Population and the Environment

The impact of population growth on economic development is a complex issue. As might be imagined population growth has positive and negative effects on development.

Start the discussion today with the notion of **sustainability**. Even if population growth can be accommodated now, are there adverse effects that will jeopardize the ability to meet the needs of future generations? On Thursday we'll consider the notion of sustainability as developed in the article by Arrow and the committee. Interesting paper on many levels, but it is unique in that the committee of authors represent famous economists and ecologists (biologists). Rare that they write together.

Michel's definition: [chart] **Sustainability**: a social and economic system is considered "sustainable" if the needs and demands of the present generation can be met without diminishing the possibility of fulfilling, minimally, a comparable set of needs and demands for all future generations.

Can think of sustainable much like **permanent income**: the level of consumption supported with no reduction of assets.

When considering the effect of population growth on sustainability, we have to look at the impact of popuatlion growth on:

- Resource Scarcity:
  - Food
  - Energy (coal, oil, uranium)
  - Raw materials (iron, copper, wood, water)
- Environmental Impacts
  - Pollution
  - Soil degradation
  - Deforestation
  - Global Warming

Population growth would not be sustainable if it has important negative impacts that will jeopardize the ability of future generations to meet their needs.

First, let's look at the evidence about resource scarcity and environmental change, and see what is the role of population growth in these changes.

Food Scarcity

Quote from Sen [slide]

Food has become less scarce because of:

- Increased production (green revolution of 60s, 70s)

- Additional farmland
- Increased nutritional food produced

So far as food is concerned, there is no clear sign of limits. See also article from {Bongaarts}. 9 to 10 billion people by 2050 — World Bank predicts no food shortage. Persistent malnutrition is due to poverty more than shortage of carrying capacity.

Energy Scarcity

First, let's look at the mechanisms which can regulate scarcity.

Prices:

In a competitive (free) market, prices an indicator of scarcity — the more scarce the higher the price.

Fluctuations in price reflect perceptions of scarcity. Oil is not a good example because its supply largely controlled by a cartel (and is not a free market)

Price affects consumption: quantity demanded declines as price increases.

Expect to see prices increase as resources become depleted.

And as prices increase, quantity supplied will increase. In terms of oil and other non–renewable energy sources this means that as the price of oil increases so too does the incentive for exploration and innovation, including creation of new, more efficient technologies or alternative energy sources (e.g., solar energy).

At low energy prices, not cost–effective to use wind or solar energy. But as the price of oil increased these energy sources (and others) become cost effective, and reduce the demand for oil.

Belief in the role of prices (more than the role of markets) is what makes economists less pessimistic of the future than biologists. Economists see the market as a viable means for regulating and or controlling energy usage. The regulation need not be simply through the market factors, as government can impose taxes. Thus, many advocate for higher gasoline taxes.

What are the trends?

For oil: real price of oil declined throughout the 20th century. [chart for oil prices]

And reserves continue to grow. [chart]

Thus no evidence of scarcity. This year witnessed the large run up of the price of oil and a startlingly rapid decline. There is a lot of manipulation in prices by the various oil producing countries, so there is a lot of uncertainty. A lot of the increase in prices was due to increased demand for oil from India, Brazil, and China. Perhaps current prices low price is the outlier.

Many metals such as copper, lead, tin, nickel, and tungsten also had declining prices (relative to wages).

Conclusion: as far as food and most resources required for economic activity are concerned, no evidence of scarcity, in spite of large population growth.

But this presume all effects of scarcity may be mediated through the market. For private property (to the extent property rights exist and are enforced) prices reflect their value. But a critical feature

of environmental issues is the potential for **externalities**. Externalities arise when the actions of a consumer or firm influence other consumers or firms other than through the market place. (So, a firm increases its price that influences consumers, but operates through the market. And is not considered an externality.)

Externalities can affect consumption or production, and may be positive or negative. What are some examples?

- Air Pollution can be an externality in both consumption and production. It lowers the utility of consumers. And can raise the cost of producers. In Pittsburgh in the 1950s office workers had to bring an extra white shirt to the office because of the air pollution from the steel mills.
- Congestion externality. A big box discount retailer can impose traffic congestion externalities. That is, the increased traffic, and congestion are not incorporated in the prices of the goods sold by the retailer.
- Planting forests can improve the water quality of those downstream and would be a positive externality.
- Landscaping in of front a house. It may improve the value of the home, but may also improve the value of homes in the neighborhood.
- Higher education. Is claimed to produce a positive externality in making for a more informed citizenry, with higher rates of voting, and public service.

Externalities thus confer costs or benefits that are not internalized within the price system. Typically, because the costs are dispersed over a large population and are hard to assign, e.g., how to capture the gain in neighbor's increased property values generated by a garden or private landscaping.

Some externalities can be offset by (Pigovian) taxes. For example, tax the air polluter based on the amount of effluent released into the air. Or (as NYC) tax cars coming into Manhattan. Thus the tax should be positive to offset negative externalities (the true cost is higher than the market price) and should be negative for positive externalities (the social cost is lower than the market price).

Concern over environmental issues frequently center on externalities. Thus, the Meadows et al. *Limits to Growth*(1972), *Beyond the Limits to Growth* (1992) and *Limits to Growth: 30 Year Update* focus on not reserves and market prices but on externalities.

Some these authors consider deforestation of the rain forest and see evidence of over–population. In 1992, "Beyond the Limits" reflected their belief that the world was living beyond its means/limits.

Much of the discussion centers on public goods. Public goods are defined as goods where, for a given output, additional consumption by one person does not imply reduced consumption by another. For examples, include public television, uncongested park or museum, national defense, clean air, or public health.

