Advanced Policy Workshop:
Sustainability and Resource Valuation

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Global Economic Sustainability

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The presentation is based on:

1. Dasgupta, P. (2014), "Measuring the Wealth of Nations," in G. Rausser, M. Hanneman, and D. Zilberman, eds., *Annual Review of Resource Economics* (Palo Alto: California).

2. Dasgupta, A. and P. Dasgupta (2017), "Socially Embedded Preferences, Environmental Externalities, and Reproductive Rights." Forthcoming, *Population and Development Review*. September 2017.

In this lecture I focus on globally sustainable population. There are two ways to address it. The approach I follow is based on the above papers. If time permits, I shall sketch an alternative approach, more congenial to economists, in which population and the standard of living are arrived at from an intertemporal optimization exercise. The latter approach can be found in

Dasgupta, P. (1969), "On the Concept of Optimum Population," *Review of Economic Studies*, 36(3), 295-318.

Dasgupta, P. (2017), "Birth and Death." Forthcoming, Gustaf Arrhenius et al. eds., *Oxford Handbook of Population Ethics* (Oxford University Press, 2018).

Additional References

World Bank (2016), *Development Goals in an Era of Demographic Change* (Washington DC: World Bank)

Layard, R. (2011), *Happiness: Lessons From a New Science* (London: Penguin).

Rees, W.E. and M. Wackernagel (1994), "Ecological Footprints and Appropriated Carrying Capacity: Measuring the Natural Capital Requirements of the Human Economy," in A.M. Jansson et al., *Investing in Natural Capital: The Ecological Economics Appropriate for Sustainability* (Washington, DC: Island Press).

Waters, C.N. (2016), "The Anthropocene is Functionally and Stratigraphically Distinct from the Holocene," *Science*, 351(6269).

Policy analysis: The idea is to evaluate an economy *at a point in time* before and after a hypothetical move from the status quo has been put into effect. The move in question is a change in policy.

Sustainability analysis: The idea is to assess an economy as it undergoes change *over time*. The question asked is whether under existing and likely future policies the economy is expected to improve over time.

In both kinds of analyses, the criterion with which the evaluation is undertaken is intergenerational well-being.

Formally, suppose $V(t)$ is intergenerational well-being at date t. If under the status quo future prospects as forecast at t by the evaluator is denoted by $f(t)$, then $V(t) = V(f(t))$. A policy change enacted at t amounts to a perturbation to future prospects. Write that as $\Delta f(t)$. Policy analysis amounts to determining the sign of $V(f(t)+\Delta f(t))- V(f(t))$. In contrast, to ask whether the economy has shown an improvement over a brief passage of time, Δt, is to ask whether $V(f(t+\Delta t))-V(f(t))$ is positive. The latter exercise defines sustainability analysis.

Define inclusive wealth as the shadow value of the economy's stock of assets (comprising manufactured, human, and natural assets). Note that assets' shadow prices are a function of, among other things, the social environment (the quality of markets, the reach and effectiveness of government, civil society - more broadly, the extent of trust in society).

Proposition. Any perturbation to an economy that brings about an increase in inclusive wealth raises intergenerational well-being. Contrarily, any perturbation that brings about a decline in inclusive wealth lowers intergenerational well-being.

Human Population and the Biosphere

Nature responds to the demands we make of it, not to rates of changes in those demands, let alone to rates of changes in the rates of changes in those demands. This simple insight has had little influence on either economics or demography. We heave a sigh of relief when told that the rate of global population growth is declining (World Bank, 2016), but that is far from being told that we are heading toward a sustainable use of the biosphere. A long run population of 10-11 billion can be expected to make a far greater demand on the Earth system than one of 3 billion.

The Millennium Ecosystem Assessment 2005 reported that 15 of the 24 major ecosystems that the authors had reviewed had either deteriorated or were currently being used at unsustainable rates. And there are hundreds of studies identifying local ecosystems that have deteriorated or been destroyed through excessive use or habitat destruction.

Students of biogeochemical signatures of the past 11,000 years have provided a revealing sketch of the Anthropocene. They have noted that a sharp increase took place in the middle of the 20th century in the rate of deterioration in the workings of Earth's life support system. They proposed that mid-20th Century should be regarded as the time we entered the Anthropocene.

Their reading is consistent with macroeconomic statistics. World population in 1950 was 2.5 billion. Global GDP was a bit over 7.5 trillion international dollars (at 2015 prices). Per capita income was bit over 3,000 international dollars. Today world population is 7.4 billion and world output of final goods and services is about 110 trillion international dollars, meaning that world income per capita now is about 15,000 international dollars. A 15-fold increase in global output over a 65-year period helps to explain the stresses Waters et al. (2017) have reported.

