

Don't Sell the Farm: The Trophic Theory of Money

Agriculture...accounts for just 3 percent of national output. That means that there is no way to get a very large effect on the US economy.

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TODAY WE HEAR all kinds of talk about the “Information Economy.” We are, it is said, no longer in the industrial era. This transformation from the industrial to the information economy was one of the “megatrends” outlined by John Naisbitt in his bestseller of the same name.¹ In the United States and most of Europe, we’ve already broken through. We’re in a bona fide information economy, and presumably that warrants an exclamation mark! In China, on the other hand, the industrial fires burn so intensely that an information economy might have to emerge from the ashes, assuming it does emerge. India is a curious case in which the information sector seemed to rise out of almost no ashes, with little industrial phase to bid adieu. Of course, most of the information services in India are provided to Americans and Europeans via phone line and Internet. Is there, then, an Indian information economy? Or is it a Euro-American information economy with an Indian supplier? Or is it “Chimerica,” the Chinese-American saving-spending partnership described by Niall Ferguson,² subsidized by an Indian information sector? Does it matter?

Yes it does, because the information economy supposedly has tremendous implications for economic growth, nationally and globally. Basically, the argument goes like this: More and more of our economy involves transactions in which the product is simply information. Therefore, less and less resources are being used up in the course of economic activity.

It is an utterly fallacious argument, namely, the self-sufficient services fallacy.

A good example of the self-sufficient services fallacy appeared in an opinion piece by Katherine Ellison, “What if they held Christmas and nobody shopped?”³ Ellison began with a timely reminder that the profligate consumption characterizing Christmas in the US has a heavy ecological footprint. She rightly noted that such consumption is finally being scrutinized by various organizations. She noted, “The rapid rise of anti-growth groups... suggests people are catching on to what one recent book dubs the fallacy of ‘shoveling coal on a runaway train.’”

Actually, the book was *Shoveling Fuel for a Runaway Train*, and the title was not meant to dub a fallacy but to introduce a metaphor. (I know because I wrote the book.) The “runaway train” is the American economy, and “shoveling fuel” describes the effect of conspicuous consumption. When we’re on a runaway train, heading for a wreck, the last thing we ought to spend precious time on is shoveling fuel!

Getting the title of my book wrong was a minor gaffe, but she was just getting started. Ellison described an interview with Herman Daly, who defended the merits of a steady state economy and then “tried to turn the tables, asking, ‘What do *you* [Ellison] think the future is going to look like?’” Ellison responded, “I’m not really looking past the holidays.” That’s a very human, humble acknowledgement, and would probably resonate with many busy readers. If she had looked past the holidays, however, an admirable New Year’s resolution would have been to learn a little steady state economics!

Instead, Ellison speculated, “In that cowardly spirit, here’s my compromise. This winter, I plan to support the US service

economy. I may just buy mom a massage, give my kids an hour of rope-climbing, and find a personal trainer for my husband.... I can help keep the world economy chugging without contributing to all those greenhouse-gas emissions..." With this reasoning, Ellison committed the self-sufficient services fallacy. It is probably the most common fallacy among those claiming there is no conflict between economic growth and environmental protection. The key point in debunking this fallacy is that the service sectors—including massages, rope-climbing and personal training—are part of an economy that grows as an integrated whole. This will be a common theme over the next two chapters.

To Ellison's credit, she did not use the self-sufficient services fallacy to promote economic *growth*, at least not explicitly. She used the non-committal "keep the world economy chugging" rather than "keep the world economy growing." An economy may chug at a sustainable level; indeed that's a steady state economy. Unfortunately, if we use the self-sufficient services fallacy to promote economic chugging (or anything else, for that matter), we empower others to use the fallacy to promote economic growth. The difference would be one of degree and not of principle.

For example, one could say, "I plan to support the service economy even more than Katherine Ellison. I'll buy mom *five* massages, plus all kinds of information. I can help keep the world economy *growing* without contributing to all those greenhouse gas emissions." That would be wrong, and dangerously so. Unfortunately, the self-sufficient services fallacy appears to be a seductive argument for many, many people (especially politicians). That is because equally many people have not studied ecology, in particular the concept of trophic levels.

The best way to demonstrate the concept of trophic levels is with a simple diagram (Figure 7.1). Trophism refers to the transfer of energy and nutrition from one organism to another in the process of feeding. In the economy of nature, only plants produce their own food, with the process of photosynthesis. The growth of plants is called "primary production." All animal life depends on the plant

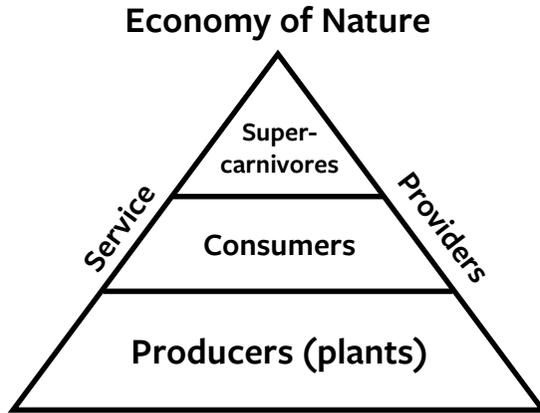


FIGURE 7.1. Trophic levels in the economy of nature. Service providers interact throughout all levels.

community for nutrition. Some animals eat plants directly, some eat animals that eat plants, and some eat animals that eat animals that eat plants. Each of these levels has a name: producers (plants), primary consumers (animals that eat plants) and secondary consumers (animals that eat those animals). Species in the highest level, such as lions, eagles, crocodiles and sharks, are sometimes called “super-carnivores.”

