How We Got to Where We Are Today: A Brief History of Economic Thought and Its Paradoxes

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2.1 Introduction

This chapter assesses earlier economic theories from an energy perspective, where that is possible. We also make the case that although economics has not dealt with energy very explicitly, the discipline has addressed many other important issues that help us today to understand just how energy operates within economies as well as provide a number of interesting and important perspectives on economies that are not related to energy. The purpose of this chapter and the next three is to utilize the insights and the methods of prior economic schools of thought to build a new theory that explains actual economies much better while addressing energy and biophysical limits to human activity far more explicitly than does mainstream theory.

2.2 Surplus and Scarcity

Economists through the ages usually have commenced their discussions of value, distribution, and growth from two fundamentally different starting points: *relative scarcity* and *economic surplus*. Before the age of fossil fuels, economic theory was based on the premise that nature limited the flow of resources; in other words, there was an *absolute scarcity* of economic goods and services. After the 1870s the physical limits became much less important because of the concentrated power of fossil fuels. Questions of the biophysical means by which the wealth was generated simply fell off the radar screen of economists. The focus of analysis shifted instead to that of *relative* scarcity: that is, of individual subjective choices while facing limited access to money. The theory depended upon the assumption that individual humans were acquisitive and rational beings whose desire for more material goods as the source of happiness could never be satisfied and for whom the desires and preferences of others were irrelevant. No level of output, no matter how abundant, could ever satisfy fully these *unlimited* wants. It is a psychological, not a physical, problem. From this perspective, the clash between limited means and unlimited wants is *the* economic problem. This view of scarcity as the starting point of contemporary economics underlies the usual formal definition of economics as we gave in ▶ Chap. 1.

The discussion of *economic surplus* begins with the premise that society can produce more than it needs for subsistence by organizational and technological means. Access to energy is rarely mentioned but lies beneath the surface. Stated simply, an economic surplus is the difference between society's economic output and the cost of producing it. The *surplus approach* relates to Polanyi's *substantive* definition of economics. In the 1960s, Karl Polanyi wrote and edited a collection of essays on ancient economies, where market-forming prices had little to do with how things were distributed. In *Trade and Markets in Early Empires*, Polanyi and his colleagues realized that markets dated back to antiquity, but that price-forming markets are a contemporary phenomenon. His point was that if one looked at ancient societies through the lens of modern, price-forming, markets, one was likely to miss more than they might discover. In order to understand the ancient economy Polanyi offered a *substantive* definition of economics. We believe that this definition is also an excellent starting point for the integration of energy and human society into economics. "The substantive meaning of economics derives from man's dependence for his living upon nature and his fellows. It refers to the interchange with his natural and social environment, insofar as this results in supplying him with the means of material want satisfaction" [1]. ▶ Chap. 1: In other words, the substantive Definition focuses on how human beings transform Nature… how human beings transform nature to meet their needs. Nature was seen to be abundant. Most economists of the classical period treated it as a "free gift." Economists of the pre-fossil fuel age relied primarily on the economic surplus approach. But by the 1870s came the dawn of the fossil fuel era, the industrial revolution, and the consumer society. For economists, the basic starting point for thinking about economics could be reformulated from *producing* an economic surplus to exchanging commodities that were relatively scarce without thinking much about how products came into being. At the same time, the analytical focus changed from social class to the individual and from an objective accounting of the costs of production to the individual valuation of subjective well-being or utility. The goal of economics became one of figuring out the optimal allocation of resources to best meet human psychological desires. In other words, economic theory was transformed from focusing on obtaining more from nature into an exercise to figure out *who* gets the goods and

services and *how* goods and services best enhance subjective well-being. According to the new *neoclassical* economists, the answers were to be found in the magic of self-regulating markets where individual pursuit of self-interest led to social harmony. While this concept was derived from the earlier writings of Adam Smith, it was augmented by mathematical "proofs" appropriated, or better misappropriated, from energy physics. Meanwhile new research in behavioral economics shows that there is little empirical evidence to indicate that human beings actually behave in this "self-regarding" way.

2.3 Economic Surplus as Energy Surplus

Economists of the seventeenth through the nineteenth centuries did not, in fact could not, focus explicitly upon energy as a source of surpluses because the formal concept of energy did not yet exist. Nevertheless, the ability to extract an energy surplus from solar flow or terrestrial stocks forms the basis of economic production and surplus. Contemporary energy analyst Richard Heinberg provides a framework by which to assess the economic roles of such energy surpluses [2]. He argues that throughout history humans have engaged in five strategies to expropriate energy: takeover, tool use, specialization, scope enlargement, and drawdown. *Takeover* was the primary method of early humans, as we appropriated more of the solar energy flow for ourselves by diverting a portion of the Earth's biomass from supporting other creatures to supporting humankind. Our ancestors took over land to grow crops, first as horticulture and later as agriculture, the growing of field crops at the expense of other species. Agriculture turned a complex ecosystem into a simple one. Plants that grew where they were not useful to humans were weeds. Animals that competed for the food were pests. As humans migrated from Africa to the far corners of the world, they took over more and more biocapacity, often disrupting the natural balance. Everywhere humans have gone large mammals have disappeared. The rapid release of chemical energy known as fire aided the process of acquiring energy surpluses. Pioneering biophysical economist Nicholas Georgescu-Roegen termed this a Promethean innovation, which was truly species altering. The only other Promethean innovation was the steam engine. In addition, humans enhanced their abilities to harness the solar flow by domesticating certain animals which could provide more motive power than the biomass necessary to feed them.

Heinberg's second strategy was that of *tool use*. Humans have long-used tools, for tools can augment the takeover of energy from other species and other societies to expropriate ever-increasing amounts of energy from the biophysical system. Specialized tools called weapons aided our ability to concentrate energy in spear points and hunt more effectively, as well as expropriate energy from other societies. Tools have evolved from those that required only human energy for their manufacture and use, such as spear points, to those that use copious amounts of energy and exotic materials from external sources for their manufacture and use, such as the internal combustion engine. As the energy surplus rose to a sufficient level so that not all members of society had to work constantly simply to provide adequate food, humans could begin to specialize on activities such as toolmaking or soldiering. All hierarchical societies that support people who are not immediate producers of crops depend upon this. Increased agricultural productivity could now support classes of artisans, aristocrats, and intellectuals who could better design and build tools and improve social organization designed to capture even greater amounts of energy. All classical political economy, from the French physiocrats to Adam Smith, acknowledged the role that specialization played in determining wealth and value. Howard Odum talks of all kinds of natural and human-dominated systems "self-organizing" to generate "maximum power." From this perspective, humans are not doing anything that other organisms don't do; they are just "good" at it because of their technologies which are now supplemented with the "large muscles" of fossil fuels.

Another strategy of energy appropriation was that of *scope enlargement* or the transcendence of limits. Justus von Liebig found that the limiting factor in the carrying capacity of any biophysical system, especially agriculture, was the factor or input least available relative to the needs of the growing plants or other ecological units. This limit could be pushed back by appropriating the biocapacity of other regions through conquest or trade. Mercantile doctrine rested de facto upon the foundation of acquiring the solar energy surpluses of other regions. The practical aims of

traders were later codified by David Ricardo into the doctrine now known as *comparative advantage*. The benefits of trade result from enlarging the scope of the energy would be shared by all traders. Industrial society depended upon the ability of urban industrial centers to appropriate the biomass of rural areas in terms of food and wood for fuel. Unfortunately, many of the nutrients that would have been returned to the soil in the countryside built up as waste in the city. Ecologist Justus von Liebig himself referred to this system of commercial agriculture as "robbery." [4]. Scope enlargement also entailed the stealing of solar surpluses from others through war, exploitation, and colonization largely to provide and enrich the treasuries of dominant powers at the expense of the conquered and colonized.

The last and most successful strategy for increasing carrying capacity that Heinberg describes is that of *drawdown*. Drawdown began occurring when we were able to change from living on steady solar flows to tap nonrenewable stocks of fossil fuels, particularly those of coal, oil, and natural gas. Drawdown was enabled by the development of sophisticated tools and greatly enhanced the previous strategies. With drawdown, humans could appropriate nature sufficiently to support a much higher population at a greater standard of living for a fraction of the population. At the beginning of the age of fossil fuels, around 1800, the world's population stood at approximately one billion. Since then the world supports more than seven times that number. Half of that increase came in the past 50 years following the "Green Revolution" when plant breeders combined hybrid grains with energy-intensive input packages of fertilizers, other agrochemicals, irrigation, and cultivation. While the benefits of increased yields were extended to a broader segment of the world's population, not everyone enjoys food security. There are about 800 million hungry people in the world today.

Heinberg also points out three dangers of the drawdown strategy. First, drawdown of fossil fuels creates pollution. This can take the form of pollutants such as sulfur dioxide and nitrogen oxides that foul the air and acidify the soils and water supplies. Runoff from lands treated with nitrogen and phosphorus fertilizers creates "hypoxic dead zones" in areas such as rivers, lakes, and the mouth of the Mississippi River in the Gulf of Mexico. Secondly, the pollution can take the form of carbon dioxide emissions, whose increasing atmospheric concentration are seen by the broad consensus of scientists as the primary driving force of climate change. Finally, terrestrial stocks of fossil fuels are finite. At the beginning of the twenty-first century, we are at or near the global peak use of these fuels, especially oil. As they become less available and more expensive, societies dependent upon them will undergo dramatic transformation with potentially grave economic as well as social consequences [3].

As we approach the limits to the drawdown of nonrenewable stocks of nature, the idea that we can satisfy human needs and economic priorities by producing and consuming ever greater quantities of material goods should become a matter of inquiry rather than of blind faith. In the post-peak years, we will need to confront the distinct possibilities of absolute scarcity and the diminished capacity to appropriate surplus energy. We need to revisit and reexamine the questions economists have asked for centuries.

2.4 The "Big Es"

Through the ages, different schools of economic analysis focused on a different "Big E." Each of these can be considered as a social construct, a way of thinking about how people integrated with the economy and with nature. The mercantilists organized their thought around a better understanding of *exchange.* How could political economists help change the laws in order to facilitate expansion of commerce and regulation of trade? Classical political economists directed their efforts toward *economic policy.* For them the object of economics was to inform policy makers. The physiocrats wanted to reform French agriculture and encourage large scale production of commercial crops. Adam Smith focused on the elimination of mercantile trade restrictions, while David Ricardo wanted to raise taxes on the aristocracy and facilitate further the trade in food and industrial commodities. Thomas Malthus, on the other hand, wanted to subsidize the aristocracy. Both Ricardo and John Stuart Mill were elected to parliament where they argued effectively to change economic policies. The theories of Karl Marx were grounded in the *exploitation* of labor and the recapitalization of surplus generated by workers and fossil fuel-driven machines.

Neoclassical economic theory revolves around *efficiency and equilibrium*, concepts appropriated from physics. Their fundamental belief is that the economy could be analyzed separately from the rest of the society and that an economy would tend toward a state of balance without intervention from political agencies. The "Big E" for Keynesian economies was *employment*. Keynes genius was to realize that equilibrium could occur at any level of employment, including very high and politically unacceptable levels of unemployment. Keynes advocated the use of the government to insure the economy balances at high levels of employment.

Institutional economics starts with the process of *evolution*. The current professional society of institutional economists is called The Association for Evolutionary Economics (AFEE). Institutionalists such as Thorstein Veblen and John Commons rejected the mechanical analogies of neoclassical economics and looked primarily at the evolution and structural changes in economic and institutions. For ecological economists, the main contribution was that of *embeddedness*. Ecological economists embed a growing economy within a finite and nongrowing ecosystem and sometimes a social system as well. Finally, biophysical economics starts with analysis of the flows of *energy* and analyzes how changes in the quality and availability of energy shape economic activity.

2.5 The Present as History [4]

We should study history as more than just idle curiosity. The lessons of history may provide valuable lessons for the problems of today and tomorrow. Studying history, in our opinion, yields a more sophisticated understanding of how we arrived at our current state of affairs, just as unifying social and natural science approaches allows a better understanding of an economy that is embedded in society and in nature.

We will need a new set of economic theories for the second half of the age of oil: theories that neither treat "Nature's Bounty" as a free gift nor posit resource endowments that appear magically as "manna from heaven." Moreover, we must contend with the problem of limits to growth. In the past humans transcended the boundaries and limits imposed by nature largely by the application of increasing quantities of cheap fossil fuels. But the era we are entering will most probably see the end of this. As high-quality fossil fuels increasingly run short, and the use of all carbonaceous fuels compromises our atmosphere and other natural systems, the specter of living within our means while protecting our home becomes more and more difficult. This is likely to mean the end of the growth economy and will cause us to reconsider the meaning of technological change. As we do this, and as we begin to develop new economic theories appropriate to a new age, we need to consider that many important questions and insights exist in the writings of the economists of the past. Thus, we examine next the most important ideas of earlier economists.

As we trace the origins and development of what we call economics today, we will return to the six questions identified in ▶ Chap. 1 again and again. We will also introduce the concept that we see each of these questions as being in large part about energy. Even though the questions asked by economists tended to remain the same over time. The theoretical emphases, methods of inquiry and analytical vision were so fundamentally different from one time to another that economic theory can be divided into six distinct periods and "schools of thought."

2.6 Schools of Economic Thought

The different schools of thought often asked similar questions but had very different visions of how the economy worked. They directed their writings toward different purposes and used very different analytical methods. We now ask how each approached the main questions of economics.

2.7 The Mercantilists

Before the European flowering of exploration and commerce in the late fifteenth century, day-to-day life changed slowly in the medieval era. European society was organized around the manor and a strict hierarchy with the church and the landowners at the top, a tiny class or artisans and merchants in the middle, and a landless peasantry constituting most of the population. Church doctrine and economics writings were dedicated to keep life from changing. For the scholastics that shaped the ideas of the medieval days of feudalism, the origins of wealth lie in the land, specifically with the ownership of the land. Those that owned and controlled the photosynthetic capability of the land

were wealthy. Those that did not own land were not. The nobility and the church owned the land, and the elaborate principles of medieval law served to concentrate land ownership. Primogenitor demanded that all land was given to the first-born son. Daughters of landowners were expected to marry sons of other landowners. The ban on usury prohibited merchants from acquiring wealth through the charging of interest, and profits by means of trade were limited by the "just price" which covered only the costs of production, transportation, and the return necessary to keep one in "their station in life." Social mobility was a mortal sin. The peasantry, known as serfs, labored primarily in the fields of their feudal lords having but 1 or 2 days per week to till the Commons for their own subsistence needs. All paid taxes to the nobles and tithes to the church.

After what historian Barbara Tuchman calls "the calamitous fourteenth century," the thousand-year stability of feudalism began to fracture, and by the beginning of the sixteenth century, the merchants, much reviled by the nobility and the church, began gaining control of society. Wealth was in new hands that found new uses for it. Art and music prospered and proliferated as did commerce. The age of exploration ushered in the age of long-distance trade as well as the Renaissance. The forests and mines of the "New World" augmented the long-depleted stocks of the old. The writers of the new mercantile period began to redefine the meaning of wealth, from control over land and its biomass to accumulation of "treasure" or stocks of precious metals. This was the essence of mercantilist "economics." By the middle of the seventeenth century, thought on how best to accumulate wealth changed from the treasure itself to the gains made by trade. Treasure, and therefore wealth, would flow to those nations which achieved a positive balance of trade. As much money could be made in control of shipping and customs as could be made mining and refining the treasure itself.

It is important to think about the six key questions from the background of the various dominant economic "schools" of thought as they evolved over the history of economics. The first identifiable school of economic thought was known as *mercantilism*, which was grounded in the economics of long-distance trade. Mercantile doctrine took the form of pamphlets written primarily to justifying the expansion of trade. Although their aims and purposes were practical, mercantilist writers did make advances in questions such as the origins of wealth and value and the accumulation of capital. In many ways, mercantilism was primarily about takeover and scope enlargement.

Mercantilist writers were most often practical business people, not academics. The most famous, Thomas Mun, was a director of the British East India Company. All defined the purpose of the economic endeavor as the accumulation of treasure in the coffers of the nation state. Mercantilists, not surprisingly, took the position that the origin of value, or price, lay in the process of exchange, and they meant to control the terms of that exchange. Their primary mechanisms were colonization, commercial treaty, and war. For most of the sixteenth century, the British battled the Spaniards for control of New World colonies. The seventeenth century was spent engaged in rivalries with the Dutch for control of colonies in the East Indies as well as the Caribbean, while the eighteenth and early nineteenth centuries saw the prolonged conflict between the British and the French. Mercantilists demanded the aid of their governments in determining the terms of trade. The British Parliament passed a series of restrictions (the Navigation and Trade Acts) to assure the positive balance of trade, at the expense of their mercantile rivals and the colonies themselves. By the time that Adam Smith penned the original *Wealth of Nations*, British supremacy was in sight. With the triumphant end of the last mercantile war against Napoleon on June 18, 1815, the world settled down to a long peace but a peace on British terms—*Pax Britannica.*

Mercantilist writers were primarily interested in changing policy to enhance their accumulation of treasure. Few spent any time pondering the historical origins of wealth. Early mercantilists, sometimes known as bullionists, took the position that trade was a pump for wringing gold from a domestic economy. This argument made some sense when a nation exported raw materials, based on the appropriation of solar flow and for which there were many substitutes, and imported finished goods, based on the harnessing of human energy supplemented by the power of wind and water, for which there were few. The terms of trade, or ratio of export prices to import prices, were against the raw material exporter, and they suffered from declining terms of trade. In this case the accumulation of wealth is served well by the restriction of trade.