The Global Footprint Network (GFN) in California has estimated that today humanity's demand for ecological services exceeds by 60 per cent the rate at which the biosphere is able to supply those services to us. The figure is based on the idea of "global ecological footprint", which is the surface area of biologically productive land and sea needed to supply the resources a human population consumes (food, fibres, wood, water) and to assimilate the waste it produces (materials, gases) relative to what the biosphere supplies. A footprint in excess of 1 means demand for ecological services exceeds their supply. If we take the current footprint to be 1.6, it means we need 1.6 Earths to satisfy our current demand sustainably. GFN has estimated that from the work of the Millennium Ecosystem Assessment's work that the footprint was about 0.6 in the 1960s.

As social scientists we are then obliged to ask why reasoned decisions at the individual level can nevertheless yield collectively unsatisfactory (even disatarous) outcomes. The collapse of past societies, a major field of historical study today, points to root causes. And they have much to do with "externalities".

Externalities

Externalities are the unaccounted for consequences for others of actions taken by one or more persons. They are symptoms of institutional failure, which is why they cannot be eliminated without collective action. The institutional failures that underlie externalities are symptoms of the absence of appropriate property rights to goods and services (provate, communitarian, or public). When externalities are adverse, the moral directives flowing from them can clash with the exercise of personal rights. (Examples: compulsory vaccination against infectious diseases, ban on smoking in public places, prohibition of effluent discharge)

Here I pay attention to population, most especially in sub-Saharan Africa, where the total fertility rate is still over 5, in contrast to the word average, which is 2.5 (in Europe it is less than 2). The classification of reproductive externalities that I offer here is prompted by the African experience. We could conduct a parallel study on the demand rich people make on the biosphere by their high consumption levels.

Classification

1 Environmental externalities. These are standard to those attending BioEcon conferences. Nature is always on the move. Property rights to the natural environment are difficult to define and enforce. One reason is that Nature is constantly on the move. The wind blows, particulates diffuse, rivers flow, fish swim, birds and insects fly, and even earthworms are known to travel undetected. You cannot contain the atmosphere you befoul. That means you pass on some of the damage caused by a deteriorating environment to others without their consent.

This kind of externality is analysed in the standard Prisoners' Dilemma (PD).

2 Reproductive Externalities.

2a. Cost sharing among kinship. Fosterage in sub-Saharan Africa. (Resembles PD)

2b. Children as status goods. The wealth-in-people thesis applied by anthropologists for parts of sub-Saharan Africa. (This resembles Veblen's understanding of conspicuous consumption in the American Gilded Age - again, PD).

2c. Socially embedded preferences ("conformism"). Here the desired number of children is an increasing function of the "peer group's" TFR. (This preference structure embodies the structure of preferences in Coordination Games). Fig. 1.

2c has a number of implications:

(i) Multiple equilibria and a driver of demographic transition.

(ii) Reproductive rights: A central plank of family planning programmes is the idea of "unmet need" (for modern contraceptives), which the UN derives from expressed desire for children. It is the percentage of women in age range 15-49 who are seekibng to stop or delay child bearing but who are not currently using modern birth control methods. Relatedly, a woman's "wanted fertility rate" (related to "desired family size") is inferred from answers to the following question:

"If you go back to the time when you did not have any children and could choose exactly the number of children to have in your whole life, how many would that be?"

2c says that the question should be changed to:

"If you could go back to the time when you did not have any children and could choose exactly the number of children to have in your whole life, how many would that be, assuming everyone else in your community had *n* children over their whole life?"

(ii) Pritchett (1994) regressed TFR on wanted fertility in a sample of 43 countries and found that 90% of cross country differences in TFR are associted with differences in wanted fertility. He concluded that high fertility in his sample is due entirely to strong desire for children. But 2c says that it is as true to say that TFR is high because the desire for many children is high as it is to say that desire is high because the TFR is high.

These externalities can reinforce one another, leading to heightened demand for children and a greater demand for ecological services. Crude but suggestive estimates of the demand humanity currently makes on the biosphere suggest that adverse environmental externalities accompanying new births are significant. That leads me to search for estimates of the size of the global population that the Earth system can support at a good standard of living.

UNFPA (1995) took it that family planning and reproductive health policies should address "unmet need", meaning that they should be made to serve women aged 15-49 who are seeking to stop or delay child-bearing but are not using modern contraception. The fundamental right of individuals "to decide freely and for themselves, whether, when, and how many children to have" is central to the vision and goals of *Family Planning 2020* (FP2020). It is also pivotal in the reproductive health indicators of the United Nations' Sustainable Development Goals.