Sometimes the precise location of a species in this system is nebulous. For example, a coyote living in one geographic area may subsist almost entirely on plant materials (grasses, tubers, berries, nuts, etc.), while a coyote living in another area may subsist primarily on small mammals and birds. It becomes even more difficult when some of the super-carnivores are considered. In many areas during the spring, grizzly bears are vegetarians. In many of the same and other areas, they specialize in harvesting salmon, which themselves are predators. So in the course of a few months, a single grizzly can go from being a primary consumer to a super-carnivore. And of course this can even happen during the course of a day, as when the bear locates a productive berry patch along the shore of an equally tempting salmon stream. However, such difficulty in categorizing species according to their trophic levels does not reduce

the applicability of this concept to the human economy. In fact, it makes the two economies even more analogous, as we will see.

In the economy of nature there are also a wide variety of species that do not easily fit into any trophic level at any time. These include bacteria, worms, bumblebees, leeches . . . small invertebrates, for the most part. These species have odd ways of making a living. They neither produce nor consume, at least not in a predatory fashion. Some of them are parasites, but virtually all are beneficial to the economy as a whole.

A large percentage of these species (myriad bacteria, for example) make their living by decomposing plant and animal materials that are either too small, too spoiled or otherwise too indigestible for “regular” consumers. Were it not for them, the Earth would rapidly become a heap of organic rubble. Some of them, like bumblebees, ingest minuscule amounts of plant nectar. In the process, moving from flower to flower, they pollinate these plants, and without them many plant species would go extinct, eroding the base of producers. Some of them, like earthworms, ingest undifferentiated organic matter. In the process, they unwittingly till the soil, making it more porous for water infiltration and efficient root growth. All of these types of species, in essence, provide services to the economy as a whole. Depending precisely on how you distinguish these service providers from “true” consumers, they constitute a high proportion of species.

The human economy also consists of trophic levels (Figure 7.2). This has been recognized in some sense at least since the 1760s when Quesnay set out to demonstrate that the true producers in the human economy were farmers (Chapter 3). Farmers, in other words, comprised the producer trophic level in the human economy, although Quesnay did not put it in terms of trophic levels. Later economists disagreed, first arguing that labor applied in other (non-agricultural) activities was also productive, then arguing that capital itself was. The arguments about what truly constituted “productivity” among the likes of Adam Smith, David Ricardo, John Stuart Mill, and Karl Marx boiled down to a matter of semantics

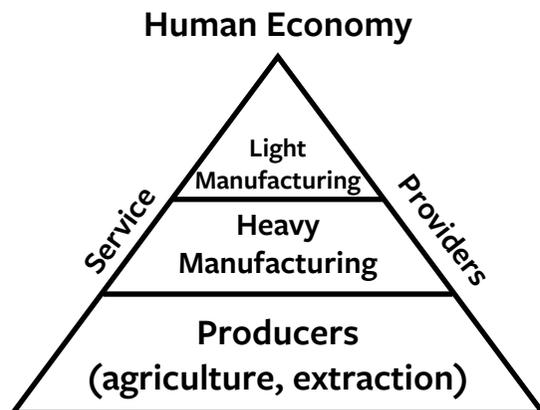


FIGURE 7.2. Trophic levels in the human economy. Service providers interact throughout all levels. Not shown is the foundation of “natural capital” that is farmed and extracted.

(albeit with ideological intent in Marx’s case at least). Perhaps such argumentation could have been avoided, or at least relegated to an appropriately lesser notch of importance, if only Quesnay had gone a step further. The fact is that the farmers themselves are not quite the ultimate source of productivity either. Just as in the economy of nature, the *plant community itself* best qualifies for the title of “source.” Vegetarians or not, all animal species (including *Homo sapiens*) depend on the plant community for life. This will be so unless technology is developed to create entirely synthetic foods, in which case the consumers won’t quite be human.

