Natural Resource Scarcity and the Opportunity to Pursue Happiness

Author: Gerd Weyer

Website: EconomicsofChoice.com

Date: June 14, 2020

[Article Structure:** Hyperlinks enable the toggling between the table of contents and section titles. Short definitions will pop-up when the cursor hovers over bold font. The list of definitions provided at the end of the document frequently expands on the pop-up.**]

Contents

1. Natural Resource Scarcity and the Opportunity to Pursue Happiness (OPH)
    a. A Fundamental Relationship
    b. Usable and Unusable Natural Resources
    c. History and Issues Related to Natural Resource Consumption
        i. The Historical Increase in Natural Resource Consumption
        ii. Natural Resource Supply and Demand
        iii. How Increasing Crude Oil Scarcity Affects OPH
        iv. Pollution
    d. Increasing Resource Scarcity and Exponential Growth
    e. Sustainability and Increased Fuel Efficiency
    f. A Solution to Accelerating Resource Scarcity
2. Key Definitions
3. References

Natural Resource Scarcity and OPH

A Fundamental Relationship

The relationship between natural resources and the **opportunity to pursue happiness (OPH)** is fundamental. People produce the **goods** and **consumption services** needed for survival, basic comfort, and leisure enhancement by spending time locating, extracting, and transforming natural resources. The time needed to transform natural resources into goods and services decreases with technology-driven **productivity** improvement and increases with natural resource scarcity.

The total number of goods and services produced within a society increases when more time is spent working (e.g., when the population increases so that more people are working or individuals throughout society spend more time at work) or when the time spent becomes more productive. Productivity and OPH increase when the sum of two amounts of time decreases: the time spent locating, extracting and transporting natural resources to the point of use, plus the time transforming natural resources into **capital**, goods and services.

Gains in population and productivity continue to cause natural resource scarcity to increase. The consumption of natural resources generally occurs during the production of goods or services, so the consumption of natural resources increases with economic growth. The extraction of nonrenewable resources always increases resource scarcity. The extraction of renewable resources at a rate that exceeds the sustainable rate of replenishment also increases resource scarcity. Unless the processes of locating, extracting, and processing natural resources improve, the time needed for those activities increases as resource scarcity increases, and that increase in time hurts OPH.

Usable and Unusable Natural Resources

The natural resources on Earth are finite, consisting, at any given time, of a certain amount of water, fossil fuels, minerals, land, solar energy, and living resources. People know how to use some of those natural resources to produce goods and services. Over time, people have learned how to use a greater variety of natural resources, so a greater proportion of Earth's natural resources has become useful. For example, crude oil was unusable in 1815, but by the 1850s it was refined into kerosene and used to provide light (San Joaquin Geological Society, n.d.). In addition to learning how to consume a greater proportion of Earth's natural resources, people have changed the composition of the natural resources on Earth through agriculture and construction so that a greater proportion of resources has become usable.

Over the millennia, the proportion of usable resources to total resources has increased by five mechanisms:

1. Because of improved skill, knowledge, tools, and clothing, people were able to hunt and gather a greater quantity and variety of wild food in increasingly diverse regions. For example, the introduction and improvement of the bow and arrow presumably enabled people to kill a greater variety of animals with less effort or time.
2. People replaced wild habitat with domesticated plants and animals. The proportion of natural resources that people can consume increased with the introduction and expanded use of agriculture.

3. The energy harnessed from the combustion of fossil fuels and other energy sources was used to increase productivity. Greater productivity enabled people to locate, extract, transport, and transform a wider variety of natural resources into goods and services than was possible with the use of only human and animal **labor**.
4. Improvement in agricultural processes, from irrigation to fertilization, caused agricultural production to increase.
5. The coverage of large swaths of land with buildings, roads, and other impermeable or semipermeable surfaces consumes many natural resources.

By improving the tools used to extract and manipulate natural abundance, people have been consuming an ever-increasing proportion of the natural abundance on Earth. The increase in consumption is part of an iterative cycle of innovation permitting increased consumption of natural resources, followed by declining productivity associated with increasing resource scarcity, then further innovation, and again more consumption, which becomes increasingly constrained by mounting resource scarcity. This pattern still holds today. In an environment of finite resources, how long can this recursive pattern of increasing resource consumption continue?

History and Issues Related to Natural Resource Consumption

This section covers the history of natural resource consumption, supply and demand, crude oil scarcity, and pollution.

The Historical Increase in Natural Resource Consumption

The fundamental relationship among OPH, time spent at improvement, and resource scarcity did not change in the transitions from hunter-gatherer communities to preindustrial agriculture to industrial and modern societies. OPH decreases with increased resource scarcity and increases with innovation. Increasing resource scarcity has always hurt OPH, and always will.

For more than 200,000 years, life in hunter-gatherer societies revolved around the daily need for shelter and food. When skill and knowledge enabled hunter-gatherer clans, with minimal effort, to obtain the wild food needed to meet caloric intake needs and the resources needed to provide shelter, clothing, fire, and basic comfort, there was presumably much time for relaxation and socializing. If the resources needed for survival became insufficient, relocation was required.

The sufficiency of natural resources depends on the abundance of natural resources and on **human capital**. In hunter-gatherer clans, OPH declined as natural resources became more scarce and increased as human capital rose. Although tools had been used for many millennia, their sophistication began growing rapidly 90,000 to 40,000 years ago, with the invention and improvement of tools such as fishing hooks, needles, and sailboats. Those tools enabled people to inhabit most regions of the world. The increased use of tools enabled people to consume a greater variety of natural resources and transform natural resources into goods and services in less time. Those increases in productivity gave people a choice between increased leisure and increased production. Presumably, the choice was to raise more children, who required the production of additional goods and services. As more goods and services were produced, natural resource scarcity increased, eventually preventing human population growth until further innovation enabled people to consume an even greater portion of Earth's natural resources.

