

**ENVS 220 Environmental Economics – Winter Term 2014**  
**Mid-term Test Information Sheet**

The test will be on material covered in this course up until Feb. 5, 2014. The test will be comprised of three sections: a multiple choice section, an 'identify and explain' section, and an essay section.

**Section 1** (worth 30%). This section will be comprised of 15 multiple choice questions. These questions will be drawn from lecture, discussion groups, and assigned reading materials.

**Section 2** (worth 30%). This section will be comprised of three 'identify and explain' type questions. Your answers should be between one paragraph and one page in length. You will be asked to answer 2 of these questions. The questions will be drawn from the following terms and concepts:

**Market failures**

In an ideal situation the basic market supply curve is determined by marginal costs and the basic market demand curve determined by marginal benefit. Their intersection is known as the ideal market. When marginal benefit and marginal cost align you have a Pareto optimal market (no other allocation of supply and demand could make at least one person better off without making another person worse off). A perfectly efficient market needs these conditions: Excludability, Rivalness, Complete markets, Perfect competition, Perfect information, Rational actors, and no Transaction costs. These are ideal type conditions that no market in the world can meet. Therefore, inefficient markets are market failures.

Types of market failures:

- An externality is an activity or transaction between some parties that causes an *unintended loss or gain in welfare* to another party, and *no compensation for the change in welfare for the third party occurs* (e.g. Pollution)
- Non-excludable, but rival goods are considered to be 'open access' regimes, and resources under these regimes tend to be over-exploited (e.g. Fisheries)
  - Market fails because we will just consume the open-access good
- Excludable but not rival - such goods have the potential to benefit many people at little added cost, but property rights have been established such that others must pay to use it (e.g. Information)
- Goods that are both nonrival and nonexcludable are considered pure public goods. The market will not provide such goods (e.g. Lighthouse)
  - Problem: in issues of scarcity we look for alternatives, however, can't price some of these goods (can't determine scarcity) and can't find alternatives for public goods.
- Missing Markets - when those affected by certain market transactions are not represented in those markets (e.g. future generations)

<p><u>NCE Approach and Market Failure</u>          Market failures seen as relatively rare.          When they do occur, they can be addressed through the market (make more markets, hand out property rights etc.)          Institutions (e.g. governments) are necessary in some cases (e.g. public goods).</p>	<p><u>Ecological Econ. Approach to Market Failure</u>          Market failures seen as widespread and serious problems.          Market solutions don't always work (e.g. especially problematic with ecosystem services).          Strong institutions are necessary to allocate resources in many cases.</p>
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## Discounting (purpose of)

Neoclassical economists claim for a market to function optimally, everyone who would want to produce or consume the goods being marketed must be able to participate. The market can therefore “efficiently” allocate resources only if we assume that future generations have no rights whatsoever to the resources being allocated. Conventional economists will systematically discount any costs and benefits that affect future generations. Intertemporal discounting can affect decisions concerning natural resource use. When evaluating present and future values, intertemporal discounting is the process of systematically weighting future costs and benefits as less valuable than present ones. \$100 in the future is worth less than \$100 today because of the opportunity cost involved (the lost opportunity to invest), and the farther in the future we look, the less the money is worth. Most conventional economists assume that money is an adequate substitute for anything, and therefore anything in the future is worth less than the same thing today.

From the Lecture:

Discounting the future - non renewables (calculating present value of future extraction)

- Idea is to weigh the benefits and costs of extracting all of a resource now, versus leaving some for future extraction
- Why should the future value be discounted to obtain the present value?

Use of Discounting:

- Discounting is used in making decisions on the rate of extraction of natural resources.
- Is it worth more to extract now, or to extract it later?

## Externality

An externality is a type of market failure. An externality occurs when an activity or transaction by some party causes an unintended loss or gain in welfare to another party, and no compensation for the change in welfare occurs. If the externality results in a loss of welfare, it is a negative externality, and if it results in a gain, it is positive. The classic example of a negative externality is a coal-fired utility plant that moves in next door to a laundry service that air-dries its wash. The soot from the coal plant dirties the laundry, and the laundry service receives no compensation from the coal utility. Because the agent conducting the activity in question is not compensated for positive externalities and pays no compensation for negative ones, she does not take into account these costs or benefits in her decision to pursue the activity. If the agent conducting the activity were to be appropriately compensated or charged, there would be no more externality; the activity would be carried out until marginal benefits equaled marginal costs, not only for the agent conducting the activity but also for society. Economists have suggested that assigning property rights will eliminate the externality problem. If the laundry has the right to clean air, then the coal utility will be forced to pay the laundry service for dirtying its laundry. Once compensation is paid, the externality is gone. The implication is that the externality issue requires no government intervention aside from the assignment and enforcement of property rights; market forces are perfectly capable of sorting it out. This is known as the Coase theorem. Three serious problems with this analysis are that it assumes that both the laundry and the utility are able to pay (i.e., that there are no wealth effects), that individuals are rational maximizers of self-interest, and that there are no real transaction costs. Probably the most important obstacle to real-life applications of the Coase theorem, however, is transaction cost. This is simply the cost of thrashing out an agreement, which can include legal fees, the cost of gathering information and, locating the interested parties, the time cost of bargaining, and so on.

