

## Lesson 3: How Big Should the Economy Be?



<p><b>Understanding:</b></p>	<p>The economy fails to account for many of the interactions that take place within nature. This is because the benefits we get from ecosystems are often difficult to own (make “excludable”) and sell to individuals. In some cases, these benefits are essential and non-substitutable. For instance, agriculture is essential even if it only comprises a small percentage of economic activity. Given this, services that nature provides to the economy are often not valued and not protected. In many cases, it is impossible to design market institutions that assign the right value to nature. In order to determine the right size of the economy, citizens will seek to balance the benefits we receive from ecosystems with those benefits we receive from increased economic activity.</p>
<p><b>Facts:</b></p>	<ul style="list-style-type: none"> <li>• Some economists estimate the global value of ecosystem services to be more than \$40 trillion.</li> <li>• Some economists estimate that the economy loses more than \$3 trillion in natural capital each year.</li> </ul>
<p><b>Concepts:</b></p>	<ul style="list-style-type: none"> <li>• Externality</li> <li>• Ecosystem Services</li> <li>• Excludable/Non-excludable</li> <li>• Rival/Non-rival</li> <li>• Sources and Sinks</li> </ul>
<p><b>Additional Resources:</b></p>	<p><b>Ecosystem services:</b>  <a href="https://www.youtube.com/watch?v=BCH1Gre3Mg0">https://www.youtube.com/watch?v=BCH1Gre3Mg0</a></p>

### **Lesson 3: How Big Should the Economy Be?**

So far, we have learned about the relationship between the size of the economy (as measured by GDP) and the ecosystem. In understanding the relationship between the economy and the ecosystem, we recognize that the economy cannot continue to grow forever. Instead, it should operate at a sustainable scale. There is a second, related question: How big should the economy be? What is size of the economy that is best for citizens?

First, let's discuss a few reasons why the economy does not naturally operate at the right size.

#### **Keyword: Externality**

An externality is something that is external to the economy. "External" suggests that the economy does not account for it. The economy does not account for many interactions in nature. Consider the case of two neighboring farmers: if one farmer develops a healthy ecosystem with lots of pollinators and water-filtering trees, and this benefits his neighbor farmer, the first farmer is not rewarded economically. These benefits from nature are external to the economy, and they are therefore considered an externality. If the second farmer is using up all the water within the region and then polluting the water downstream, other farmers will suffer. This is also an externality—a negative externality. Because the economy mainly impacts the ecosystem in negative ways, most externalities related to ecosystems are negative.

Economic value captures only a small slice of the interactions that occur in the world. In 2009, economists estimated that we were losing about \$7.3 trillion per year due to the cost of pollution and other externalities. At the time, this was about 13% of the global GDP.

#### **Keyword: Ecosystem Service**

An ecosystem service is a benefit provided by nature to the economy. For instance, when it rains, crops are watered, and plants grow. This rain creates economic value for farmers who then sell the crops. The economy depends on many ecosystem services, so many that it is challenging to keep track of all of them. The ecosystem regenerates itself to provide raw materials, cycle water and nutrients, and maintain stable weather patterns.

Often, we don't realize that a service is being provided by the ecosystem until it is no longer available. For instance, if we cut down a forest, we may realize many years later that the forest was providing water for cities hundreds of miles away. Some economists have estimated that the value of global ecosystem services equals more than \$40 trillion, which is roughly half of the global GDP.

#### **Excludable/Non-Excludable**

Many ecosystem services are often non-excludable. This means that it is impossible for a single actor to own an ecosystem service. We can own a car, but can we own the air that we breath? We can own a bottle of water, but can we own the ecosystem's water cycle? We can own a piece of land with forest, but can we own the birds that fly from one tree to the next?

In some cases it is possible for humans to create rules so that we can own parts of ecosystems that we could not previously own. For instance, nations work hard to determine who has the right to the fish in the ocean. For a long time, there were no rules; now there are some. In other cases, we realize that, despite our best efforts, it is challenging to create ownership. With the emergence of the Internet, it was difficult to protect copyrighted music, because it was easy to share and download music without paying for it. Non-excludability is a challenge for economies: It is nearly impossible to own all facets of ecosystems.

### **Rival/Non-Rival**

Often, ecosystem services are non-rival. If a good is rival, it means that one can benefit from this good to the exclusion of others. Pizza is a rival good, because if your friend eats a slice of pizza, you can't eat the same slice. However, you and your friend may both enjoy climate stability, and it is impossible for only one of you to enjoy a stable climate. Similarly, everyone in a town can enjoy a fireworks show. If an additional person looks out the window and sees the fireworks, it does not prevent someone else from also seeing the fireworks. In fact, it may enhance people's experiences if they are able to reflect on the fireworks with more members of their community. The market economy deals mostly with rival goods, and non-rival goods do not fit easily into the market. Consider how much money it would cost for one person to create a fireworks show alone or for one person alone to create climate stability.

