influence of Keynesian economics is evident in the New Deal politics of the Roosevelt era, in large part through the involvement of Milton Friedman.¹²

From a Keynesian perspective, growth rates of an economy vary with aggregate demand, to which firms react by producing more or less goods for the consumer market. Pursuant to Keynes's emphasis on growth as a matter of increased production, economics began to focus on the phenomena of economic growth specifically, with attention both to its causes and to how it is measured. Since early in the 20th century, the conventional measure of an economy's growth has been its GDP (Gross Domestic Product; section 7.2). Due to the prevailing assumption that GDP per capita is directly correlated with standard of living, it is generally taken for granted that growth in economic production is a desirable thing. Research into the causes of growth has been motivated by the aim of maintaining long-term growth in production, and of moderating the effects of short-term recessions.

The basic model of economic growth during this period was articulated in a paper by Robert Solow,¹³ for which he won the 1987 Nobel Prize in Economics. In keeping with its classical antecedents, Solow's model deals with the interaction between capital and productive output. It assumes a fixed-sized labor force and a fixed proportion of depreciation in capital stock over time. This depreciation is compensated in varying degree by savings that change in constant proportion with overall income. The model assumes that rate of return on capital decreases as capital investment increases (the principle of diminishing return on capital). It also assumes a constant progression of

technological innovation, which means that technology is external (“exogenous”) to the model.

When savings equal depreciation, capital is in equilibrium (unchanging in amount). The dynamics of the model hinges around this point of equilibrium. When savings are greater than depreciation, and when capital per worker is relatively low, capital investment generates a relatively large increase in future income and yields a relatively high rate of return. A consequence is that capital continues to rise. Because of diminishing returns on capital, however, additional increments of capital generate decreasing amounts of additional income and thus a falling rate of return on investment. By the time depreciation catches up with savings (i.e., capital returns to a state of equilibrium), the rate of return on investment will have declined to a point where there is no incentive to accumulate more capital.¹⁴

In Solow’s model, equilibrium is a state of zero economic growth. Due to diminishing returns on capital, there is no additional investment and economic growth comes to a halt. This means, in effect, that no economy can grow indefinitely merely by accumulating capital.

One factor that can induce additional growth once an economy has reached equilibrium is technological progress. As the level of technological sophistication increases, a given quantity of input can yield greater quantities, or improved qualities, of output. In effect, technological innovation raises the rate of return on capital, thus counteracting the diminished rate of return that otherwise would lead to economic stagnation.

As already noted, Solow’s model treats technological innovation as exogenous. This is an obvious limitation of that model in today’s economic climate. Economists working in the 1980s undertook to rectify this shortcoming by developing growth models that included mathematical explanations of technological advancement. In addition to

making technology thus “endogenous,” this more recent approach to growth theory also downplays the principle of diminishing returns on capital. The sense is that increasing productive efficiency stemming from technological innovation can work instead to enhance the marginal product of capital investment. This supposedly enables continuing growth as capital increases.

10.6 Growth not vindicated by economic growth theory

Let us review the circumstances that called for this brief survey of the history of economic growth. After examining current strategies for curbing the severe ecological damage resulting from two centuries of excessive energy use by industrial society (Chapters 8 and 9), we concluded that the only effective remedy would be to cut back radically on the energy consumption involved. This latter strategy runs directly counter to the widely held belief that continued growth is essential to economic health. If economic well-being indeed is inseparable from perpetual growth, then humanity faces a dilemma it might prove unable to resolve. Either it retreats into a state of economic calamity or it faces collapse of the biosphere that supports its existence. The foregoing account of economic growth over recent millennia was undertaken in an effort to determine why unending growth should be thought essential to economic well-being.

One thing our brief survey indicates is that large-scale economies in fact have tended to expand up to the point of ultimate collapse. This is true especially of the economies of the Roman Empire, of feudal Europe, and of the mercantilist period of expansion into colonial markets. In each of these cases, economic growth was bound up with warfare and some form of slave labor. This pattern continued through the 20th century with its global wars, albeit with a gradual shift from slave labor to poorly paid workers. Generally speaking, it seems that the world’s largest economies tend to get bigger and bigger until they disintegrate.

By and large, the economies of developing regions tend to follow suit. As predicated by neoclassical growth theory (http://en.wikipedia.org/wiki/Economic_growth), to be sure, some emerging economies have been expanding more rapidly than their previously developed counterparts. Notable instances during recent decades have been the ballooning economies of China and India.

It should be noted, however, that our brief survey says nothing about innumerable small economies that may have functioned adequately for extended periods without significant expansion. It says nothing about any number of relatively stable economies in Europe, Asia, and Africa that must have coexisted with their neighbors (not always peaceably) for centuries before being swallowed up by the Roman Empire. It says nothing about the presumably numerous agrarian societies that existed on other continents while wars raged in feudal Europe. And it says nothing about the many traditional economies that may have flourished in previously isolated territories before being subjugated in the expansion of European colonialism.