By the end of the sixteenth century, however, England had become a manufacturing nation and

was exporting its products to Europe and to the world. Mercantile thought then turned to crafting an argument that justified the expansion of trade as the primary mechanism to augment a nation's stock of precious metals. The most widely recognized tract of high mercantilism was *England's Treasure by Forraign Trade,* written in 1630 by Thomas Mun and published, after his death, in 1664. Mun's primary purpose was to persuade legislators to abolish the ban on exporting gold. He argued that the export of gold could facilitate the accumulation of treasure if that export led to a positive balance of trade or the excess of exports over imports. To accomplish this goal, Mun and his followers advocated state policies of the regulation of trade. While the mercantilists stood for the expansion of trade, they were not advocates of free trade.

At that time, the ability to extract an energy surplus was limited by the lack of concentrated energy sources. The ability to extract solar flow and turn it into products with economic value could be enhanced only by organizational change, primarily, in the form of plantation agriculture and slave labor. Mercantile doctrine contained no insights as to how to reduce the costs of production, other than the encouragement of the carrying trade, which aided the gains of the trade itself and the accumulation of treasure. Ships were constructed from wood (biomass) and powered by the solar flow of the winds, which may or may not have blown in the desired direction at the desired speed. Yet speed and tonnage improved in the mercantile period. Mercantile doctrine was a matter of scope enlargement by means of expanded trade. As much money was to be made in transportation as was to be made in the initial appropriation of the embodied energy in crops and precious metals. But expanded and speedy transportation was limited by energy availability. Trade, in the mercantile era, was a dangerous and slow endeavor, albeit often a profitable one.

2.7.1 Mercantilist Theory

Mun distinguished between natural and artificial wealth. Natural wealth was what could be spared from domestic use and consisted primarily of agricultural products. Artificial wealth was that derived from trade and manufacturing. Mun thought that acquiring artificial wealth through trade would be more profitable than producing natural wealth domestically. By pursuing a policy of a positive balance of trade, a country without mines would be able to accumulate precious metals. In terms of distribution theory, the mercantilist writer took a very hierarchical position as to where the treasure should flow. Trade was at the top of the scale, followed by manufacturing and then by agriculture. Another mercantilist theorist, Charles D'Avenant, considered a seaman engaged in trade to be worth three farmers [5]. The royal treasury should use the gains of trade to subsidize the carrying trade, and wages should be kept low to restrict consumption, especially consumption of imported goods.

It should not be surprising that the primary advances made by the mercantilists were with regard to the theory of money. While the mercantilists believed in expanded trade, they did not advocate free trade. Rather they believed the government should enforce a strict set of codes known as the Navigation and Trade Acts. Those familiar with American history might recognize that it was the vigorous enforcement of the acts such as the tax on tea and the prohibition of white settler farming west of the Appalachian Mountains (and its large photosynthetic potential) that helped precipitate the American Revolution. The mercantilists believed that treasure would accumulate only if there were to be nonequivalent trade. To accomplish this, the mercantile power needed to run a positive balance of payments. This implied that colonies were to experience balance of payments deficits. The drain of wealth from colonies to augment the coffers of the mercantile powers was a source of social discord in countries other than the United States as well. The mercantilists, while they borrowed heavily to finance their foreign operations, wrote in an era of metallic, or commodity, money. Achieving a positive balance of trade made gold and silver flow into the royal treasury. For them an expansive monetary policy meant acquiring more treasure, not the conscious manipulations of the interest rate and size of the money supply. In fact, the mercantilists argued that the government should simply not take overt action to limit the export of gold or the size of the money supply.

Two important figures represented the transition between mercantilism and classical political economy. William Petty, an English mathematician and physician, began to explore the connection between the costs of production, economic surplus, and the value of commodities by the late 1600s. He

was one of the first to express himself mathematically in *Political Arithmetick*, published in 1690, 3 years after his death. Since prices were crucial to the mercantile endeavor, Petty sought to explain the origin of prices and values. His work was the immediate predecessor of the labor theory of value that came to characterize the approach of classical political economy. Yet Petty also stressed the importance of land, reducing all forms of economic surplus to rent. He valued land as the sum of annual rents and was among the first to link the value of land to the rate of interest. Petty also drew upon the political and economic writings of John Locke, who stressed the connection between nature and the products of human labor. Locke believed that nature furnished fundamentally worthless materials, and it took human labor to transform the products of the Earth into something useful. Locke and Petty struggled with the difference between use values, derived from products of nature, and exchange values which resulted from the application of human labor. This distinction would later be clarified in the era of classical political economy. Petty, however, thought along incipient biophysical lines when he reasoned that "Labour is the Father and active principle of Wealth, as Lands are the Mother." [6]. The French precursor to the physiocrats, Richard Cantillon, who was influenced by Petty argued along similar lines. "Land is the Source of Matter from whence all Wealth is produced. The Labour of man is the form which produces it." [7].

2.8 Classical Political Economy: The Physiocrats, Adam Smith, David Ricardo, Thomas Malthus, and John Stuart Mill

By the end of the eighteenth century, mercantilism would give way to *classical political economy*. This era began around 1759 when a French school of natural philosophers called the Physiocrats developed a theory of value that tied the origins of wealth to the photosynthetic capabilities of the land and the agricultural labor that appropriated it. Agriculture in the pre-fossil fuel era transformed solar flow into food by means of land. In 1776 Scottish moral philosopher Adam Smith published *An Inquiry into the Nature and Causes of the Wealth of Nations*, linking a preindustrial and pre-fossil fuel manufacturing process to a general theory of circulation. Smith's book led to the great debates over distribution, population, and, in time, the concept of diminishing returns of Thomas Malthus and David Ricardo and the utilitarianism of John Stuart Mill. These hundred years generated a rich and thoughtful discussion about what the proper focus and moral obligation of economics was and should be.

Classical political economists had an entirely distinct set of purposes. Both the physiocrats and the first important classical political economist, Adam Smith, desired to overturn the mercantilist doctrines of regulated trade. The Physiocrats, who gave us the term laissez-faire ("let us alone"), sought a change from small-scale peasant crop production to large-scale commercial agriculture. One can reasonably assert that Smith's 1776 *Wealth of Nations* was the greatest anti-mercantilist tract ever written. Not only did he believe that state regulation inhibited commerce but also that mercantilist doctrine retarded domestic production. Smith pursued and developed the idea that markets could lead to the expansion of well-being, guided as if by an unseen hand, rather than by the heavy and visible hand of state regulation. Half a century later, David Ricardo would refine the doctrine of mutual benefit from unregulated trade.

The classical political economists, taken as a school, desired to build an economic science and to uncover the origins of wealth. They did this largely through a substantive, and historically specific, study of economic surplus. Their method was essentially a narrative, supplemented by abstract propositions and the occasional recourse to numerical tables. All classical political economists were policy oriented. Adam Smith advocated not only the end of mercantile restrictions but increased expenditures for public education and a high-wage economy; Thomas Malthus and David Ricardo debated the perpetuation or abolition of the Corn Laws limiting the import of food from continental Europe. John Stuart Mill argued in favor of reforms to diminish the gap between those living in wealth and poverty as well as for the emancipation of women.

These political economists grounded their analyses of the origins of wealth and value in the process of *productio*n, rather than in the process of *buying and selling*, or exchange, as did the mercantilists. Moreover, all used social class as their unit of analysis. The familiar "factors of production" of land, labor, and capital had their origins in the actual, and historically specific, social structure of their days. The primary questions of interest for the classical economists were those

regarding the production, accumulation, and distribution of economic surpluses. Their theories of capital were historically specific and related to those of accumulation and value. "Capital accumulation is regarded as a necessity prior to production and production as necessity prior to the exchange of commodities" [8]. Price formation, which has come to dominate modern microeconomics, was of minor concern to them.

2.8.1 The Origins of Wealth and Value

For *classical* economists, who called themselves "political economists," wealth (a stock) and value (a flow) originated in the process of *production*, rather than that of exchange, as the mercantilists believed. Further, the idea that united the diverse classical political economists was that value could be determined objectively by adding up the costs of production. They believed that human labor, augmented by tools, land, and organization of the labor process, was the source of value.

Classical political economists were careful to make two distinctions. They separated use value from exchange value. Unlike modern neoclassical economists, a product did not command a price because consumers found it useful. A commodity commanded a price because the products of nature were transformed by means of human labor. The transition from classical to neoclassical economics represents an epistemological break as far as value theory is concerned. Alongside the distinction between public wealth and private riches, James Maitland, eighth Earl of Lauderdale, wrote in 1819 that public wealth consisted of use values—"all that man desires that is useful or delightful to him." Private riches, however, consisted of exchange values—delightful or useful things that are scarce. So, for Lauderdale a paradox emerged: the enhancement of private riches comes at the expense of public wealth, precisely by making the enjoyments offered by nature scarce so they can command a price [9, 10]. Since the days of the triumph of neoclassical economics, few economists today separate use value and value. They see wealth as merely the accumulation of exchange values, expressed in money form. But as resources become absolutely scarce in the future, a knowledge of the theories that existed, and the theoretical separations that were made, could be a vital component of an economic theory for the second half of the age of oil.

The first classical political economists, the *Physiocrats*, asserted that value originated in the land and the agricultural labor that appropriated the Earth's biomass by planting, harvesting, and transporting food. Only nature created a net product (or *produît net*). Manufacturers were considered sterile in that they only transformed the value created by the land. From their perspective, they added no net product.

In the English-speaking world, in contrast, economic theory extended the creation of value to manufacturing as well as agriculture. The generally acknowledged founder of British political economy was a Scot, Adam Smith. Smith is most often recognized for his belief that the "invisible hand" of the market would transform individual self-interest into social harmony. He began his 1776 opus, *The Wealth of Nations*, by raising the question of value. Smith diverged from both the mercantilists and the Physiocrats. He asserted that the origin of value could be found not in the bounty of nature and agricultural labor but labor in general, specifically in the productivity of labor and the number of productive laborers. Wealth was the accumulation of values generated by producing goods and services for sale on the market. He was writing in the era before fossil fuels were applied widely to manufacturing, and his theory reflected his time. Smith's observations, the most famous being that of a pin factory, led him to believe that the primary method of augmenting the wealth of a nation was to implement the division of labor, where the production process would be subdivided into separate and more productive tasks. Smith, who was a professor of moral philosophy, then had to connect the division of labor to an overall "system of perfect liberty" found in the unencumbered operation of free markets. He did so with a surprisingly simple statement: "The division of labor is limited by the extent of the market" [11]. In order to reap the benefits of the division of labor, a manufactory must have access to a sufficiently wide market to sell the products the division of labor made possible. An important constraint on that perspective, however, barely understood by Smith, was that the market itself was limited by the reliance on solar flow and animal power to transport products of the division of labor.

Smith also deals with the origins of the division of labor. Partly he attributes it to human nature. We all have an ingrained propensity to "truck, barter, and exchange," in addition to possessing a desire to increase the number of necessaries, conveniences, and amusements available to

us. Always the historian, Smith addresses the question of how much any particular commodity (known today as a good or a service) was worth in earlier times as well as in his own day. He argues that in the "rude and early stage" of society, before the development of tools and private property, the value of any commodity consisted of the amount of human labor *embodied* in production (meaning the hours of labor that had been used to make something). This was the sole determinant of value or price. Workers could generally fashion their own tools. A distinct tool manufacturing sector would have to wait for the application of more concentrated energy. "Labour was the first price, the original purchase money that was paid for everything. It was not by gold or silver, but by labour that the wealth of the world was originally purchased…If among a nation of hunters, for example, it usually costs twice as much labor to kill a beaver which it does to kill a deer, one beaver should naturally exchange for or be worth two deer." [11]. In this stage of development, the whole product of labor belonged to the producer. But in the eighteenth-century society, characterized by the division of labor, this situation would not hold. At that time "modern" society enhanced the production of each worker through various kinds of equipment, and the owners of capital stock, who provided the equipment and advanced the wages before the crops were harvested, demanded a share of the output. So, too, do the owners of land. Smith argued that the "natural price" or value can be obtained by adding up the natural prices of land, labor, and capital. Smith was not particularly clear about this and had to devote pages upon pages to determining the natural rates of wages, rents, and profits. Moreover, Smith patterned this "rude and early" society after North American Indians, of which Smith knew little to nothing about. Had he been more knowledgeable, he would have realized that the hunter and the trapper would not have made exchanges based on labor hours. They both would have taken their catches to the clan mother. She would have distributed the meat and the fur according to tribal tradition [8].

2.8.2 Smith on Money

This view of the division of labor was crucial to Smith's vision, as his views of money depended upon it. Once the division of labor was established, all people lived by exchange. Money evolved, according to Smith, because the barter system had one important drawback. Exchange could not occur if your trading partner did not desire the use value you possessed and vice versa. Over the years people chose a particular commodity to serve as a currency. Smith lists items, such as cattle, salt, cod, tobacco, and sugar, but argues people eventually chose metals because of their durability. Spartans used iron and ancient Romans copper. Modern commercial nations chose gold and silver, stamped with the image of the ruler to assure weight and quality. Smith does argue, however, that the avarice of all princes and sovereigns led them to debase the currency.

Smith's chapter on money also contains several theoretical positions. In this chapter, he argues for the separation of use value and exchange value and argues that natural price flows only from exchange value. He introduces the idea that natural price is the money expression of the costs of production of land, labor, and capital and prefaces later chapters that will explain why market prices often diverge from natural price. It is also in this chapter that Smith advances the diamond-water paradox and explains the all-important role of relative scarcity in the determination of natural price.

Smith then goes on to explain the original accumulation of stock by the virtuous behavior of those frugal individuals who save. "Capitals are increased by parsimony and diminished by prodigality or misconduct." When the frugal abstain from immediate consumption they add to their capital. They use this capital to set to work industrious persons, and as capital accumulates, the potential productivity embodied in the division of labor rises too. In the end for Smith, the source of the increase of wealth can be found primarily in the increased labor productivity of an increasing population and the virtuous behavior of frugal savers.

The next great English-speaking political economist was David Ricardo, whose 1817 *Principles of Political Economy* [13] represents the definitive statement of classical political economy. Although Ricardo had little to say about the origins of wealth, he made significant contributions to the theory of value. Ricardo was the premier advocate of a pure labor theory of value. He believed Smith to be incorrect when he separated labor *embodied*, the amount of human labor time used in production, and labor *commanded*, or what that labor is worth in terms of purchasing

alternative commodities. Ricardo reconciled the two when he declared that capital was simply "dated labor." Most capital at the time was known as circulating capital or the money advanced to purchase labor. Since capital can be reduced to labor, the value of any commodity, or good produced for sale rather than use, was determined solely by the amount of human labor embodied in production.

The problem of dealing theoretically with long-lived fixed capital is an old one, indeed. Ricardo believed that market processes would equalize profit rates. But if one commodity was produced in a more capital-intensive process, problems emerged. If the amount of total capital was the same for two producers, then an equal profit rate meant selling the goods for the same prices, as the market also equalized price. But if, for example, wages increased, it would have a much greater impact on the more labor-intensive commodity. Two goods with unequal amounts of labor would have different prices according to the labor theory of value, as the theory states that the value of a product is a function of the labor put into crafting it, not a function of the use or pleasure derived from the product. But competition in markets would yield the same price. It seemed mechanization was incompatible with the labor theory of value. Ricardo was never able to solve this problem. An unfinished manuscript was found on his desk at his death. His theory did not reflect reality—the less efficient, more costly production would simply be less profitable—as Marx discussed. Ricardo never dealt directly with energy. Nonetheless, he provided two theoretical tools that critically inform energy analysis to this day: the *best first principle* and *diminishing marginal returns*. We will deal with these principles in the next section on income distribution.

John Stuart Mill began his 1848 *Principles of Political Economy* [14] *by* asserting that production was the process of the transformation of natural resources by means of human labor. He began the project of updating and revising Ricardo's *Principles of Political Economy* by expressing an affinity to the labor theory of value. But he ran into the same problem that vexed Ricardo in a mechanized economy. Mill believed the pure labor theory of value applied only when there were equal capital/labor ratios across industries. However, Mill knew this was not accurate depiction of the English economy in the mid-nineteenth century. Instead he fell back onto Smith's adding-up theory of value. In his approach profits were the natural price of capital and a reward for the service the capitalist provided. Mill also relied on an opportunity cost approach. In a phrase taken from Nassau Senior, Mill asserted that profits were also the reward for the "abstinence" of the capitalist who sacrificed by saving and investing instead of consuming.