One reason people transitioned to agriculture is, presumably, that the human population increased to a size for which there was insufficient wild food. Agriculture displaced wild animals and vegetation, replacing them with crops and domesticated animals that could provide the calories needed to support the increase in human population density.

OPH increased as the processes and tools used in agriculture improved. The productivity of food production increased with improved processes, such as irrigation. As improvement raised the amount of food an individual could produce in a season, a smaller proportion of society dedicated their lives to producing the food consumed by all. Cities developed as a declining proportion of people spent their time at food production and a larger proportion became government employees, sculptors, blacksmiths, soldiers, and so on.

The number of persons one farmer can support declines as the productivity of food production declines. Natural resource degradation can cause the productivity of food production to decline and has contributed to the collapse of powerful societies. For example, deforestation, salination, and desertification probably contributed to the collapse, 3,000 years ago, of Nineveh, the capital of the Assyrian empire, which had an estimated population of 120,000 people (Ehrlich and Ehrlich 2004).

Beginning with the industrial revolution, productivity increased more rapidly as knowledge expanded and was disseminated more broadly, and as more and more capital was used in the production of goods. Increased knowledge was used to increase productivity by expanding the use of capital, increasing specialization of labor, and using fossil fuels to power mechanized systems of production. The latent energy released from fossil fuels during combustion increasingly replaced or assisted human labor in the extraction and transformation of natural resources. The increase in productivity led first to a rapid increase in population and then to a massive increase in per capita consumption.

Resource scarcity changed from a local phenomenon to a regional and global one as fossil-fuel-powered transport increased. Before the use of petroleum fuels, access to natural resources was greatly limited by the distance between the sites where minerals were extracted and the places where they were used and between agricultural land and the places where food was consumed. As infrastructure development and advanced transport methods (e.g., airplanes, helicopters, trains, ships and trucks) have boosted transport capacity and efficiency, businesses and consumers have gained access to natural abundance extracted anywhere in the world and to goods and services produced anywhere. As resource scarcity increases, however, the time needed to locate, extract, and transform those resources into goods and services will increase, and OPH will decline. If resource scarcity becomes acute, then cities and entire societies could collapse.

Natural Resource Supply and Demand

The supply of natural resources increases as productivity improves and decreases as resource scarcity increases, whereas the demand for natural resources changes with economic output. If economic output, or the quantity and variety of goods and services produced, stays constant, a **demand curve** for a natural resource looks like the downward-sloping line in Figure 1. Demand curves slope downward because the quantity of a natural resource, such as copper that is purchased, increases when the price decreases. As shown in Figure 2, the demand curve shifts to the right when the demand for a natural resource increases because of an increase in economic output. If there are no fundamental changes in economic conditions, such as increased productivity or resource scarcity, a **supply curve** looks like the upward-sloping line in Figure 2. A supply curve slopes upward because businesses want to supply more when the price increases. Equilibrium, or the price where the quantity demanded is equal to the quantity supplied, occurs at the point where the supply and demand curves intersect.

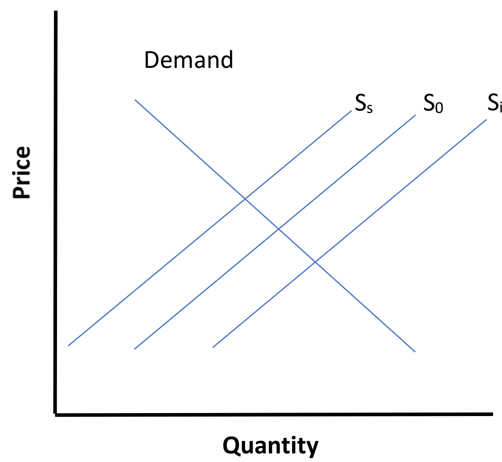

Figure 1. The supply of resources.

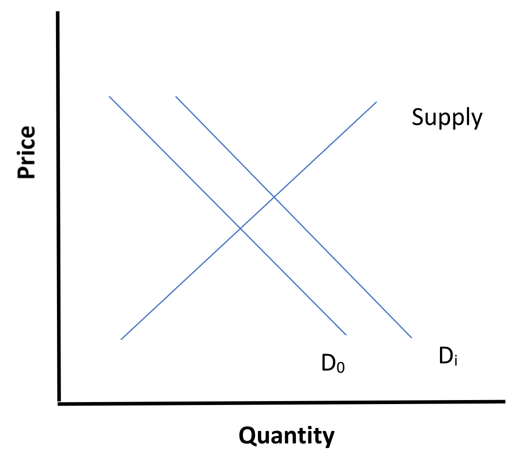

Figure 2. The aggregate demand for resources.

The cost of locating and extracting natural resources and transferring them to the point of use generally declines with time spent improving the equipment and processes used. When the cost of resource extraction declines, the supply of natural resources increases, as indicated by the shift from S_o to S_i in Figure 2, because companies want to supply more at a given price. As natural resource scarcity increases because of a lower grade or density of the resource or a greater distance between the points of extraction and use, the cost of locating, extracting, and transporting to the point of use generally increases, and the supply of natural resources declines, as indicated by the shift from S_o to S_s.

Both the supply of a resource and the productivity of resource extraction increase when the time needed to extract the resource decreases. That happens when productivity improvement more than offsets the adverse effect of increasing resource scarcity. For example, suppose it takes one hour to extract an ounce of gold. The first gold to be taken is the purest or easiest to extract, and therefore the most profitable. After that has been taken, the time to extract an ounce of gold increases to two hours, and the supply of gold decreases. If the time it takes to extract an ounce of gold later declines to less than one hour because of the use of automated mining equipment, the supply of gold, at a given price, increases.

Over the millennia, people have increased productivity by improving the tools and equipment used in the production of goods and services. In the vast history of modern man, the benefit of productivity improvement has usually been used to produce more goods and services. The demand for goods tends to increase as a result of income gains associated with productivity improvement. Decreasing productivity associated with increasing scarcity tends to cause a decline in economic output, income, and the demand for goods and services.