## Laws of thermodynamics

Basics:

The First Law of Thermodynamics states that neither matter nor energy can be created or destroyed.

The Second Law of Thermodynamics states that entropy never decreases in an isolated system. Although matter and energy are constant in quantity (First Law), they change in quality. The measure of quality is entropy, and basically it is a physical measure of the degree of “used-up-ness” or randomization of the structure or capacity of matter or energy to be useful to us. Entropy increases in an isolated system. We assume the universe is an isolated system, so the Second Law says that the natural, default tendency of the universe is “shuffling” rather than “sorting.” In everyday terms, left to themselves, things tend to get mixed up and scattered. Sorting does not occur by itself.

From the Textbook:

Throughput is the metabolic flow from raw material inputs to waste outputs. By the First Law of Thermodynamics, the conservation of matter and energy, we know that throughput is subject to a balance

**equation: Input equals output plus accumulation.** If there is accumulation, the economic subsystem is growing. In steady-state equilibrium, growth and accumulation would be zero, and input flow would equal output flow. In other words, all raw material inputs eventually become waste outputs. The throughput has two ends: depletion of environmental sources and pollution of environmental sinks. Ignoring throughput is the same as ignoring depletion and pollution. Unlike exchange value, the flow of throughput is not circular; it is a one-way flow from low-entropy sources to high-entropy sinks. This is a consequence of the Second Law of Thermodynamics, the entropy law. We can recycle materials, but never 100%; recycling is a circular eddy in the overall one-way flow of the river. Energy, by the entropy law, is not recyclable at all. More precisely, it is recyclable, but it always takes more energy to do the recycling than the amount that can be recycled.

From the Lecture:

First Law of Thermodynamics:

- States that there is only so much matter and energy on earth and that matter and energy cannot be created or destroyed
  - Thus, earth is a closed system and there are finite limits of resources
  - Input of energy and resources into the economy must equal its output (called throughput)
  - Throughput is the flow of raw materials that we use to create goods in the economy
- The problem with the way neoclassical economists perceive throughput is that the process of taking goods and services in the supply chain and using them creates entropy

Second Law of Thermodynamics

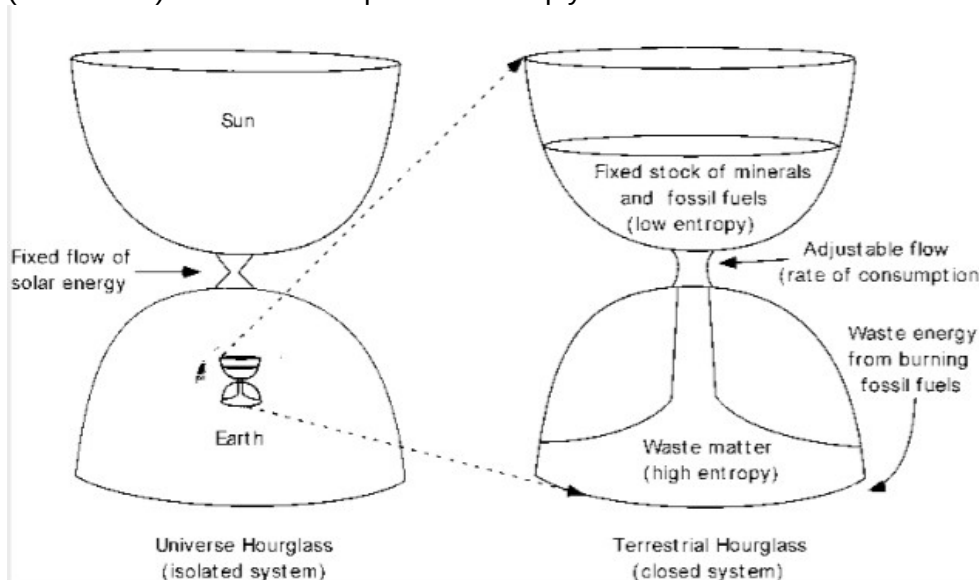
- Entropy increases when throughput occurs
- Whenever work is done or energy is used the amount of usable energy decreases and the amount of unusable energy (entropy) increases