### **The Tragedy of the Commons**

When economists first began to consider common property, they noticed a pattern of over-exploitation, and they called this "the tragedy of the commons". This occurs when everyone acts in their own self-interest, and everyone is worse off because of their actions. For instance, if fish in the ocean are non-excludable, and everyone overfishes the sea, then the sea will produce far fewer fish, and everyone will be worse off. In the long run, everyone would be able to catch more fish, if the stock of fish was not over exploited.

### **Sources and Sinks**

A source is a part of the environment that provides raw materials. A forest, for example, is a source of timber. A sink is a part of the environment that receives a waste flow. For instance, a forest absorbs certain pollutants. The earth has a limited quantity of sources and sinks.

The ocean is a CO<sub>2</sub> sink. As humans have emitted more and more CO<sub>2</sub>, the oceans have been able to absorb a certain amount of it. However, now the oceans cannot absorb any more CO<sub>2</sub>.

Aquifers are a source of fresh water that exists beneath the ground. Aquifers recharge water at a very slow rate. We are rapidly depleting the supply of fresh water contained within aquifers.

Sometimes, one source or sink can be substituted for another. For instance, in order to absorb CO<sub>2</sub>, we can use soil as a sink instead of the ocean. However, as we face mounting resource constraints, our capacity to substitute is limited; e.g., now we need that same soil for producing

agriculture, for growing forests, and for developing homes for an increasing population. Whereas some economic services are substitutable, ecological goods and services are essential and cannot be substituted for human-made goods and services in the long run.

### **The Nature of Resources**

Certain types of ecological resources tend to have certain economic characteristics, such as being rival and excludable. Let's start by distinguishing two types of ecological resources, abiotic and biotic resources.

#### **Abiotic resources**

Abiotic resources are non-living. A rock is abiotic. Nitrogen is abiotic. On the other hand, a tree is biotic, because a tree is a living organism that grows and dies. Most abiotic resources exist as a stock-flow, and some abiotic resources can be made excludable (owned) within the economy. For the most part, these resources are rival between people and are essential, non-substitutable resources for economic activity. One might suggest then that these resources lend themselves well to simple market allocation. However, this picture is complicated by the fact that abiotic resources are non-renewable. So, an increase in consumer demand for a certain type of rock does not lead to increased production of that rock. In nature, supply is ultimately fixed and ever declining. Further, the economics of abiotic resources is fraught with common market failures related to pollution, waste, uncertainty, and monopoly.

#### **Fossil Fuels**

Today, approximately 90% of our global economy runs on fossil fuels, and that number has increased in the last decade. Even if fossil fuels are used as a means to achieve the goal of sustaining the economy, there are two main problems with fossil fuel use.

The first problem is that fossil fuels are a non-renewable resource, and they are increasingly difficult to access. The amount of energy required to access new fossil fuels grows, as we must dig deeper and deeper into the earth to find new supplies. In the short term, as resources decline, we will be forced to compromise. For example, should we drill for oil on public lands instead of preserving areas of nature that are not destroyed by industry?

The second problem is exemplified by climate change. Burning fossil fuels releases CO<sub>2</sub> and other greenhouse gases like methane into the atmosphere, which accelerates climate change. The impacts from extracting and burning fossil fuels is likely to be a much greater threat to human welfare in the coming century than fossil fuel shortages were during the 21st century.

#### **Mineral Resources**

Minerals are an abiotic resource that people are extracting at an exponentially increasing rate. Some examples of minerals include silver, gold, copper, iron, and zinc. We need minerals for the essential activity of food production, and much of our modern tech-based economy relies on finite mineral resources.

We are not confronted with an immediate, absolute scarcity of minerals for our food. Scientists estimate that within the top 20 cm of soil worldwide, there are adequate minerals to feed our population for more than 1,000 years. However, the nutrient density of our food has been decreasing since we began to take measurements earlier in the 20th century. The challenge is that these minerals do not just need to exist; they need to be in a form that plants can use. For instance, only 1% of the earth's supply of zinc is available to plants in a form they can use. Unfortunately, roughly 800,000 people worldwide die of zinc deficiency each year, and supplies of available zinc are declining.

This mineral-accessibility challenge applies to other economic products too. We know that large deposits of minerals exist hundreds of feet beneath the earth's surface and at the bottom of the ocean, but it will require more and more energy to access these minerals.