The productivity measured by economists has been consistently lower than expected during at least the past two decades. Economists at the National Bureau of Economic Research have dedicated much time to explaining the lower-than-expected increase in productivity (Hulten, Dean, and Harper 2001). One cause might be increasing natural resource scarcity.

How Increasing Crude Oil Scarcity Affects OPH

The following assessment shows how the increasing scarcity of crude oil might affect OPH. The outcome warrants further analysis. More importantly the systematic approach might be used to determine the national and worldwide effect of increasing resource scarcity on OPH. This is important because natural resources are finite and resource consumption is likely to increase with economic growth.

Production in modern societies involves a complex interplay of a vast array of natural resources; the production of goods, services, and capital; and OPH. The time it takes to extract and refine crude oil into petroleum products includes the time needed to consume a broad variety of natural resources. Locating, extracting, and refining crude oil into petroleum products requires the use of capital and the consumption of energy, natural resources, and **material**. The production of capital requires additional capital, and additional capital requires the consumption of more natural resources. When the time it takes to locate and extract those natural resources increases, the time it takes to extract crude oil or refine crude oil into petroleum products increases, and this has an adverse effect on OPH.

Ultimately, the only cost of producing goods and services is time spent at work producing capital from natural resources, and using that capital, combined with additional time spent at work, to transform more natural resources into goods and services.

OPH and the productivity of producing goods and services increases when the sum of time spent producing the energy consumed plus the time spent producing the goods and services using that energy declines. OPH increases when the time spent directly on the production of goods and services remains constant, and the time needed to produce the energy consumed decreases. A decrease in the time needed to produce the energy consumed during the production of a unit of economic output has a positive effect on OPH.

The time it takes to produce the energy consumed during the production of a **product** depends on the quantity of energy consumed and the time it takes to produce a unit of energy. The time it takes to produce the energy consumed during the production of a product decreases when (a) the amount of energy required declines while the time it takes to produce a unit of energy stays constant, or (b) the time it takes to produce a unit of energy decreases while the amount of energy consumed stays constant.

If the energy consumed is produced from crude oil, OPH increases when the sum of the time needed to extract and transform crude oil into energy and the time needed to produce goods and services using that energy declines. If the time it takes to produce a good or service stays constant, and it takes more time to produce the energy consumed, then OPH decreases. If the time to produce a good or service declines, and that decline is greater than any increase in the time needed to produce the energy consumed, then OPH increases.

Time spent improving the capital and processes used to locate and extract crude oil reduces the time needed to produce energy from oil, whereas increasing crude oil scarcity increases it. Crude oil is nonrenewable, so its scarcity increases as it is extracted. Because worldwide production of crude oil is forecast to increase until 2040, crude oil scarcity is increasing faster and is forecast to continue (Figure 3). Increasing crude oil scarcity is affecting OPH by reducing productivity improvement.

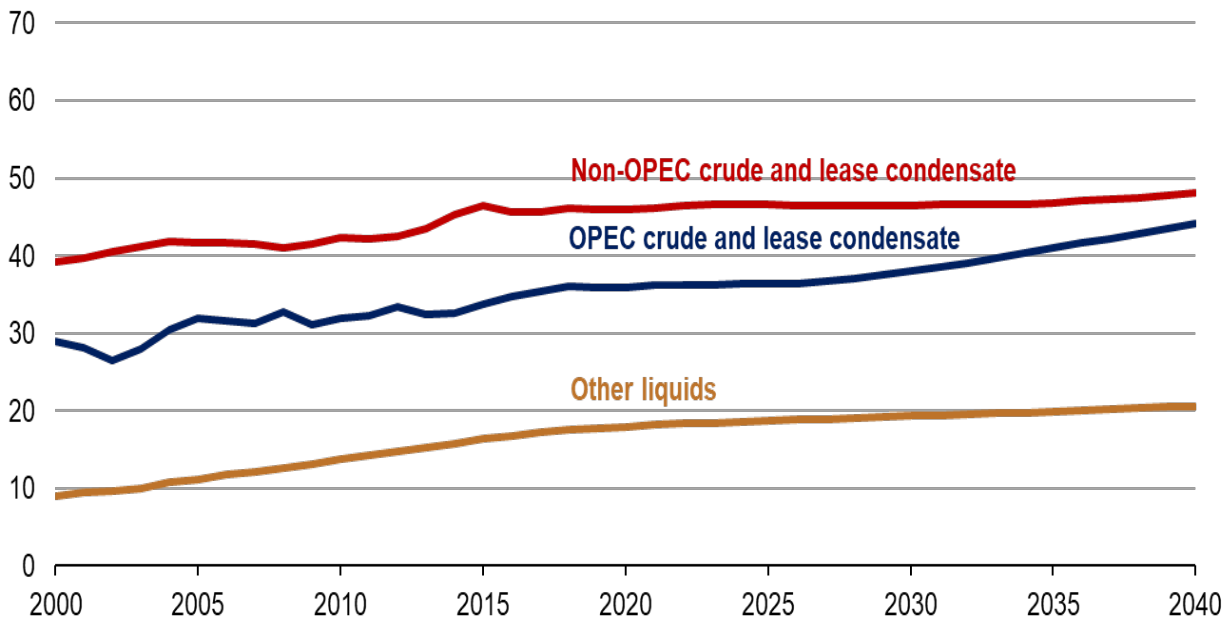

Figure 3. World production of petroleum and other liquids (in millions of barrels per day). Data from EIA 2017.