Throughput

- Transformation of low entropy resources into high entropy products
- Taking something with a lot of energy and creating something less usable (energy still exists but is not usable)
  - Start with the assumption that the market is self regulating based on incentives derived from exchange value, we buy things, use things, discard things, and when goods become scarce the price will become so high that we will stop buying these things
  - Ecological economists claim that this ignores the linear throughput of matter and energy by which the economy lives off the environment; there are physical limit that the exchange value ignores – the price isn't an effective signal (called the fallacy of misplaced concreteness – Alfred North Whitehead)

### Entropy hourglass

The law of entropy states that energy and matter in the universe move inexorably toward a less ordered (less useful) state. An entropic flow is simply a flow in which matter and energy become less useful.



The hourglass on the left is an isolated system; no sand enters, no sand exits. Also, within the hourglass there is neither creation nor destruction of sand; the amount of sand in the hourglass is constant. This, of course, is the analog of the First Law of Thermodynamics, the conservation of matter and energy. Finally, there is a continual running down of sand in the top chamber and an accumulation of sand in the bottom chamber. Sand in the bottom chamber has used up its potential to fall and thereby do work. It is high-entropy or unavailable matter-energy. Sand in the top chamber still has potential to fall; it is low-entropy or available matter-energy (still useful). This is the analogy of the Second Law of Thermodynamics: Entropy, or “used-up-ness,” increases in an isolated system. The hourglass analogy is particularly apt because entropy is “time’s arrow” in the physical world—that is, we can tell earlier from later by whether or not entropy has increased. However, unlike a real hourglass, the entropy hourglass cannot be turned upside down!

With a bit of license, we can extend the basic analogy by considering the sand in the upper chamber to be the stock of low-entropy fossil fuel on Earth, depicted in the right-hand figure. Fossil energy is used at a rate determined by the constricted middle of the hourglass, but unlike a normal hourglass, humans alter the width (i.e., they change the rate of consumption of fossil fuels). Once consumed, the sand falls to the bottom of the chamber, where it accumulates as waste and interferes with terrestrial life processes.

To represent solar energy, the top of the hourglass on the left would be vast (from the human perspective), as would the bottom; solar energy, too, ends as waste heat, but it is not confined to the Earth. It does not disappear, but it radiates into outer space, and unlike waste matter does not accumulate on Earth. The constricted middle, however, would be quite small, and humans would be unable to adjust it. The solar source of low entropy is stock-abundant but flow-limited. In other words, there is a lot of it, but we get only a little at a time. The terrestrial source is stock-limited but flow-abundant, until the stock runs out. The asymmetry is important. With industrialization we have come to depend more and more on the least abundant source of low entropy. However convenient in the short run, this will be uneconomic in the long run.

### Excludability/Rivalness

Excludability is a legal principle that when enforced allows an owner to prevent others from using his or her asset. An excludable resource is one whose ownership allows the owner to use it while simultaneously denying others the privilege. Excludability is often synonymous with property rights. In the absence of social institutions enforcing ownership, nothing is excludable. However, the characteristics of some goods and services are such that it is impossible or highly impractical to make them excludable. While someone could conceivably own a streetlight on a public street, when that streetlight is turned on, there is no practical way to deny other people on the street the right to use its light. When no institution or technology exists that makes a good or service excludable, it is known as a nonexcludable resource.

Rivalness is an inherent characteristic of certain resources whereby consumption or use by one person reduces the amount available for everyone else. A rival resource is one whose use by one person precludes its use by another person. A pizza (a stock-flow resource) is clearly rival, because if I eat it, it is no longer available for you to eat. A bicycle (a fund-service resource that provides the service of transportation) is also rival, because if I am using it, you cannot. Although you can use it after I am done, the bicycle has worn out a bit from my use and is not the same as it was. A nonrival resource is one whose use by one person does not affect its use by another. If I use the light of a streetlight when riding my bike at night, it does not decrease the amount of light available for you to use. Nonrival resources are not scarce in any conventional sense. They do not need to be allocated or distributed, and their use does not directly affect scale. Rivalness is a physical characteristic of a good or service and is not affected by human institutions. However, institutions can make nonrival resources such as information excludable, artificially enclosing them in the world of scarcity and allocation.

### Uneconomic growth

Growth has a cost. It is not free, as it would be if we were expanding into a void. The Earth-ecosystem is not a void; it is our sustaining, life-supporting envelope. It is therefore quite conceivable that at some point the further growth of the macro- economy could cost us more than it is worth. Such growth is known as uneconomic growth. This leads to another insight that is fundamental to ecological economics and distinguishes it from conventional economics: Growth can be uneconomic as well as economic.