In the human economy, most members do not make their living by literally eating what exists in the next lowest trophic level. Instead, the bottom level consists of a variety of resources that many humans harvest to make their living. In addition to plants, these resources include minerals, petroleum, fish and—today—even water (Chapter 1). Most of these resources are not even living, so it would be inappropriate to call the entire collection producers. Only the plants actually produce their own food. And some of these resources (fish, for example) exist at a higher trophic level in the economy of nature. Nevertheless, what these resources all have in common is that they comprise the foundation of materials

upon which the rest of the human economy is built. In ecological economics, these materials are often called “natural capital.” So the lowest trophic level of the human economy is natural capital or, in less fancy terms, land. This terminological variety has the advantage of resonating with neoclassical economists as well as ecologists, farmers and common sense.

With natural capital at the base of the human economy, the primary consumers are farmers, loggers, miners, ranchers, oilmen, fishermen and others who harvest goods directly from the land. Among these primary consumers, the farmers come closest to being true producers (à la Quesnay) because they participate closely with the process of photosynthesis.

The manufacturing trades, on the other hand, are clearly two steps removed from the foundation of the economy (natural capital), because they harvest nothing. They use the raw materials extracted by the primary consumers to manufacture goods. They range from a heavy manufacturing base (such as iron ore refining) up through the trophic pyramid to the lightest manufacturing sectors (such as computer chip manufacturing). Heavy manufacturing requires the rawest of materials, whereas much of the light manufacturing can be done with raw, refined or manufactured materials flowing from lower in the trophic structure.

In the human economy, the service sectors also defy placement in a particular trophic level. Truck drivers, bankers, waitresses, janitors, gravediggers—none produce or consume in a systematic fashion that proceeds upward from one trophic level to the next. The truck driver may deliver a load of cotton from farm to factory one day, and a load of fence posts from factory to farm the next. The banker may lend to the farmer or to the industrialist. Waitresses wait on farmers, industrialists and bankers. All contribute to GDP.

As described in Chapter 2, GDP is simply a measure of the scale of human economic activity, and it depends on how many humans are economically active and how active each one is. An analogy to GDP in the economy of nature is the amount of biomass production, biomass being the sum total of living flesh.

The growth of biomass on Earth got off to a slow and tentative start. The economy of nature apparently started with a “primeval soup” in which, by act of God or random chance, a chemical reaction involving carbon apparently produced a self-perpetuating and therefore living form.⁴ Some creation theorists attribute the beginning of life to lightning, a sort of biological big bang, which they say provided the energy to catalyze this reaction. Perhaps in a series of chemical “experiments,” various forms of life blinked in and out of existence for millions of years. As they say, the rest is history, albeit natural history, and today’s global biomass is approximately 2 trillion tons.⁵ It’s not increasing ad infinitum, however. Rather, biomass and species diversity have waxed and waned for the past 540 million years, punctuated by five great episodes of extinction.⁶

It bears repeating that nature’s GDP has not increased ad infinitum, nor was it ever slated to. Neither is the human economy. In fact, this is probably the right time to offer readers a sound-bite, radio-friendly refutation of perpetual economic growth. You’ll win the debate with it every time. To think there is no limit to growth on a finite land mass (Earth, let’s say) is precisely, mathematically equivalent to thinking that one may have a steady state economy on a perpetually *diminishing* land mass. In other words, we could gradually squish the \$70 trillion global economy into one continent, then one nation, then one city...you get the picture. It’s becoming an “information economy,” right? So eventually we could squish it into your iPod, leaving the rest of the planet as a designated wilderness area.

Have you ever heard anything so ludicrous? Yet it’s precisely, mathematically as ludicrous as thinking we could have a perpetually growing economy on Earth.

Let’s look a bit more at biomass and then apply some ecological principles to the human economy. Biomass is analogous to GDP because, in nature, virtually all activity is economic, and no biomass is inactive. Unlike certain stocks of manufactured capital, such as sheetrock or fence posts, biomass can’t just sit there idle. Of course there are shades of exceptions, such as a hibernating reptile or the

bark of a tree, but in general the life of a nonhuman is a perpetual struggle to obtain the resources required for survival and reproduction. Ecology, therefore, is primarily about the allocation and distribution of resources in the economy of nature. Ecologists are the economists of nature.

If the “success” of the human economy is measured by its level of activity, or GDP, then presumably the success of the economy of nature may be measured by its level of activity. And that is best measured by the amount of biomass. One may wonder about the propriety of using biomass as a measure of “success.” After all, what if we compared 40 billion tons of algae and bacteria with 40 billion tons of gorillas and humans? However, this question does less to negate the analogy than it does to negate the use of GDP as a measure of success in the human economy. GDP does not differentiate whether the economy is one of poor tenant farmers and a handful of wealthy landlords, or the more diverse economy we currently experience. The useful thing about GDP is that it does indeed provide a gauge of the economy’s growth, regardless of whether or not the growth is a good thing.

Theoretically, a growth in biomass may come strictly from more plants, but growing biomass typically means that the ecosystem is growing as an integrated whole. Therefore, a growing economy of nature means more consumers as well as producers. Likewise, while growth in GDP could theoretically come strictly from more farmers, a growing GDP typically means that the economy is growing as an integrated whole. Therefore, economic growth means more manufacturing and services as well as more farming.