Data about the time it takes to extract crude oil is not readily available. For this discussion, the time it takes to extract and transport crude oil to the point of use is assumed to be directly proportional to the price of crude oil over the long run. The ultimate cost of extracting crude oil is the time spent. The benefit of time spent extracting oil is the oil extracted. The production cost is the time spent multiplied by the wage compensation. Over the long term, crude oil prices generally increase with production costs. If the sales price, labor compensation, and profits increase at the same rate then oil prices increase at the same rate as the time needed to extract and transport oil. Over the long term, market forces tend to cause the benefit or loss associated with changes in productivity to be distributed evenly among different sectors of society such as oil company profits, wages, and consumers through crude oil and ultimately gasoline prices. For further explanation, please see "The Income Distribution Equation".

When the assumption that extraction time and crude oil prices increase at the same rate is applied to the relative increase that is forecast in crude oil prices (Figure 4), the time needed to produce a barrel of oil in 2050 is forecast to be 1.7 times that needed in 2021. The 2020 projected crude oil price is significantly lower than the actual 2019 price and the price forecast for 2021. According to the data in Figure 4, beginning in 2021, crude oil prices are forecast to increase at a steady rate, presumably because of the time it takes to locate, extract, and transport increasingly scarce crude oil.

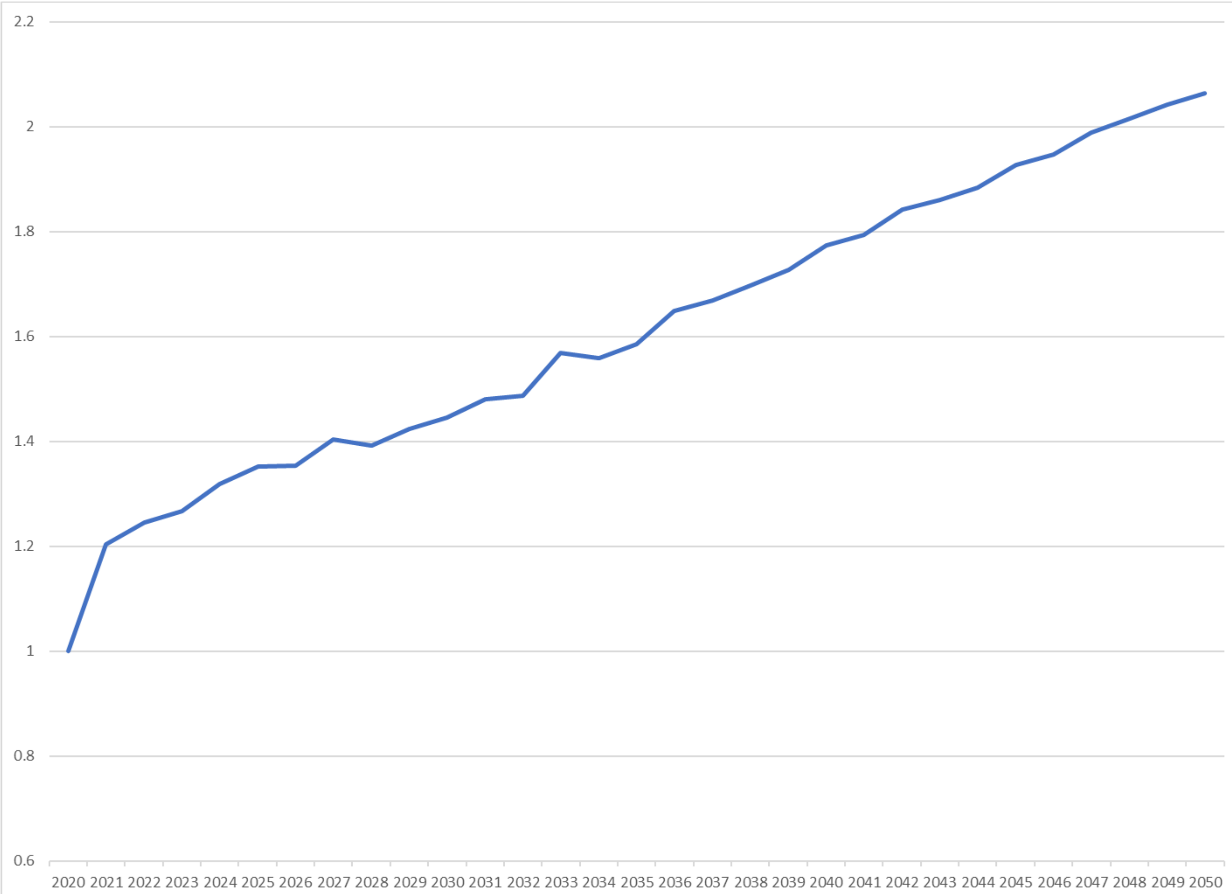

Figure 4. Projected change in crude oil prices (as ratio to 2020 crude oil prices). Data from EIA 2020a, Table 12, Petroleum and Other Liquids Prices (average imported cost, reference case).

As shown in Figure 5, total U.S. energy consumption is forecast to remain close to 100 quadrillion British thermal units (quads) per year between now and 2034 before gradually increasing to 110 quads by 2050. A constant 36 to 39 quads per year of that forecast is projected to be produced from the combustion of **petroleum and other liquids**. Crude oil accounts for roughly 60 percent, by volume, of petroleum and other liquids (EIA 2020a, Table 11, Petroleum and Other Liquids Supply and Disposition).