Marginal disutility curve:

-Same as the utility curve, the more we consume something the less benefit we get from it and the less we're willing to pay for it

-It includes factors that neoclassical economists don't deem necessary for welfare (ex. the use of your labor, the loss of leisure, depletion of natural resources, exposure to pollution)

-When you include these things we see uneconomic growth

-Going down the curve: at first you're pretty willing to work and spend money on goods that increase your marginal utility, however the more you consume the less benefit you gain

Important:

A – at this point we're kind of sick of the good and we're not really willing to pay that much more for it

B – at this point you start to see disutility emerge

E – at this point utility, without considering the impact to the environment, is 0. Growth is futile since we've gained nothing from it. If you factor in some of the costs of the environment it gets worse. If you kept growing you would encounter an ecological catastrophe.

As marginal utility declines we see disutility exceed utility.

Why is it that we ignore these environmental issues?

- The neoclassical perspective is that we live in an empty world
- The economy is simply not seen as a subset of the environment, in fact the environment is seen as a subset of the economy

### Circular flow of the economy

Given that standard economics has a preanalytic vision of the economy as the whole, what is its first analytic step in studying this whole? The familiar circular flow diagram with which all basic economics texts begin. In this view, the economy has two parts: the production unit (firms) and the consuming unit (households). Firms produce and supply goods and services to households; households demand goods and services from firms. Firm supply and household demand meet in the goods market (lower loop), and prices are determined there by the interaction of supply and demand. At the same time, firms demand factors of production from the households, and households supply factors to the firms (upper loop). Prices of factors (land, labor, capital) are determined by supply and demand in the factor market. These factor prices, multiplied by the amount of each factor owned by a household, determine the income of the household. The sum of all these factor incomes of all the households is National Income.

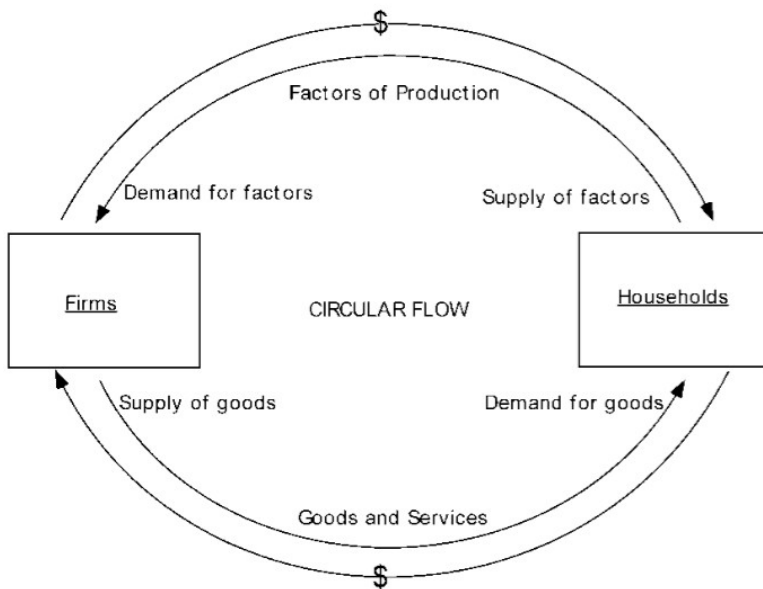


Figure 2.4 • The circular flow of the economy.

There is no denying the usefulness of the circular flow model for analyzing the flow of exchange value. However, it has glaring difficulty as a description of a real economy. Notice that the economy is viewed as an isolated system. Nothing enters from outside the system; nothing exits the system to the outside. But what about all the leakages and injections just discussed? They are just expansions of the isolated system that admittedly make the concept more useful, but they do not change the fact that nothing enters from outside and nothing exits to the outside. The whole idea of analyzing leakages and injections is to be able to reconnect them and close the system again. Why is the isolated system a problem? Because an isolated system has no outside, no environment. This is certainly consistent with the view that the economy is the whole. But a consequence is that there is no place from which anything can come or to which it might go. If our preanalytic vision is that the economy is the whole, then we cannot possibly analyze any relation of the economy to its environment. The whole has no environment.

## Environmental Kuznets curve

From Lecture:

Is there a correlation between growth and the environment?

- Environmental Kuznets Curve: Growth causes an increase in pollution, but once we reach a certain point, pollution decreases
- Kuznets Curve: Argues that when growth is low income inequality is quite high but as we grow that gap decreases

Why does pollution go down?

