Globalization, Development, and Energy

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Fig. 11.1 The spice route (Source: Dyfed Lloyd Evans)

Young adults today have grown up in a world where globalization is a ubiquitous reality and where most of our politicians accept its supposed virtues or did so until recently. There are fierce discussions, or more often positions, about whether or how globalization is losing (or gaining) us jobs, or whether we have globalized too much or not enough, but for most people it is just a fact represented by the labels on their clothes or electronic devices indicating production or manufacture from all around the world. This was not the case when the authors of this book were young—at that time nearly everything we ate, wore, or drove was "made in America." Anything from overseas—except specialized luxury goods—was normally viewed with great suspicion. Thus globalization, at least at the scale we see it today, is a relatively recent phenomenon. That makes it useful and important to understand why globalization has become so important, what are the perceived and actual gains and costs and how these are related to energy use [1].

Before we consider this from a modern perspective, however, we think it's important to emphasize that trade has been important for at least as long as written human history and much earlier as indicated by many foreign artifacts found in archeological digs going back tens of thousands of years. People have long wanted luxury goods from abroad and have always sought interesting and different tools, amusements, foods, and experiences not found locally. One of the clearest examples of long-range trade is the "spice route" connecting Europe and the Middle East to all parts of Asia (Fig. 11.1). Spices were very important in ancient times for their own sake and also to hide the sometimes tainted smell and taste of rotting food in the days before refrigeration. Spices were good items of trade because they were exotic, relatively light, and non-bulky and could be carried for thousands of miles by camel and donkey and still make a profit. We were amazed when, at an archeological dig near Stockholm, Sweden, we watched the excitement of the excavators of an ancient Viking site when they found a coin that was from Constantinople, a very long way away. Obviously, the Vikings, often more traders than plunderers, had traveled thousands of miles on European Rivers. Many archeological digs of Native Americans find, for example, arrowheads made from stone quarried hundreds or thousands of miles away. With the advent of European colonization and imperialism in Africa, Asia, and the Americas, trade took on a whole new dimension. As we saw in chapter 2 the mercantilists (fifteenth through eighteenth century), believed wealth was measured in gold or silver and promoted trade and imperialism to obtain these metals. Nevertheless, the day-to-day lives of most people, including Europeans, remained based on materials that rarely traveled more than a few tens or rarely hundreds of kilometers from their growth or extraction.

While Adam Smith highlighted the benefits of free trade and "the system of perfect liberty," his successor, David Ricardo, developed the first formally enunciated theory of trade. This theory, known to

the world as comparative advantage, argued that everyone benefited from internationalization and trade. A careful reading of history reveals that the term *comparative advantage* did not originate with Ricardo. He talks of comparative costs and the comparative value of money, as well as speaking of more advantageous employments in his famous chapter "On Foreign Trade" in his 1817 *Principles of Political Economy and Taxation*, but never pens the phrase, comparative advantage [2]. Ricardo's argument was forged in his debate with Thomas Malthus over the repeal of the Corn Laws (see pages 36–37). The Corn Laws prohibited the importation of cheaper grains from Continental Europe. As England's population increased, additional, and lower quality, land had to be put into production in order to meet subsistence needs. Landlords' benefited from this policy, as they were able to charge additional rents when poorer lands went into production. Moreover, food became more expensive as more labor was required to grow food on poorer quality, and nutrient poor, land. According to Ricardo, capitalists were doubly squeezed as rising rents and rising wages both diminished profits.

Ricardo was a shrewd politician, and a Member of Parliament, as well as a prominent political economist. He argued that everyone would be better off if international trade were freed from restrictions such as the Corn Laws. He created a highly abstract, and historically unrealistic, example of the production and trade between England and Portugal for wine and cloth. In his example, Portugal possessed an absolute cost advantage. They could produce both wine and cloth with fewer labor hours. England, however, had relatively cheaper costs of producing cloth, or a lower ratio of labor hours embodied in the production of cloth to wine. Ricardo argued that international specialization in production would result in more commodities being produced for fewer labor hours. Everyone would be better off by trade liberalization. Ricardo also insisted that only finished commodities would be traded internationally. Capital and labor were immobile. If they were not, then capital would flow to where labor was cheaper. Trade between England and Portugal would be no different than trade between London and Yorkshire.

The example paid little attention to history. Portugal had enlisted England's help in a war with Spain. The price of the aid was to open the economy to English cloth imports. Since the application of waterpower to large-scale textile production made English cloth much cheaper, the nascent Portuguese textile industry withered and Portuguese capital flowed towards the vineyards. English imports of cloth far outweighed Portuguese exports of wine, and the trade imbalance was paid for by the gold produced by means of slave labor in Brazil.

The term "comparative advantage" comes from the sanitization of Ricardo's doctrine in the 1930s by Eli Heckscher and Bertil Ohlin. Working from a framework of general equilibrium theory (or neo-Walrasian economics), Hecksher and Ohlin replaced ratios of labor hours with ratios of opportunity costs, which are subjective valuations of the cost of the best-foregone alternative. Normally, opportunity cost increases, and increasing opportunity cost is synonymous with diminishing marginal returns. In Heckscher and Ohlin's model, opportunity cost remains constant. So Ricardo's greatest theoretical contributions, the labor theory of value and diminishing marginal returns, are missing from the modern theory of comparative advantage. Now, comparative advantage depends upon "resource endowments." Rich countries should continue to specialize in finance and research, while poor countries should specialize in mineral extraction, labor-intensive agriculture, and the manufacture of mass production goods such as clothing and electronics. Moreover, in the model, all industries are perfectly competitive, and no nation has any technological advantage. From this set of assumptions, it is an easy mathematical exercise to derive mutual gains from trade, despite an empirical record that the poor parts of the world are becoming far poorer as trade relations become less restricted, and that the terms of trade favor the already rich nations, who capture the highest amount of value-added through the supply chain [3].

11.1 Trade and Imperialism

The advantages of trade were often conflated with those of raw exploitation of others and with imperialism. During the sixteenth, seventeenth, eighteenth, and nineteenth century, most European powers laid claim to territory in Africa and the Americas. We have already discussed the raw exploitation of natives in these areas by the Spanish as they sought gold and silver, the English for tea from India and Ceylon, and especially sugar from Barbados and so on. Much of the labor energy for the production of these products came from actual

or virtual slaves. Few consumers of cotton clothes in 1860 or of rubber tires in 1900 (or even of some clothes, diamonds, or cell phone materials today) understood the human slavery that produced the products they purchased, or where the raw materials came from, or the human cost of those entities. We found a particularly chilling account in Hochschild's book *King Leopold's Ghost* about how some estimated ten million Africans were savagely used and killed as Belgians and other Europeans "developed" the interior of Africa for ivory (much used before plastics were available for everything from false teeth to piano keys) and rubber (for tires and many other things). The lies used by Leopold to justify his horrendous abuse of the people living in the Congo basin are a reminder of how so many economic practices are sugarcoated by governments and in the press.