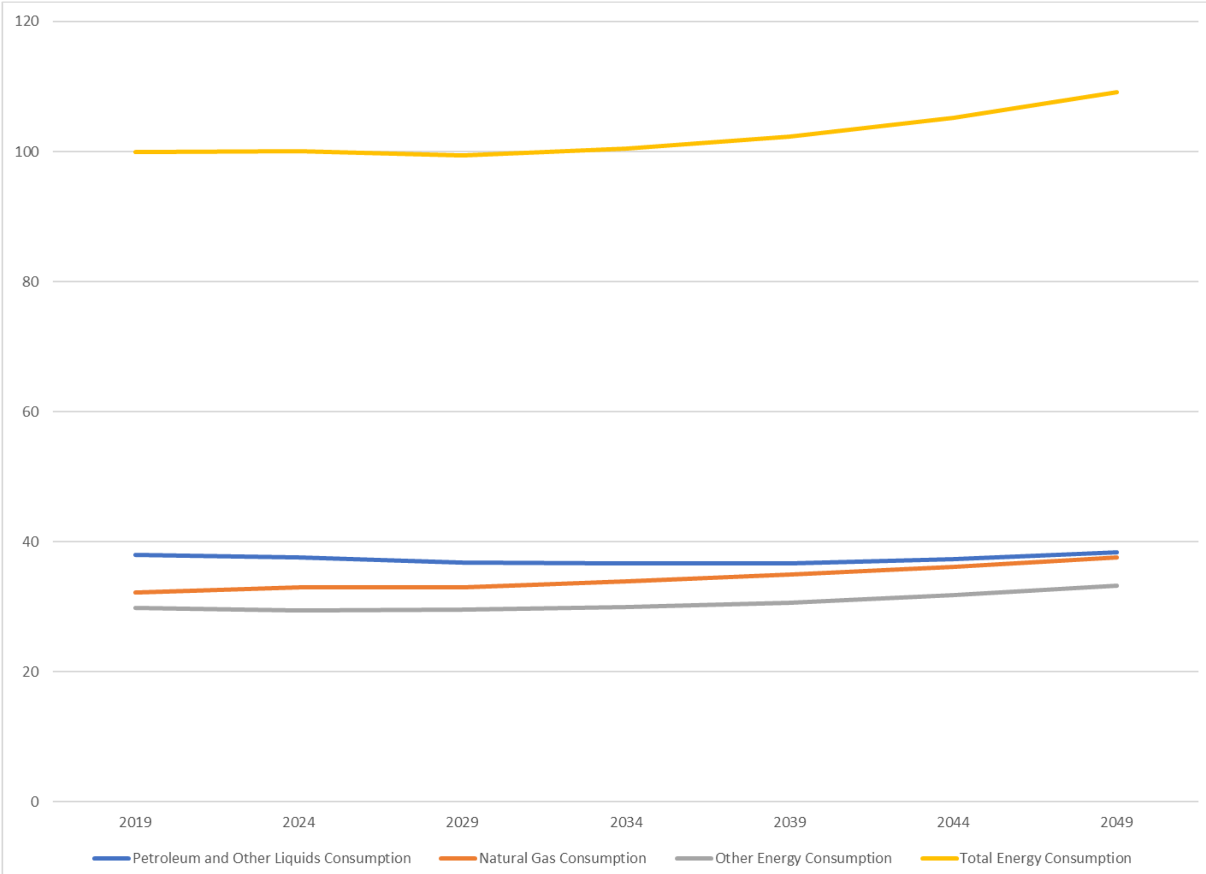

Figure 5. U.S. energy consumption (in quads per year). Data from EIA 2020a, Table 1, Total Energy Supply, Disposition, and Price Summary (reference case).

The U.S. Energy Information Administration (EIA) makes three annual projections: low, reference, and high. The graphs and data used in this analysis are the reference data.

The EIA 2020 reference rate of economic output growth is 1.9 percent (EIA 2020b). The purple line in Figure 6—calculated from that 1.9 percent growth rate and the consumption of petroleum and other liquids (shown in Figure 5)—shows the change in energy consumed per unit of economic output relative to the forecast for 2021. In other words, the purple line shows the decline in **energy intensity**. For example, the energy forecast as needed to produce the same economic output in 2030 is 0.82 that of 2021. (The ratio 0.82 is determined as follows: Let total economic output produced by using petroleum and other liquids during 2021 equal one unit of economic output. The energy intensity during 2021 is then equal to the energy consumed, 38.2 quads [as shown by the blue line in Figure 5], divided by 1, or 38.2 quads of energy per unit of economic output. With an economic growth rate of 1.9 percent per year, economic output in 2030 will be 1×1.019^9, or 1.18, times the 2021 economic output. Since 36.8 quads of energy from petroleum and other liquids are projected to be consumed during 2030, the energy intensity declines to 31.2 [36.8/1.18] quads per unit of economic output. The 2030 to 2021 energy intensity ratio is therefore 31.2/38.2, or 0.82.)

The change in time needed to extract a certain quantity of crude oil (Figure 6, green line) is based on Figure 4. It shows that the time needed to produce a given amount of energy is projected to increase between 2021 and 2050.

The change in the time it takes to produce the energy consumed during the production of a unit of economic output is equal to the change in time needed to produce a given amount of energy multiplied by the change in the amount of energy consumed. Multiplying the projected change in time needed to extract a unit of crude oil (Figure 6, green line) by the change in energy intensity (Figure 6 purple line) gives the projected change in time needed to produce the energy consumed during the provision of a unit of economic output. As shown by the gray line in Figure 6, the time spent on energy production per unit of economic output stays nearly the same between 2021 and 2050. That happens because in this scenario the increase in time needed to produce a certain amount of energy is offset by the decline in energy consumed during the production of a given amount of economic output.

The analysis just presented indicates that rising crude oil scarcity is having an adverse effect on OPH and that declining energy intensity is reducing or nullifying the effect. The magnitude of the effect on OPH is uncertain because of the assumptions made.