Mill also rejected the classical doctrine of the wages fund, whereby capitalists advanced only a fixed amount for the payment of wages. If one group organized to increase their wages, it would come at the expense of other wages. This was essentially Malthusian in origin, as the limited ability of pre-fossil energy sources to produce food and the proclivity of the poor to produce children keep wages at bare subsistence. But food production was increasing, and the social order was subject to change in the mid-1800s. Remember, Mill's *principles* were published in the same year, 1848, as the *Communist Manifesto.* Instead, Mill thought wages would be determined in a struggle between workers and capitalists [15].

While claiming some adherence to the labor theory of value, Mill was also a utilitarian. Mill's utilitarianism was rather eclectic and rather different from Bentham's. Bentham, as you may recall, thought that one could not compare the utility of one pleasure to another. Each individual was the best judge of his or her own well-being. Mill, on the other hand, separated higher from lower pleasures. Higher pleasures included those of the Victorian salon: poetry, opera, and philosophical conversation. Lower-order pleasures can be summarized in the modern saying: sex and drugs and rock 'n roll. Mill did not believe, as did Smith and other classicals, that all humans are motivated solely by self-interest. He believed that people are driven by nobler motives then competing with one another to get ahead. In modern terms, a sustainable society had to be a just society. Nonetheless utilitarianism made its way into Mills' value theory in the guise of the separation of use value and exchange value. Recall that Lauderdale had separated public wealth, in the form of use values, from exchange values that commanded a price because of scarcity. Mill concluded eventually that the basis of wealth was not only things that delighted us, or use values, but things that delighted us and were scarce. In other words, wealth could be calculated by summing

exchange values or prices. In this sense Mill was the consummate transition figure from classical political economy to neoclassical economics [10].

2.8.3 Classical Political Economy and the Distribution of Wealth and Income

The unequal distribution of wealth was the fundamental problem that had been addressed by the physiocrats. French agriculture yielded little surplus product, as production was on a small-scale subsistence basis with basic wooden (biomass) implements and little application of fertilizer. What little surplus existed was appropriated to support the lavish court in Versailles and to subsidize a set of pampered workshops dedicated to the hand production of luxuries. The Physiocratic program advocated instead the reinvestment of agricultural surpluses on the farm and the creation of large-scale commercial agriculture on the English model. The first economic model ever, the *Tableau Economique*, was designed to illustrate the problem of unequal distribution of wealth. Its modest reforms, however, ran afoul of Louis XVI and were ultimately doomed to failure. The physiocrats ultimate success was the influence they had upon later theorists such as Adam Smith and Karl Marx.

Neither the mercantilists nor Smith focused primarily on the problem of income distribution. Mercantilists, focusing on trade and exchange as the source of wealth, had little to say about the internal order of the domestic economy. This is hardly surprising as the ability to transform fundamentally the process of production by utilizing fossil energy had yet to be developed. Their main focus was the distribution of subsidies. Mercantile doctrine held that a trader was worth several artisans, and artisans are worth many husbandmen. Therefore, subsidies should flow toward those engaged in international trade. Profits were to be made and hence encouraged in the carrying trade and in the exploitation of colonial resources, not by means of reducing the cost of production at home or elsewhere.

Smith, too, wrote relatively little about income distribution, which is surprising given that he was professor of "moral philosophy" and published a lot. Smith did believe that some degree of inequality was natural and that it provided incentives for increased productivity. "Wherever there is great prosperity there is great inequality. For every rich man, there must be at least 500 poor, and the affluence of the few presupposes the indigence of the many." Yet at the same time he believed: "No society can surely be flourishing and happy of which the far greater part of its members are poor and miserable" [18]. Smith truly believed that accumulation of capital would raise living standards for all in the long term, although inequality would persist. In the final book of *The Wealth of Nations*, Smith held out that a commitment to education would also raise the status of the working poor, a position commonly held by many in society today. In his chapter on wages, Smith also wrote at length on the factors contributing to the differences in wages, including the difficulty of learning the trade, constancy of employment, the degree of responsibility, and the uncertainty of success [15]. Smith held a special distaste for the landed aristocracy who loved to reap what they had not sown. He considered rents to be primarily a monopoly extraction on the part of proprietors who did not labor productively. To this day, the term "rent seeker" is one of the most powerfully negative epithets leveled by conservative economists (usually wrongly) at those who do not obtain their incomes by labor or investment.

The next prominent English-speaking political economists writing in the period following the death of Adam Smith in 1790 were Thomas Robert Malthus and David Ricardo. Surprisingly, neither was particularly interested in the origin of wealth. In his 1798 *First Essay on the Principle of Population* [16], Malthus provided a narrative history of the transition from "savagery" (known today as hunting and gathering) to modern societies. Like Smith he favored the (supposedly) virtuous behavior of the parsimonious wealthy classes over that of the prodigal poor. Unlike Smith, he seldom addressed the issues of capital accumulation in his *Essays on Population*. Malthus directed his analysis as to why populations remained stable in early societies and not to why capital accumulated.

David Ricardo subordinated the question of wealth creation to secondary status. For him the real question was one of distribution, and distribution changed according to the specific historical period. Like Malthus he accepted the division of society into classes of landlords, capitalists, and

laborers as natural and inevitable. Ricardo believed that the proportions of the whole produce of the Earth which will be allotted to each of these classes, under the names of rent, profit and wages, will be essentially different in different stages of society, depending mainly on the actual fertility of the soil, on the accumulation of capital and population, and on the skill, ingenuity and instruments employed in agriculture. He said, "To determine the laws which regulate this distribution, is the principle problem in Political Economy." [13].

2.8.4 The Origin of the Concepts of Diminishing Marginal Return and Comparative Advantage

Ricardo and Malthus were writing during the late eighteenth and early nineteenth centuries when there was a great rivalry between landowners and emerging capitalists for control of the British economy and society. English Corn Laws, passed in the early 1800s, limited the import of cheaper grains (corn) from continental Europe. This benefited the landed classes by extending the margin of cultivation to poorer quality lands, most of which they owned. Simultaneously the law increased rents and raised wages, since wages were determined by subsistence and ultimately the costs of extracting an energy surplus from poor land. This limited the power and income of the rival capitalists as most of the wealth of society had to go for the necessary food and hence to landowners. David Ricardo and Thomas Malthus undertook great debates concerning the efficacy of the Corn Laws and their effect upon the economy and society. This debate was the genesis of two of the most sacred principles of modern economics—*diminishing marginal returns* and *mutual gains from trade*, technically known as *comparative advantage*. David Ricardo devoted his life to the pursuit of political economy and the repeal of the Corn Laws by crafting myriad arguments in support of the interests of the emerging class of capitalists. His primary aim was to change the distribution of income and wealth from the less productive landed classes to the more productive capitalists, although he himself was a landowner. Malthus argued for just the opposite, the redistribution of income and wealth toward the landowners.

Ricardo enunciated a theory of rent based on the principle of diminishing marginal returns since the price of food (or "provisions") depended upon the costs of production (primarily labor costs) at the no-rent margin (or the land of lowest fertility). The owners of more fertile lands received a rent, so that food grown on more fertile, and less costly, land would sell at the same price as food that was costlier to produce. Ricardo's theory also depended upon the *best first principle*. Farmers, being no fools, would tend to utilize the most fertile and most accessible land first, and poorer lands second. In other words, returns diminished at the margin of cultivation, i.e., the poorest land that was still put into production to meet total food needs. As we shall see in later chapters, this principle is also useful for explaining peak oil and the falling energy return on investment over time. But in the pre-fossil fuel age, the only thing that stood in the way of the redistribution of incomes toward productive commercial farmers and manufacturers was the cumbersome Corn Laws limiting the import of cheap grains. If these laws were repealed, the cultivation of poorer quality lands could be postponed or eliminated.

Ricardo crafted his arguments in the context of benefits to the nation rather than in terms of benefits to a specific class. He reasoned that free trade among nations in finished commodities would result in more goods for a cheaper price than if each nation produced all that they needed on a self-sufficient basis. He also reasoned that capital and labor would be immobile internationally, a proposition subsequently repudiated by advocates of globalization. (We will return to the details of this argument in ▶ Chap. 8). Moreover, Ricardo believed that such a redistribution of income would enhance the growth of the domestic economy as vibrant profit-seeking commercial farmers would reinvest their returns in improved techniques (what we would call today technology) that would reduce the overall cost of provisions and thereby improve society in general.

Thomas Malthus held the opposite position. He believed that frugal capitalists would over-save and that savings would not automatically find their way into investment. As a result, the economy would lack the demand needed to realize profits, and the economy would fall into a depression. Malthus' solution was the redistribution of wealth to the landed classes who would use it to build monuments and surround themselves with unproductive retainers, ensuring

adequate overall demand. We will save the details of the argument for the next section on the balancing of supply and demand, but it is important for the reader to see that many of today's most important economic arguments were developed by Malthus and especially Ricardo as they contemplated the effects of what we would call today free trade.

John Stuart Mill's 1848 book, *Principles of Political Economy*, dominated the discipline until the 1870s but offered little new in terms of value theory. Indeed, he envisioned his own task as little more than updating Ricardo. Mill did offer a unique perspective, however, on income distribution. Production, according to Mill, was subject to natural law (i.e., the limitations of what we would call today resources), as envisioned by Smith, Ricardo, and the other classical economists. But distribution was entirely a matter of the free will of human beings, and humans could change social institutions to accommodate a more equal distribution. Mill therefore showed concern about Irish peasants, industrial workers, and the position of women and supported a series of reforms to increase their share of social wealth and elevate their status. Influenced by his wife, Harriet Taylor, Mill became a tireless advocate of the emancipation of women at work and in the home. Mill wrote that the time of Adam Smith—where the pursuit of self-interest would lead to social harmony—had come to an end as evidenced by the destitution of the working classes and significant social strife. Like Marx, Mill considered the qualitative aspects of social inequality and the future of society. The good life, for Mill, entailed a simpler and more equal society. "I confess that I am not charmed with the ideal of life held out by those who think that the normal state of human beings is struggling to get on; that the trampling, crushing, elbowing, and stepping on each other's heels, which form the existing type of social life are the most desirable lot of human kind, or any but the disagreeable symptoms of one of the phases of industrial progress" [14]. For Mill industrialization brought greater material prosperity, but it also brought many undesirable and unpleasant aspects to the working class that he was interested in overcoming.

2.8.5 Balancing Supply and Demand

Adam Smith's genius lay in his ability to connect productivity increases made possible by the division of labor to events in the broader market. He believed that the natural price of any commodity could be found by the summation of wages, rents, and profits. Smith, however, also contended that commodities do not always sell at their natural prices. Rather, the short-term forces of supply and demand could result in a price that exceeded, or fell below, the natural price. The market price of any commodity was regulated by the quantity that was brought to the market and the willingness and ability of potential buyers to purchase the products. Smith termed this desire, backed by money, "*effectual demand*." If the quantity brought to market falls short of effectual demand, those individuals seeking to acquire the goods will be willing to offer more money for them. Competition among these individuals will result in an increase in market price above the natural price. If effectual demand is less than the quantity brought forth, then market price may fall below natural price. When the quantity brought to the market just equals the effectual demand, market price will equal natural price.

The Physiocrats had not worked out any theory of supply and demand, although the *Tableau Economique* can be thought of as an early circular flow model. What Smith took away from the physiocrats was a confirmation in his belief in liberty. The market provided a mechanism by which the haggling of daily commerce would result in a tendency toward the balance found in natural law. This is most often known as the "invisible hand," and it is greatly admired by many economists today who resent government (or anyone) telling individuals what they should or should not purchase, for example, in response to concerns about climate change [11]. The other side of the coin is that in the absence of government regulation large, powerful corporations have increasing power to regulate markets and impact individual freedoms.

Jean Baptiste Say argued in his *Treatise on Political Economy* that a market characterized by liberty would adjust automatically to produce an equilibrium in which all resources would be fully employed. Say held that every purchase was simultaneously a sale. No one would sell a commodity without the intent to buy another. Money would not be hoarded because it was simply a means of exchange and had no value unto itself. Because of this, supply creates a demand of equal magnitude. Furthermore, the means of purchase

are created, in the form of factor payments (wages, rent, and profit) such that there is no shortage of effectual demand. Therefore, according to the principles of Say's law, a general glut of unsold commodities, and a resulting depression due to lack of demand, is theoretically impossible. Say argued that an acute glut is certainly possible, but a glut in one sector would be matched by excess demand in another. Moreover, price fluctuations as described by Smith would assure that price changes born of competition would assure that market price would equalize with natural price. One could say that Say generated an idealized theoretical situation in which the free market would generate the best of all material worlds; many since have believed that to be true.

Malthus rejected Say's law, arguing that a general glut was a defining characteristic of a commercial economy. The years before the publication of his *Principles of Political Economy* were marked by severe depression. The subsequent riots alerted Malthus to the dangerous destabilizing effects of actually existing general gluts. For Say's system to work, every class must spend its entire income. While this was true of the working classes, Malthus realized that the components of price—wages, rent, and profit—were also the incomes of the wealthier classes in England. He argued that capitalists limited their consumption in order to save. This meant that savings must equal investment. But he found that as capitalism progressed, businesses could not find sufficient outlets in which they could receive profitable returns. As investment declined and savings were maintained, a shortage of effectual demand would appear, heralding the onset of a depression due to lack of demand. The Malthusian solution was, as we have already seen, a redistribution of wealth and income to the landed classes. As gentlemen of leisure, they would spend this income on unproductive personal retainers and monuments to themselves which would, according to Malthus, help maintain full demand. They would also patronize the arts, leading to an improvement in the character of society. Servants and artists would consume the material wealth produced by industry but would not produce it. This would negate the cause of an overall lack of demand. Also, as we mentioned previously, the primary mechanism of income redistribution toward the aristocracy and gentry was the continuation of the Corn Laws.

Ricardo defended Say's law and rejected the Malthusian solution of an expansion of unproductive laborers such as servants and retainers. He said that the support of unproductive personal servants would be as beneficial to future production as fires in the warehouses of the business classes. Ricardo believed that market forces would result in the balancing of savings and investment because of the behavior of investors. "No man produces but with a view to consume or sell, and he never sells but with an intention to purchase some other commodity, which may be immediately useful to him, or which may contribute to further production. By producing, then, he necessarily becomes either the consumer of his own goods, or the purchaser and consumer of the goods of some other person" [26]. Ricardo also criticized Malthus for focusing solely on consumption and failing to consider adequately investment itself as a component of effective demand. Ricardo's argument carried the day. His goal of enhancing accumulation by means of redistribution of income and wealth toward capitalists was finally realized in 1846, 23 years after his death, when Parliament repealed the Corn Laws.

2.8.6 Growth, Accumulation, and the Steady State

For Adam Smith, the process of economic growth began with the frugal saving capitalist and the workings of the "invisible hand." The desire to accumulate, which for Smith is innate in the human spirit, manifests itself as saving and investment. Frugal individuals save, invest the capital in expanding the division of labor and employment, and purchase improved equipment. The expansion of employment leads to rising incomes among all sectors of the population providing the means for the extension of the market. Since Smith wrote in preindustrial days, he did not believe that augmented machinery would replace labor. Rather it would expand its employment. But here lies the beginning of the stationary state. As employment and production expanded, so too would the demand for labor. This would serve to raise wages and diminish profits which would hinder further accumulation in the short term. The solution to rising wages and falling profits could be resolved only by the rather cruel

operation of nature. Increased wages would lead to a greater number of surviving children. This would increase the supply of labor and result in the subsequent reduction of wages. But the reduction of wages would eventually decrease the labor supply as infant mortality would increase with less money to purchase food. But while nature would operate to regulate the labor market, the long-term tendency was toward decline. When a nation was fully complemented with people with respect to biophysical capacity to support them, wages would fall to the bare subsistence level. As long as food production depended upon limited natural fertilizers and animate power, agricultural productivity would remain low and wages would tend toward subsistence. When the nation was fully stocked with all that the low level of wages could support, profits would fall as new investment opportunities vanished. Thus, the fate of a vibrant system of perfect liberty was the stationary state. Smith saw this as unfortunate, as the quality of life in the progressive state was vibrant but life in the stationary state was melancholy. Life in the declining state was tragic. But for Smith, no nation was close to achieving its full complement of labor and capital, so the stationary state was a prospect for the distant future [28]. Smith's analysis of accumulation gave economists two methodological lessons that are strong still today. The lack of economic growth was stagnation which was to be avoided at all costs. Moreover, the tragedy of the end of accumulation was found in the distant future. Today economists, politicians, and citizens alike tend to follow Smith's logic. Growth is the primary goal of most economic policy now, and many believe that the environmental consequences of growth will not occur for at least a hundred years.

Less than a decade after Smith's death his optimism, or that of his followers, was dashed. The arrival of the steady state seemed imminent instead of not distant. British philosopher Thomas Carlyle surveyed the debate over the end of accumulation between Thomas Malthus and David Ricardo and dubbed political economy "the dismal science." The primary limit to accumulation for Ricardo was the existence of diminishing marginal returns. Given the existence of the Corn Laws, the extension of cultivation onto poorer lands resulted in reduced harvests and increasing rents accruing to the landowners. The increases in rents and wages would diminish profits, resulting in the cessation of productivity increasing investments as soon as potential profits fell to the prevailing rate of interest. Only a suspension of the Corn Laws could remove the limit to growth.