Whatever the virtues or not of globalization, it is clear that it is a fact and that the world has become enormously internationalized in the last decades (Fig. 11.2). Essentially all recent American presidents until Trump have called for either continued or more "free trade," implying a continuation of internationalization. Where there are arguments against free trade, they tend to be that many US factory jobs are moved overseas, resulting in economic hardship in the United States. An obvious example is automobiles, as the United States in 1950 produced some 99% of the automobiles it used but now imports about half. As a consequence the city of Detroit and the State of Michigan, which once had the comparative advantage of relatively easy access (through Great Lakes shipping) to Minnesota iron ore and Pennsylvania coal, plus the early development of mass production of automobiles by Henry Ford, have suffered enormous economic impact. What is less obvious today, at least to the comfort of the developed world, is that increased internationalization of trade means that the processes of exploitation of nature and of manufacturing all require an enormous amount of labor, and the working conditions elsewhere often have fewer safeguards than does labor in the United States. This misuse of others in an attempt to get low production prices extends even to the existence of virtual slavery, as we saw recently in the use of "made in the United States" sweatshop labor in Guam during the trial and conviction of Jack Abramoff and as continues today as chronicled by groups such as Amnesty International.

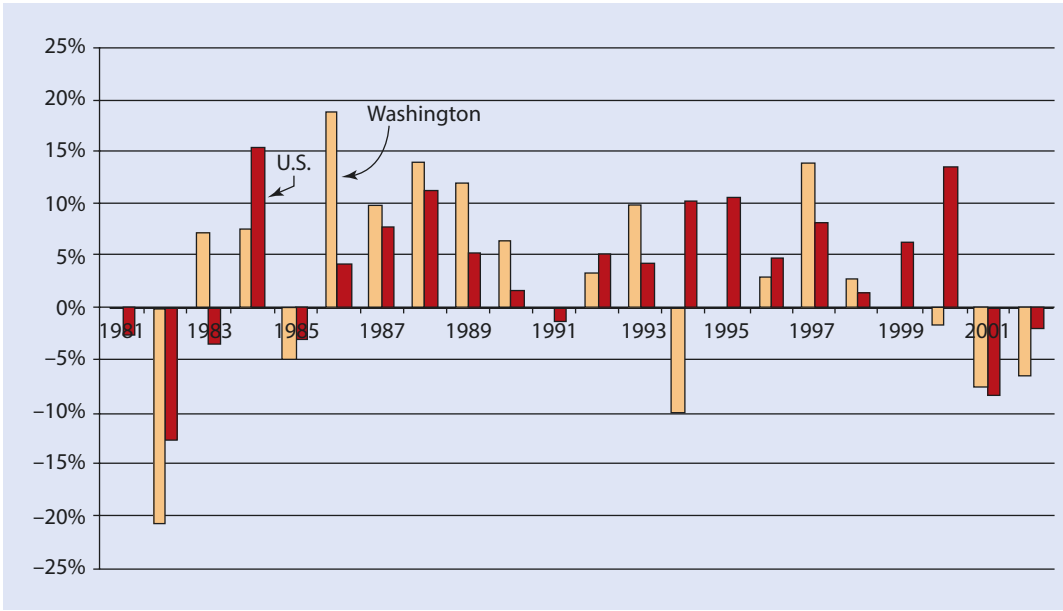


Fig. 11.2 Whatever the virtues or not of the internationalization, it is clear that it is a fact and that the world has become enormously internationalized in the last decades

11.2 The Concept of Development and Its Relation to Trade

Most of the world today is quite poor, at least relative to the affluent nations, such that one billion of the Earth's more than seven billion people live on only one dollar a day, and some three billion people live on less than $2.50 a day [4]. A very general concept is that there are very large pressures for the poorer countries to develop in order to become less poor and that this development is often done in accordance within the concept of comparative advantage, that is, a search for some kind of product that might be produced well in that location. While Ricardo originally devised his concept of comparative advantage around the idea of various growing conditions, one comparative advantage that poor developing nations almost always have is cheap labor. As the process of industrialization continues to require unskilled rather than skilled labor, there seems to be always new areas where wages are so low that people are willing to work hard in terrible conditions for very little to get some small piece of the global economic pie. Of course each area would like to get a bit larger piece of that pie. Thus around the world people do not wish to stay poor, and consequently there are extreme pressures for nations to "develop," which normally means to increase economic activity. The way that is usually used to do this is in accordance with the neoclassical model, although of course development in fact requires the land, capital, other biophysical resources, transformations, and processes to occur if it is going to work. The pressure to develop comes from many sources including governments attempting to help or placate their constituents, idealistic foreign aid or NGOs from the developed world, various business and economic interests who are interested in a cut of the hopefully increased action, and, of course, the people themselves who may be quite tired of an economically restricted life. What is rarely mentioned is that the real force behind much or perhaps most development is simply an increase in the number of people over time (a biophysical aspect), so that if some kind of development does not keep pace, people will get poorer, which nobody wants. This economic activity and its changes normally are measured as GNP or GDP or sometimes per capita GNP or GDP.

The principal tool, or more accurately suite of tools, used to guide development is, as in most things economic these days (or at least was until quite recently), neoclassical (or free market or neoliberal or "University of Chicago") economics. The ascendancy of the neoliberal model occurred over the first half of the twentieth century as economists sought to generate a "scientific," "neutral" model that would focus on improving welfare of the economy in general and leave the issue of the distribution of that wealth (properly in their view) to governments, hence absolving economists from any responsibility pertaining to that issue. The logic, summarized nicely in Palley [5] and Gowdy and Erickson [6], is that free markets will lead to "Pareto optimization" where, due to market pressures for lower prices from suppliers, the various factors of production (i.e., land, labor, capital, and so on) are being used so "efficiently" that they cannot be combined in any other way that would generate greater human satisfaction. The logic continues that if markets are completely "free" (e.g., from governmental interference) at each step of the production chain, each producer will be seeking the lowest possible prices, and each potential supplier will be seeking to cut his or her costs (ideally through "efficient" use of resources) so that the total net effect is that the final demand product will be generated as cheaply in that economy (which means increasingly the global economy) as possible. This should lead to lowest possible prices, which is the objective of many economists. It should also lead to low prices for people in poorer countries. Most economists argue that this process works very well and generates substantial net benefits (e.g., Bhagwati [7]). Likewise most economists are enthusiastic about the free market system because, at least in theory, it is *efficien*t, that is, economic resources are generating as much personal well-being as possible from their limited resources.

An important part of this is that there should be trade, and an important component of trade is that there should be more trading partners, including less developed regions where there are resources that the developed world increasingly needs and where there is "unmet demand" for the products of the industrial countries [8]. This is a, or the, mantra of most neoclassical economists and has guided how we undertake trade and our

relations with the less developed world and, increasingly, government itself over the last half of the twentieth century. Thus development should lead to more wealth for both the nation becoming developed and for the developed country increasingly trading with it. In theory this should lead to efficiency, that is, that all parts of the economy are generating what consumers desire at a maximum rate given the resources at their disposal. Thus, at least in theory, development should lead to both improved conditions in the nation being developed and in the developed nation supplying the funds for that development through foreign aid. Yet the degree to which this does occur is not at all clear from objective analyses of the behavior of real economies, and the converse is often true (See [4, 9]).

11.2.1 The Leverage of Debt

In Latin America and Africa, especially, there have been pressures for development promoted by development agencies of the developed nations, internal elites, foreign NGOs, and the World Bank for many decades. These efforts have been motivated by genuine humanitarian concerns as well as (often) by the self-serving desires of the development agencies themselves. More recently there have been enormous pressures to repay debts associated with development (and other reasons) and for revisions in how economics are undertaken, according to the neoliberal model from outside entities including especially the World Bank and the International Monetary Fund (IMF). The pressures have come from the leverage these institutions have because of outstanding international debt from many countries in Latin America and elsewhere. Given the nearly impossible demands on governments due to poor and growing populations, and the difficulty in extracting taxes from rich elites who are often the same as those running governments, the easy solution has been and continues to be debt, which is a tax on future citizens. When governments can no longer afford to pay their debt service, which often exceeds 10–25% of total GNP and perhaps all tax incomes, a not surprising result is that from time to time governments have defaulted. Default has generally meant that the banks and their agents are able to impose their sometimes draconian "structural adjustment" programs which has meant, basically, reducing government expenditures, eliminating tariffs that have protected home industries (such as agriculture), and basically opening countries to globalization. The basis for this is usually neoclassical economics as codified in the "Washington Consensus." The results are mixed at best but often horrific, and are insightfully reviewed in Kroeger and Montanye [10].