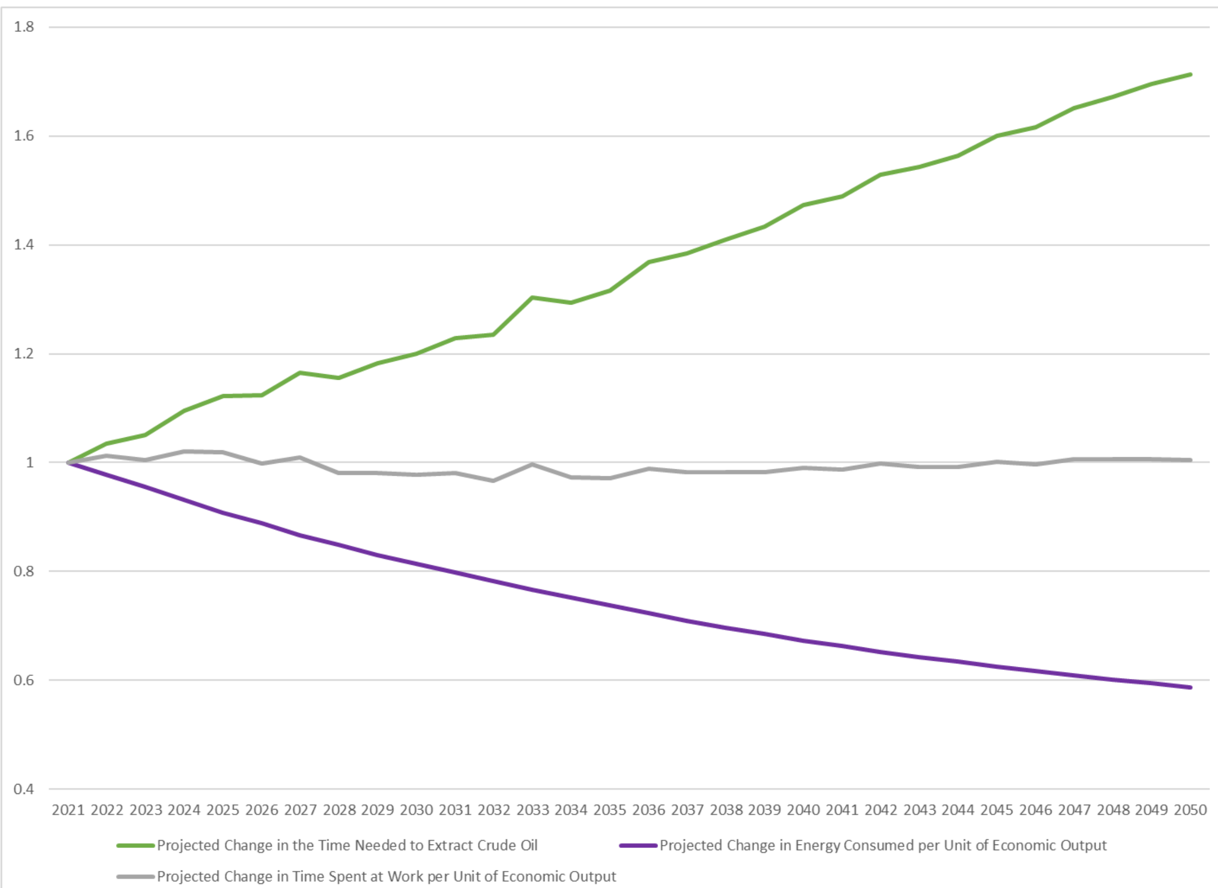

Figure 6. Change in time spent at work per unit of economic output. Data from above charts.

The preceding analysis used the reference-case crude oil prices the EIA forecast in 2020. The 2017 forecasts for the high, reference, and low cases are shown in Figure 7. The high-oil-price case is associated with the greatest rate of economic growth and, therefore, a greater rate of increasing resource scarcity. If the increased resource scarcity caused the time needed to extract crude oil to increase at a rate that exceeds the decrease in energy intensity shown in Figure 6, then the time needed to produce the energy consumed per unit of economic output increases. OPH declines when the increase in time needed to produce the energy consumed during the production of a good or service exceeds the reduction in time spent during other phases in the production process.

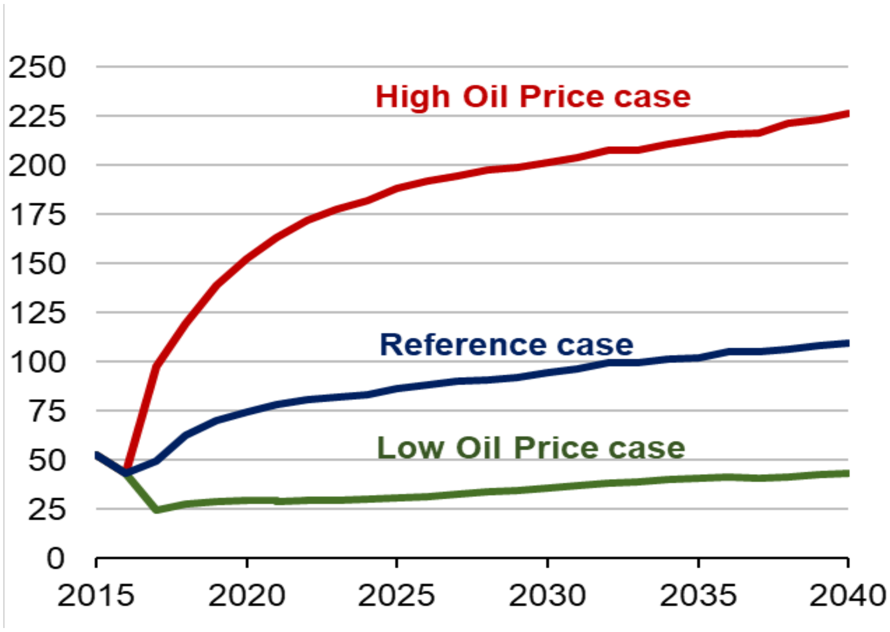

Figure 7. World oil prices (in real 2016 dollars per barrel). Data from EIA 2017, slide 13.

The foregoing assessment of the effect of increasing resource scarcity on OPH is based primarily on the increasing scarcity of crude oil. The approach might be expanded to include energy produced from all other sources. A thorough assessment on how the corresponding increased consumption of natural resources will affect OPH over the next 50 to 100 years should be completed before investing in and transitioning to alternative energy solutions.