“Success” may also be measured within various subsets of the economy. We may say, for example, that an increasing proportional contribution of entertainment to GDP makes it a successful sector, just as we may say that an increasing proportional contribution of cervids (antlered mammals) to biomass makes it a successful sector. Viewed in terms of these subsets, “success” seems like a more pertinent concept than it does as applied to whole economies. After all, the entertainment sector grew because its employees successfully

competed with other sectors, like the restaurant industry, for resources. Meanwhile the cervid sector grew because its species successfully competed with other sectors, like bovids (horned mammals), for resources.

Finally, this leads us to the implications of trophic levels for perpetual economic growth. One of the fundamental principles of the economy of nature is that no trophic level may consist of more biomass than the underlying trophic level. In other words, the success of any one trophic level is dependent upon the success of the underlying trophic level. This follows simply from the second law of thermodynamics—the entropy law—and from the life histories of species.

The second law of thermodynamics, to put it in the simplest of terms, is that all things tend to disorder.⁷ It takes energy to organize anything, whether it's a steel beam with the energy derived from coal or a cervid's antlers with the energy derived from grass. But neither of these products will last forever. They ultimately break down into a collection of substances with less order, or less embodied energy, because some of the energy is dissipated into the environment as the product breaks down. If this were not the case, the Earth would gradually be replaced by a giant collection of everything that had ever been converted from its elements. Instead, in the real world, it's "ashes to ashes, dust to dust" and along the way some piles of rust.

Conversely, the construction of these products took more energy than was finally embodied, because energy was dissipated along the way. In smelting the iron, much of the coal's energy was dissipated as heat. In growing the antler, much of the plant's energy was likewise dissipated. Thus the ecological principle that no trophic level may consist of more biomass than the one upon which it feeds.

Not only must one trophic level contain less biomass than the underlying trophic level, but there are limits to the *fraction* of an underlying trophic level's biomass that may be attained by the overlying trophic level. This too follows from the entropy law, which

essentially states that nothing is perfectly efficient. These proportions are not readily ascertained; we can never expect to know precisely how much antler may be produced in proportion to how much browse is consumed, or how much iron may be smelted in proportion to ore and energy consumed. The precise proportion is purely academic. For what it's worth, though, academics who study this subject of "ecological efficiency" indicate that each trophic level contains approximately ten percent of the biomass of the next-lower trophic level. For example, in an ecosystem with 10,000 tons of producers, one may expect approximately 1,000 tons of primary consumers and 100 tons of secondary consumers. In a simplified example with only three species and three trophic levels, we might have 10,000 tons of grass, 1,000 tons of elk and 100 tons of mountain lions. Perhaps it is even possible to have 10,000 tons of grass, 2,000 tons of elk and 400 tons of mountain lions. Perhaps. But certainly we cannot have an ecosystem comprised of 10,000 tons of grass, 10,000 tons of elk and 10,000 tons of mountain lions, much less an ecosystem comprising 100 tons of grass, 1,000 tons of elk and 10,000 tons of mountain lions. There is a limit to efficiency (second law of thermodynamics) and, even more fundamentally, a limit to matter and energy (first law of thermodynamics). You can't convert 10,000 tons of grass into 10,000 tons of elk because that would entail absolute efficiency, violating the second law of thermodynamics. Likewise, you can't convert 10,000 tons of grass into 100,000 (or even 10,001) tons of elk because that would entail something from nothing, violating the first law of thermodynamics.

In the economy of nature, the life histories of animals also contribute to the "inefficiency" with which one trophic level's biomass is converted to the next. Elk, for example, expend a great deal of energy at various life stages in looking for mother, playing, escaping insects, wallowing, dispersing, fighting, courting and mating (plus, for females, raising their young). If all the bull elk's resources were devoted to maximizing the efficiency of antler growth, it would come at the expense of its other activities, including the primary advantage of growing the antlers (that is, successful courtship).

This would hardly be efficient in a holistic sense. If all the resources of a steel manufacturer were devoted to maximizing the efficiency of the smelting process, it would have none left for its other activities, including the primary reason for manufacturing the steel, selling it. Efficiency is a slippery concept, when viewed in a holistic and practical sense.

The service providers, too, are limited in proportion to the trophic levels with which they interact. Bumblebees do not live without flowering plants, unless they evolve a whole new way of living (in which case they tend to become different species, not bumblebees). Meanwhile, plants that have become dependent upon bumblebees for their pollination do not live without bumblebees, unless they evolve a different mode of pollination, including perhaps self-pollination. Similarly, chainsaw mechanics do not live without loggers, unless they evolve a new way of living (in which case they become a different economic species). And vice versa with loggers, unless they adapt to maintaining their own saws completely. This means that the amount of bumblebee biomass is dependent on the biomass of flowering plants, while the GDP contribution of chainsaw mechanics is dependent on the GDP contribution of loggers.