The pervasiveness of reproductive and environmental externalities mean that reproductive rights, when used to delineate the boundaries of family planning and reproductive health services, is at odds with rights of future people to inherit a reasonable biosphere. So the UN stance and the entire subsequent literature on family planning and reproductive health undervalues their stated objectives.

How Many People Can the Biosphere Support?

It proves useful to regard the biosphere as a gigantic renewable natural resource, offering ecosystem services in units of biomass. The stance involves a heroic aggregation exercise, in which billions of assets are aggregated into a single measure, but recall that global fisheries and forest biomes are routinely measured in units of biomass, which also involves giant aggregation exercises.

In the face of externalities the natural social corrective is the use of policies that are based on shadow prices. Barring carbon concentration in the atmosphere, we don't have shadow prices for global environmental resources. So I make use of the crude estimates of the Global Footprint Network's work on the demand humanity is making on the biosphere.

If the fottprint is 1.6, sustainable global output (at current compositions of output) is, as a crude approximation, $110x10^{12}/1.6 = 70$ trillion international dollars. I'll take that as the global bound on sustainable economic activity.

there are two approaches we can take to identify the optimum combination of population and per capita consumption that add up to 70 trillion dollars.

(i) Conduct a full optimization exercise where both consumption and human numbers are control variables. That was done in Dasgupta (1969), which can be used to work here.

(ii) Choose a standard of living that is deemed comfortable and then deduce the human numbers that can enjoy that living standard.

I follow the latter approach here.

An analysis of one set of global surveys on happiness and their relationship with household incomes has revealed that in countries where per capita income is in excess of 20,000 international dollars, additional income is not statistically related to greater reported happiness. We work with that figure (Layard, 2010). More to the point, 20,000 international dollars (at 2015 prices) was the per capita income in the OECD countries in the mid-1970s (the final years of the Golden Age of Capitalism!). Were people there then unhappier than they are today?

If we regard 20,000 dollars (PPP) as the desired standard of living for the average person, maximum sustainable population comes to 3.5 billion. That was global population in the early 1970s. So we are not talking of unfamiliar times.

High Consumption vs High Fertility

The World Bank estimates that the 1.4 billion people living in its list of high-income countries enjoy a per capita income of 40,700 international dollars. Imagine the 1.4 billion people in today's high-income countries were to reduce their average consumption (or income) to 20,000 international dollars. The drop of 20,700 (viz. 40,700-20,000) international dollars per person in a population of 1.4 billion adds up to a total of 31 trillion international dollars. Other things equal, world income would then be 79 (viz. 110-31) trillion international dollars, a figure for global economic activity that is not far above the 70 trillion dollars we obtained as a crude estimate for sustainable global income under present technologies and contemporary social institutions.

According to UN projections, world population will increase from the current 7.4 billion to 11.2 billion in 2100. More than three-quarters of that increase is projected to be in sub-Saharan Africa, from today's approximately 1 billion to 4 billion (Fig. 2). Per capita income in sub-Saharan Africa is currently 3,500 international dollars. Comprising a little over 13 per cent of the world's population, the region represents a bit in excess of 3 per cent of the world economy. So, sub-Saharan Africa cannot remotely be held responsible for the global environmental problems we face today.

But to raise incomes there even to the current global average income (15,000 international dollars) in the face of a 3-billion rise in numbers would require an increase in the region's annual output from 3.5 trillion dollars to 60 trillion dollars. That rise, assuming it is possible, will have severe consequences for the region's ecology, contributing to further societal conflicts there and to greater attempts by people to move both within the region and out of it. It is not difficult to imagine the international tensions that scale of attempted movements would give rise to.