And here is Hardin's **Tragedy of the Commons**. It is a classic and you should read it on two levels (1) substantive (what is claimed) and (2) rhetorical (style, how the case is made whether true or not). **Tragedy of the Commons** offers a powerful metaphor to illustrate the dangers of over

use of public goods. The great rhetorical device is that the village green or commons represents the earth's resources. We cannot fathom the earth's bounty, but we can understand the concept of a village green or commons.

Whats the value to the herdsman of adding an additional animal to the herd and grazing on public land? Answer: Herdsman benefits by the full value of the extra animal. What is the cost to the herdsman? If there are n people in the population, his share of the cost of using the public good equals $1/n$. That is, the herdsman receives the full benefit, and pays only his share of the cost. The obvious implication is that there will be over grazing, as everyone has the same incentive. This is called a free rider problem: the individual herdsman grazing his animals on public lands does not internalize the full cost of adding an additional animal (that is the cost imposed on others).

Earth is the commons, and private incentives for resource use may differ (widely) from social incentives.

What are possible solutions? Hardin notes two:

1. Private ownership. The owner receives the full value of an extra animal but pays the full cost. The owner has an incentive then not to over–graze the pasture.

2. Taxes and subsidies. As we have discussed.

The paper by {Portney} on the reading list forecasts environmental policy over the next 50 years. He expects three changes:

1. Increased use of incentive–based systems — carbon tax or market permit.

2. Increased public disclosure by firms on their emissions in the air and water. Internet site for reporting on the amount of each pollutant is discharged in each neighborhood. `www.scorecard.org` I entered my zipcode and received reports for Dane county.

3. Reduced role for national environmental policy. Portney expects localities and international organizations to play a larger role.

Evidence about Environmental Degradation

The evidence is well–summarized by article by {Preston}. Environmental degradation can be seen in local and global effects.

Local effects include:

- Pollution (air, water, soil)

- losses (forest, soil, fish)

Global effects include:

- Atmosphere (ozone layer, global warming)

- Biodiversity (number of species of plants and animals)

For local effects the evidence varies depending on whether we consider MDCs or LDCs.

Rich Countries General improvement in the quality of the human environment, especially since 1970.

Better sanitation systems. Cleaner waste disposal facilities, and overall waste management. Decrease in the emission of air pollution. **[chart]**

Continued losses of forests is balanced to some degree by preservation efforts. Consider {Mann's} comments on the Hudson Valley.

Transformation of forest and swamp into cultivated land during the Middle Ages in Europe, in general, was accompanied by maintenance or improvements in soil quality. Thus, deforestation does *not* necessarily imply soil degradation.

Poor Countries Here the evidence is mixed: Improvements affecting the quality of human environment in some areas (improved sanitation, sewage systems) but deterioration in others (air pollution).

{Portney} notes that most of the additional three billion new inhabitants on earth during the next 50 years will be born and live in the developing world.

And inhabitants of the developing world will continue to migrate to already very crowded mega–cities. They will want modern amenities: cars, electricity. Meeting the demand for electricity almost certainly will have to be met by coal. And, the cars will burn gasoline. Thus, air quality in developing countries may be in trouble. Also concerned that increased population in cities may overwhelm water supply and sewage treatment systems (where such systems exist).

Portney notes the challenge of the developed countries is to help the developing countries increase their standards of living in ways that help them skirt, as much as possible, the pollution–intensive period through which developed countries passed.

Portney notes the difference between reversible and irreversible environmental damage. Degradation of air or water quality can be eventually reversed. However, we can not resuscitate a species once driven to extinction or regrow (in any meaningful time scale) a redwood or other old growth forest lost to logging or urban growth.

In terms of evidence, {Preston} notes that forest loss less tightly controlled in poor countries than in rich countries. Poor countries have less preservation. And there is evidence of soil degradation (soil exhaustion) in the less developed countries. Effects concentrated in soil in tropical areas, rain forest).

What is the evidence about environmental degradation at the Global level?

Climate: the issue of global warming and greenhouse gasses (e.g., CO_2).

There is evidence that the temperate has been rising for a century or so. [chart]

Gas emissions have increased greatly after industrialization. [chart pred temp]

Temperature simulated in models driven by greenhouse gases. This chart doesn't demonstrate a causal connection. But the mechanisms through which greenhouse gasses could lead to increased temperature are known and clear. There is a consensus that global warming results from increases in the emission of greenhouse gases.

The Role of Population

Can we say that population growth is an important contributor to environmental degradation? If so, will decreased fertility help the preservation of the environment?

This is an important issue to consider. But the link between population growth and pollution, and environmental degradation, has not been clearly established. The most polluted areas of the world are not the most populated (e.g., former Soviet Union low population density, but high pollution).

We see that in both LDCs and MDCs, population contributed positively to the energy use. Affluence did so as well. However, energy use per income (which is a measure of the technology – the lower the best technology) contributed positively in LDCs, and negatively in MDCs.

Technology can counteract (or exacerbate) increases in population and affluence.

There is a link between population density and technology level. And higher levels of affluence lead to better, cleaner less polluting technologies (compare MDCs and LDCs).

In brief, the direct evidence of the effect of population growth on the environment is clearer for forest loss and soil degradation than for pollution. But population is *not* the only factor affecting environmental degradation.

Simple models that link population growth to environmental change do not recognize that humans can manipulate their environment. They create institutions, solve problems, etc {McNicols}

Basic Conclusion:

Environmental degradation can not be addressed solely through population policy. It is easy to blame population growth. Population growth seem easier to address than problems associated with institutions, land tenure system (private versus public ownership of resources), technologies. Answer: just enact family planning programs. But in reality, slower population growth will not resolve the complex set of problems related to environmental change. Policy must address a range of issues.

Population growth does not have to produce environmental degradation.

And population control may not produce less environmental degradation.