What all this means to the human economy is precisely the same as it means to the economy of nature: just as the capacity of the economy of nature is based on the amount of primary production, the capacity of the human economy is based on the amount of natural capital. Within this economy, the production of the manufacturing trophic level is dependent on the production of the primary consumers—the farmers, miners, loggers and such. The service providers depend on the whole system.

Is the empirical evidence consistent with this theory? Of course it is. People don't eat unless the farmer and fishermen do their jobs. That doesn't mean the GDP figures will stack up neatly in a pyramid of trophic levels. For example, a pile of two-by-fours costs more than the tree from which it was milled, and a house costs more than the two-by-fours required for its construction. On it goes through all sectors of the economy, the "value-added" prod-

uct “contributing” more to GDP than the natural capital. For two centuries this added value has been attributed primarily to labor or capital. The mill worker added value to the log by milling it into a pile of two-by-fours, and the construction worker added value to the pile of two-by-fours by constructing the house. The effect is to veil or distort the trophic levels in the human economy, such that the GDP attributed to agricultural products and other natural capital is actually less than that attributed to manufactured products, and far less than that attributed to the service sectors. Therefore, we shouldn’t be surprised if a single television episode of *American Idol* “contributes” more to GDP than one seasonal episode of Iowa’s corn crop. The former is good for full belly laughs, while the latter is only good for filling the bellies. Right now we pay a lot more for the former.

This modern-day mismatch between trophic levels (with profound value at the bottom) and GDP figures (with big money spent at the top) has led neoclassical economists astray. There seems to be a neoclassical sucker born every minute. For example, William Nordhaus, Sterling Professor of Economics at Yale University, famously stated: “Agriculture, the part of the economy that is sensitive to climate change, accounts for just 3% of national output. That means that there is no way to get a very large effect on the US economy.”⁸ Herman Daly traced a succession of nearly identical errors,⁹ at one point even committed by Thomas C. Schelling, a past professor of economics at Harvard, past president of the American Economic Association and 2005 Nobel laureate. In a 1997 issue of the prestigious *Foreign Affairs*, Schelling persuaded readers not to overreact to climate change by stating, “in the developed world hardly any component of the national income [GDP] is affected by climate. Agriculture is practically the only sector of the economy affected by climate, and it contributes only a small percentage—3% in the United States—of national income. If agricultural productivity were drastically reduced by climate change, the cost of living would rise by 1 or 2%, and at a time when per capita income will likely have doubled.”¹⁰

Let's not be sidetracked by the context of climate change. It wouldn't matter if the agricultural decline was from climate change, a population explosion of woodchucks or a farmland invasion of space aliens. The salient point is that Nobel laureates with no background in ecology are talking about per capita income doubling while agricultural productivity is "drastically reduced." And not just talking over a beer at a backyard barbeque. Rather, talking in *Foreign Affairs*, giving influential policy advice. It would seem ridiculous enough to be funny, if it didn't put us in such serious trouble!

This misleading distortion—percentages of GDP increasing as we move from the most to the least essential of economic sectors—compels me to advance what I would like to coin, so to speak, the "trophic theory of money."¹¹

Few economists have examined the origins of money, at least not in the sense of "origins" that is satisfactory for our purposes. Adam Smith devoted Chapter 4 of *The Wealth of Nations* to the origins and use of money, but the portion dealing with the *origins* of money, including the *preconditions of its existence*, was limited to the first two paragraphs. Keynes's biographer described how Keynes "succumbed repeatedly to his 'Babylonian madness'—an essay on the origins of money,"¹² but this was really a study in historical numismatics (the study of currency) and metrology (the science of measurement). Other great minds have likewise given short shrift to the real origins of money. Rupert Ederer attempted to summarize these accounts in *The Evolution of Money*,¹³ but went on to focus on the properties and use of money. Economics texts today totally disregard the origins of money. Chapters on the "creation" of money focus on the injection of money into the economy by national banks. That's like focusing on the grocery store as the origin of milk.

Let us be perfectly clear. The real origins of money were in the agricultural surplus that freed the hands for the division of labor. This made money a meaningful concept. Adam Smith alluded to this, but didn't emphasize or clarify it, and didn't have the benefit of

trophic theory to do so. Prior to agricultural surplus, no one got to focus on spinning cloth, building houses, accounting for anything, writing books, dancing with the stars or doling out legal tender. That's the trophic theory of money in a nutshell, and it's just as relevant today as it was in the early stages of human evolution. Today as then, it is only when someone else produces our food that we are free to think about clothing and shelter, much less dancing, accounting, writing books or paying for anything. Without an agricultural surplus, our hands are on the plow, not on the keyboard and certainly not on a meaningless wallet. Our feet are in the field, not on the treadle, not on the floor of the stock exchange and certainly not on the dance floor.