In the unlikely event that a full history were written of the world's less ambitious (and hence less noteworthy) societies, we might expect it to reveal a large portion of cases in which economic stability had been maintained without constant expansion. History might teach us that economic growth is necessary to support political and military expansion, or to maintain borders against growing threats from outside enemies. But there is scant historical evidence to back up the common assumption among mainstream economists that continued economic health depends upon continual growth.

As far as I am aware, no economic historian would claim otherwise. When mainstream economists discuss the topic of growth, it usually is in the context of axiomatic growth theory of the sort reviewed previously (section 10.5). What mainstream growth theory amounts to, by and large, is an abstract consideration of the likely effects of various factors that contribute to growth.

Thus Solow's model, for example, implies that increases in capital investment will yield growth only up to an equilibrium point, after which technological innovation is necessary for growth to continue. By making innovation endogenous, more recent growth theorists have explored ways in which technology can increase the effect of additional investment on production; and so forth. Mainstream growth theory is not concerned with vindicating growth, but rather with laying out possible ways in which growth can be maintained.

Strange as it may seem to a nonspecialist, technical growth theory offers little help toward understanding why continual growth should be thought essential to a thriving economy. If growth theory shows that stratagems A, B, and C can lead to increased economic output, this provides incentive to implement those approaches for policy makers already committed to economic growth. But as far as the theory itself is concerned, it might also provide incentive to avoid those approaches on the part of other people convinced that continued growth at this point in human history may not be a good thing.

As matters stand, it appears that neither economic history nor standard growth theory offers persuasive reasons why human society should not abandon the path of continued growth that has caused such extensive damage to its supporting ecosystems. Given the deep involvement of economies in other facets of human affairs, however, there are arguments to be heard from other quarters contending that growth is essential for human well-being. We consider several such arguments in the following chapter.

Notes

1. The addiction is behavioral, not chemical. In a consumer society like ours, high levels of economic production provide goods and service that consumers tend to find attractive. To the extent that society fosters lifestyles to which such goods and services are essential,

consumers tend to rely on them as necessary ingredients of their perceived well-being. This reliance tends to be habit-forming. When it sets in, the benefits of high economic production become addictive to the individual in that without them the individual feels a loss of personal welfare. The high levels of energy use an economy requires to produce these benefits become addictive by extension. Inasmuch as a perceived loss in well-being on the part of individual consumers is likely to follow a decline in available goods and services, high levels of productivity are required to maintain a cumulative sense of welfare on the part of consumer society at large. This converts into a requirement for high levels of energy use. Consumer society is addicted to excessive consumption of energy in the sense that large amounts of energy are necessary to maintain consumer satisfaction.

2. Vaclav Smil, *Energy in World History* (Westview Press, Boulder, 1994), p. 66.
3. *An Inquiry into the Nature and Cause of the Wealth of Nations* was published in 1776, eleven years after Anders Chydenius's *The National Gain*, which espoused some of the same principles (http://en.wikipedia.org/wiki/The_Wealth_of_Nations). Smith did not use the term 'economics' in reference to his own work, speaking instead of political economy.
4. *The Wealth of Nations*, Bk. I, Ch. XI, in the digression on the value of silver.
5. This is a generalization from Smith's discussion of the origins of the division of labor in Bk. I, Ch. II.
6. This expression occurs three times in Smith's writing—twice in the following citations and again in his posthumously published "History of Astronomy." In the latter, the invisible hand is that of a deistic God who regulates events in nature.
7. *The Theory of Moral Sentiments* was published in 1759.
8. Economists disagree on whether this was the case. As far as the contents of *The Wealth of Nations* are concerned, it seems likely that he never addressed the issue explicitly.

9. As laid out in his *Introduction to the Principles of Morals and Legislation* (1789), Bentham's utilitarianism maintains that one ought always to act in a manner resulting in the greatest overall pleasure. The hedonic calculus is a theoretical algorithm for maximizing pleasures and minimizing pains. The internal optimizing mechanism assumed by neoclassical economics is supposed to maximize pleasures for the individual affected rather than for society at large.
10. Thorstein Veblen, "Why is Economics not an Evolutionary Science?" *Quarterly Journal of Economics*, 1898, vol. 12, p. 373.
11. See the Introduction to the 1962 edition of Keynes's *Treatise on Probability* by Norwood Russell Hanson, a prominent philosopher of science. Keynes's *General Theory* was preceded by his *Treatise on Money* (1930).
12. By the time of his Nobel award in 1976, Friedman had recanted his New Deal leanings in the 1950s in favor of what he described as a "libertarian" view that the role of government in guiding the economy should be severely restricted (http://en.wikipedia.org/wiki/Milton_Friedman/Political_views). In 1988, he received both the Presidential Medal of Freedom and the National Medal of Science from President Ronald Reagan.
13. R.M. Solow, "A Contribution to the Theory of Economic Growth," *Quarterly Journal of Economics*, vol. 70, pp. 65-94.
14. This brief account of the dynamics of Solow's model is a simplification of (already simplified) accounts in "Energy and Economic Growth" (2003) by David I. Stern, Department of Economics, Rensselaer Polytechnic Institute, and in various websites (notably <http://en.wikipedia.org/wiki/Economic_growth> and <<http://william-king.www.drexel.edu/top/Prin/txt/gro/gro10.html>>).