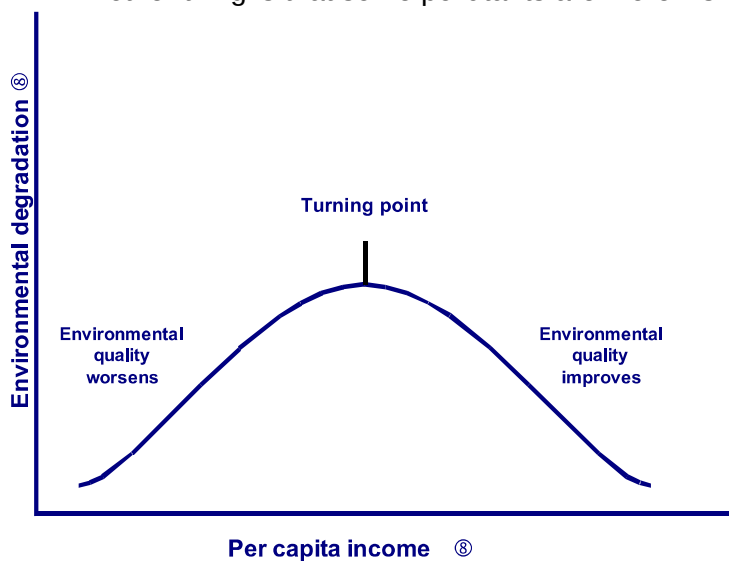
- Economy changes
  - Agrarian to industrial to information
- Preferences change as income rises
  - 1. Food, 2. Shelter, 3. Healthcare, 4. Environment?

Policy implications of EKC, or environmental economics on growth?

- policies that promote growth are good for the environment
- some environmental degradation is inevitable
- environmental regulations that limit growth can be counter-productive

What are some of the potential critiques of EKC analysis?

- Why limit growth when we can grow our way out of pollution? Very contentious position and highly disputed.
- Pollution rates begin to go down because we move the polluting factories to LDCs that have lax environmental regulations (if any at all)
- Another thing is that some pollutants are more visible than others (CO<sub>2</sub> versus SO<sub>2</sub>, acid rain)



From the Reading:

At low levels of per capita income most economic activity is subsistence-level farming. In these areas one expects to find a relatively unpolluted environment, at least with respect to pollutants associated with industrial processes. As the economy grows and industrialization begins, people begin to move out of subsistence living, using more natural resources to acquire more secure sources of basic needs such as food, shelter, and clothing. This results in increases in emissions of industrial pollutants. But, as economic growth continues and incomes grow beyond that required for basic needs, people make marginal choices about how to spend additional income. Once basic needs are met, people start choosing longer life expectancies, cleaner water, proper sanitation, and improved air quality. As the economy grows even further, investment may be made in cleaner technologies and shift to information and service-based activities. These changes combine with an increased ability and willingness to enact environmental protection regulations and improve environmental quality.

## Optimal scale

There is an optimal scale of the macroeconomy relative to the ecosystem. As we increase any activity we also increase both the costs and the benefits of the activity. It is generally the case that after some point, costs rise faster than benefits. Therefore, at some point the extra benefits of growth in the activity will not be worth the extra costs. In economist jargon, when the marginal costs (extra costs) equal the marginal benefits,

then the activity has reached its optimal scale.

### **Ecosystem Services**

We just described forests as a stock of trees that generates a flow of trees. Now we want to look at the forest as a creator of services; as such, it is very different from a stock of trees. A stock of trees can be harvested at any rate; that is, humans have control over the rate of flow of timber produced by a stock of trees. Trees can also be harvested and used immediately or stockpiled for later use. Ecosystem services are fundamentally different. Intact ecosystems are funds that provide ecosystem services, while their structural components are stocks that provide a flow of raw materials. However, recall that stock-flow resources are used up, and fund-service resources are worn out. But when ecosystems provide valuable services, this does not “wear them out.” Examples of ecosystem services: water supply, cultural, climate regulation, and etc.

Ecosystem services. Living species interact to create complex ecosystems, and these ecosystems generate ecosystem functions. When functions are of use to humans, we refer to them as ecosystem services. Many of these ecosystem services are essential to our survival.

Key assumptions by Neoclassical economists:

- Markets are the most efficient way to allocate goods and services
- Economic systems operate as if humans are rational and self-interested actors
- Growth is limitless

Key features of Ecological Economics:

- Highly critical of the neoclassical approach
- Concerned about environmental impact of growth
- Value-based
- Referred to as ‘strong sustainability’

### **Relationship of prices to resource scarcity**

Neoclassical economists claim that the solution to any problem regarding scarcity is the market.