## **Water**

Water is found many places on earth, and it seems to be very abundant: It comprises 70% of the earth's surface. However, less than 1% of water is in a form that is readily usable by humans. Thus, it is essential to consider how much water we use and how we use it.

Agriculture uses 70% of available freshwater. The greatest challenge with our water supply is that the supply needs to be consistent in order to enable consistent agricultural yields. As weather patterns fluctuate, many regions are experiencing devastating droughts and high-risk complications related to water scarcity, such as increasing frequency and intensity of wildfires. Droughts impact agricultural yields directly, and they have cascading impacts throughout the economy.

For instance, Sao Paulo and Rio de Janeiro are two cities in Brazil that are home to most of Brazil's population. Both cities recently experienced unprecedented drought. As water reserves fell to below 5%, from 2014-2017, the economy stagnated. In regions more directly dependent on water supplies, this type of decline can cause food scarcity, migration, and significant political destabilization. Water shortages can have immense impacts on economies and political systems, and they directly impact humans.

## **Land**

Land is an essential and scarce resource. Currently, 50% of the land on earth is allocated to agriculture. Other important uses include natural habitats, such as forests and wetlands, and urban areas inhabited by people—all towns and cities, whether large or small, occupy land, and that land can be used for no other purpose (although some cities include rooftop gardens, city parks, and similar positive uses of urban landscapes).

## **Solar Energy**

Solar energy can be used to grow forests, grow biomass, grow food, or to create electricity through solar panels and the sun's influence on weather, including wind, which is also used to

create electricity. More solar energy hits earth each year than is available in all existing, recoverable fossil fuel stocks combined. An energy transition will be necessary as fewer fossil fuels are available, and solar energy is a good, abundant source to consider.

### **Biotic Resources**

Biotic resources include living organisms like trees, which grow and die. These resources provide renewable materials and energy for the economy, as well as ecosystem services. Of course, if biotic resources are used for one purpose, they cannot be used for another. For example, corn can provide energy as a source of ethanol or it can be used to feed people, but not both. Biotic resources provide ecosystem services, including waste absorption. For instance, plants in wetlands are biotic resources that can provide services like cleaning water. Insects like bees provide pollination of a huge percentage of the world's crops, and smaller bugs, like microbes in the soil, also provide important, if unseen, services that benefit humans by keeping the planet running. However, when we extract biotic resources for matter or energy, their capacity to provide ecosystem services will decline.

### **Renewable Resources**

Biotic resources can be extracted as stocks and converted into flows. For instance, the products of a forest can be extracted and used as timber in economic production. However, unlike abiotic resources, these stocks and flows regenerate at a certain rate. Forests can grow back, whereas minerals cannot grow back. Resources that can grow back or be renewed are called renewable resources. Solar energy is considered a renewable resources because the sun provides new energy, day after day. On the other hand, we use fossil fuels much faster than they regenerate, so fossil fuels are considered non-renewable.

### **Waste-Absorption Capacity**

Ecosystem structure provides one immense, and often overlooked, benefit to human economies: waste absorption. The ecosystem has the ability to dilute chemicals, make use of excess nutrients, and hold elements of economic waste, but only up to a certain amount. Past this point, ecosystem structures begin to break down when they are loaded with too much waste. For instance, the atmosphere has the capacity to hold about 400 PPM (parts per million) of CO<sub>2</sub>. Beyond this point, there will be significant disturbances to climate stability.

### **Sustainable Scale**

For the economy to function correctly, all economic products and services must be:

- excludable (able to be owned by individuals)
- rival (benefit owners to the exclusion of non-owners)
- renewable (can be produced as a result of human efforts)
- substitutable (can be traded for an alternative product)

Ecosystems, on the other hand, are often:

- non-excludable (not able to be owned, not able to be protected by property rights)
- non-rival (not used up by individuals to the exclusion of other people's use)
- non-renewable (abiotic resources such as oil and minerals have fixed quantities)
- essential (for example, water cannot be substituted for a manmade product)

In a sustainable economy, ecosystems regenerate as fast as they are depleted. This means that:

- Resource flows cannot exceed the growth of resource stocks (e.g., timber use cannot exceed forest growth).
- Waste absorption capacity cannot be exceeded by waste production (e.g., CO<sub>2</sub> emissions cannot exceed the atmosphere's ability to absorb CO<sub>2</sub>).

An economy that operates at a sustainable size or sustainable scale meets all these requirements. To consider sustainable scale is to ask: "How big CAN the economy be?" There is another question, though. That is, "How big SHOULD the economy be?"