Malthus saw the primary impediment to long-term accumulation in the increase in human population at a rate that would soon overwhelm the ability to provide sufficient food, resulting in mass starvation. Malthus advocated not only measures to limit population by "courting the return of the plague" but a transfer of wealth to the morally restrained landed classes. But Malthus too saw internal limits to accumulation. Capitalists tended to over-save, thereby limiting effectual demand needed to extend the market and justify the increased level of production. He advocated the redistribution of wealth to the aristocracy who would spend the income on retainers and monuments to themselves, eliminating the shortage of effective demand and perpetuating all that is good in modern society. For both Malthus and Ricardo questions of accumulation ultimately resolved the questions of distribution of wealth.

2.9 Proper Role of the Government

The theory of classical political economy follows directly from the political theory of Enlightenment philosopher John Locke. Locke's basic idea was that the reason for government was the protection of private property and that government works best when it limits itself to this function. The familiar dictum of Thomas Paine, that "the government that governs best governs least," is consistent with this Enlightenment view. It should surprise no one that the two most important Enlightenment documents in the English-speaking world, the American *Declaration of Independence* and Adam Smith's *Wealth of Nations,* spoke directly to the proper role of limited government.

Smith argued that mercantile restrictions, especially the granting of royal charters and high rates of tariffs, favored the large trading corporations, limited competition, and reduced the benefits for the public. Smith clearly spoke of the mercantile monopolists and their government benefactors when he said: "People of the same trade seldom meet together even for merriment

and diversion, but the conversation ends in a conspiracy against the public, or in some contrivance to raise prices." [16] Smith was optimistic that with a government that supported mercantile monopolies out of the way the "system of perfect liberty" could flower and the pursuit of self-interest could be channeled into social harmony by means of price competition, "as if by an invisible hand."

Contrary to the common wisdom, Smith did not oppose government in all its forms. He simply did not believe that a government representing mercantile monopolists should meddle in the market process and distort the workings of the system. Since the system of natural liberty depended upon the increase in productivity that resulted from the division of labor, Smith was aware of, and sensitive to, the plight of detail worker in the manufactories based upon the division of labor. He thought that repeating the same unvarying tasks would render a worker as "rude and ignorant as it is possible for a human creature to become." He therefore recommended strongly public expenditure on education. In Book V of the *Wealth of Nations,* Smith declared that a sovereign had three fundamental obligations: to provide for the common defense, to maintain an independent system of courts to adjudicate property rights, and to construct public works necessary for the smooth functioning of commerce. Smith also believed that poverty relief was another proper role for the government. According to Robert Heilbroner [17] there were a million and a half paupers out of 12 million people in Smith's Britain. Other than paltry poor relief, a welfare system simply did not exist. Smith believed the expansion of markets could relieve poverty. He called for the repeal of the Poor Laws that tied the poor to their local parishes as a condition of receiving their meager subsistence. Sometimes, he thought, the best thing the government could do was to stay out of the way.

This idea of laissez-faire, "leave us alone," did not originate with Smith. Rather it was the brainchild of the aforementioned Physiocrats. Their program consisted of the removal of onerous taxes like the quitrent (having to pay rent on a property you own), sharecropping, and forced labor. By such means the process of the economic surplus flowing away from the productive classes on the farm and into the lavish court and the luxury workshops could be stopped. To expand French agriculture from small-scale subsistence to large-scale commercial necessitated investment on the farm. Only if the taxes were repealed could these investment funds be generated.

Classical political economists shared some fundamental ideas, despite their differences. All believed that nature, in the form of land, played a role in the creation of value, along with the role played by human labor in transforming the products of nature into sellable commodities. As long as land was a fixed factor of production with a highly concentrated ownership, expanding food production would be difficult. From this observation came the principle of diminishing marginal returns. In addition, the classicals shared the perspective that a fixed quantity of lands, in conjunction with high fertility rates, would reduce wages to a paltry subsistence level. All classical political economists grounded the analysis in terms of social class, and all were focused upon economic policy. The coming of the fossil fuel era would bifurcate economic theory into two distinct approaches by the 1870s, one based upon economic surplus and the other based on relative scarcity. The first political economist to understand the power of fossil hydrocarbons in transforming the productivity of human labor was Karl Marx. Within 3 years of the publication of the first volume of *Capital* [18], the first theories of neoclassical economics would appear.

2.10 Karl Marx

The German philosopher turned political economist Karl Marx was probably the first political economist using the labor theory of value to comprehend fully the industrial revolution and the role that mechanization and fossil energy played in its development. Marx is seen by many in the environmental community as an economic determinist. This comes largely from his treatment of the biophysical world as "a free gift of nature." As we have already seen, this was a customary practice among the most prominent political economists, especially David Ricardo, whose works Marx admired. Another oft-quoted passage comes from an early work *The Poverty of Philosophy*, Marx's critique of utopian socialist Pierre Joseph Proudhon's *The Philosophy of Poverty.* In this book, he said: "the hand-mill gives

you society with the feudal lord; the steam-mill society with the industrial capitalist." For Marx, this was no simple mechanical relation but a set of complex dynamics between humans, energy, and machinery. Marx was both fascinated and admiring of the increased output made possible by the application of fossil fuels to production. "The bourgeoise, during its rule of scarce 100 years, has created more massive and more colossal productive forces than have all preceding generations together" [19]. According to Adam Smith, 10 men in his time, using the system of the division of labor, made 48,000 sewing needles every day. A single needle-making machine, however, makes 145,000 needles every hour. One woman or one girl superintends four such machines and so produces nearly 600,000 needles in a day or over 3,000,000 in a week [20]! Marx thought that this was a marvelous means of making labor more productive, and he clearly understood, but did not dwell upon, the role of energy in this process. According to contemporary political economist Andreas Malm steam power engenders and extends the role of the division of labor, transcends strength, skill, and endurance, and allows for substantial increases in labor productivity. In his more mature work, *Capital,* Marx realized that changing machinery and energy led to a different mode of production, which led to changing social relations. Improvements in energy and machinery change the economy by working through the agency of human labor [21].

2.10.1 The Origins of Value and Wealth

Marx began the first volume of *Capital* with a chapter entitled "The Commodity." The basic reality of capitalist society, the commodity, possessed a "two-fold nature." It possessed both use value and value. Commodities were produced for sale, rather than for personal use but could not be sold if they had no use value. This distinction between use value and value was crucially important for Marx, as it was for earlier political economists. While use value was the origin of wealth, exchange value was the sole basis for price or, simply, value. In his later political commentary, *A Critique of the Gotha Programme*, Marx chided other socialists for claiming that labor was the source of all wealth and therefore labor deserves the entire product. Marx's position that wealth, as a use value, also has its origin in nature and that capital also plays a part in its creation [22]. Exchange value or, simply, value depended upon the average amount of socially necessary labor that was embodied in its production, a similar, if more refined, version of the labor theory of value of Ricardo.

This distinction manifests itself as an analysis of circuits. The first Marx called "simple commodity circulation." An independent artisan entered the market possessing title to a commodity. He or she would sell that commodity for money and use the proceeds to purchase another commodity. The goal here was to obtain a different use value of the same value (say 10 hour of labor). Like previous adherents to the labor theory of value, Marx began *Capital* by assuming all commodities exchanged at their value. With the goal met, the circuit self-extinguished, although the owner of another commodity may make another exchange. Money, for Marx, was a medium of exchange. In simple commodity circulation, if C represents a commodity, and M represents money, the circuit can be depicted as C-M-C. The value at the end equals the value at the beginning.

Marx contrasts this with the circuit of capital. Money, in this case, was the object of desire, not just a medium of exchange, or as he called it, "the universal equivalent of commodity values." The capitalist begins with money, buys commodities, and sells them for more money. The additional money is then reinvested and the system becomes self-perpetuating. Unlike most economists, who viewed capital as a thing, Marx saw capital as *a process of self-expanding value!* Schematically this is represented as M-C-M', with M' > M. But how is this possible if all commodities exchange at their value? The answer is found in the types of commodities capitalists buy as capitalists. As wealthy individuals capitalists may purchase expensive transportation, elegant housing, and fancy clothes. But as capitalists they purchase means of production (machines and energy) and labor power. Marx made special efforts to distinguish labor from labor power. Labor power, or work per unit of time, was a commodity with an exchange value. The value of labor power was the cost of reproducing the worker or the subsistence wage, with subsistence defined culturally and historically as the average bundle of wage goods consumed by the working class, not a

minimum biological subsistence in terms of calories. Labor power was also the potential to work. Labor was a use value and part of the human essence, as expressed by Marx's collaborator and benefactor Frederick Engels in his essay, "The Part Played by Labour in the Transition from Ape to Man" [23]. Since labor is the essence of humanity, a capitalist does not purchase either labor or the human being. Rather he purchases a worker's ability to work for a specific amount of time. If a capitalist can get a worker to produce more in a day's work than the cost of subsistence, then the extra value produced, or surplus value, accrues to the capitalist. This surplus value is the basis of profit.

In the era before the widespread use of fossil fuels, the only means of increasing surplus value was to either lengthen the working day or increase the intensity of the labor process. Both measures had physical and social limits. Both increasing the time workers remained on the job without increasing wages and implementing harsh supervision provoked absenteeism, high quit rates, political Factory Acts to limit the work day, and many, many strikes. Marx called this method *absolute surplus value.* Although working hours have fallen from the daily average of 12–14 hours in Victorian England, profits have not disappeared. This means another method must have been successful. Marx called this *relative surplus value.* The basic premise of classical political economy was that workers were paid at their value. Reducing wages below the costs of subsistence was not a long-term option for capitalists. However, if capitalists could reduce the costs of wage goods, they could reduce the money wages of workers but maintain their real wage, which was the value of labor power. Mass production, powered by fossil fuels, accomplished this goal. Moreover, mechanization augmented the possibilities of intensifying the labor process. Coal-driven steam engines could provide continuous power, and they and steam-powered machines could be run faster than machines driven by other sources.

Marx's analysis was qualitative as well as quantitative and focused upon the quality of work life as well as wages. Economists who focused only on the quantitative aspects of lower prices and higher productivity overlooked the changes in the process of labor. Marx's critique of the existing political economy was grounded in terms of both qualitative and quantitative approaches to value. He believed that qualitative relations among people undergird the quantitative relations between people and things. The accumulation of capital depended upon the extraction of surplus value from immediate producers (i.e., workers), and the profit rate depended upon increasing the rate of surplus value or labor productivity. To accomplish this, the character of work became stripped of its meaning. The mental work was separated from the manual work, first by organizational means such as the division of labor and later by the application of fossil fuels to machinery. These changes had many social impacts. The worker became an appendage to the machine, no longer directing its application for the improved quality of the product, but rather the worker had to follow the dictates and pacing of the machine. The intellectual unity of head and hand was severed for all but a very few workers whose skills were sufficiently unique such that they could not easily be replaced by machines. The resulting alienation that the worker felt from the products and processes of production would drive social change. Marx believed it was likely that wages could rise with economic growth but that the changes in production and the degradation of the labor process could not be overcome with more money. This qualitative aspect formed a crucial part of Marx's theory of income distribution and inequality and the inevitability of social revolution.

2.10.2 Supply and Demand

Marx chided Ricardo for defending the automatic balance between supply and demand ("the childish babble of a Say, but hardly worthy of the Great Ricardo"). Marx argued that Say's law was applicable only to the stage of simple commodity circulation where an independent artisan enters the market with a commodity and sells it for money to purchase a different commodity. It was not applicable to an industrial capitalist society. The possibility of such an equilibrium occurring in a simple economy did not imply its inevitability in a modern one. Marx's writings on the balance of aggregate supply and demand in a modern economy can be found in the little-read Volume II of *Capital*, where Marx discussed the process of exchange. Here Marx begins with the abstract and highly unlikely possibility of a nongrowing capitalist economy, where the entire surplus value is

consumed and the economy goes on year after year at the same level and composition of output. He calls this "simple reproduction," as opposed to a growing economy that he terms "extended reproduction." To begin the analysis, Marx divides the economy into two sectors or "departments." Department I produces means of production, known today as the capital goods industry. Department II produces means of consumption. In both sectors, the total value (V) is composed of the sum of constant capital, variable capital, and surplus value. Equilibrium necessitates that the output of these two sectors is balanced [24].

In plain English, Marx believed that the combined demand of workers and capitalists in the department producing capital goods had to balance the demand for capital goods in the consumption goods sector. The formula for this is $c_2 = v_1 + s_1$, where c stands for constant capital or means of production, v stands for variable capital or the money advanced for wages, and s equals surplus value. This is highly unlikely and highly abstract. It is a mathematical equilibrium condition. The reason for the low likelihood is that capitalism is a dynamic system of self-expanding value. The driving force of capitalist competition is technological change to increase labor productivity. Capitalists simultaneously restrict their own consumption while paying workers no more than the value of the subsistence wage to accumulate capital. Therefore, there is no reason to believe that this abstract equilibrium condition will occur in an actual economy. If the conditions of simple reproduction are not met in an actual economy, crises can occur for a variety of reasons. The pace of technological change may result in a capital-labor ratio that increases faster than does labor productivity, precipitating a tendency for the rate of profit to fall. Slowly growing wages and technological unemployment may lead to insufficient effectual demand, and disproportionalities may develop as the capital goods and consumption goods sectors grow at different rates. For Marx, sectoral imbalances are the norm, while the possibility of a balance in aggregate supply and demand is but a highly unlikely theoretical possibility that contradicts the very essence of capitalism [28].

In the first volume of his 1867 opus, *Capital*, Marx turned to the accumulation that occurred prior to the emergence of industrial capitalism [13]. His chapters on "the so-called primitive accumulation" chronicle the process by which former artisan producers and independent farmers—even before the evolution of industrial capitalism—were forcibly "stripped of the means of production" by those with more financial or political power and left with only their labor power to sell. Furthermore, Marx analyzes the effects of mercantile strategies where fortunes were built on colonization, slave labor, and war. Unlike Smith, who attributes the origins of wealth and capital to the virtuous behavior of the frugal saver, Marx declares "If money…comes into the world with a blood-stain on its cheek, capital comes dripping from head to toe, from every pore, with blood and dirt" [25]. Thus, Marx added, or continued to add, a moral dimension to how economies worked under different systems.

Accumulation

Marx did not have a theory of the stationary state. Unlike his classical predecessors, Marx wrote in an era of fossil fuels where a fixed supply of land was no longer the limiting factor. Rather, he believed the internal contradictions of the capitalist system could result in its passage into socialism before the physical basis of the end of accumulation arrived. For Marx only human labor created new value, although it was augmented to an unprecedented extent by the application of coal to large scale mechanization. Such mechanization reduced the per unit labor content of commodities resulting in the reduction of their prices. Capitalists competed by means of mechanizing to reduce the price of their individual commodities below the social average. But as the expansion of constant capital increased faster than the increase in productivity, profits would fall. This touched off an economic crisis, which could not, in the long run, be overcome by the mere addition of more fossil fuel-driven equipment. Marx termed the tendency for the rate of profit to fall a "law of motion of the capitalist system." A second law of motion was the tendency toward monopolization, as during the crisis better capitalized and better managed companies would acquire their less fortunate rivals, creating bigger operations that were owned by fewer capitalists. The resulting depression "solved" the tendency for the rate of profit to fall by decreasing the level of capital to labor, as bad debts were written off and factories shuttered, as well as by increasing the productivity of labor when

desperate workers would work harder for less. Before the stationary state set in the increasing severity of periodic crises and a socialist political party would transform society by instituting rational planning into the investment process resulting in an end to economic crises and the true beginning of human history.

2.10.3 Marx and the State

Human history has not actually worked out as Marx envisioned. His vision of socialism was one where workers would use the state to humanize the labor process and to distribute incomes more evenly. It was a system, unlike capitalism, that was not crisis prone and crisis dependent. Growth and accumulation would serve the needs of the populace, rather than being the *sine qua non* of the system. Communism would arrive when the state was no longer needed and workers could manage the economy by themselves. Socialism and communism in the real world tended to be characterized by strong rather than by withering states, and worker alienation remained high. After the fall of the Soviet Union in the late 1980s and the transformation of the People's Republic of China into highly centralized state capitalism, few examples of socialism in the real world still exist. The prospects for the future, whether some form of democratic socialism could still emerge, remain unknown at this point. But the future of capitalism is also unknown. In ▶ Chap. 23 we will discuss a series of planetary boundaries and biophysical limits, some of which we have already exceeded. We do not know how a system in overshoot can grow its way into sustainability. Neither do we know how a nongrowing capitalism can exist in the absence of stagnation and high unemployment.

Marx on Money

As mentioned previously in the analysis of circuits, money took different forms for Marx. It could be a simple means of exchange or it could be money capital. This money capital could be used to purchase means of production (constant capital) or labor power (variable capital). Surplus value was the basis of profit and accounted for in monetary units. Like his classical predecessors, Marx wrote in an era of commodity money or money that was backed up by a precious metal. This meant the amount of money could not be expanded at will, as is the case today. However, Marx was also aware of the extension of credit and that in a time of economic crisis, financial factors themselves could exacerbate the crises caused by a tendency for the rate of profit to fall.