Most structural adjustment programs also include policies and incentives for development, normally of industries that will generate foreign exchange (after all the bank's objective in structural adjustment is to get dollars or euros to repay the debt owed to them). For example, as part of the structural adjustment program implemented in Costa Rica for the mid-1990s, there were large incentives to encourage the development of "non-traditional" agricultural crops for everything from Macadamia nuts to cut flowers. Since these crops tend to be as dependent upon expensive imported agrochemicals as are bananas, it is not surprising that they did not have any significant effect on resolving debt. Meanwhile rising oil costs add greater balance-of-payment strains on most economies. In Costa Rica population growth has meant more food imports and the need for more agrochemicals for domestic crops, also making the resolution of debts more difficult [11]. The failure of many past development concerns, generally fueled by neoclassical economic concepts of growth, to deal with the issue of population growth binds developing countries into pursuing economic growth, whether real growth is possible or not.

11.2.2 The Logic for Liberalizing Economies

In the United States, especially, during the Reagan and Bush years, conservative leaders were extremely successful in convincing many formerly apolitical or even labor union people that their own personal conservatism in issues such as family, society, religion, gun ownership, and so on could be best met through making an alliance with economic and political groups whose agendas were quite different. These groups and their representatives in government were very much opposed to government in general and any interference with individual "freedom," especially intervention in the market. Thus they opposed,

for example, government programs to generate energy alternatives (such as solar power or synthetic substitutes for oil), believing that market forces were superior for guiding investments into energy and everything else. They also tended to be opposed to restrictions on economic activity based on environmental considerations and even mounted campaigns to discredit scientific investigation into environmental issues such as global warming.

The authors wish to point out that they use the term "liberal" and "conservative," as they tend to be used regularly and loosely in the United States, to refer to the role for government—usually larger by the Democratic Party and smaller by the Republican Party (at least in theory—the data are quite a bit more mixed). The terms themselves are often very misleading—for example, many conservative people are extremely interested in conservation of nature and the concept of free trade is advocated by many liberals too—and in fact as we pointed out earlier in many countries such as Argentina, "liberal" means liberal free trade and is often associated with business interests.

These new conservative or neoliberal forces tended to oppose government policies that restricted free trade. This view contributed to the movement of many American companies or their production facilities overseas where labor was cheaper and pollution standards often less strict. As developed in ▶ Chap. 7, by 2000 the United States seemingly had recovered from the stagnant 1970s and the recessions of the early 1980s and early 1990s. Stock values began to increase steadily, and the general economic well-being of many Americans led to a general sense of satisfaction in market mechanisms. The end of communism in Eastern Europe and Russia effectively ended the cold war, and the free market approach to economics came to be the only game in town with respect to economics. The presidential administrations of Republican George H. W. Bush and Democrat Bill Clinton alike pressed a free trade agenda. These programs included for many foreign lands reduced spending on social programs and the reduction of government ownership and enhanced international trade. The terms of trade greatly improved for the United States as markets became "liberalized," and prices of basic commodities from coffee to cotton to oil declined by more than 100%. Unfortunately poverty rates often soared in Africa and Central America as a consequence. For example, the price paid to a farmer for a pound of coffee in Costa Rica (about a dollar per pound) was essentially barely changed from 1980 to 2005. These issues are discussed in depth by, e.g., Annis [12] and Bello [13], and reviewed in Hall [11]. Fundamentally the arguments go back to the "Ricardian" concept of comparative advantage, as previously discussed, and to the concept that free trade will lead to efficiency. An implicit assumption of those who promote international trade and the advantages to all that are supposed to flow from it is that the players have equal power in the face of the supposedly neutral market. Of course, this is patently absurd—a small coffee grower in Costa Rica does not have equal power in the face of some coffee buyer for a large U.S. supermarket chain.

11.2.3 We Need to Test Our Economic Theories About Globalization, Development, and Efficiency

A recurrent theme of this book is that if economics is to be accepted as a real science, we must expose the main ideas to empirical testing. For example, Gowdy has undertaken this by reviewing the work of those who have subjected the basic tenets of our dominant economic paradigms using the scientific method "one cannot help but be impressed with the rigor of modern social scientists" [14]. There is a crying need to subject more of our economic theories to broad, unbiased, and thorough assessment of whether they deliver on what they promise (Bromley [15], Gintis [16], Hall et al. [17] Sekera [18]). There may be no trusted, or at least broadly accepted, concept within economics with a greater need of such testing than that of "efficiency" because efficiency is the principal argument used to promote the neoliberal model and of its application to international development and unrestricted international trade. Economists themselves have increasingly questioned the effectiveness of their development models. A particularly fine example of this is William Easterly's book, *The Elusive Quest for Growth: Economists' Adventures and Misadventures in the Tropics*. Easterly reviews the use of economic theory (basically neoclassical) as applied to development, especially development in the tropics. Easterly did what few econo-

mists do: he actually tested whether the models of economists that had been the backbone of billions of dollars of aid had accomplished what they were supposed to do. In particular Easterly asked whether the main development model, the Harrod-Domar model, as used by contemporary neoliberal development economists, is as sanitized as is the model of "Ricardian" comparative advantage. The model abstracts Harrod's equations for savings and the capital labor ratio from the psychological propensities that produce instability. Domar's concept of the "dual nature of investment" is ignored completely. As a result, the rate of income growth is a function of the national rates of savings and investment. Governments of starving countries should thereby increase forced savings, and further impoverish their citizens, for the overriding goal of economic growth. The Harrod-Domar investment model, had, when applied, resulted in a perceptible increase in GNP as it was supposed to. His answer was that there was a perceptible increase in GDP for only for 4 of 88 cases where it had been tried. In other words, when tested, these models were a disaster with respect to achieving their goals. LeClerc [19] arrived at a similar conclusion while testing a broader array of economic models as applied to development. Likewise Sekera [18] found for many examples in the United States that private entities did not deliver services more efficiently than the governmental institutions that they replaced in the name of improved efficiency. Anyone involved in the broad world of investment economics should read these three studies.

Sometimes it is not terribly difficult to test certain economic models yourself even though it is often said that real economies are too complex, and the difficulty of undertaking proper tests and controls is so daunting that you should not expect economic concepts to be explicitly testable. As an example Hall's former student Dawn Montanye asked whether the (neoliberal) structural adjustment model imposed upon Costa Rica by USAID (Agency for International Development) in the early 1990s had achieved its own clearly stated objectives when the subsequent behavior of the economy was examined [20]. This was a seemingly straightforward and reasonable thing to do that, although, curiously, seems not to have been undertaken by USAID. Her results were yes for two and no for four out of their six principal objectives. In addition, there were a number of quite important but unanticipated "bads" that occurred even for the cases where the objectives were met. If in fact there is such a large void between theory and application then one wonders whether or not there should be so many routine pronouncements on how to run real national economies based on conventional theory and models [19].