According to them, market prices act as an indicator of scarcity. When the supply of a good or service is low and the demand is high, the price rises. This increase in price reflects the scarcity of that good. When the price is too high people will look for alternatives (reflecting that scarcity and preserving that resource). However, this way of thinking has several faults. First, markets may be slow to react to resource scarcity; in extreme situations this can cause irreversible damage to resources. Moreover, it is the scarcity of flow that determines prices, not the scarcity of stocks.

### **Basic assumptions of neoclassical and ecological economists**

Economics is the study of the allocation of limited, or scarce, resources among alternate competing ends. Neoclassical economics assumes that humans are insatiable, so welfare is increased through the ever-greater provision of goods and services, as measured by their market value. Thus, unending economic growth is typically considered an adequate, measurable proxy for the desirable end. The reason the market is considered the appropriate mechanism is that under certain restrictive assumptions it is efficient, and efficiency is considered a value-free, objective criterion of “the good.” Efficient allocation is shorthand for Pareto efficient allocation, a situation in which no other allocation of resources would make at least one person better off without making someone else worse off. In ecological economics, efficient allocation is important but far from being an end in itself. Neoclassical economics is concerned almost solely with efficient allocation. Ecological economics also considers efficient allocation important, but it is secondary to the issues of scale and distribution. Ecological economists always ask if the extra growth is worth the extra sacrifice it entails. Neoclassical economists tend to forget this question or to believe that the answer is always affirmative.

### **Stock flow vs. Fund service**

Georgescu-Roegen used the terms “stock” and “fund” to distinguish between these fundamentally different types of resources. A stock-flow resource is materially transformed into what it produces. A stock can provide a flow of material, and the flow can be of virtually any magnitude; that is, the stock can be used at almost any rate desired. Time does not enter into the equation, so the appropriate unit for measuring the production of a stock-flow resource is the physical amount of goods or services it can produce. Further, a flow can be stockpiled for future use. Finally, stock-flow resources are used up, not worn out. A fund-service resource, in contrast, suffers wear and tear from production but does not become a part of (does not become embodied in) the thing produced. Instead, a fund provides a service at a fixed rate, and the appropriate unit for measuring

the service is physical output per unit of time. The service from a fund cannot be stockpiled for future use, and fund-service resources are worn out, not used up. The stock-flow and fund-service concepts are important when analyzing human production, and probably more so when focusing on the goods and services provided by nature. Note that “material cause” is always stock-flow in nature, and “efficient cause” is always fund-service.

Summary:

Stock-flow resources

- Are materially transformed into what they produce (material cause).
- Can be used at virtually any rate desired (subject to the availability of fund-service resources needed for their transformation), and their productivity is measured by the number of physical units of the product into which they are transformed.
- Can be stock piled.
- Are used up, not worn out.

Fund-service resources

- Are not materially transformed into what they produce (efficient cause).
- Can be used only at a given rate, and their productivity is measured as output per unit of time.
- Cannot be stock piled.
- Are worn out, not used up.

### Abiotic vs. Biotic resources

Abiotic resources are non-living, chemical or other parts of the environment that influence living beings (fossil fuels, minerals, water, land, and solar energy). Our goal is to explain how the laws of thermodynamics, the distinction between stock-flow and fund-service resources, and the concepts of excludability and rivalness relate to these resources, in order to better understand the role they play in the ecological-economic system. We will also assess the extent to which substitutes are available and the degree of uncertainty associated with each resource. As we will see, however, abiotic resources are fundamentally different from each other, and it is their even greater dissimilarity from biotic resources that binds them together more than their similarity to each other. Perhaps the most important distinction is that biotic resources are simultaneously stock-flow and fund-service resources that are self-renewing, but human activities can affect their capacity to renew. Abiotic resources are either nonrenewable (fossil fuels) or virtually indestructible (everything else). Biotic resources include the raw materials upon which economic production and human life depend, the ecological services that create a habitat capable of supporting human life, and the absorption capacity that keeps us from suffocating in our own waste. As nonrenewable resources are exhausted, human society will come to rely more and more on the self-renewing capacity of biotic resources. It is therefore critically important that we understand the nature of these resources. Biotic resources are almost entirely considered means to various ends, where one of the foremost ends is the sustenance of life, the maintenance of biotic resources. Biotic resources not only enhance human wellbeing directly, they are also considered by many to be an end in their own right, especially in the case of sentient creatures. Biotic resources are also physically complex in two ways. First, the processes responsible for the sustained reproduction of individuals, populations, or species are highly complex and poorly understood. Second, individuals, populations, and species interact with other individuals, population, and species, as well as abiotic resources, to create an ecosystem.