Pollution

Time spent addressing the adverse effects of pollution is not available for leisure, the production of goods or services, or the improvement of productivity. For example, time spent addressing the effects of climate change, such as building barriers to protect against rising sea levels and creating and implementing carbon cap-and-trade programs, is time that cannot be spent producing or improving other goods and services. Like the increase in time spent producing goods and services that is associated with locating, extracting, and transporting increasingly scarce natural resources, the increase in time spent dealing with the effects of pollution causes the opportunity to pursue happiness to decline. Therefore, both pollution and increasing resource scarcity harm OPH.

Increasing Resource Scarcity and Exponential Growth

The production of goods and services generally require the consumption of natural resources. If resource consumption increases at the same rate as economic output, then resource consumption increases exponentially when economic growth is exponential. **Exponential growth** occurs when economic growth increases by the same percentage every year. For example, continuous year-over-year economic growth of 1.9 percent constitutes exponential growth. Figure 8 shows world economic output when year-over-year growth is 1.9 percent and when it is 2.5 percent.

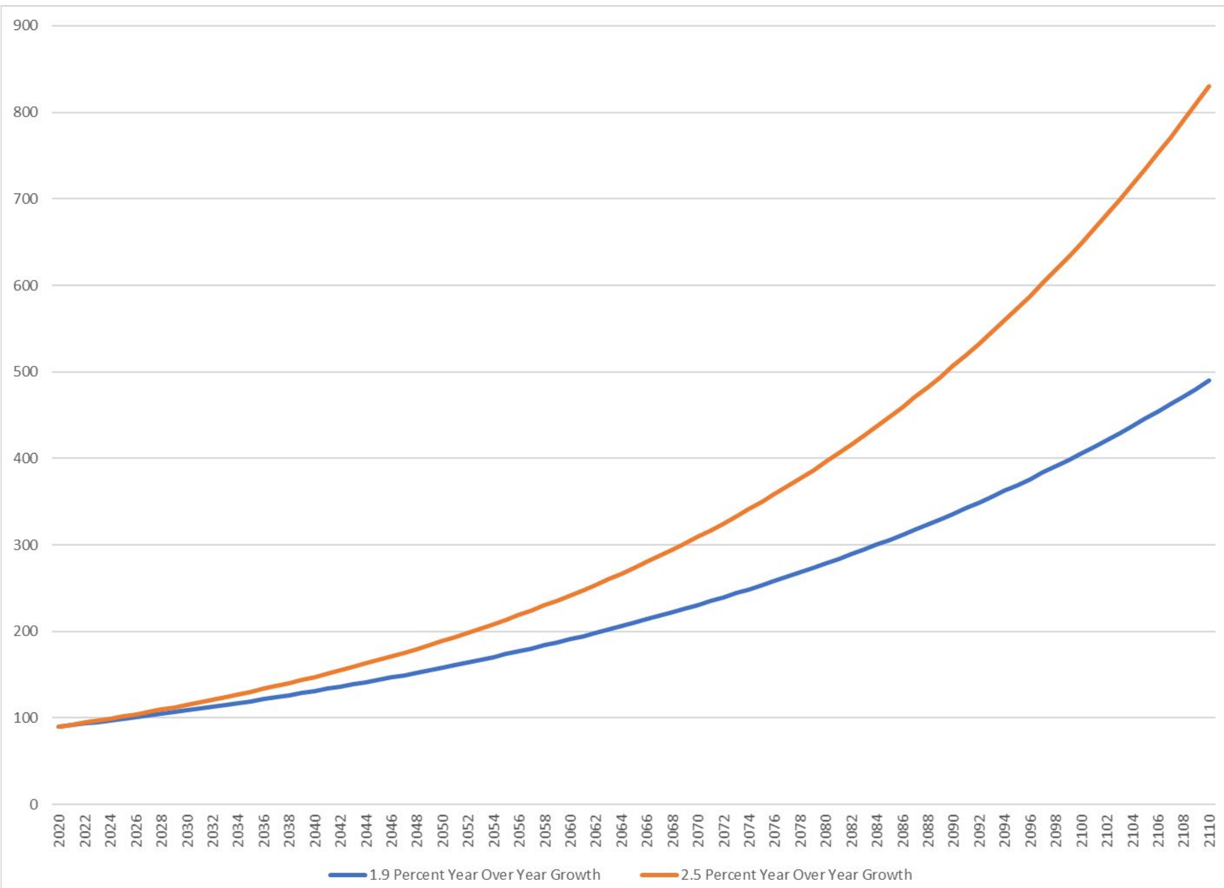

Figure 8. Exponential economic growth (output in trillions of real dollars).

Economic growth of 1.9 percent corresponds to the EIA reference rate used in calculating the data represented by the purple line in Figure 6. The World Bank (2020) estimated in January 2020 that world economic output will increase 2.5 percent during 2020.

As can be seen in Figure 8, when annual economic output grows at a rate of 1.9 percent a year, it doubles approximately every 38 years. When it grows 2.5 percent a year, it doubles approximately every 29 years. If the world economy were to grow 2.5 percent a year for the next 90 years, worldwide annual economic output would be more than eight times what it is today. Natural resource consumption would also increase more than eightfold if it rose at the same rate as economic output.

In a world of finite resources, measuring the effect of increasing resource scarcity seems vital. It might be accomplished by expanding the approach used to determine the effect of increasing crude oil scarcity on OPH to include the combined effect on OPH of the increase (or decrease) in the scarcity of each natural resource consumed during the production of all economic output. The effect of pollution can be added to this approach by estimating the time needed to address the effects of all forms of pollution, including climate change.

Sustainability and Increased Fuel Efficiency

People purchase gasoline to power other goods they purchase. When those goods become more energy efficient—that is, when it takes less energy to operate those goods—less energy is consumed if usage stays constant. When less energy is used and the price of energy stays the same, then less money is spent on energy. When less money is spent on energy, less time must be spent at work to earn the income to pay for the energy consumed. If the time spent earning an income stays the same, and income itself does not change, then additional goods and services can be purchased. More goods and services, and thus more natural resources, are consumed when energy efficiency improvements occur and the time spent at work, and income saved, stay constant.