If efficiency is the main reason that neoclassical economics is promoted, and if, to our knowledge, this efficiency has been tested barely or not at all, how then might we go about testing efficiency? One can argue that since many Latin American countries have been under tremendous pressure from roughly 1990 to 2005 to "liberalize" their economies according to the neoliberal "Washington consensus" models, especially those countries such as Costa Rica that have been subject to structural adjustment, a program often imposed upon debt-laden countries that are desperate for loans and who must turn to "the lender of last resort" (the World Bank and especially the International Monetary Fund), then if indeed structural adjustment does lead to efficiency, this should be obvious from the data comparing pre- and post-structural adjustment. That this is not observed (except arguably in Chile), it seems to us hard to argue that structural adjustment and neoclassical economics do in fact lead to economic efficiency.

11.2.4 Definitions of Efficiency

The first thing to consider about the word "efficiency" is that it is often confused with "*efficacy*," which means "getting the job done," without regard to efficiency. The engineer's definition of efficiency measures output over input. But a second difficulty with the meaning of efficiency is that it is hard to find a consistent definition of output of what? And input of what? Economists usually think of efficiency (of, e.g., an economy) as the output of all desirable goods and services over the input of all resources available for production, usually referring to money or capital or labor. Perhaps the best way to explain efficiency, as economists use the word, is by giving the counterexample of economics that is, supposedly, *not* efficient. This is because the economist's definitions of Pareto efficiency and allocative

efficiency are, in essence, immeasurable. Pareto efficacy means trading to the point where no one individual can be made better off except at the expense of another. But well-off is entirely subjective. Allocative efficiency can occur only at the output level where price = marginal cost. This can happen only in the market structure of perfect competition, which does not exist in the real world. In the socialist states of Eastern Europe and the Soviet Union from roughly 1920 to 1990, the determination of how much of a good and service was produced (i.e., the allocation of productive resources) was decided in large part by *central planning*, that is, by government economists whose jobs were to decide how many tractors, carrots, chickens, or other commodities were needed. There were some famous fiascos resulting from this (or at least good stories), so that, for example, in the 1950s in Russia and Poland, too many tractors and far too few refrigerators were ordered by the central planning committee, so that there were mountains of unused tractors, while people were very unhappy because they needed refrigerators. To most Western economists, this was a tragic example of how it was far better to leave the decisions of what to make up to markets, i.e., Adam Smith's invisible hand of supply and demand. In other words, in the centrally planned economy, the productive resources of the nation, steel mills, labor, and factories themselves, had been used *in*efficiently, that is, they had produced too much of one thing that was not needed or wanted and not enough of another that was. In addition it had required a large, perhaps expensive government bureaucracy to do the allocation decisions. It is this argument about efficiency that is used most commonly by neoclassical economists to argue for free markets and free trade. Centrally planning a large industrial economy is a daunting task, and it was even more difficult before the age of large-scale electronic computing. This is why most centrally-planned economies made no attempt to plan all aspects of an economy. Rather they focused on the most important sectors, known as "the commanding heights."

A problem with estimating efficiency by this method is that it is very difficult to decide just what the inputs are that should be considered as the inputs to a particular economic activity since the economy is very complex. Despite the constant use of the word efficiency by economists, you would be hard pressed to find where that has been measured or tested explicitly (except for some very general international comparisons using often rather arbitrarily defined quantifications of such terms as "level of financial development" and "improvements in efficiency," e.g., King and Levine [21]).

Engineers often use a very explicit measure of efficiency: simply the ratio of energy out of a process to the energy in. For example, coal is converted to electricity at about 40% efficiency in a modern power plant and gasoline to road transport at about 20% efficiency. Humans, too, generate work at roughly 20% efficiency. Some of the energy loss is inevitable such as losses to the second law of thermodynamics, some is related to needing to run the process at a more rapid rate than would generate maximum efficiency, and some is caused by poor design or poor housekeeping (i.e. not keeping the tires properly inflated).

A kind of combined ratio is often used to measure efficiency of economies within biophysical economics: the GDP output over the energy input, usually for a country. We call this the *biophysical economic efficiency*. The economic output must be corrected for inflation to compare different years. The ratio does not mean anything explicitly (as the engineering one does) but rather is one relatively unambiguous way that we can measure the efficiency of an economy—e.g., test explicitly the hypothesis that more free trade leads to greater efficiency, something that, as we said above, is not possible to do with the more nebulous "productive resources" perspective usually given by economists. It is useful mostly for comparative purposes—either for different countries or for one country over time—which we do here. The idea is that since the economies of many countries were explicitly or implicitly (via the general spread of neoclassical economic concepts) "converted" at least partially to less government restrictions and more market freedom in the 1990s and early 2000s, then our hypothesis is simply to test whether national economies in general (especially in those countries like Costa Rica and Chile which were subject to explicit structural adjustment consistent with neoclassical economics) became more efficient during the 1990s. If efficiencies are increasing then this would tend to support the hypothesis and the contrary.

11.2.5 Testing the Hypothesis that Freer Trade Leads to Economic Efficiency

The actualization of neoclassical economics in Latin America and elsewhere was carried out with great enthusiasm, some would say relentlessly, through a program called "the Washington Consensus" that was administered to, especially, countries that could not pay interest on their debts to the World Bank or to the International Monetary Fund (IMF) [22]. These programs of increasing free trade and reducing governmental spending ("stabilize, liberalize, and privatize") were thought to be good and tough medicine for the debtor nations. And they were supposed to lead to economic efficiency. Since we could not find any data by economists about whether economies had in fact become more efficient after liberalization, we undertook this ourselves by examining simple time trends in biophysical economic efficiency.

Our methods were very simple: for developing countries plot the biophysical efficiency (i.e., real GDP/energy used, agricultural output per unit of fertilizer, and so on for various countries) and see if there is any trend toward increasing efficiency. Explicitly we test the hypothesis that following the implementation of neoliberal policies (either in the country or more generally worldwide after 1990), there will be subsequently an increase in the biophysical efficiency of nations. We undertook this explicitly for 4 countries in each "developing" continent and for 133 countries more recently [23].

11.2.6 Results of Testing for Biophysical Efficiency Following Liberalization

We found in both studies that when the energy use and the GDP for all countries in the world are plotted on the same graph, the results are basically linear, indicating that energy is required, or at least associated with, increases in the production of GDP for essentially all nations (Fig. 11.3). We also found that for those countries that were increasing in per capita wealth that energy use increased at approximately the same rate as the GDP (Fig. 11.4).