The trophic theory of money has much more to offer, however, than basic insight about the evolutionary origins of money. It also tells us that the real (non-inflated) money supply today is in direct proportion to the amount of agricultural surplus. When a stock market crash, a "liquidity crisis" or a fiscal impasse strikes at the heart of economic growth, we had better look deeper than derivatives peddlers, bailed-out bankers or careless Keynesians in the government. The usual suspects from the financial and fiscal sectors are problematic, all right, but these financial and fiscal crises are becoming increasingly *real* as we approach limits to economic growth. The real money supply, reflecting the production and consumption of real goods and services, can only grow so far. Forcing it to grow further results in nothing but inflation.

Neoclassical economists who discount the importance of agriculture have clearly not evolved to comprehend the implications of trophic levels. Ecological economists have, for the most part. Still, I wish to take this chapter one step further, into implications that even most ecological economists have not yet fully comprehended. The trophic theory of money implies that real (non-inflated) GDP is a reliable indicator of the amount of agricultural surplus and of the "ecological footprint" of the human economy. Not a direct measurement, but a reliable *indicator*. To establish this implication, a closer look at the ecological footprint concept is required.

The ecological footprint is a measure of our demand on the planet. It is expressed as the acreage of land (and sea) required for regenerating the resources we consume and for absorbing our pollutants. Ecological footprinting makes it possible to estimate how many planets it takes to support us with a given lifestyle. It is extremely important to bear in mind that there is but one planet—Earth—known to be conducive to the human economy.¹⁴ At this point in history, the best available ecological footprinting research indicates that we use the equivalent of approximately 1.5 Earths to provide our resources and absorb our pollutants. In other words, it now takes the Earth one year and six months to regenerate what we use in a year. Of course some of us (such as average Europeans, Japanese and especially Americans) have a far larger ecological footprint than others (such as average Indians, Kenyans and Bhutanese). But the matter of international equity is for Part 4. Here we are focused on the relationship between GDP and agricultural surplus, and thenceforth the ecological footprint.

To establish the relationship between GDP and the ecological footprint, let us start from the lower extreme: if there were no humans on Earth, and therefore no human economy, by definition the ecological footprint would be zero. So far, so good!

Now let us consider the earliest stages of hominid evolution, when humans struggled among their fellow mammalian species for the basic habitat components of food, water and cover. Was there an ecological footprint at that point in prehistory? Some would say yes, there was a small and growing ecological footprint, while others would say that humans were just part of the economy of nature, and that an “ecological footprint” was as yet irrelevant. This is a matter of semantics and irrelevant for our purposes. We are concerned with the relationship between the money supply and the ecological footprint. Such a relationship did not exist prior to widespread agricultural surplus, when money came into being.

By the time we humans got to the point of using money, the concept of an ecological footprint was quickly becoming relevant. In fact, the earliest forms of money were themselves agricultural commodities, such as the shekel in ancient Mesopotamia, which

originated as a unit (approximately 180 grains) of barley. The amount of barley produced was a function of the amount of land irrigated along the Tigris and Euphrates Rivers. The amount of Mesopotamian land irrigated or otherwise occupied and managed by humans was one of the first recorded indications that humans were vulnerable to the limits of their ecosystems. Today, when the process of human-induced desertification is discussed in scientific circles, Mesopotamia is cited as the quintessential precedent. It is no coincidence that Mesopotamia is also one of the first regions to be mentioned when discussing the history of money.

Over the course of a few thousand years, the shekel evolved into units of silver and gold. More money, then, meant more mining, which itself would clearly indicate a growing ecological footprint. More importantly, though, many of the silver and golden shekels were spent on barley and other agricultural products. Metallic shekels had value because they were accepted for the purchase of food, raw materials, clothing and other finished goods and services. The production and consumption of each of these goods and services took their bite out of Earth, and the increasing flow of shekels reflected the growing ecological footprint.

Eventually, of course, shekels were also spent on arms, ammunition and all the accouterments of colonization and national defense. In other words, the governments of empires “got money” and took over its management. Meanwhile, it is impossible to imagine a war without an ecological footprint. More shekels spent by the government on warfare, along with more shekels spent on private goods and services by individuals, continues to indicate a growing ecological footprint.

Eventually money evolved (or devolved, depending on the perspective) into paper, but the way it was used barely changed at all. Money is valuable because it is legally tendered for goods and services, private or public. The use of more money indicates an increasing volume of goods and services.

The connection of a growing money supply to a growing ecological footprint should be coming into focus by now. There are but three phenomena that might distort or delay our focus. Moving

from the simplest to the most complex, these phenomena are: inflation, technological progress and “animal spirits” (a Keynesian term).

Inflation of course refers to a rise in prices. When prices increase, your money buys less. As inflation progresses, you start to lose confidence in your money. If inflation runs rampantly into a condition of “hyperinflation,” your money becomes worthless. When money becomes worthless, you and fellow citizens get angry and frustrated and you panic. Social and political upheaval is sure to follow. Inflation is a monster, and economists of all ilks recognize it as such. Inflation was the economic origin of the Third Reich. Inflation is precisely what happens when a monetary authority (such as the Federal Reserve System in the United States) increases the money supply faster than the real economy can grow. Recent periods of rapid, real economic growth (such as we had in the latter decades of the 20th century) have tended to result in inflation, because the monetary authorities are too removed from the realities of economic life to understand the ecological limits to growth. Monetary authorities sometimes complain about a lack of “consumer confidence.” In a full-world economy it is probably more appropriate for consumers to complain about the childish “confidence” of monetary authorities, which leads to inflation.