The Metabolic Rift

By the third volume of *Capital*, Marx was deeply concerned about the fate of the Earth, arguing that capitalism systematically undermines the material conditions of its very existence: human labor and the soil. He was profoundly influenced by Justus von Liebig, telling Engels that the work of the agricultural chemists was more valuable than that of the political economists. In his chapters on ground rent, Marx tried to incorporate new understandings of energy and entropy. Ricardo based his principle of diminishing marginal return on the "original and indestructible powers of the soil." Through his careful study of Liebig, Marx realized that the powers of the soil are not indestructible. Rather, large-scale commercial farming (British high agriculture) according to Liebig was a "generalized system of robbery." Nutrients would be shipped from the rural agricultural districts in the form of food and not returned to the soil. Unfortunately, because matter and energy are not destroyed, these missing nutrients, which we now know to be nitrogen and phosphorous, emerged as pollution in large cities such as London. We will see in ▶ Chap. 23 on planetary boundaries that the disruption of such biogeochemical cycles remains a problem in the modern day. The appropriation of the land by large-scale agricultural monopolies created a metabolic rift between humans and nature, and the abolition of these monopolies would be essential to create the kind of society we now call sustainable [10].

2.11 The Origin of Neoclassical Economics

This period of classical economics lasted through the early 1870s. Then the discipline underwent a profound transformation in questions of value, production, and distribution. This shift in emphasis and analysis led soon to the emergence of *neoclassical* economics, based on the concept, or perhaps faith, that mechanical

details of the market economies are based on the "invisible hand" of Adam Smith. Furthermore, that markets are self-regulating by means of competition and flexible prices and that these could be well represented by analytical models borrowed from physics. The originators of this idea came from the French-Swiss Léon Walras, Englishman Stanley Jevons, and Austrian Carl Menger and focused much less on production and much more on "marginal value," that is that the value of something became less the more of it you had. Neoclassical thought derived from this "marginal revolution" was fully synthesized by the early years of the twentieth century and remained the primary mode of thought until the Great Depression of the 1930s. Then system-wide economic collapse rendered the prevailing orthodoxy incapable of understanding the depth of economic decline or formulating policies to improve it. In this climate of dislocation, the theory advanced by the British economist John Maynard Keynes provided an alternative that soon dominated the profession.

Keynes visions and methods are in sharp contrast with neoclassical economics, which was enunciated in the 1870s and continually refined until the present day. The neoclassicals were interested in the development of universally applicable theory, modeled after physics and independent of historical context. Nobel Prize winning economist Robert Solow stated this clearly if somewhat tongue in cheek:

> My impression is that the best and brightest in the profession proceed as if economics is the physics of society. There is a single universal model of the world. It needs only to be applied. You could drop a modern economist from a time machine—a helicopter maybe, like the one that drops money—at any time in any place, along with his or her personal computer; he or she could set up business without even bothering to ask what time and what place [26].

British economist G.L.S. Shackle stated that the principle around which neoclassical economics was organized, the principle that served as the equivalent of gravity in celestial mechanics, was self-interest [7]. But neoclassical economists focused not on the pursuit of self-interest, as did Smith and the classical school, but upon the *maximization* of personal self-interest through the mechanism of people buying what they want in markets. Their approach was mathematical and abstract and based upon relative scarcity as a universal principle. In short, neoclassical economics was the marriage of differential calculus with utilitarian philosophy. The classical focus on social class as the unit of analysis was replaced with that of the individual, and the role played by accumulation gave way to a stress upon static equilibrium and allocative efficiency. A neoclassical analysis of growth was not to appear until the 1950s when it was enunciated by Robert Solow.

2.11.1 Value and Wealth

Perhaps the greatest break with classical political economy came in the area of *value theory*. Classical political economists all commenced their analyses from the viewpoint that value and wealth were created in the process of production and that value could be calculated *objectively* from the costs of production. Neoclassical economics was, and continues to be, grounded in the proposition that value, like beauty, is in the eye of its beholder—that is a matter of *subjective* well-being or utility. Their overall objective was not to pursue the origins of wealth as much as to show, under ideal theoretical conditions, that market economies are self-regulating by means of small, or marginal, fluctuations in prices driven by competition on the individual level. The result of voluntary trades, based solely on the maximization of self-interest, leads us to a situation of Pareto efficiency (named after its originator, Vilfredo Pareto) where no one individual can be made better off without making another worse off. this state is called *Pareto Efficiency*. According to neoclassical doctrine, government intervention could do no good, and much harm, as it would distort the signals of the market, which is seen as a perfect carrier of information [27].

An important problem facing economists in 1870 was what is often called the "diamonds vs. water" paradox. Water was, and remains, essential for human life. But since it was abundant and often available for the taking in rural areas, it did not command a high price. In the parlance of classical political economy, water had great use value but little exchange value. Diamonds, on the other hand, had little use value, except as ornaments, but a very high exchange value. Classical political economists would attribute this to the great

amount of human labor that had to be expended in mining the stones, cutting them, and polishing them for the market. Water, on the other hand, took little labor to harvest from the ground.

The newly evolving neoclassical economists saw this as a "paradox." But from our perspective, the reason was not some fundamental problem with the classical view but was because the neoclassicists did not separate use value from exchange value. Unlike classical economists, who saw exchange value as independent from use value, the early neoclassical economists viewed use value, now called *utility*, as the source of exchange value. Thus, the relative prices of water and diamonds now became a paradox to them because how could something so useful be so cheap, while something of little use, like diamonds, command such a high price? Their resolution was to make exchange value *subjective*. Diamonds were costly because people liked them, they were not especially abundant, and people were willing to pay a lot of money for them. Water was mundane but abundant. Scarce commodities carried a higher price.

The change that neoclassical economics brought to this problem was a change in the conception of value. Classical economics believed that humans generated value objectively by transforming the products of nature into things humans wanted through the actions of labor. Neoclassical economists, on the other hand, thought that the origin of value was subjective. Value was determined by human preferences, and these preferences were revealed by what humans chose to purchase in the marketplace. This was, at least in theory, a very democratic process in that any consumer is as important as any other in that his or her purchases will "send a market signal" to the whole economy about what that economy should be producing.

This subjective approach became the jumping-off point for neoclassical economics, whose practitioners began a "new" approach to economics in the early 1870s—and still dominate the profession today. They differed from the classical economists in not being particularly interested in the origin of wealth, other than to agree with Smith that the origins of wealth could be traced to the virtuous behavior of individuals. By and large they accepted the idea that wealth was a stock. From the beginning Swiss economist Léon Walras, one of the originators of neoclassical economics, saw the study of economics as the transformation of stocks of natural resources into human-satisfying utilities, with production relegated to a rather irrelevant intermediate position [28]. Thus, neoclassical economists changed the focus of the discussion from an *objective* theory grounded in economic surplus and the (labor) costs of production to a *subjective* utility grounded in psychological scarcity which ultimately was translated into willingness to pay. To create the core of neoclassical economics, this idea was married to utilitarian philosophy, based on the propositions that individuals rationally endeavor to increase their happiness, also married to differential calculus as well. If a commodity provided utility (greater happiness), more of that commodity would provide more total utility.

The focus of early neoclassical thought was also upon *marginal utility* or the extra utility received from consuming one more unit of the good. Neoclassical economists believed that it was marginal utility, also known as the final degree of utility, or rareté, that determined value or price. Marginal utility declines as more of a commodity is consumed. Thus, the first liter of water that might be consumed would have a nearly infinite value, and each subsequent liter was less valuable to the subjective tastes of the consumer. Since water was abundant, it was not worth too much. Theoretical "rational consumers" were thought to continue to trade with one another until the marginal utilities of the two traders equalize. At that point neither party will benefit from additional trading. No individual consumer can be made better off by trading without making another worse off. This is the genesis of what is called *Pareto efficiency*. The reader should note the irony that although the neoclassical concept of value is based on "economic scarcity," this is only *relative*, *not absolute* scarcity. Even though industrialization made possible an abundance of goods, neoclassical economists spoke about scarcity only from the perspective of an individual's infinite wants.

The theory of neoclassical economics assumes that in a money economy, consumers will continue to purchase a "set" of two or more "commodity bundles" even though they have less and less additional value to them. Therefore, they experienced *diminishing marginal utility*. The consumer will cease buying when the ratio of marginal utilities equals the ratio of prices, resulting in "consumer equilibrium." Graphically this

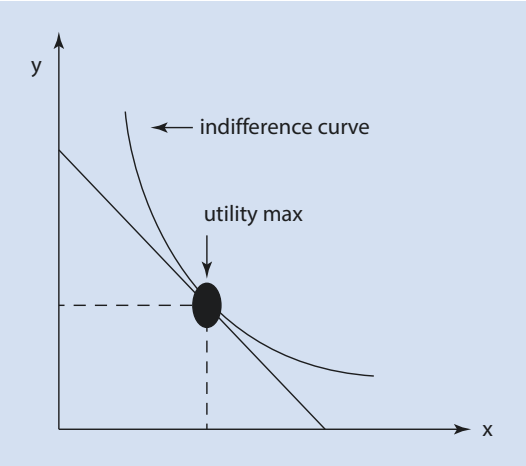

Fig. 2.1 Consumer equilibrium is reached when the slope of the indifference curve (or the marginal rate of substitution) just equals the slope of the budget constraint. At this point the consumer values the tradeoff at the same rate as does the market

can be depicted in Fig. 2.1. Utility is constant along any indifference curve, labeled U_0. Its slope is the ratio of marginal utilities. A budget constraint, B_0, exhibits a slope that is equal to an exogenous price ratio.

In other words, when a consumer trades good x for good y at the same rate that the market trades them off, she or he will be in the best possible position. As prices change, so, too, does the equilibrium position, with lower prices generally resulting in higher quantities purchased. Although the initial assumptions require that interpersonal utilities cannot be compared, they can be aggregated mathematically. The standard "rite of passage" for every student of intermediate microeconomics is to decompose these changes into income and price effects and derive a downward sloping demand curve, despite the complete unreality of the assumption.

For a consumer-based price theory to replace the classical value theory based on costs of production and social classes, let alone come to dominate economic thinking, a reasonably large cohort of consumers must exist. This consumer class was first created by means of low food prices, enabled by the application of fossil fuels to economic production. The industrialization of agriculture began to drive food prices down by the early 1830s, and the increase in productivity made possible by the application of coal to machinery drove down the price of wage goods sold to workers. Moreover, mechanization was accompanied by an increase in the ranks of supervisory employees who enlarged a nascent middle class whose incomes allowed the expansion of consumption and the expansion of the market [29].

By the late years of the nineteenth century, neoclassical economists expanded their early marginalist roots by extending the marginal utility approach to the analysis of production. They believed that production functions mirrored utility functions and that efficient production begot equilibrium in utility as well. Factor price ratios (such as the ratio of wages to profits) were substituted in their equations for the price ratios of utility theory, while ratios of marginal productivities, or the change in output with respect to the addition of one more factor, took the place of ratios of marginal utilities. Producer equilibrium occurs when the two ratios are equal. Moreover, the theoretical distinction between production and distribution found in classical political economy simply vanished. The theory of production and the theory of distribution are one and the same in neoclassical economics. The neoclassical theory of production does not deal explicitly with energy, but the very functions themselves are built upon pre-thermodynamic energetics [30]. The typical production function is simplified to include only capital and labor as the independent variables that produce output.

2.11.2 The Marginal Productivity Theory of Distribution

The neoclassical vision of distribution could not have been more different from that of Mill. Rather than separating the mechanisms undergirding production and distribution, as Mill had done, the neoclassical theories of production and distribution are virtually identical. For 20 years, following the 1870s marginal revolution, neoclassical economics, based on scarcity and utility, was solely a theory of demand. Production was still based on classical principles of cost. But classical theory utilized an economic surplus approach, which entailed the possibility of exploitation—value created by one class is appropriated by another. Marginalism would become neoclassical economics only when production was placed on a marginal utility basis, and the possibility of exploitation was eliminated (at least in theory).

The fundamental idea is that each factor of production [land (T), labor (L), and capital (K)] earns its marginal product (or incremental contribution to total output), no more and no less, as rational individuals follow the price signals of the market. The result is equitable—one's reward depends solely upon one's contribution to society. The marginal product of labor therefore equals the wage rate (w), profits (π) are equated with the marginal product of capital, and rents (r) are determined by the marginal product of land. This can be added up to generate the total output (P), with MP_L being the marginal contribution of labor, capital, and land.

$$P = \mathrm{MP_L} \bullet L + \mathrm{MP_K} \bullet K + \mathrm{MP_T} \bullet T.$$

- P = Total output.
- MP_L = Marginal product of labor.
- L = Labor.
- MP_K = Marginal product of capital.
- K = Capital.
- MP_T = Marginal product of land.
- T = Land.

Unfortunately, this equation can be true only under a limited set of mathematical conditions. British economist John Hobson showed that if marginal product of labor exceeded the average product (or the output elasticity is positive), the product of $MP_L \bullet L$ can exceed the total output to be distributed. But this is possible only if one or more of the factors (e.g., labor, capital) are not paid their marginal contributions. Economists in the neoclassical tradition arrived at some elegant solutions in the subsequent years. However, they depended upon two conditions being met. Equations of degree one are linear, either because they have no exponents, or because the exponents add to one, as in a Cobb-Douglas production function. The function had to be linear homogeneous, and of degree one, and equal to zero. Furthermore, production had to exhibit constant returns to scale [49].

Constant returns do exist when output expands proportionately with the increase in all inputs. In 1928 mathematician Charles Cobb and economist Paul Douglas published an article on long-term trends in income distribution. They were most interested in why the distribution of income remained stable, despite momentous changes in industrial structure and the position of the United States in the world economy. However, the paper is most famous for the *Cobb Douglas production function*.

$$Q = aK^{\alpha} L^{1-\alpha}$$

This equation says that the quantity of production (Q) equals the product of capital (K) and labor (L). The Greek letter α represents capital's share of the income distribution, while the remainder ($1 - \alpha$) was labor's share. Cobb and Douglas estimated capital's share to be 25% of national income, with labor receiving 75%. The fact that the two exponents added to one assured constant returns to scale and the substitutability of resources. Land, which symbolizes all natural resources and which had been used in most previous assessments, was simply left out of the equation, as was energy. Both were subsumed, inappropriately, under the category of capital, as capital, as a productive asset, is essentially useless without energy. But if all inputs are substitutes, the theory implies that society can maintain, and even increase, its level of output in the virtual absence of resources or energy, even were these included explicitly. This failure of neoclassical economics to include energy in their basic equations of production has bothered many biophysical scientists greatly, including Nobel prize winning chemist Frederick Soddy, anthropologist Leslie White, ecologist Howard Odum and his students Robert Costanza and Charles Hall, physics trained economist Phillip Mirowski, and other economists including Nicolas Georgescu-Roegen. Nearly a century after the formulation of these neoclassical equations, Cleveland et al. [31] and Reiner Kümmel [32] showed that 90% of productivity increases can be attributed to increases in net energy, that the productivity of labor is principally determined by the energy used to subsidize labors' muscles, and that capital is important because it is the means of using energy. More explicitly when energy is inserted into Cobb Douglass type functions, it is a far more important determinant of changes in production than is either capital or labor. Why this basic and empirically incontestable concept has escaped incorporation into general economic thinking is astonishing to us and to the distinguished scientists mentioned above.

The marginal productivity theory can be shown, mathematically at least, to produce equity, or fairness, but only under conditions known as *perfect*

competition. As seen in ► Chap. 1, this hypothetical market structure entails creating an abstract model in which equally powerless firms meet perfectly rational consumers in an impersonal market. In addition, firms must be willing to accept zero economic profit in long-term equilibrium. In this model entrepreneurs earn only a "normal" profit, which is what they could earn in wages working for someone else. In 1934 economist Joan Robinson demonstrated that such outcomes are equitable *only* under conditions of perfect competition. In perfect competition workers are paid what they are worth. The pay of a worker is a combination of their individual productivity and the value of the extra production that the firm sells. Technically, this is known as the value of the marginal product, or MRP. It is the production of the marginal product of labor ($MP_L = \Delta Q/\Delta L$) time marginal revenue ($MR = \Delta TR/\Delta Q$), where total revenue (TR) equals all the money the firm brings in by selling its products. $TR = P \times Q$. The Value of the Marginal Physical Product is marginal Revenue × Price. Since in perfect competition, and only in perfect competition, marginal revenue equals price, the marginal revenue product and the value of the marginal physical product are identical. However, in imperfect competition, with any degree of control over price on the part of the firm, marginal revenue is less than price. This means the marginal revenue product (what workers are paid) is less than the value of the marginal physical product (what workers are worth.) Mrs. Robinson referred to this as exploitation. She and we believe this to be the normal, not exceptional, situation [33].