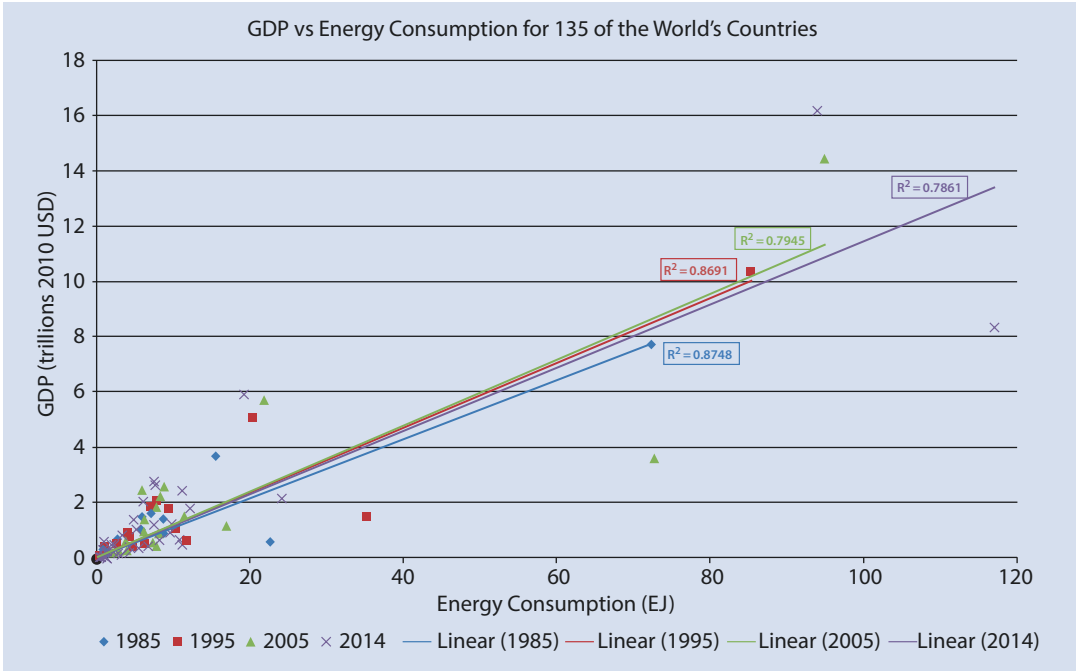


Fig. 11.3 The relation of energy use and GDP for 127 countries in 1980, 1995, 2005, and 2014. The basically linear results indicate that energy is required for, or at least associated with, increases in the production of GDP for essentially all nations, and that whatever (small) increase in efficiency that may have occurred (i.e., an increase in the slope of the line) tended to occur before the increased global liberalization of markets that began usually in the 1990s. Primary electricity is multiplied by 2.6 relative to fossil fuels to reflect their quality (Source: Ajay Gupta)

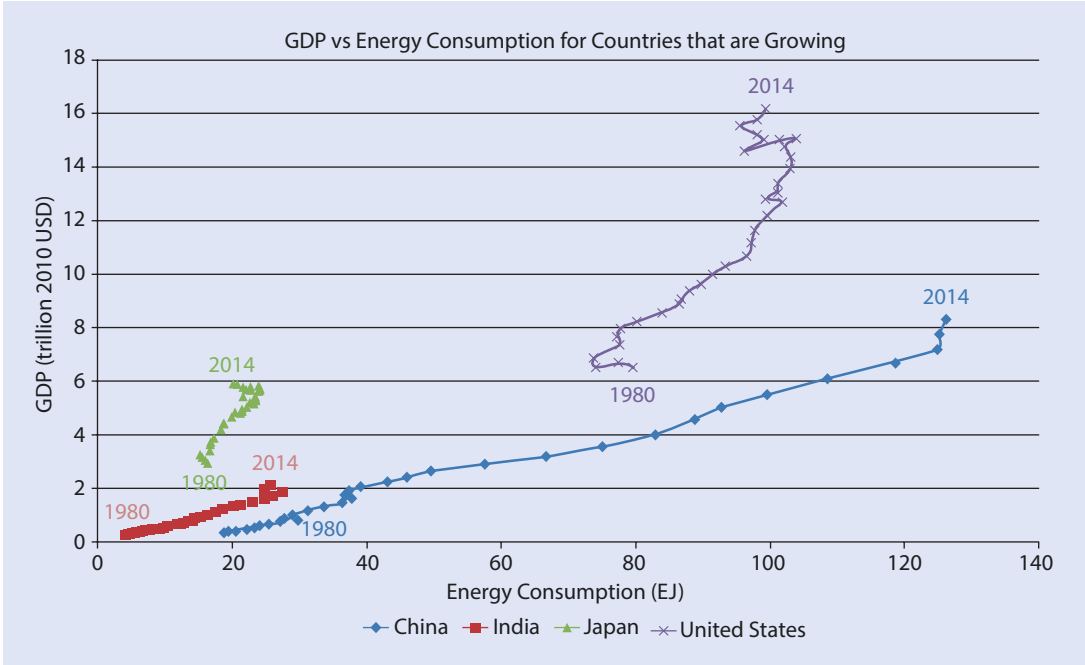


Fig. 11.4 The relation of GDP and energy use for four economically growing nations of the world. Rapidly developing nations including China and India tend to have a strong correlation between their increase in energy use and their GDP, implying that energy is needed for economic development. This appears less so recently for the developed nations such as Japan and the United States which have increased their official GDP with little or no increase in energy use (Source: Ajay Gupta)

Today there is an enormous variation in the wealth of different national economies, from the poorest, where people tend to live on but 38 cents a day (or 140 dollars a year) to the wealthiest in the developed world where annual mean incomes varied from 50,000 to 87,070 dollars annually in 2008 (World Bank 2009). Not surprisingly, from our perspective, the energy use by these different countries varies similarly from about 0.32 GJ per capita to nearly 800 GJ per capita for 2005 (Fig. 11.5). Additionally as countries have developed, they have tended to use more energy over time, generally in rough proportion to their increase in wealth (Fig. 11.4). When we examine the relations of GDP and energy use for developing countries in Africa and Latin America (the region especially impacted by "liberalization of markets"), we find no evidence at all that biophysical efficiencies have increased in the developing countries analyzed in response to the liberalization trends of the 1990s and early 2000s. When all countries are considered, biophysical efficiency has tended to, if anything, remain the same or decrease, both since 1970 and also since 1990 (Fig. 11.6). Colombia, relatively unaffected by neoliberal policies, may be an exception. Similar results were found for many other countries [11, 24, 25] . Hence the hypothesis of this chapter that the increasing use of "liberal," "free market," "neoclassical," or "Washington Consensus" approaches to economics in the last decade of the twentieth century in the developing countries will necessarily bring increased efficiency of economies is not supported, and we must seek some other explanation for economic growth besides increased efficiency (as derived from neoclassical policies or anything else). These results are consistent with the increasing view of many development economists themselves [25].

Our results do show, however, that efficiencies have increased in many developed nations (Figs. 11.4 and 11.7). Whether this is because highly developed countries are capable of becoming more efficient through pure technology, or rather have basically exported their frequently polluting and energy-intensive heavy industries to the rest of the world is another question. For some countries, many energy exporting countries, efficiency is lower (Fig. 11.8). Further analysis in which the embodied energy associated with imports and exports is added or subtracted to the energy use (denominator) of the equation suggests that when this is done, the val-