For our immediate purposes it is necessary to acknowledge the simple fact that inflation can cloud the tight relationship between real GDP and the ecological footprint. However, the cloud is quickly lifted when we specify that we are talking about “real GDP,” or GDP adjusted for inflation. And it makes little sense to speak of “unreal” GDP, or GDP not adjusted for inflation. GDP was always intended to indicate the level of production of real (not unreal) goods and service. This level of real production is accurately reflected by monetary expenditures and income only if the monetary unit is not inflated or deflated. Allowing inflation to shroud the linkage between GDP and the ecological footprint could only happen in amateur circles, but it has to be mentioned here and now set aside.

Technological progress is another story. It doesn't take an amateur to become befuddled by the implications of technological progress. Technological progress allows the same amount of natural capital to produce a greater amount (or value) of goods and services. With technological progress, apparently, economic production may increase without a growing ecological footprint. In other words, real GDP may increase without a growing ecological footprint. Theoretically, we could reconcile the conflict between economic growth and environmental protection with technological progress. So let's just keep progressing technologically and we can continue to grow the economy, with no additional environmental impact.

If you smell a fish, you have a good nose. We will explore your olfactory savvy in Chapter 8 and digest the relevant findings. As an *hors d'œuvre*, let us recall that there's no such thing as a free lunch. Technological progress is not free, and its costs add up in real GDP. Ultimately, technological progress is limited by the laws of thermodynamics. (Remember, we can't produce something from nothing, and we can't get 100 percent efficiency.) This leaves us with only animal spirits shrouding the relationship between GDP and the ecological footprint.

I am taking a bit of rhetorical license here, because "animal spirits" was coined by Keynes to describe the emotions or attitudes of consumers. Here I am adapting the term to describe not only the "propensity to consume," as Keynes called it, but the propensity to *use money* in order to consume. Even in the most modern of monetary economies, the use of money is not necessarily required for consuming things we find valuable such as friendliness or compassion. It is our common sense or "animal spirits" that tell us when it is appropriate to use money for procuring satisfaction. Using the term "common sense" reflects stability in our judgment of when to use money; using the term "animal spirits" reminds us that our judgment may be altered (or may falter) at times. As with inflation and technological progress, animal spirits could shroud the relationship between GDP and the ecological footprint.

For example, if two billionaires were determined to prove that there is no relationship between GDP and the ecological footprint, they might say, "Let us now pay each other a billion dollars apiece for saying the word "ombudsman." One billionaire would say "ombudsman" and the other would pay her a billion dollars. The latter would echo "ombudsman" and be paid back the billion dollars. On and on the utterances of "ombudsman" would go until, by the end of the day, a trillion dollars had been "spent" on utterances of "ombudsman." If each billionaire claimed that the utterance of "ombudsman" was a finally produced good or service, would our national income accountants argue? They might, unless the political pressure to demonstrate GDP growth was irresistible.¹⁵ And for those vested in perpetual economic growth theory, the temptation would be difficult to resist, politics or none. After all, a trillion dollars would have been spent—even "earned"—in one day among two people, to prove that we could "dematerialize" economic growth.

Imagine if everyone with time on their hands spent the day exchanging money for utterances of "ombudsman!" And imagine that such expenditures were added to the official calculations of GDP. That would shoot the trophic theory of money, for it would disengage the relationship between GDP and the ecological footprint.

Of course, no one spends the day uttering "ombudsman," nor does anyone spend money on such utterances. The monetary animal spirits aren't crazy enough. Nor would you pay a friend to say "hi." In fact, you wouldn't even use money to pay your husband or wife, boyfriend or girlfriend for giving you information about the weather, dinner ingredients or their state of mind. Nor would such non-paid activities have a significant ecological footprint. Such are the animal spirits—and common sense—with regard to the use of money.

In other words, "real" expenditures go toward real things—real goods and services—that have real ecological footprints. Real expenditures do not go toward non-material things with no ecological footprints.

To be more precise, expenditures might go toward non-material, unreal things, but only for short unsustainable periods of time. This

may occur, for example, when unscrupulous salesmen stir up demand for unreal “assets” such as derivatives. Soon enough, however, analysts (including consumers with common sense) conclude that these assets are actually unreal. Then the markets for these unreal assets crash and, if enough suckers bought in, we find ourselves in the midst of financial crises. Sure, not much of an ecological footprint would be associated with the “increase” in GDP, but no real increase in GDP occurred to begin with. That is why the markets crashed, back down to Earth, back down to the real economy of goods and services, produced and consumed by real people with common sense.