In summary, neoclassical economists built a mathematically elegant structure establishing a nonexploitation theory of distribution. The functions that explain distribution are the same as those that describe production. The two theories are indistinguishable. However, the theory depended upon structures that do not occur in the real world: perfect competition, unlimited and reversible input substitution, and constant returns to scale. In addition, they do not give energy any special role—it is just another commodity. Nonetheless students of economics are trained routinely and often exclusively on such models of perfect competition. It is the only market structure that has been conceptualized in which distribution is equitable and exploitation cannot exist, but it is contradictory to the reality in which humans operate.

2.12 What Most Economists Missed: The Impact of Industrialization

The production and accumulation of wealth have been a central issue of economics since its earliest days, but the concept that energy is a critical factor in that production was (and is) generally treated only peripherally, if at all. The physiocrats understood that land was the origin of wealth, but they had little or no explicit understanding of land as the way that solar energy was captured and turned into things of economic value such as crops or wood, often from photosynthesis of nutrient-starved plants on long-depleted soils. Not surprisingly, most early economics focused upon understanding and explaining the primacy of land in overall production. But since resources took substantial amounts of human labor to extract and the rewards were distributed unequally, they rightfully thought labor was important. Malthus thought that the meager agriculture of his time would limit human populations to something like what were present in his day.

But once humans discovered coal, and later oil, our ability to do economic work, including agricultural production, soared. The energy density found in these new resources led to the rapid transformation of the human condition. Population, which had barely grown for a thousand years, reached one billion in the early 1800s and has soared to nearly seven and one-half billion by 2017. A very few economists, such as William Stanley Jevons and Karl Marx, did address energy explicitly. Jevons found in 1860 that "all economic activity leads back to coal." Marx understood that large-scale economic production was not possible without coal and emphasized the role of coal and machinery in increasing labor productivity. We know now that energy is central to all economic issues and is likely to have serious influence upon, and even limit, the economist's usual goal of economic growth. But even Marx and Jevons mentioned energy only peripherally in their most important writings [34, 35].

As time went on humans constructed an economic infrastructure of factories, refineries, bridges, automobiles, suburban homes, and shopping malls and could now exert a greater degree of control over nature than at any time in the past. However, working conditions for those laboring in nineteenth century textile factories were often horrid and degrading, as are the contemporary

conditions for most textile workers in Africa, Asia, and Latin America. The prosperity of the fossil fuel era has not been equally visited upon the world's diverse population. Yet the economic situation, in terms of access to material goods, for most people has not been better than today [36]. This is largely because each human can generate vastly more wealth per unit time than in the past because of the subsidy by fossil fuel.

Thus, humans have increased their ability to acquire and accumulate resources through the use of fossil fuel. Although we have been trained to think about the economy as something run by money, from our perspective, money is just our means of keeping track of debt, facilitating exchange and serving as a lien on the acquisition of surpluses of energy and labor. The fossil fuel-based economy has given each of us in the industrialized countries the equivalent of 60–80 of what futurist Buckminster Fuller called "energy slaves," and the more money you have, the more energy servants you can have. Why economists mostly missed the importance of the industrial revolution as they developed their theories is rather a mystery.

2.12.1 Supply and Demand

Most of what is taught as introductory microeconomic theory in English-speaking colleges and universities today is but an updated version of the neoclassical theory enunciated by Alfred Marshall in his 1890 *Principles of Economics* [37]. Marshall was among the first to link marginal utility with demand, and he aggregated market demand curves from individual ones. By linking supply and demand, Marshall reasoned that equilibrium in the labor market occurred when individuals decided to supply hours to the market up to the point where the marginal utility of the wage equaled the marginal disutility of the work. This unrealistic point, although rejected by Keynes, still forms the theoretical core of modern labor economics.

Marshall also based his analysis on the substitutability of resources. Consumers will substitute one good for another based on the ratio of extra utility to the price that must be paid. Rational consumers substitute the relatively cheaper good for the more expensive one, as long as happiness or utility remains nearly constant, and substitution ends when the ratio of marginal utility to price is the same for all commodities considered. This is known as the equimarginal principle. Marshall's mode of analysis applied equally to the firm as it did to the consumer. The theory of the firm began with the "representative firm" that exhibited no marketing, energy, or technological advantage over any other. He divided his analysis into periods. The short period was one in which one factor (capital) was fixed but labor would be allowed to vary. This period was ruled by diminishing marginal productivity. If a firm applies increasing quantities of a variable input to a fixed input, eventually the rate of increase in output begins to decline. Ricardo first enunciated this idea in his debate with Malthus, but Marshall formalized it.

The onset of diminishing marginal returns implied an increase in marginal cost. If each additional laborer produces less output then, once diminishing returns have set in, a firm would need to hire additional workers, at additional costs, to produce the same incremental increase in output. The marginal cost curve, above the minimum point of average variable cost, becomes the supply curve. This became the basis of profit maximization for the individual firm. Profits would be optimized at the point where marginal cost equals marginal revenue or the extra income derived from selling an additional product. Since the marginal cost curve was equivalent to supply and marginal revenue could be equated with demand, this point also represents the intersection of supply and demand. Any profits in excess of the normal rate, which Marshall termed "quasi rents," would be eliminated by price competition among firms (Fig. 2.2).

In Marshall's long period, all factors of production are variable. Consequently, diminishing marginal returns, which require the application of variable inputs to fixed inputs, cannot operate. Long period costs were regulated by economies of scale. Traditionally classical political economists had posited that capitalists would add fixed and circulating capital up to the point of constant returns to scale, where output expanded proportionately with the application of inputs, and the investment of additional resources would yield no more than the value of the investment. But Marshall saw no a priori reason to assume constant returns. In the era where land played the

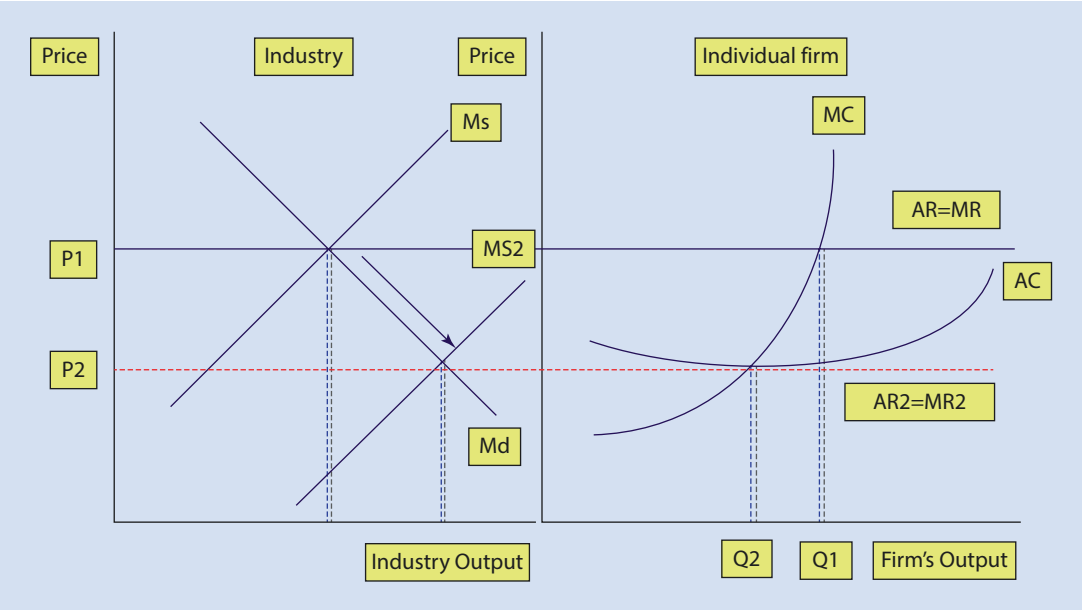

Fig. 2.2 Any profits in excess of the normal rate, which Marshall termed "quasi rents," would be eliminated by price competition among firms

primary role in production, Marshall, following Ricardo, believed there was a tendency toward decreasing returns to scale. But in the era in which the restrictive role of nature was diminished, and the application of fossil energy could increase productivity dramatically, the tendency was toward increasing returns [29]. This rendered a parabolic long-run average cost curve where constant returns to scale represented the minimum achievable cost.

In Marshall's neoclassical synthesis, the market will self-regulate to generate long-period equilibrium where marginal revenue = marginal cost = price = the minimum short-period average cos = long-period average cost. At this point profits are forced to the "normal" level, and the outcome is *allocative efficiency*. Allocative efficiency occurs when the market price covers fully all underlying incremental costs and resources flow to their most lucrative use. Firms unable to achieve constant returns to scale can produce only at above average cost and will be forced into bankruptcy by price competition. Since the firm-level supply can be aggregated into market supply and market demand is simply the summation of individual demands, the market-level balance of supply and demand is the most efficient allocation of resources. The idea that markets allocate efficiently is a deeply held belief of almost all economists, including most ecological economists.

By the 1920s, supply and demand analysis had been extended to describe the workings of the primary sectors of the overall economy. According to Marshall the supply of labor, set by the disutility of the work, would come into balance with the demand for labor, which was determined by marginal productivity by means of subtle adjustments in the price of labor, or the wage rate. If wages were below the equilibrium rate, shortages would occur, causing competing employers to offer a higher wage in order to attract workers. Unemployment was a surplus of labor, caused by workers demanding wages in excess of equilibrium. The solution for unemployment was therefore a reduction of wages. In many ways, the neoclassical or market model provided logical rationales for management to pay labor as little as possible.

Economist Knut Wicksell offered an analysis of the market for savings and investment, called loanable funds, based on the idea of the self-equilibrating market. Savings were specified as a positively sloped function of the interest rate (the price of money). Those with enough income to save would be induced to augment their savings

by an increase in interest rates. Investment was negatively related to interest. At higher interest rates, the costs of borrowing rose, and less profitable investment projects would be curtailed. The market would find its own equilibrium interest rate, and savings would equal investment.

2.12.2 The Neoclassical Perspective of Indefinite Growth

Neoclassical economists held a very different opinion on the future of economies. The potential of continued dramatic increase in productivity (made possible by fossil fuels, although that was not mentioned) relegated questions of accumulation and growth to secondary status. Consumption was limited only by a budget constraint. However rational consumers would maximize their well-being by substituting cheaper for more expensive goods, so that consumption could increase indefinitely. A similar process worked on the production side. Initially the optimal situation was the point at which supply balanced with demand. While the possibility that that reinvested profits could lead to economic growth was considered, the focus was clearly on static equilibrium. Only later, in the profound depression of the 1930s, did a neoclassical theory of growth begin to emerge. Sir John Hicks developed the idea of the *elasticity of substitution*—which meant in practice that expensive, unreliable labor could be substituted by cheaper, more reliable capital. He believed that a progressive society necessitated a positive elasticity. In other words, the price of progress was the redistribution of wealth from labor to capital. This would allow growth to continue indefinitely.

One conspicuous exception exists in the work of William Stanley Jevons. Before Jevons solidified his reputation as a marginalist, he produced the previously mentioned empirical work, *The Coal Question*. Jevons theory was based on that of Malthus, but he argued the limiting factor had switched from corn to coal. He had no particular interest in sustainability or resource conservation. Rather he wanted to maintain England's industrial and imperial domination of the world. These depended upon the development of mass production industry, especially textile manufacturing, and industry depended upon an adequate supply of cheap coal [10]. But Jevons believed there was no prospect for a reliable and cheap substitute for coal and that England's mines were slowly becoming exhausted. This would render much of England's population superfluous (and perhaps incapable of being fed) and essentially create the conditions for the return of the stationary state. While Jevons offered no satisfactory solutions, his essay represents the initial exercise of the economic consequences of the absolute scarcity in the age of fossil fuels [29]. For Jevons, England's greatness depended upon lavish use of a declining resource, and he looked toward the future with trepidation. "We have to make the momentous choice between brief but true greatness and longer continued mediocrity" [34]. Many today still fear this prospect, and this will make the transition to living within nature's limits all the more difficult.

Jevon's Paradox, today called the rebound effect, shows that an increase in resource efficiency increases resource use. If you recall the supply and demand diagrams from ► Chap. 1, the rebound effect becomes less paradoxical. Increased resource efficiency increases supply and relative to stable demand, drives down prices. The lower prices increase quantity demanded and resource use. Savery's inefficient steam engine used very little coal because almost nobody could afford to use it. Watt's engine led to the expansion of coal use because the engine was efficient enough to compete with, and eventually dominate, water power.

2.12.3 Accumulation and Growth

Neoclassical growth theory emerged as a critique of the Keynesian economists Roy Harrod and Evsey Domar, who proposed separately that the growth path of a capitalist economy would be unstable because of the system's internal dynamics. We will review their work in detail in the next section. In 1956, Robert Solow argued that the flaw in the Harrod-Domar approach was in the way they specified their equations. According to Solow, the Harrod-Domar model used fixed proportions between labor and capital. When he replaced these fixed coefficients with a Cobb-Douglas function the instability disappeared and the functioning of markets would lead to stable growth trajectories. Solow managed to turn a social problem into a technical one and

maintained the neoclassical ideal of self-regulating markets over the long term [37].

Unfortunately, Solow's model suffered from a large unexplained residual. As we stated previously, Reiner Kummel explained the residual satisfactorily by adding energy to the production function. Solow's explanation was that the residual was due to technological change that could increase output without increasing the quantities of labor and capital [38]. In this approach, technological change was exogenous, appearing as "manna from heaven" rather than being determined within the parameters of the model. In the mid-1980s, following the most severe recession since the Great Depression in 1981–1982, neoclassical economists sought to model technological change as endogenous to the process of accumulation and growth. Economists such as Paul Roemer and Robert Lucas theorized that investments in innovation and "human capital" were important determinants of economic growth. These models are often termed "AK" models because all inputs were specified as a form of capital. No longer were there land, labor, and capital. Now there are natural capital, human capital, physical, capital and money capital. Expenditures on education and training are therefore important for the future and within the domain of proper government activity, and government policies should focus on innovation and competition. The model assumes that marginal productivities are constant at the aggregate level, so no declines occur due to the addition of capital. The models also tend to utilize perfect competition as the basic market structure. Although short-term monopoly profits might fall to those in research and development, but free entry into the market will equalize these profits in the long term.

The current state of the art of neoclassical growth theory is known as dynamic stochastic general equilibrium theory or DSGE. Dynamic refers to change over time, which is the very essence of growth. Stochastic is used not just as being probabilistic but in the sense of the economy being subject to random errors. If all errors are random, then policy prescriptions are essentially irrelevant. The model is cast within Walrasian general equilibrium theory. If you recall, general equilibrium holds that individual agents will trade amongst one another, with accurate knowledge and foresight of prices until no trader can be made better off until another is made worse off. This is referred to as Pareto efficiency. Since all agents have the same perfect information of the present and future and the same reasoning process, they can be treated as exactly the same, and the entire economy can be reduced to a single representative agent. Technological changes are a random error, and treated as frictionless, despite the fact that technological changes benefit some in the real world and hurt others. Moreover, in the words of James K. Galbraith, capitalism is treated as a perfect or nearly perfect system, the analog of a frictionless physical system, that adjusts to random shocks and results in a steady-state growth trajectory [38]. The two main variants of DSGE are real business cycle theory, based on perfect competition, and new Keynesian economics, which allows for some monopolistically competitive price setting.

2.13 Thorstein Veblen and the American Institutionalists

Institutionalism as a school of economic thought focuses on the structural transformation of social institutions over time, and not price formation, as the key to understanding how an economy functions. Institutional change affects human behavior and human behavior affects institutional change. Institutionalism's main proponent, Thorstein Veblen, can be classified more as a social critic than as an economist, for he read and wrote widely in science, politics, anthropology, philosophy, and history, as well as economics. Veblen is most known for being a vociferous critic of neoclassical economics, taking on the giants of the day such as monetary theorist Irvin Fisher and his own mentor, John Bates Clark who was the originator of marginal productivity theory. Veblen's critique of neoclassical economics, a phrase which he coined and often used interchangeably with "the hedonistic approach," stemmed from his active study of science, especially Darwinian evolution. Veblen adopted Darwin's descent with modification based on random variation and natural selection in a way that was far different than other "social Darwinists" such as Herbert Spenser and William Graham Sumner who focused on the competitive nature of humanity and "the survival of the fittest." Veblen juxtaposed

the competitive, or predatory, side of humanity with the altruistic, that took the form of the "instinct of workmanship" or the parental bent. Veblen's adaptation did contain one important difference from Darwin's ideas on evolution in the nonhuman world. Humans can adapt to changes in the biophysical world by changing their behavior within one generation. Within this context, much of Veblen's work was rhetorical in the strict sense of the word: the art of persuasion. Veblen urged his readers to adapt to the pecuniary exploits and fraudulent behaviors of the "captains of industry" in the Guilded Age.