### **Optimal Scale**

In a steady state economy, we want to find the right size for the economy. We call this the optimal scale. In order to determine the optimal scale of the economy, we can ask a few questions:

- What are the tradeoffs between growing the economy and growing nature?
- At what point are the benefits from nature more valuable than the benefits from increased economic activity?
- How can we get the highest sustainable yield from ecosystems?
- What are the benefits of ecosystems to the economy?

When we consider these questions, we can begin to assess what the costs and benefits are from increasing economic production and consumption. After evaluating these costs and benefits, a democratic process can determine what the optimal scale of the economy is.

Some metrics used to determine the optimal scale for the economy include: The Genuine Progress Indicators (GPI), the Sustainable Welfare Index (SWI), Gross National Happiness (GNH), and others.

However, as we consider the optimal scale of the economy, we should remember to use precaution and play it safe. Ecosystems are complex. Whereas it is easy to account for small changes in simple, mechanical systems, in complex ecosystems, it is nearly impossible to account for all the small changes that occur. Have you heard of the butterfly effect? The butterfly effect is a term coined by Edward Lorenz and reflects the notion that the flap of a butterfly's wings in the United States could lead to a chain of reactions in wind patterns that eventually cause a tsunami in China, illustrating how interconnected wind is around the world.

That is just one example of how difficult it is to account for all the interactions in an ecosystem. There are many other delicate connections across the spectrum of natural systems. Ecosystems have reached relative stability after millions and billions of years of unstable conditions on earth, but in many ways we don't know what has led to this era of stability, and therefore, we may not be able to reproduce the right conditions, should we manage to destroy them.

### **Implementing a Steady State Economy**

There are many tools we can use to impact the size of the economy. We can implement new ownership rules, making some dimensions of ecosystems excludable. We can incentivize and tax certain behaviors depending on their degree of help or harm to ecosystems. We can change the amount of money flowing through the economy and change the amount of money in the economy.

One example of an instrument used for regulating the size of the economy is called cap and trade. Here's how it works: If we know that the ecosystem can only produce a certain amount of resources or absorb a certain amount of waste, we can set an absolute limit on the amount of resource that is used or the amount of waste that is produced. This limit is the cap. Governments can then distribute the rights to pollute or use resources to the business community, and the business community can trade these rights, but the total allowed by all of them put together is still the same, and it is capped or limited. This is a form of turning a non-excludable ecosystem service into an excludable ecosystem service. Cap-and-trade policies have been explored to address climate change and recognize the limit to the atmosphere's ability to absorb CO<sub>2</sub> emissions. Under this arrangement, the public owns the absorptive capacity of the atmosphere and distributes the rights to pollute it to businesses who can trade these rights, with total pollution and emissions staying under the limit, or cap.

Another option for implementing a steady state economy is to use monetary policy. Intuitively, the amount of money in the economy impacts investment and total economic activity. If governments aim to stimulate economic activity, they can inject more money into the economy. If governments aim to reduce economic activity, they can make money less accessible.

Governments also control the accessibility of money through the required reserve ratio in banks. If the required reserve ratio is increased, banks can loan less money.

Governments can also use fiscal policy to influence the money supply and to incentivize or disincentivize modes of economic activity. For instance, with a carbon tax, the price of carbon increases and some of this money flows to the government. This money can be redistributed to those who were affected by the tax or it can be invested in another way.

In other words, once a government has democratically determined the right size for the economy, there are many controls that can be used to ensure that the economy operates correctly. Currently, all these instruments are set according to the goal of GDP growth, rather



than to the goals of sustainability and resource efficiency. Creating economic instruments that specifically consider the goals of sustainability and resource efficiency, not just GDP, is the next step that governments need to take in order to create a steady state economy, one that is not too big or too small and that is sustainable.

## **Conclusion**

In this chapter we discussed some conceptual tools used to determine the right size of the economy. The right size of the economy will be a sustainable and optimal size. Some important concepts include:

- externalities (interdependencies external to economic valuation)
- ecosystem services (the benefits that humans and the economy receive from nature)
- excludability (whether a good or service can be owned by individuals)
- rivalness (whether a good or service benefits individuals to the exclusion of other individuals)
- biotic vs. abiotic resources (living, regenerating, and dying; or non-living, finite, and permanent)

These concepts can help us to determine the sustainable size of the economy and the optimal size of the economy. Determining the sustainable size of the economy depends on assessing the stocks and flows of abiotic and biotic resources, as well as assessing the ecosystem services provided by abiotic resources. Determining the optimal size of the economy depends on our values and moral beliefs about what matters to us and the importance of conserving nature.