In a sense, the use of money is a type of social contract, not only between citizens and government, but between consumers and producers. In the classical, political social contract (à la Thomas Hobbes and John Locke), citizens gave up sovereignty to a central government in order to procure social order through the rule of law. Eventually this social contract included the creation of a monetary authority, such as the Federal Reserve System in the United States. However, the monetary social contract goes beyond the relationship between citizen and government. Pursuant to the monetary social contract, not only do citizens give up their sovereignty to the monetary authorities, but consumers give up purchasing power (in the form of money) to producers, with the understanding that what is produced will benefit them (the consumers) in a real, tangible fashion.

When a political social contract is deemed violated by the citizens en masse, a revolution or anarchy ensues. When a monetary social contract is deemed violated by consumers en masse, and whole classes of “products” (such as derivatives) are found to be bogus, a financial crisis ensues. When a government is complicit in a bogus monetary social contract (for example, by investing tax revenues in derivatives), a crisis in political economy ensues. In any event, when bogus production and consumption (such as payment for the utterance of “ombudsman,” or for derivatives) become widespread, the monetary social contract is violated, markets crash, inflation ensues and real GDP is brought back down to Earth,

whereupon it once again reflects the ecological footprint of the human economy.

In short, because of the trophic structure of the human economy, GDP provides a reliable indicator of the ecological footprint. To some degree, the relationship between GDP and the ecological footprint can be muddied by inflation, technological progress and “animal spirits.” However, inflation is easily accounted for, so that the relationship between *real* GDP and the ecological footprint may be muddied only by technological progress and animal spirits. If technological progress rained down like manna from heaven, it could disrupt the relationship between real GDP and the ecological footprint. However, technological progress does not really rain down, and that will be the principal subject of Chapter 8. Meanwhile, animal spirits are kept within a range of common sense by an invisible hand of sorts. The invisible hand won’t be doling out real money for utterances of “ombudsman,” but rather for real goods and services with real ecological footprints.

Finally, however, there may come a time when real GDP, measured as it is by real income and expenditure, *declines* while the ecological footprint continues to grow. This is not a distortion of the relationship between GDP and the ecological footprint caused by inflation, technological progress or animal spirits. Keep in mind that those types of distortions occur when GDP is *growing*. Rather, this new reality, with GDP declining, is reality at its sternest. It’s

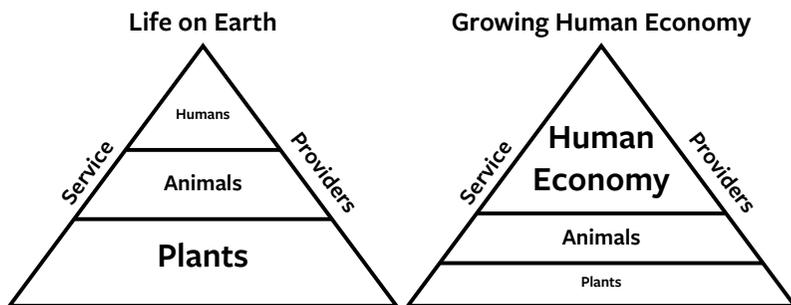


FIGURE 7.3. Trophic levels of all life on earth (*left*), making it plain to see the effect of a growing human economy—real and monetary sectors—on other species (*right*).

what happens when the human population continues to grow, placing a heavier burden on the planet, while agricultural surplus decreases, diminishing the amount of real money available for purchasing real goods and services. Is it sounding familiar enough to resonate, with economic growth at the crossroads?

We are in the midst of a full-fledged, post-industrial, 70-trillion-dollar information economy. We saw in Chapter 2 how we are pushing the agricultural limits of Earth to the breaking point. If per capita agricultural production declines far enough, the masses will be forced back to the farm and agriculture will constitute the focus of human economic activity, accounting for the lion's share of GDP, as it was in the early stages of monetary economies. If global per capita agricultural production declines to a level of mere subsistence or less, the monetary economy will virtually cease to exist, blending instead with the economy of nature where money is meaningless. All the dollars, yen or pesos in the world won't buy the last cob of corn from the farmer's field.

Yet this hypothetical example, whereby money becomes universally meaningless, should not be interpreted as a doomsayer's prediction. I for one am not predicting an ecological and monetary calamity of that magnitude, although others have done so.¹⁶ This extreme hypothetical example would only become reality far beyond the crossroads where we currently find ourselves. Surely we won't stagger blindly straight ahead, learning nothing, failing completely to alter our course.

In summary, the purpose of this chapter was to demonstrate that money is a function of agricultural surplus. It truly *originates* from agricultural surplus, in the sense that matters most at this point in history. Agricultural surplus is what "generates" money; not tourism, not even ecotourism and certainly not the bank. Therefore, money supplies indicate the amount of agricultural surplus, and in turn the ecological footprint. Lots of agricultural surplus generates lots of money. No agricultural surplus generates no money. Limits to agricultural surplus means limits to money.

Real money, that is.