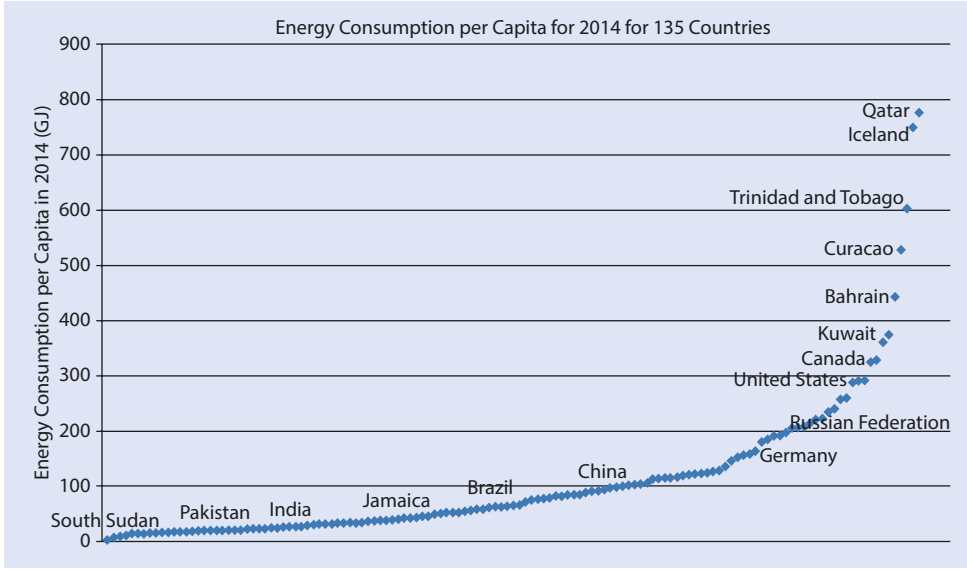
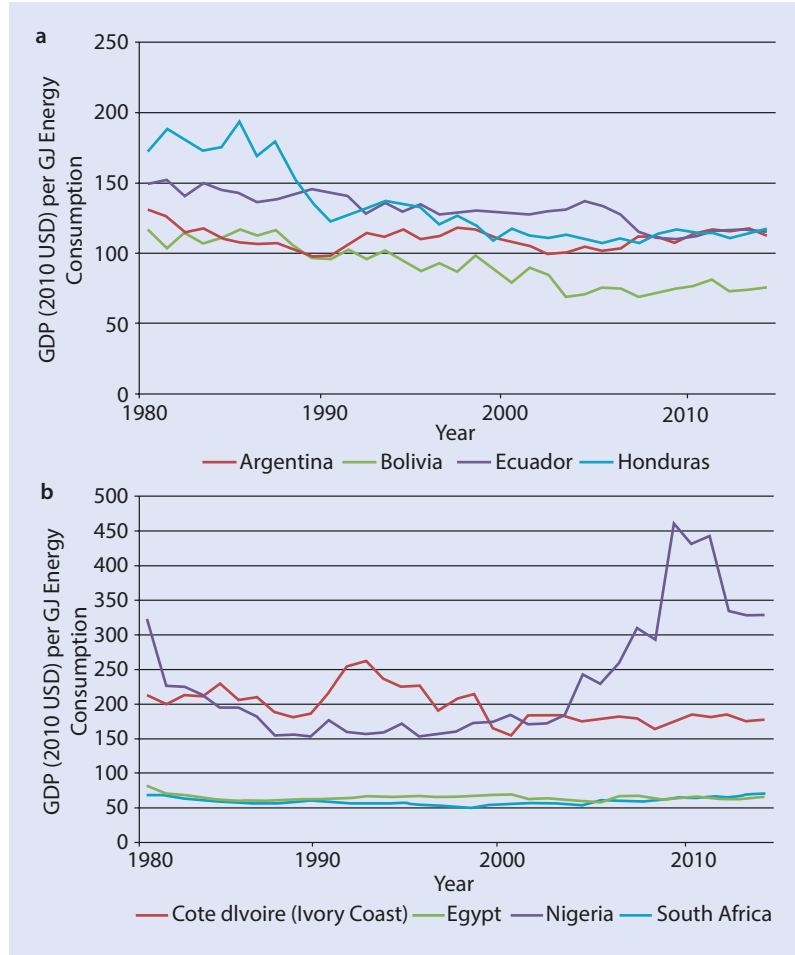


Fig. 11.5 One hundred and thirty-five nations of the world ranked in order of increasing energy use per capita (Source: Ajay Gupta)

Fig. 11.6 **a** The ratio of GDP to energy use and for four countries in Latin America from 1971 through 2001. The flat or decreasing lines for all countries after 1980 are not consistent with the hypothesis that liberalizing markets increase efficiency (Source: Ajay Gupta). **b** The ratio of GDP to energy use and for four countries in Africa from 1971 through 2001. The flat or decreasing lines for all countries after 1980 are not consistent with the hypothesis that liberalizing markets increase efficiency (Source: Ajay Gupta)



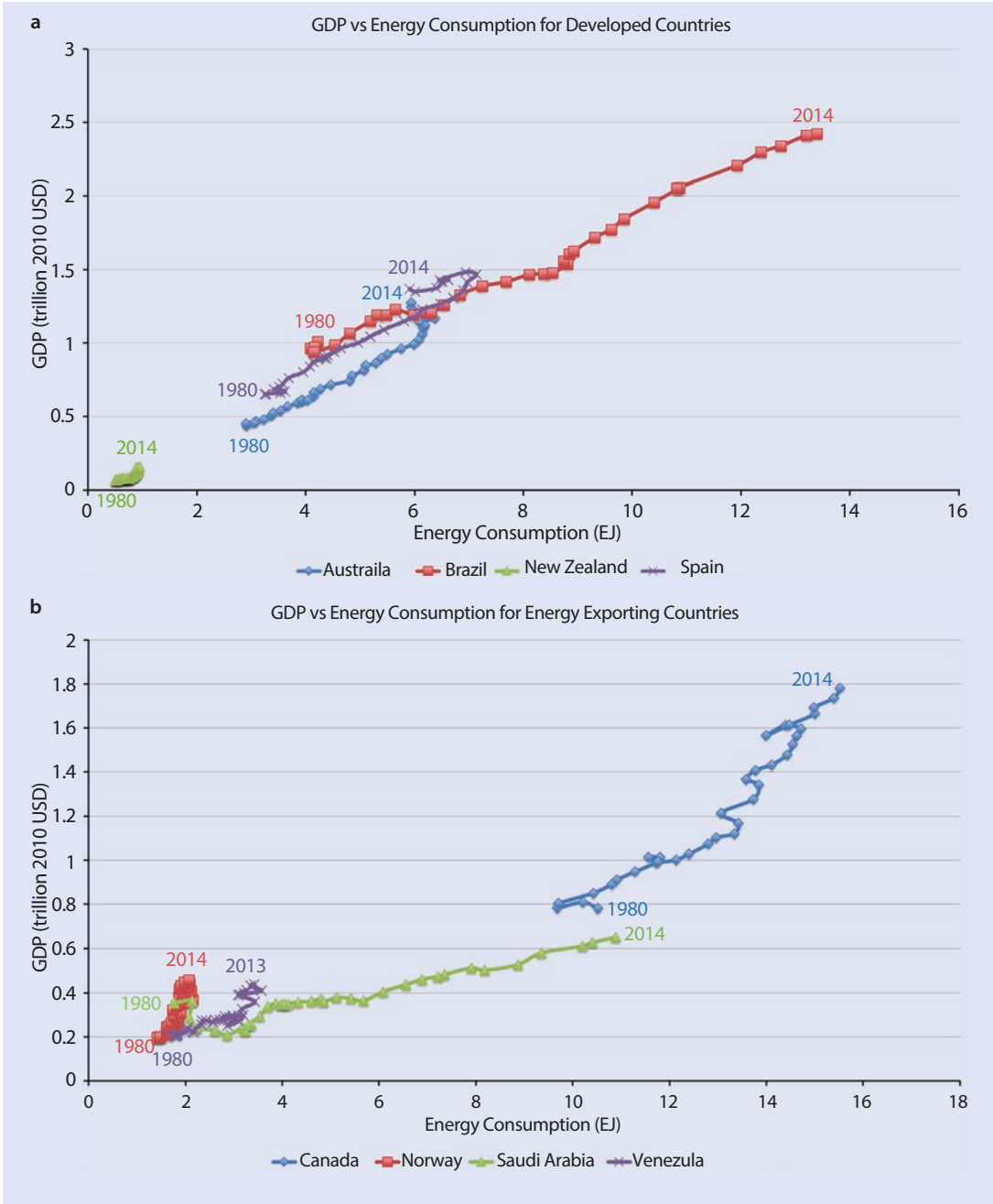


Fig. 11.7 **a** Energy use and GDP for several well-developed (the United States and Japan) and rapidly developing (China and India) nations. Note the relatively high apparent efficiency of the United States and Japan. Most relatively developed but still growing nations increase energy use in proportion to economic growth (Source: Ajay Gupta). **b** The same relation as Fig. 11.6a for large energy-producing nations, which use much more energy per unit GDP produced. This figure suggests that much of the reason for the apparent increase in efficiencies in, e.g., the United States and Japan (Fig.11.4) is due to the import of energy-intensive components (such as energy itself) to the economy