For example, suppose a government-mandated program causes the gas mileage of a given size of car to increase from 20 miles per gallon to 40 miles per gallon, the price of fuel stays constant at $3 a gallon, household **real income** does not change, and each user of that size of car drives 10,000 miles per year. Each user who continues to drive 10,000 miles per year saves $750 per year in gas expenditures. The consumption of natural resources increases when the $750 is spent to purchase goods like books, boats, computers, and bikes. The consumption of fuel does not decline if the $750 is used to drive twice as far every year, and consumption increases because tires and other car components wear out and need to be replaced more frequently.

From an environmental perspective, increased fuel efficiency generally does not increase sustainability when the time saved is spent producing and consuming more goods and services. Although increased fuel efficiency may reduce greenhouse gas emissions, the net result is usually an increase in the quantity and variety of natural resource consumption. Although climate change is the most pressing issue associated with exponential growth, combating it is only one component of sustainability.

A Solution to Accelerating Resource Scarcity

Taxes that increase with the distance between production and consumption could reverse exponential economic growth, environmental degradation, and the accelerating rate of increasing resource scarcity. For example, a 10 percent tax on all products shipped more than 50 miles, increasing to 20 percent at 100 miles and 40 percent at 500 miles, would promote local production and consumption, decreased productivity, and increased sustainability. Crucially, productivity will decrease if the tax rate is great enough, but at least in wealthy nations, happiness can increase, even with a reduction in OPH, because factors like meaningful relationships and work, time spent pursuing a hobby, and living in a modest neighborhood surrounded with like-minded people most likely contribute more to happiness than higher income levels (Buettner 2010).

Key Definitions

capital: Products, including buildings, infrastructure, equipment, machines, and tools, that businesses or governments use to produce goods and services.

consumption services: Services purchased by households or individuals. Consumption services are either leisure-enhancing or time saving. Services provided to businesses are part of the chain of provision and contribute to the production of goods and services.

demand curve: The relationship between the purchase price and quantity demanded.

energy intensity: The energy consumed per unit of economic output.

exponential growth: Occurs when economic growth increases by the same percentage every year. For example, continuous year-over-year economic growth of 1.9 percent constitutes exponential growth.

goods: Product consumed by private individuals or households. Goods are produced by individuals, businesses, and government entities in the measured and unmeasured sectors of society.

human capital: The capacity and propensity, embodied in a group of individuals, to produce and improve. Capacity corresponds to knowledge and skill, whereas propensity consists of desire, passion, and commitment to improvement and production.

inherent productivity of capital: The variety and speed of operations that can be performed as a result of using a specific tool, machine, or building and the efficiency of capital production. The inherent productivity of capital changes when capital is produced more or less efficiently or if there is a change in the variety or number of operations that can be performed, using that capital.

labor: Time spent producing goods and services. In the Economics of Choice, time spent doing work is divided between time spent producing goods, time producing capital, and time improving productivity. Time spent at work producing goods and services is equivalent to labor. Time spent at work is also divided between production and consumption.

material: Product, components, or natural resources that are consumed during the production process. Steel, wheels, bearings, breaks, cable, and bolts are all materials consumed or used in the production of a bicycle.

measured sector: In the United States, the portion of economic output that contributes to GDP, as measured by the U.S. Bureau of Economic Analysis, using the national income identity GDP=consumption spending + investment spending + government spending + net exports. Economic output produced by businesses and government entities.

opportunity to pursue happiness (OPH): Individual capacity to purchase goods and services and spend time at leisure. Purchasing power and leisure are referred to as the two dimensions of OPH.

petroleum and other liquids: A category of natural resources that consists mainly of crude oil, natural gas liquids, and biofuels. Natural gas liquids include ethane, propane, normal butane, isobutane, and natural gasoline. (EIA n.d.)

product: Goods, services, material, capital, and infrastructure. This is a general term that encompasses all physical items produced or services provided by businesses, individuals, or government entities.

productivity: Economic output per unit of time. Productivity increases when the time it takes to produce or consume a good or service declines. The number of goods or services produced or consumed during a time period; the number of identical tasks that can be completed in a time period. Productivity increases when the time it takes to produce or consume a good or service declines.

real income: Increases in income that cause the capacity to purchase goods and services to increase. Increases in income that are not associated with inflation.

services: Consumption services unless stated otherwise are services purchased by households or individuals. Consumption services are either leisure-enhancing or time saving. Production services are services purchased by businesses. Services provided to businesses are part of the chain of provision or the production of goods and services.

supply curve: The relationship between the purchase price and quantity supplied.

unmeasured sector: Economic output that is not included in the measured sector. Economic output produced within households.

References

Buettner, D. 2010. Thrive: Finding Happiness the Blue Zones Way. Washington, DC: National Geographic Society.

Ehrlich, P., and A. Ehrlich. 2004. One with Nineveh: Politics, Consumption, and the Human Future. Washington, DC: Island Press.

EIA. 2020a. Annual Energy Outlook 2020. Accessed. https://www.eia.gov/outlooks/aeo/data/browser/#/?id=11-AEO2020&cases=ref2020&sourcekey=0.

EIA. 2020b. Annual Energy Outlook 2020. PDF of slide presentation. Accessed April 2020. https://www.eia.gov/outlooks/aeo/pdf/AEO2020%20Full%20Report.pdf.

Hulten, Charles R. 2001. "Total Factor Productivity." In New Developments in Productivity Analysis, by Charles R. Hulten, Edwin R. Dean and Michael J. Harper , 7-9. Chicago: The University of Chicago Press.

San Joaquin Geological Society. n.d. "San Joaquin Valley Geology and the History of Its Oil Industry." From "The History of the Oil Industry." Accessed April 2020. http://www.sjvgeology.org/history/.