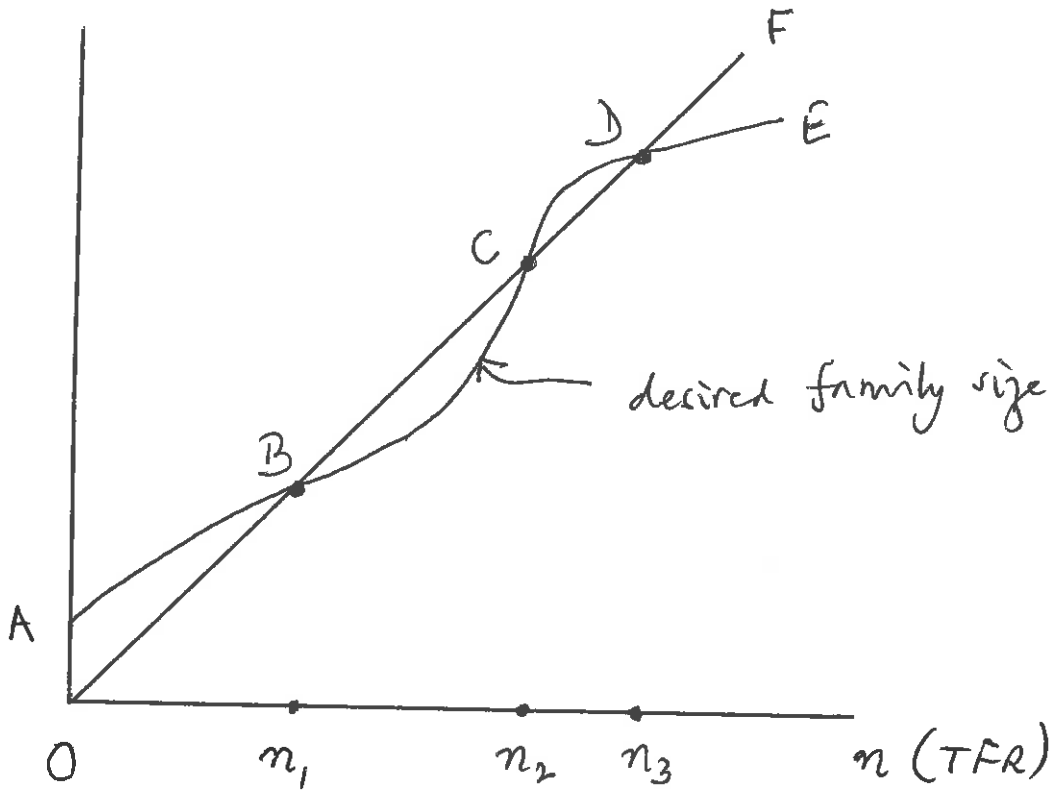

Figure 1

socially-embedded preferences

Total population by region, 2015-2100

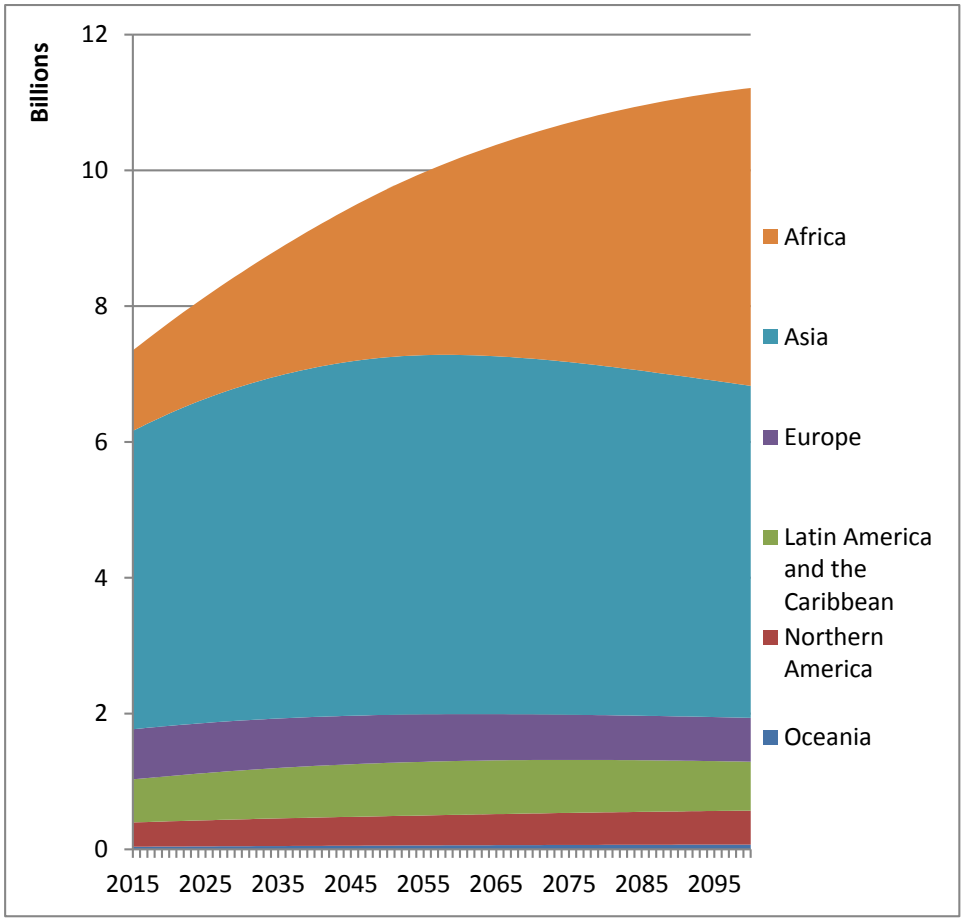

Figure 2

Source: United Nations, Department of Economic and Social Affairs, Population Division (2015). World Population Prospects: The 2015 Revision