### Marginal benefits and marginal cost

- **Marginal utility:** The marginal utility of something is the additional benefit or satisfaction you derive from obtaining an additional unit of that thing. The law of diminishing marginal utility states that the more one has of something, the less satisfaction an additional unit provides. For example, the first slice of pizza on an empty stomach offers considerable satisfaction, but each additional slice provides less satisfaction than the previous one.
- **Marginal cost:** Marginal cost is the additional cost of producing one more unit. The law of increasing marginal cost is similar to that of diminishing marginal utility. For each additional ton of wheat harvested, you have to make use of inferior land and workers (you used the best first). Also, once you've used all the land for wheat, adding more labor, fertilizer, and so on is the only way to increase the wheat harvest. But with fixed land, we will have diminishing returns to the variable factors (labor, fertilizer)—more and more laborers and fertilizer will be needed for each additional ton of harvest. Diminishing returns is a further reason for increasing marginal costs. Neoclassical economics is constantly comparing increasing marginal costs with declining marginal benefits, looking for their point of intersection that defines the optimal scale of

each microeconomic activity. It does not apply this logic to the macroeconomy or recognize that it has an optimal scale. Ecological economics insists that the logic of optimal scale is relevant to the entire macroeconomy, as well as to its parts.

**Section 3** (worth 40%): Two questions will appear on the test and you will be required to answer **ONE** of them. Question #1 below will be on the exam. Question #2 **OR** #3 will also appear. Your answer should be approximately 3-4 handwritten pages in length. Please use examples to illustrate your answers.

**1. What are the main arguments on both sides of the “limits to economic growth” debate? Which side of this debate do you find most convincing, and why?**

Conventional economics sees the economy, the entire macroeconomy, as the whole. To the extent that nature and the environment are considered at all, they are thought of as parts or sectors of the macroeconomy—forests, fisheries, grasslands, mines, wells, ecotourist sites, and so on. Ecological economics, by contrast, envisions the macroeconomy as part of a larger enveloping and sustaining Whole—namely, the Earth, its atmosphere, and its ecosystems. The economy is seen as an open subsystem of that larger “Earthsystem.” That larger system is finite, nongrowing, and materially closed, although open to solar energy. It is important to understand the distinctions between open, closed, and isolated systems.

An **open system** takes in and gives out both matter and energy. The economy is such a system. A **closed system** imports and exports energy only; matter circulates within the system but does not flow through it. The Earth closely approximates a closed system. An **isolated system** is one in which neither matter nor energy enters or exits.

Back to the problem of the whole and the part. Why is it so important? Because if the economy is the whole, then it can expand without limit. It does not displace anything and therefore incurs no opportunity cost—nothing is given up as a result of physical expansion of the macroeconomy into unoccupied space. But if the macroeconomy is a part, then its physical growth encroaches on other parts of the finite and nongrowing whole, exacting a sacrifice of something—an opportunity cost, as economists would call it. In this case, if we choose to expand the economy, the most important natural space or function sacrificed as a result of that expansion is the opportunity cost. The point is that growth has a cost. It is not free, as it would be if we were expanding into a void. The Earth-ecosystem is not a void; it is our sustaining, life-supporting envelope. It is therefore quite conceivable that at some point the further growth of the macroeconomy could cost us more than it is worth. Such growth is known as uneconomic growth. This leads to another insight that is fundamental to **ecological economics and distinguishes it from conventional economics**: Growth can be uneconomic as well as economic. There is an optimal scale of the macroeconomy relative to the ecosystem.

The basic rule of microeconomics, that optimal scale is reached when marginal cost equals marginal benefit ( $MC = MB$ ), has aptly been called the “when to stop rule”—that is, when to stop growing. In macroeconomics, curiously, there is no “when to stop rule,” nor any concept of the optimal scale of the macroeconomy. The default rule is “grow forever.” Indeed, why not grow forever if there is no opportunity cost of growth? And how can there be an opportunity cost to growth of the macroeconomy if it is the whole?

Even if one adopts the basic vision of ecological economics and considers the economy as a subsystem of the ecosystem, there still would be no need to stop growing as long as the subsystem is very small relative to the larger ecosystem. In this “empty-world vision,” the environment is not scarce, and the opportunity cost to expansion of the economy is insignificant. But continued growth of the physical economy into a finite and nongrowing ecosystem will eventually lead to the “full-world economy” in which the opportunity cost of growth is significant. We are already in such a full-world economy, according to ecological economists.