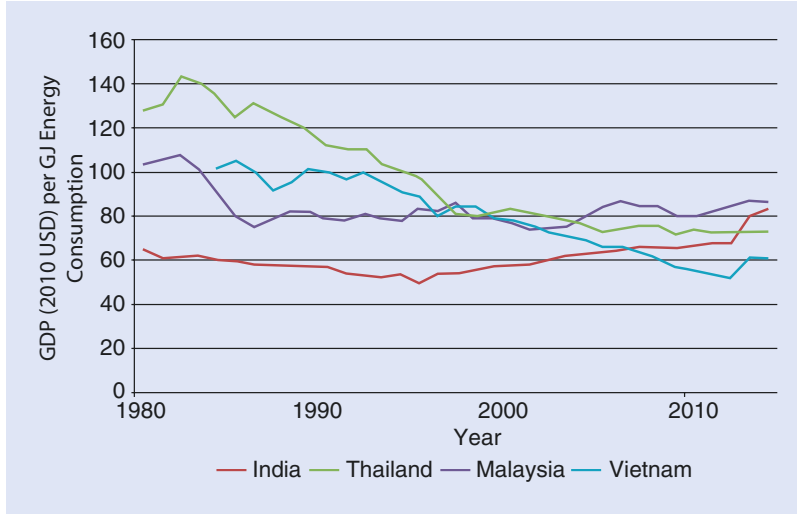


Fig. 11.8 The efficiency increases for some Asian countries, India, and decreases in others, Malaysia and Vietnam (Source: Ajay Gupta)

ues tend to become much more similar, i.e., that the main result for the disparity of the different countries is the degree to which each country is associated with undertaking the "heavy lifting" for others [26].

In our original paper, we also examined the efficiency of GDP vs. water and forest products used as well as agricultural output vs. inputs of fertilizer and found that there was always a strong relation between economic development, as indicated by GDP, and the use of resources with no indication of an increase in efficiency over time [24].

11.2.7 Development as an Increase in Energy Use

Our main conclusion from these and many other results is that for the vast majority of countries, there has been no increase in efficiency as measured by GDP produced per unit energy or other resources since "liberalization" of the economy. Instead it is clear that whatever economic growth has occurred as a consequence of (or at least highly correlated with) increasing the rate of the exploitation of energy and other resources. We conclude that neoclassical economics does not increase wealth by increasing efficiency in any sense that a scientist or engineer would recognize, at least by the relatively crude assessments we use, but only by increasing the rate of resource exploitation. These resources can be domestic or imported if there are other resources, including specialized human resources, that allow one to pay for them. If wealth comes from resource exploitation and not from efficiency, then the concept of development must be very tightly tied to the soils, climate, agricultural potential, mineral resources, and other biophysical resources that tend to be given short shrift in conventional economic analysis. If the human condition is to be made better, as has been the case in Costa Rica, it apparently requires as much attention to the biophysical as well as the political and monetary environment, and it must be within biophysical possibilities.

If neoliberal economics does not seem to be in agreement with empirical tests and in addition violates the basic laws of physics and is not consistent with its own assumptions (e.g., ▶ Chap. 3), then what alternative do we have to guide development or to attempt to operate our economies by, at least in the macro sense?

Our partial answer is *biophysical economics*, a rather imperfect but growing approach to economics that is based upon the recognition that wealth is fundamentally generated through exploitation of natural resources and that recognizes that economic policies are mostly about directing how energy is invested in that exploitation. The fundamental approach to biophysical economics can be found in our books (Hall [11], LeClerc and Hall [11]) and, of course, this one. This approach leads to some rather different views as to how we can improve the average economic plight of the poor of the world. In particular the biophysical model of development puts a real onus on the availability of affordable energy for successful development to occur.

There are many models of development including the Harrod-Domar (focusing on the importance of savings), the Rostow (focusing on

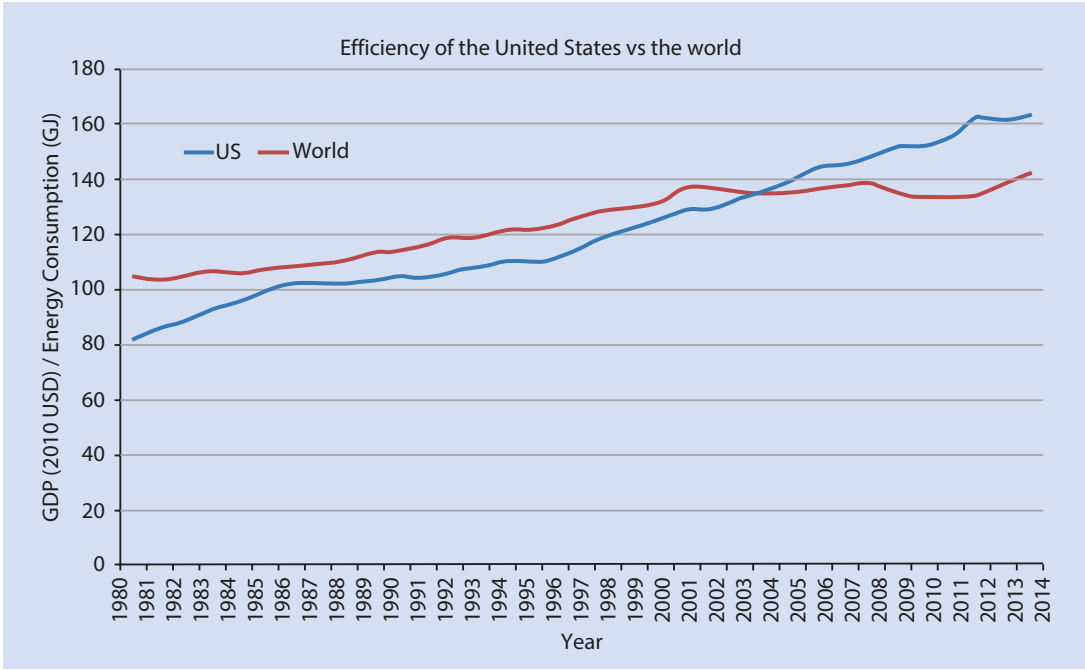


Fig. 11.9 While there has been an increase in apparent efficiency (GDP/unit energy) in a few highly developed countries such as the United States there has been little or no increase for the world as a whole, suggesting that much of the energy used to generate wealth by the highly developed countries has been outsourced

"stages of development"), and others. These are reviewed in LeClerc [19], and it is no secret that data that supports their importance in generating or even explaining development is pretty thin. We suggest another model, specifically the *biophysical model of development* which says that real material development (i.e., an increase in wealth) occurs only when the ratio: energy resources/number of people increases. This can be seen in Fig. 11.4, where per capita wealth increased only in those countries where per capita energy use increases (e.g. China and India).