In one of his first articles, the 1898 "Why Economics is not an Evolutionary Science," Veblen took on the utilitarian theory of human behavior and classified it as "pre-Darwinian." He asserted that the utilitarian perceptions of the rational, self-absorbed *homo economicus* were incorrect, as they allowed for neither the adaptation of the individual nor the institution of the market, which shapes individual behavior and is shaped by behavior in return. For Veblen, the economic life of the individual was a process of cumulative adaptation, with the economic agent and the social environment being the result of the last adaptation. This is a far cry from the unchanging individual with self-regarding preference sets who is unchanged by the institutions of the market. In Veblen's words:

> The hedonistic conception of man is that of a lightening calculator of pleasures and pains, who oscillates like a homogenous globule of desire of happiness under the impulse of stimuli that shift him about the area, but leave him intact. He is an isolated, definitive human datum, in stable equilibrium except for the buffets of the impinging forces that displace him in one direction or another. Self-imposed in elemental space, he spins about symmetrically about his own spiritual axis until the parallelogram of forces bears down upon, whereupon he follows the line of the resultant. When the force of the impact is spent, he comes to rest, a self-contained globule of desire as before [39].

According to Rick Tilman, editor of *A Veblen Treasury,* Veblen's work was centered around duality and conflict. Some of the main conflicts included those between superstition and science, between business and industry, and predatory exploit and warlike animus vs. peaceable congeniality and workmanlike efficiency. These conflicts appeared in all of his major works [40].

Veblen's best-known work was his 1899 *Theory of the Leisure Class* [41]. It was here where he coined the term "conspicuous consumption." Veblen historically and anthropologically, analyzed the role played by a growing economic surplus (based on an energy surplus) in the development of a class that did not have to work. Veblen's analysis began with hunting and gathering societies and the emergence of settled agriculture (which, in the parlance of the day, Veblen called savagery and barbarism). Predatory activities such as war and sports led to the highest of social statuses, and people emulated these upper classes to improve their own senses of well-being. Veblen believed that the utility preferences of the common man could not be understood in absence of understanding the preferences of the upper classes. In this work, he began to utilize his concept of instincts that would appear throughout the remainder of his works. Veblen used instincts differently than would an animal behaviorist. For Veblen, instincts were more like propensities. They were purposive, learned behaviors.

In his 1904 *Theory of Business Enterprise* [42], Veblen refined the distinction between business and industry and the instinct of predation and the instinct of workmanship. Pecuniary activity (making money) was grounded in the instinct of predation while making products found its base in the instinct of workmanship or doing a good job for the sake of doing a good job. Veblen called the process of consciously denying efficiency for the sake of pecuniary gain (think of the recent revelations regarding Volkswagen) to be sabotage. It was also in the *Theory of Business Enterprise* that he enunciated his theory of the business cycle. Veblen was among the first to incorporate analyses of monopoly concentration and finance into his analyses, stating that the cause of economic instability lay in excessive capitalization and credit inflation. Fundamentally, there is a tendency for firms to borrow too much based on overestimation of their future earning power. When banks and creditors realize this, they call their loans which set off a chain of bankruptcies and liquidations. When expectations of future earnings coincide, once again, with reality, the bankruptcies stop until the next round of speculative excess drives the cycle once again. Veblen thought that

the growth of monopolies and wasteful government spending might stop the cyclical instability but did not express a great deal of optimism.

Veblen never enunciated a theory of income distribution, although he spent a great deal of time criticizing the marginal productivity theory of his mentor, John Bates Clark. He thought that the assumption that compensation equals effort was wholly untenable, for there was no reliable way to measure an individual's contribution in a social setting, especially when pecuniary activity, based on the instinct of predation, was at the base of the process. Veblen ridiculed theories of abstinence and waiting that justified the appropriation of economic rents by those absentee owners who did their best to avoid hard work. He also realized, because of the pecuniary processes, that wages were administered rather than being the result of supply and demand in competitive markets. Veblen was an ardent supporter of unions, most notably the Industrial Workers of the World, and advocated for democracy in the workplace instead of dictatorial control by the agents of predation.

Economist Lisi Krall asserts that this distinction between business and industry and the concept of administered prices is crucial for understanding the dynamics of the oil industry in the second half of the age of oil. The Saudi-led cartel realizes that if prices are maintained at too high a level for too long, the oil-dependent industrial nations of the global North will find alternatives and find them quickly. Historically, the business strategy has been to limit production to maintain the "correct" administered prices, just the process that Veblen termed "sabotage." Yet despite price fluctuations and peak oil, the motives and the power of the oil industry have not been negated [43]. With the advent of new technologies such as hydraulic fracturing, one cannot fully understand the future prospects without looking at the institutional structure of the oil industry. The theories of Thorstein Veblen are a good place to start.

2.14 Keynesian Economics

The beginnings of *Keynesian economics* date to 1936 with the publication of *The General Theory of Employment, Money, and Interest* [44]. In this work Keynes was mostly interested in how uncertainty led to declines in capital investment and an imbalance with aggregate savings. He concluded that periodically the overall level of economic activity would fall as a result of falling investment, leading to an overall decline in the level of (aggregate—or total national) demand for goods and services. The economy could come to rest at an equilibrium point that was characterized by elevated levels of unemployment unless the economy was stimulated by an outside force. Keynes attributed the depression to a market economy's inability to sustain sufficient demand for goods and services over the long period, as well as the misguided policies of neoclassical economics that reduced consumption demand as they advocated wage cuts to reduce business cost. Keynes believed in a mild redistribution of income from rich to poor, primarily by means of job creation, and government stimulation of demand during recessions. Keynes was somewhat of an advocate of economic planning and restricted trade.

A more "business-friendly" although perhaps somewhat corrupted Keynesian economics was synthesized, primarily in the United States, in the 1950s. Most students of economics learn that Keynes was mostly about the government's use of its power to tax and spend (known as *fiscal policy*) and its control over the price and quantity of money (*monetary policy*) to keep the economy on an even keel. For decades, it appeared to many that Keynesian economics was the longed-for antidote to periodic business downturns until, in the 1970s, it itself fell victim to the prolonged economic stagnation following the peak of US oil production and the subsequent "energy crises." Keynesian economics was no longer able "deliver the goods" of economic growth with stability. Neoclassical economics made a strong comeback from the 1980s until the global financial collapse of 2008 and the subsequent recession. Recently Keynesian economics has seen somewhat of a revitalization, but there also has been a great deal of resistance to Keynesian measures that exists in the circles of economic policy as well as in economic theory. As of 2017 there is no clear agreement of what kind of economics works and what kind does not.

Economies in general, and capitalist economies in particular, suffer from strong cycles of expansion and recession. Recessions tend to bring enormous hardships to people as workplaces close, and fewer people are employed. John Maynard Keynes had, unlike his neoclassical predecessors, developed a

theory that these cycles were caused by internal conflicts. The market as a system was not self-regulating. In his 1936 work, *The General Theory of Employment, Interest, and Money,* Keynes showed that a mature market economic system could reach equilibrium at considerably less than a full employment level. Consequently, the market could not be left to its own devices to restore balance, especially if was already "balanced", but by doing so through substantial numbers of people unable to find work. Keynes considered himself a "moderate conservative" and was primarily interested in saving the market economy from its own worst feature of periodic depressions accompanied by high rates of unemployment. Instead of believing that market forces of competition and flexible prices would correct the ills of depression, Keynes thought that the imbalance of savings and investment led to a deficiency of *aggregate demand* that is for goods and services. Rather than wishing to replace capitalism with another form of organization and governance, Keynes believed that judicious use of government policy could boost the overall level of demand to reduce unemployment during recessionary times. In the 1950s a new generation of economists calling themselves Keynesians would attempt to "fine-tune" the economy by spending more when the economy was contracting and less when it was expanding too rapidly as to make prices rise. These actions would, they thought, tend to smooth out economic fluctuations over time. One can argue that in fact it worked, as the proportional fluctuations in the US economy decreased to much less than before the general acceptance of Keynes's ideas. We will explore this period in our chapter on the postwar economic order.

2.14.1 Keynes and the Taming of Economic Cycles

John Maynard Keynes, who influenced the application of economic theory to day-to-day economics more than nearly anyone else since Adam Smith, had little to say about wealth and value or price formation. He accepted, on face value, utility theory and marginal productivity theory and was relatively uninterested in price formation. He did base his critique of the labor market on the proposition that wages were "sticky" and did not fall as workers attempted to protect their standards of living. This, however, was not original to Keynes, as his neoclassical mentor Arthur Cecil Pigou had worked on this topic.

John Maynard Keynes had little to say about income distribution and what he did offer was contradictory. In ▶ Chap. 2 of *The General Theory* he stated that the classical theory of employment rested upon two premises. First, the wage equaled the marginal product of labor. This established the demand for labor as capitalists would hire labor only up to the point where the marginal product of labor equaled the prevailing equilibrium wage. At that point, they would cease hiring additional workers. Second, neoclassical theory asserted that the marginal utility of the wage equaled the marginal disutility of the work or the pleasure obtained from the wage earned equals the displeasure of the work done. In other words, the prevailing wage is sufficient to bring forth the needed amount of labor. While he rejected premise number two, Keynes accepted marginal productivity theory without reservation. But this implies that a reduction in wages can expand employment. Unfortunately, this was inconsistent with much of Keynes' main point that the economy can balance at full employment only if the population has enough money to spend purchasing the products they have manufactured.

In ▶ Chap. 10 of *The General Theory*, Keynes discusses the relation of savings vs. spending in stimulating the economy. Specifically, he examined the role played by the propensity to consume (or the fraction of additional income that is spent). Keynes utilized R.F. Kahn's multiplier principle when he considered overall investment and employment, which states that income is expanded by an amount that equals propensity to consume, that is, the amount of consumption changes with respect to the rise and fall of income. Mathematically, $k = \Delta C/\Delta Y$, where. C symbolizes consumption and Y stands for aggregate income. But Keynes realized that savings came primarily from the wealthy, which he called "the saving classes." If the poor saved a smaller proportion of their incomes than do the rich, then a redistribution of wealth would result in greater total spending and a greater multiplier effect and a more rapid expansion of income and employment. But Keynes never came out for a policy of income redistribution. Rather he addressed the issue indirectly, calling for an expansion of public works [44].

Overall many economists, especially classical economists, thought deeply about the questions of distribution of wealth between the different classes of society. We can say that their discourse, and others like it, had a great deal of effect on the actual implementation of economic policy, at least until the last two or three decades. This was because tax and other government policies based on their thinking tended to result in a much greater equity in the distribution of the great wealth made possible by the industrial revolution, especially in the United States and Europe.

These two conclusions about the functioning of aggregate markets served as the backdrop for John Maynard Keynes' critique of neoclassical economic policy. For John Maynard Keynes, the question was not one of whether overall, or aggregate, supply would balance with aggregate demand, but whether or not the balance would occur at full employment. Keynes began his 1936 opus, *The General Theory of Employment, Interest, and Money*, by accepting all the neoclassical postulates except two. He rejected Say's law and Marshall's idea that the supply of labor is determined by the interaction of the marginal utility of the wage and the marginal disutility of the work. Whether this change in two initial propositions constituted a revolutionary change in the profession or was a matter of "moderate conservatism," as Keynes himself believed, has been and probably will continue to be a matter of considerable debate. But Keynes' conservatism was not about domestic spending. He saw the enterprise economy of the 1930s as being limited by internal and external factors. The internal factor was the persistence of severe unemployment and social dislocation that characterized the depression. The external factor was the presence of two alternate systems, Fascism and Bolshevism, which Keynes found highly distasteful. Keynes conservatism came from his desire to save and perpetuate the free enterprise system. His moderation came from a belief that leaving the economy to its own devices and awaiting the triumph of market forces would be insufficient to solve the problems created by the Great Depression.

The prevailing orthodoxy in the middle third of the last century was grounded in the notion that savings determined the level of investment. Furthermore, the balance of saving and investment was needed to achieve the overall balance of supply and demand. A simplified version modifies the circular flow model, (which is essentially a depiction of Say's law), to accommodate the reality that not all firms and household members spend all their money in current consumption. Money "leaked" out of the system flow when individuals saved a portion of their income, when taxes were levied on income, and when purchases of foreign goods were made. On the other hand, income flowed into the system when businesses made investments, when the government purchased goods and services, or when an economy sold goods in foreign markets and received the incomes from doing so. Consequently, the traditional circular flow model can be augmented with both leaks and injections.

Given the conventions of the early twentieth century of a political commitment to a balanced budget that equated government spending and taxation, along with an international gold standard that balanced imports and exports, the main question facing Keynes was to what degree would savings balance with investment? Unless savings and investment balanced the aggregate supply of products (which were increased by investments) and the effectual demand for them (which were increased by consumptive expenditures) would not balance at full employment. He believed that finding adequate investment outlets for surplus savings, and not wage reductions, was the key to finding a macroeconomic equilibrium at full employment. The prevailing orthodoxy, on the other hand, was to treat the market for savings and investment as a market for loanable funds. Competitive market forces would lead savers and investors to vary the amount of funds with the price, leading the market to find an equilibrium rate that balanced savings and investment. Keynes disagreed vehemently that this was how it worked. Savings, in his analysis, depended upon income, and savings would increase only as income rose. Investment depended upon expected profit and the rate of interest. Savings and investment were functions of different variables. Keynes believed there were no reasons for planned (or *ex ante*) savings to equal realized (or *ex post*) investment.

Keynes' greatest concern was not a shortage of savings but savings that exceeded investment. The orthodox method of increasing savings was to increase the interest rate. This had the unfortunate effect of simultaneously depressing investment, thereby reducing the level of aggregate output and employment. As investment fell, so

too did employment. Workers with less money buy fewer products, forcing business to reduce investment once more. The economy spiraled into depression, and when it came to a balance, the equilibrium was at a low level of output and a high level of unemployment. But if the interest rate is not determined in the loanable funds market, where is it determined? For Keynes, interest was a monetary phenomenon. The amount of money in the system depended upon the interaction of the supply of money (determined politically by monetary authorities) and the preference investors have for holding their money as cash (called transactions demand) or as balances to be invested in financial securities (called speculative demand). Money plays an essential feature in a modern economy, and the economy could not run without it. For Keynes, the fundamental problems of investment were those of uncertainty. The present, when investments are made, lies between an unchangeable past and an unknowable future. Despite efforts of economists and mathematicians, the uncertainty posed by investment over the long term makes the rational calculations of neoclassical microeconomic theory essentially impossible. The future is sufficiently uncertain that the self-regulatory capacity of the laissez-faire economy is unlike that posed by neoclassical theory. Keynes believed that the object of the accumulation of wealth entailed investing now to receive rewards in the distant future. But our knowledge of the future is uncertain. In an oft-quoted passage from his 1937 *Quarterly Journal of Economics* article entitled "The General Theory of Employment," Keynes declared:

> The calculus of probability, tho mention of it was kept in the background, was supposed to be capable of reducing uncertainty to the same calculable status of certainty itself…By "uncertain" knowledge, let me explain, I do not mean merely to distinguish what is known for certain from what is only probable. The game of roulette is not subject, in this sense, to uncertainty; nor is the prospect of a Victory bond being drawn. Or, again, the expectation of life is only slightly uncertain. Even the weather is only moderately uncertain. The sense in which I am using the term is that in which the prospect of a European war is uncertain, or the price of copper and the rate of interest twenty years hence, or the obsolescence of a new invention, or the position of private wealth owners in the social system in 1970. About these matters there is no scientific basis on which to form any calculable probability whatever. We simply do not know [45].

The use of money allows for a method to avoid all of one's assets being fixed in permanent and unchangeable assets. This ruled what Keynes called the speculative demand for money. But speculation is subject to waves of pessimism and optimism. While the primary driving force of output, and therefore employment, was investment, the level of consumption was also important in determining the level of aggregate demand. The amount of consumption, like savings, was dependent primarily upon the level of income. The fraction consumed (the marginal propensity to consume) was subject to multiplier effects. Since the poor spend a greater fraction of their income than do the wealthy Keynes believed that some augmentation of income growth could be affected by a redistribution of income. Given the uncertainty of investment, and the limitations of expanding the economy by means of money creation when interest rates are low, Keynes allowed for the state to spend to assure sufficient aggregate demand for the economy to balance at the full employment level of income. We will return to his methods in the final question of this chapter.

What should we conclude about this main question of economics, about how economists view whether supply can possibly balance demand, and lead the economy away from the troubling boom and bust patterns that have characterized capitalism? The optimist might point out that most economists believe that firm-level supply is aggregated into market supply and likewise market demand is simply the summation of individual demands. Together these forces operating at the market level balance supply and demand well enough and in a way that is the most efficient allocation of resources. The idea that markets allocate efficiently is a deeply held belief of almost all economists. But cycles remain, although much less as a percent of GDP following the publication of Keynes magnum opus and its partial implementation [31]. Even so, today Keynes, as represented by arguments as to whether, or to what degree, governments should undertake deficit spending to restore

ailing economies, is very much hotly contested. The cynic might say "economists throughout the history of economics often held strongly held beliefs that were in fact often contradictory to each other. Today we have little or no better idea than in the past as to which is correct." This is hardly a surprise to anyone who follows economics today.