The ultimate physical output of the economic process is degraded matter and energy—waste. Neglecting the biophysical basis of economics gives a false picture. But neglecting the psychic basis gives a meaningless picture. Without the concept of welfare or enjoyment of life, the conversion of material resources first into goods (production) and then into waste (consumption) must be seen as an end in itself—a pointless one. Both conventional and ecological economics accept the psychic basis of welfare, but they differ on the extent to which manmade and natural capital contribute to it.

<b>Neoclassical Economic View:</b>	<b>Ecological Economists View:</b>
<ul style="list-style-type: none"> <li>-Neoclassical economists really like growth because it improves human welfare</li> <li>-Growth is great as long as the marginal cost of growth is equal to marginal benefit to society</li> <li>-Because growth is good and costs are insignificant there are no constraints to growth</li> <li>-They embrace this view that the world is blank and that there are no limits to growth</li> <li>-Manmade capital and natural capital is substitutable</li> <li>-Manmade capital = goods we get from production</li> <li>-Natural capital = stocks of resources that fuel the economy</li> <li>-As long as we derive enough benefits from exploiting these resources there's no tradeoff</li> <li>-Money we get from exploitation makes depletion okay because we incur benefit</li> <li>-As long as you replace natural capital with manmade capital growth continues (political economists would argue that so does our disutility)</li> </ul>	<ul style="list-style-type: none"> <li>-We can't keep growing at the rate that we are</li> <li>-There is just some natural capital that, regardless of all the cash, we can't replace/ substitute</li> <li>-Natural capital to an ecological economist is finite, this means that there is a physical limit to the size of the economy</li> <li>-There is an optimal scale for the use of natural capital, so we must make it sustainable, and we cannot exceed this optimal scale</li> <li>-What is the optimal scale? Thermodynamics shows that isolated circular diagram that neoclassical economists use ignores basic laws of physics, does not account for leakages and injections</li> </ul>

**2. "Since natural resources are finite, increased consumption must inevitably lead to depletion and scarcity." (Paul Ehrlich, 1963) What basis do ecological economists use to justify their pessimism about resource scarcity? Why do resources economists disagree? What side of this debate do you support?**

There are two predominant schools of thought when it comes to resource scarcity. Neoclassical economists believe that price will guide the consumer and ultimately affect their purchasing decisions. When a resource becomes scarce the price will increase and consumers will look for alternatives. On the other hand, ecological economists adopt a more pessimistic view on this topic. They believe that neoclassical thought ignores several important issues. It is my opinion, that a pessimistic view on resource scarcity is more beneficial for society in the long run as it emphasizes problems with economic valuation and market failures, particularly dealing with common goods, pure access regimes, and missing markets.

Economists assume that price increases will trigger innovation and generate substitutes for any given resource. If resource owners are optimists, they believe new discoveries will be made and substitutes invented. This means that their resource will not become scarce and its price will not go up (and may even go down). Under such circumstances, it makes sense to extract the resources as quickly as possible and invest the returns. If the resources are being extracted quickly, aboveground supply is large, and the price is low. This reduces the incentives for exploration and the development of substitutes. The problem is that developing substitutes requires technology, technological advance requires time, and the less warning we have of impending resource exhaustion, the less time there is to develop substitutes. In this regard, ecological economists come to a most basic conclusion: finding alternatives is hard. This is particularly true in regards to time and equivalence.

In regards to pure access goods, which are non-excludable and leads to their overuse and resulting scarcity. Classical economist Garret Hardin emphasized property rights in dealing with the "tragedy of the commons". This is a commonplace solution for classical economists, the problem, however, is that property rights are hard to enforce for an open-access good like fisheries - especially schools of fish that migrate. Property rights therefore aren't the best solution.

On a similar note, sometimes alternatives simply don't exist. This is particularly true for public goods. Neoclassical economists have a hard time applying sustainability to public goods; for them if these goods aren't priced how do we preserve them? The idea should be that prices should go up and we find alternatives. The problem with this view is that you can't price some of these goods so how do you demonstrate scarcity? Valuation of nature is cause for a lot of debate in this field. How do you value a walk through a park, or a swim in a clean lake? Moreover, what's an alternative to a swim in a clean lake?

Due to these issues mentioned, I strongly believe that pessimism and adopting an ecological economists view on this topic is better for society in the long run. Ecological economists acknowledge the issues with valuing nature, they account for missing markets, and they identify the problems with open-access regimes and pure public goods.

- 3. “Can the supply of natural resources – especially energy – really be infinite? Yes!” (Julian Simon). What is the basis of the type of natural resource optimism presented by neoclassical economists like Julian Simon? How does this approach compare to ecological economists’ view of the natural resource scarcity question?**