While there are many theories of development (see review in LeClerc [11]), few of them are very powerful in predicting success or failure of development, and not surprisingly, few of them connect development directly to energy use. Hall [11] found many examples where development, at least as expressed as real GDP per person, is correlated very closely to the energy used per person. Where energy use has increased more rapidly than populations, people have become wealthier; where energy use has increased less rapidly than population, people get poorer.

While it is true that the United States and some other developed nations (Fig. 11.9) [11] have become more efficient in turning energy into GDP, according to Robert Kaufmann (personal communication), about half of that is due to the increased use of higher-quality inputs, and much of the rest is due to the change in the economy from industrial production (much of which has been exported) to services (or even, strangely, consumption!). The degree to which this can occur for other countries is not clear. The GDP produced per unit energy for the world as a whole has remained nearly constant or increased only slightly, suggesting that gains in the developed countries are matched by decreases in the less developed countries that often are undertaking more of the heavy industrial work for the developed nations [23]. Thus our explanation for increases in economic activity is that quite simply if more resources, and explicitly more energy, can be developed economic activity can occur. This energy is used to fuel the productive process which in the contemporary world is more dependent upon energy than either capital or labor [11]. While this is hardly news to most energy scientists, it is quite remarkably the degree to which it is a concept foreign to economists. Wealth comes from nature and the exploitation of nature and much less so from markets or their manipulation.

In all fairness it should be mentioned that it is not just the neoclassical model that seems to be having trouble generating economic growth. According to a web-based review (cepa.newschool 2004), there have been various models for encouraging development over time, and each has basically been abandoned when it had failed to generate much in the way of the desired development. This is in agreement with LeClerc's perspective. The CEPA review, and our own, concludes that any rationale for the dominance of the neoliberal model today and the evidence for its effectiveness is "ambivalent," at best, yet this perspective continues to be shoved down the throats of many developing nations.

If it is not clear that neoliberal policies have resolved the persistent economic problems of the developing world, why then are they pursued so continuously? The cynical view is that they serve rather nicely the interests of those who impose them by maintaining cash flow to the banks of the developed countries and their shareholders. Whether in fact net benefits always, or even generally, occur, or occur in a way that leads to net human welfare of all affected, is a much more contentious issue within the broader world of those who think about these issues than most economists are likely to agree to. If, for example, at the most trivial level, one can generate low prices by paying laborers as little as possible or by paying as little as possible for environmental cleanup then there will be strong pressures for this to happen. Such pressures are behind much of the move for globalization, although there are those that argue that by bringing developed world standards of labor treatment and pollution control to the developing world that too generates net benefits. We are unaware of much in the way of thorough systems-oriented case history research that examines whether or not this is true except for Brown et al. and Kapilinsky [27, 28].

11.2.8 Development in More Detail: Assessment of Sustainability in Costa Rica

We certainly recognize that the assessment above can be criticized for superficiality, although we believe the results are nevertheless basic and important. But we have, with our colleagues, undertaken such analyses in much more detail in the past. The most important of these studies has been for the economy of Costa Rica, which we have examined in great detail (e.g., Hall [11] a 761-page book published in 2000 with explicit, data-intensive chapters on each of the major segments of the economy) from a biophysical and conventional economics perspective. Our original purpose for undertaking this analysis was to determine how a sustainable society and economy might be developed. Subsequently we view the book as a model for undertaking biophysical economics. But to our surprise, our study (also given in LeClerc and Hall) found at least 19 reasons that Costa Rica (often the poster child of sustainability) could not possibly be considered sustainable. Many of these reasons were based upon the interaction of energy and resource use to create a situation of decreasing efficiency (as defined in this paper). These 19 reasons include:

1. Impossible debt loads which have been approximately constant since the 1970s and which drain the government of substantial precious revenue each year.
2. There are too many people to feed, especially without fertilizers and other industrial inputs to agriculture, which can hardly be made in Costa Rica. Even with these Costa Rica now imports about half its food, requiring even more foreign exchange.
3. This results in a need to generate foreign exchange for the necessary agricultural and food inputs.
4. Even with increasing inputs, the yield per hectare for most crops has not increased since about 1985 due to erosion, depletion of nutrients, and a saturation of response to fertilizers.
5. Costa Rica, as a nation with no fossil fuels, has been, continues to be, and almost certainly will become even more dependent upon imported fossil fuels. This is true despite the very great efforts that Costa Rica has undertaken to exploit its natural advantage it has with many renewable energies: hydropower, wind, and geothermal, all a consequence of its extensive and high mountains.
6. Therefore Costa Rica is extremely vulnerable to an increase in oil prices and eventual oil depletion. All oil-importing countries are very susceptible to decreasing future availability of oil. The continued population growth makes this problem more severe year after year. Attempts at a growth economy mostly have been negated by population growth, much of it from immigrants.

7. Despite enormous efforts there have been no "silver bullets" (i.e., magic solutions to problems), and probably, the concept of sustainable development has no utility, at least so far, except, perhaps, to make the user feel good and to attract tourists.
8. Nevertheless, Costa Rica has generated an extremely good society on a relatively small resource base. There is a great deal that the rest of the world can learn about the efficiency by which Costa Rica generates good government services on a relatively small monetary and resource base.

11.2.9 Discussion

Our main conclusion from these and many other results is that there has been no increase in efficiency as measured by these criteria since "liberalization" of economies. Such economic growth as has occurred is usually by continuing the general increase in the rate of resource exploitation and use, especially energy. Neoclassical economics does not increase wealth by increasing efficiency in any sense of a scientist or engineer, at least such as we can see, but only by increasing the real work done in economies including the rate of fuel use and resource exploitation, although of course these resources can be imported (if there are other resources, including specialized human resources, that allow one to pay for them). If wealth comes from resource exploitation and not from the economists' view of free market efficiency, then the concept of development must be very tightly tied to the soils, climate, agricultural potential, mineral resources, and other biophysical resources that tend to be given short shrift in conventional economic analysis. If the human condition is to be made good, as has been the case in Costa Rica, it requires apparently as much attention to the political as economic environment, but it all must be within biophysical possibilities.

So, in summary, what must we do if we seek economic development that works?

1. Examine neoclassical economics with suspicion.
2. Use the scientific method!
3. Build a real biophysical model of the actual economic possibilities based on the real resources of a nation and its population level.
4. Consider reducing demand through, e.g., population control as an at least equally viable development strategy to increasing economic activity and, hence, the need for fossil fuels.

Questions

1. Why do you think the world economy has been so globalized?
2. What early economist might be especially interested in seeing the degree of globalization that has taken place?
3. What was the "spice route"? What replaced, in part, its function? Can you give an energy argument for that?
4. What has been the relation between imperialism and foreign trade?
5. What does "development mean"? What are some of the groups that encourage development today? (I am meaning government foreign aid, NGOs, and local investors.)
6. Many say that economic globalization is a two-edged sword with positive and negative aspects. What are some of the positive aspects? Negative?
7. Have most development models been tested? Why or why not? If so what results were found?
8. Do you think it is always difficult to test whether economic models work? Why or why not?
9. How is efficiency different from efficacy?
10. Define several uses of the word efficiency related to global issues.

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