What is missing from this and other economics questions is a consideration of what has become what is likely to be the most critical issue of economics today: issues of energy and other resources. And environmental degradation. The issue was always how to take nature's abundance and mobilize forces to turn that into wealth and employment. We can perhaps understand how this came about since economics was mostly developed before the appropriate science, but the roots of economics have hardly budged with the new information we have now on resources and the environment, and probably most economists today do not think there is any particular reason to worry too much about resource or environmental limitations.

2.14.2 Accumulation and Growth

Keynesian economics gained prominence in the failed growth economy and Great Depression of the 1930s, but it was, perhaps surprisingly, not particularly oriented toward growth. Rather it focused on an explanation of the role of inadequate demand and uncertainty in producing depression, as well as the futility of relying upon markets alone to produce sufficient demand to end the depression. A Keynesian growth theory was not to emerge until the very end of the depression in 1939. Roy Harrod, Keynes' collaborator and biographer, began his "Essay on Economic Dynamics" with the conflict between what he termed "the actual growth rate" (G) and the "warranted growth rate" (G_w). The actual growth rate is the percentage change in output from year to year, $x_1 - x_0/x_0$. The warranted growth rate follows from the Keynesian tradition of psychological theories of the trade cycles. This is best remembered as Keynes' idea of the role of "animal spirits" in the investment process. It is the growth rate that leaves all parties satisfied that they have produced neither more nor less than the correct amount or the growth rate that will lead them to produce just enough to maintain the rate of growth. The warranted growth rate is determined by the ratio of the propensity to save or the change in savings relative to the change in income ($s = \Delta S/\Delta Y$) and the value of capital goods needed to produce one unit of output (C). Stated mathematically: $G_w = s/C$. The instability emerges from this fundamental equation. If there is excessive output and G exceeds G_w, the actual increase in capital goods per unit of output falls below the desired level and will lead to an undesired reduction of the capital stock by means of inventory depletion. Investors will then increase their capital stock even more, causing a further movement of G from G_w. The larger the gap, the greater the stimulus for further expansion. If the actual growth rate falls below the warranted growth rate, excess capacity will emerge, resulting in a decline in the incentive to invest. This creates a positive feedback loop and economic instability due to the internal dynamics of the investment process. In Harrod's own words:

> A departure from equilibrium, instead of being self-righting, will be self-aggravating…A unique warranted rate of growth is determined jointly by the propensity to save and the quantity of capital required by technological and other considerations. Only if producers keep to this line will they find that on balance their production in each period has been neither excessive nor deficient. On either side of this 'field' in which centrifugal forces operated, the magnitude of which varies as the distance of any point from the warranted line. Departure from the warranted line sets up an inducement to depart farther from it. The moving equilibrium of advance is a highly unstable one [46].

On the 17th page of a 22-page essay, Harrod introduces the concept of the natural rate of growth (G_n). We mention the pagination because Solow's aforementioned critique of Harrod in his 1956 paper advanced the proposition that Harrod's conflict was between the warranted and the natural growth rate, not the warranted and actual growth rate as Harrod contended. Population, work/leisure preferences, capital accumulation, and technology determined the natural growth rate, which was defined as the maximum growth rate allowed by these factors. Furthermore, there is no inherent

tendency for the warranted and natural growth rates to coincide. If the warranted rate were to exceed the natural rate, a depression (or stagnation) would result as the social and economic forces are limited by the systematic biophysical limits found in the natural rate. The warranted rate must fall to the natural rate, and this can be achieved only by chronic unemployment. Harrod's policy recommendations were to "manipulate the proper warranted rate [by means of public works, fiscal and monetary policy] so that it would be equal to the natural rate" [Harrod 1939: 32].

Harrod's natural growth rate can be interpreted on a biophysical basis by adding the quantity and quality of energy sources, as well as the assimilative capacity of the atmosphere and the oceans as independent variables. The fundamental problem remains that the warranted growth rate that would lead to maximum profits exceeds the natural rate but now by a greater fraction. Stagnation and unemployment will still result, and stimulative measures, which may be successful in the short term, will not rectify the long-term problem. This problem would reverberate through the economy as a whole, including labor and financial markets. Combined with the structural changes enabled by information technologies that reduce the need for human workers in the manufacturing and service sectors, short-term stimulative policies may be successful in increasing the growth rate but will not lead to full employment [38]. The impact of the structural shift in labor markets will not be measured fully in the unemployment rate but rather in slow rates of growth of wages and labor force participation and in long-term underemployment. Reducing the warranted rate to the natural rate will be a difficult problem in the absence of significant social restructuring. Energy prices will eventually rise, as the undulating plateau created by the interaction of supply and demand is transcended by geophysical realities. Most probably before we lack access to sufficient fossil fuels, growth-dependent financial markets may fluctuate wildly before declining. The debt-based global economies will find it difficult, to say the least. In a nongrowing economy, capitalist societies may well tear themselves apart with distributional conflicts in the interim. The problem of living within nature's limits is considerably more difficult than technological optimists believe. What is needed is to decouple employment from economic expansion.

Seven years after Harrod's paper was published, Evsey Domar enunciated a similar theory of growth and instability, although he never read Harrod's work until after his own papers went to the publisher. He made explicit connections between economic growth and employment in two papers published in the immediate postwar period [47, 48]. The expansion of employment depends not just upon the growth of national income but upon the *rate of growth* of national income. Job growth necessitates that national income and effective demand (consumption + investment) grow perpetually at an *increasing rate*. After making a set of simplifying assumptions including no time lags, the use of net savings and investment, and a constant price level, but not fixed proportions of labor and capital, Domar set out a model word add dynamic elements to the static Keynesian system. New investment is simply capital accumulation. It increases national income but also increases the productive capacity of the economy. Unfortunately, the national income that produced full employment would not be sufficient to produce it in the next because of increases in technology, the labor force, and access to new resources. Domar criticized the mainstream (neoclassical) approach of increasing income by reducing prices, as price decreases were a rare occurrence in the monopolized economy that he observed.

The essence of Domar's argument lies in the *dual nature of investment*. New investment is simply capital accumulation. As a form of spending, investment increases aggregate demand and national income. However, on the supply side, investment also increases productive capacity. The instability comes from the fact that the stimulation of demand is short lived, while the expansion of capacity is long lived. Excess capacity reduces the demand for new capital formation. From this simple realization, Domar developed a model that included the growth of investment on both the supply side and the demand side.

If Y = national income, α = the marginal propensity to save, then $1/\alpha$ will equal the multiplier (k) which shows the degree to which an increase in spending will translate into an increase in national income. Domar also posited that σ represented the productive potential of the economy or, more precisely, the average social productivity

of investment. σ measured the dollar amount of capital needed to produce a dollar increase in national income. From the supply side perspective, σI represented the total output that an economy can produce. From the demand side, $\Delta I\ 1/\alpha$ indicates the total aggregate demand. In equilibrium:

$$\Delta Y = \Delta I 1 / \alpha = \sigma I$$

To maintain a constant state of full employment, investment and national income must grow at a constant percentage rate $\alpha\sigma$, which equals the rate of compound interest. To expand employment to keep up with resource availability, technology, and labor force, growth investment must grow perpetually at an increasing rate. This is unlikely, if not impossible, because the buildup of excess capacity stunts the rate of investment growth. Domar's model was in the tradition of multiplier-accelerator models. Balanced growth is difficult because to have a high multiplier, one must have a high marginal propensity to consume. To have an equally high accelerator, one must have a high propensity to save. Since the sum of marginal propensity to save and the marginal propensity to consume = 1, it is impossible for this seemingly simple mathematical condition to exist in the real world. Domar concluded by stating that excess capacity would not be a problem in a competitive economy, as those firms with too much capital would go bankrupt. Yet in a monopolized economy, excess capacity would be a chronic problem that the private sector could not solve on its own. According to Domar, the government needed to assume the role of investment banker to keep the funds for expansion flowing.

2.15 Biophysical Economics

Most of the economic schools mentioned so far were growth oriented to greater or lesser degrees. The main disagreement then, as now, was how would growth be best achieved? Classical political and neoclassical economists tended to focus upon market processes in achieving accumulation and growth. Karl Marx explored the internal contradictions that inhibited the accumulation process. Keynesian economics relied on the role of the government to provide the growth stimulus when private economy could not. In the absence of growth, employment would stagnate and human well-being would decline. In the early classical era, growth could be achieved principally by organizational means; the capacity to increase material output by means of technological change barely existed. It was only in the later stages of classical political economy, neoclassical, and Keynesian economics that the ability to increase output dramatically by means of harnessing energy-dense fossil fuels was possible.

What, then, should be the purpose of biophysical economics, the approach we are advocating in this book? Clearly it must deal with a world that is increasingly dependent upon stocks of fossil fuels, the depletion of those stocks, and the increasing difficulty of achieving growth as depletion occurs. Unlike the utilitarians, biophysical economics considers and encourages the possibility that humans can achieve happiness by means other than the acquisition of ever-increasing quantities of material goods—goods that cannot be produced with declining resources. As such, it calls back to the center stage the question of distribution: for generations that question has been suppressed. If the pie has been getting larger then everyone can get a larger piece. But if the size of the pie is not growing, who should get how large a piece?

Biophysical economics serves as a wake-up call to the impending and inevitable end of the economy based on high-quality fossil fuels and with it the end of growth economics. It also provides important caveats as to which of the many alternatives proffered has a good chance of succeeding by providing guidelines for the assessment of alternative sources of energy. How we can live well within nature's limits is a question we can no longer afford to postpone or subsume to a series of equations unconstrained by reality. But to answer this whole new set of questions, we must first assess how economists have addressed the age-old ones, for these questions remain as relevant for these new conditions as they were for the circumstances when they were asked. In other words, for a relatively few decades—a century and a half at most—in the most favorable situations has a year by year increase in general affluence been the normal condition. It was not true back when early economists were writing and it appears no longer true. So, we must pay attention once again to their questions—but we need to do that while including an energy perspective.

2.16 Summary

In this chapter, we chronicled the development of economic thought over the ages focusing, when we could, on the role played by energy. We also tried to emphasize the major transitions that occurred in the actual economy and explored how they affected the course of economic thought. Economic thinking and writing in the ancient and medieval world tended to justify the prevailing social order of a small elite controlling the society through land ownership. Collective sets of privileges and obligations were codified as natural law, and individual self-advancement was castigated as a mortal sin. By the early 1500s, individualism emerged in the age of exploration, the Renaissance, and the Enlightenment.

The first recognized school of thought were advocates of expanded trade known as the mercantilists. Their basic theory held that the origin of wealth could be found in the process of exchange. Buy cheap, sell dear. The real money was to be made in colonial exploitation and control of the carrying trade. By the mid-1700s, the idea that wealth and value could be determined by adding up the costs of production, rather than by counting sales, began to emerge. The first school of thought, the Physiocrats, held that all value came from "the natural bounty of the land" and the agriculturalized labor that transformed nature's bounty. By the late 1700s, the idea of value being produced by labor in general became the norm, as enunciated by Adam Smith and David Ricardo. Value, and price, could be determined objectively by adding the costs of production, especially labor costs.

Smith and Ricardo, along with Thomas Malthus, lived in an age of the solar flow. Animate power, biomass, and water served as the primary, and limited, energy resources. Energy was embodied in a fixed supply of land and that fixed amount of land gave rise to diminishing returns and pressures of a growing population upon the limited capacity to grow food. Limited energy densities helped account for the small-scale nature of production. Although all the classical economists advocate policies of capital accumulation and economic growth, all believed the eventual fate of an economy would be a nongrowing stationary state. Ricardo and Malthus, especially, engaged in great debates about the distribution of society's income, and each advocated a policy to redistribute income to their favored classes, as class was the primary unit of analysis. Ricardo favored putting money in the hands of the newly emerging capitalist class, who would invest the money to drive economic progress, while Malthus favored the landed aristocracy who would spend the money on comforts and personal servants, ensuring adequate spending and keeping the economy from stagnation and depression.

John Stuart Mill was a transition figure. He started out as an advocate of the labor theory of value but popularized the principles of utilitarianism that would come to characterize neoclassical economics. Mill still believed that the fate of the economy was in the stationary state, but unlike his predecessors believed such a state could be superior to a growing economy where individuals stepped on one another's backs in order to get ahead.

Karl Marx was the first economist of the industrial revolution. He realized the productive power of fossil fuel-driven machinery to enhance labor productivity and to augment wealth and income. But Marx's analytical method looked for contradictions. The same economic forces that increased wealth and income expanded the exploitation of labor. The economic process of recapitalizing the surplus labor of workers sets the condition for an internally generated decline in the rate of profit and an economic crisis. The process of capital accumulation that resulted in increased wealth also undermined systematically the very material conditions of its existence: the worker and the soil. Unlike prior classical political economists, Marx was interested in the transition to the next society, rather than the perpetuation of the existing form of capitalism.

Within a decade of the publication of the first volume of Marx's *Capital*, a fundamental epistemological break occurred in economic theory. The marginal revolution occurred, and the determination of value was to be found in the sphere of exchange rather than in the process of production. In addition, value now depended upon the subjective well-being of the individual rather than upon an objective counting of labor hours. Social class ceased to be a proper category of analysis, and the historical specificity of classical political economy gave way to universal theory. The focus of accumulation gave way to a search for static equilibrium. The marginalism of the 1870s became the neoclassical economics when the

process of production was placed on a marginal utility basis. Supply and demand graphs made their appearance, and the purpose of economics became price determination. By the 1920s, the neoclassical approach expanded beyond the well-being of the individual and began treating the economy as a whole as if it were an individual market. Competition and flexible prices became the method of self-regulation, not just for individual markets but for the entire economy.

At the turn of the nineteenth to the twentieth centuries, institutional economists such as Thorstein Veblen criticized strongly the neoclassical ideas about human behavior, ideas on perfect competition, and the very idea of self-regulation. For Veblen and his followers, price formation should not be the focus of economics. Rather economic evolution by means of structural and institutional change was the path to a deep understanding of how an economy operated. Veblen, like Marx, based his theory on conflict and contradiction: the conflict between business and industry and the conflict between the ethic of workmanship and that of predation.

While the dominance of neoclassical economics could survive the ideas of a Veblen, it could not so easily survive the devastation of the Great Depression. The idea of self-regulation fell into disrepute in an era of 25–50% unemployment rates and a collapse of industrial production. This social dislocation provided a fertile backdrop for the ideas of John Maynard Keynes who argued that economic equilibrium could occur at any level of output, even levels that produced high unemployment. Keynes advocated reducing unemployment by expanding overall, or aggregate, demand. He discounted the idea that the private economy could produce sufficient demand, so he advocated the role of government spending as a solution. Yet Keynesian economics was not about producing economic growth, it was about recovery and stability. If anything "proved" Keynesian economics worked, it was the economic recovery, especially in the United States that accompanied the Second World War. Little concern was displayed, even by the most conservative legislators, for budget deficits when it came to defeating fascism.

After the war both a Keynesian and a neoclassical growth theory emerged. Keynesian growth theory emphasized the instability of the economy, while neoclassical growth economics stressed the idea that substitution of resources would result in a steady-state growth path. Keynesian and neoclassical debates characterized the 1960s, but Keynesian economics fell into disrepute when its policies could not solve the problem of simultaneous recession and inflation. Neoclassical economics reemerged as the dominant mode of economic thought in the 1980s and has remained the primary approach by which today's students are taught about the economy.

Yet there is need for a more comprehensive theory, as the mainstream Keynesian-neoclassical synthesis excludes the crucial role of energy and discounts the disruption of the Earth's biophysical systems. This is the void that biophysical economics seeks to fill. Fortunately, many lessons can be learned from economic analyses of the past, especially those of classical political economy. We hope you have gained a better understanding and appreciation that the role of history plays in shaping the future.

Questions

1. Do you think that combining natural science and economics is a good idea? Why or why not?
2. How is a city like a natural ecosystem? How is it different?
3. What ideas did you get in this chapter from earlier economists that you think might be important for understanding our current situation?
4. Can you think of a "peak oil" situation that occurred 150 years ago? Does that have any relevance today?
5. Why do you think economists have tended to ignore energy in their basic equations? Were they justified in doing that?
6. Where did the early group of economists known as the physiocrats believe that wealth came from?
7. Define relative vs. absolute scarcity.
8. What is economic surplus?
9. What are Heinberg's "five strategies for obtaining energy?"
10. Discuss one of the four main economic questions.
11. List four major schools of economics over time and one idea associated with each
12. What is natural capital?

13. What is the source of wealth for a physiocrat? A classical economist? A neoclassical economist? Yourself?
14. What was the "Wealth of Nations?" How does that relate to the title of this book?
15. Give one of the great economic ideas derived by David Ricardo.
16. What was the "diamonds vs. water" paradox? How was it resolved?
17. How did Keynes think we could diminish the large swings in the capitalist economy?
18. What did classical political economy have to say about the distribution of wealth?
19. Discuss comparative advantage.
20. What is the "best first principle?"
21. Was Karl Marx principally interested in communism?
22. Did Mill think about the distribution of wealth?
23. What important factor did the Cobb-Douglass production function leave out?
24. What are the main two views as to whether economies can balance supply and demand?
25. What earlier economist probably had the largest impact on what is taught today in basic economics courses?

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