Ecological Economics 80 (2012) 109–120

Contents lists available at SciVerse ScienceDirect

Ecological Economics

journal homepage: www.elsevier.com/locate/ecolecon

Analysis

Population matters in ecological economics

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ARTICLE INFO

Article history:
Received 31 July 2011
Received in revised form 28 May 2012
Accepted 4 June 2012
Available online 22 June 2012

Keywords:
Population size
Limits
I = PAT
Food production
Cultural carrying capacity
Rights and responsibilities

ABSTRACT

It is an axiom of ecological economics that resource depletion and environmental pollution depend on the number of people and how many goods-and-services each consumes, modified by the technological efficiency of production. The paper reviews some studies quantifying the contribution of human numbers to environmental impact. It warns against playing this factor off against that of high consumption in rich countries. It asks whether from the environmental point of view complacency about either present or predicted population size is warranted. The answer depends both on fertility and mortality assumptions and on constraints such as resource and food availability. The concept of cultural carrying capacity would aid societies in determining their optimal population when account is taken not only of subsistence, but of quality of life. A population-control toolkit for both rich and poor societies is sketched, and some controversial, 'coercive' policy possibilities analysed.

Epigraphs: "I was born in a family of 11, so after the death of my father, because we were many, my mother could not help us all. So, everybody has to go and look for his own life. So that's how I came to Kibera." — Joseph Djemba "I've never seen a problem that wouldn't be easier to solve with fewer people." — Sir David Attenborough

1. Introduction

Ecological economics seeks ways to lower environmental impact to sustainable rates of resource consumption and pollution, necessitating analysis of the factors contributing to the impact. For this it has for four decades applied the formula *I = PAT*: amounts of natural-resource consumption and pollution (*Impact*) are a function of number of people (*Population*), how many goods-and-services the average person consumes (*Affluence*), and the amount of natural-resource input or pollution per unit of goods-and-services (*Technology* as efficiency).[1]

I = PAT is more accurately written *I = f(P,A,T)* to indicate that a change in any of the three right-side factor affects the other two (Alcott, 2010). For instance higher population, *ceteris paribus*, means lower affluence (Boserup, 1981, pp ix, 4–5; Cohen, 1995, p 6). Higher affluence lowers mortality and can both raise and lower fertility (Lin, 2010, pp. 260-261).[2] By increasing resource scarcity, higher $P \times A$ increases pressure for greater resource efficiency (lower *T*) (Boserup, 1981; Simon, 1996).[3] Lowering *T* – raising efficiency, *e.g.* in cars or steel production – in turn enables more goods-and-services to be produced (higher *A*, the rebound effect) (Alcott, 2005). Due to this interdependence, autonomous reduction of any right-side factor does not necessarily result in lower impact.[4]

Concerning population reduction, the lesson is that after its first-order effect of freeing up resources, it enables higher affluence. Should a community decrease in numbers whilst the supply of resources remains the same, the smaller number of people can then use the resources for further economic activity; in this case this rebound effect raises present affluence (hopefully reducing poverty) but does not affect impact. Lower *P* is thus not a sufficient condition

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[1] Refinements of *IPAT* include *MEPAT* (Myths and Entitlements) (Swaney, 1991), *STIRPAT* (Stochastic effects) (Dietz and Rosa, 1994, 1997), *I = PACT* (Culture) (Durham, 1992), and *IHAT* (Households) (MacKellar et al., 1995). Each right-side factor can also be endogenous. Note also that *I = PAT* is not an 'identity' but a formula, since each right-side factor is independently measurable (Ehrlich et al., 1973), and that the numerator of *A* is not *I* but goods-and-services.

[2] The demographic transition model shows a stage of relative poverty with high death and high birth rates, followed by decreasing mortality as living standards rise, in turn followed by decreasing fertility as income, education, and female autonomy rise, and finally population stabilisation. Researchers however sometimes observe fertility decline before mortality decline and fertility increase when affluence rises (Abernethy, 1993; Engelman, 2010, p 11; Haub, 2011; Sardon, 2006).

[3] Boserup's position on limits to population size is not as extreme as Simon's (1996/1981) and is reconcilable with Malthus' theory, as shown by Lee (1986), who sides with Malthus against Simon.

[4] Strictly, changes in the *absolute* number *P* cannot be compared with changes in the *ratios A* (whose denominator is *P*) and *T* without further assumptions; *e.g.*, higher *A* means higher *I* only if *P* rises or stays the same or *A* rises faster than *P* falls. Elasticities between the 3 right-side factors are not meaningful.

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doi:10.1016/j.ecolecon.2012.06.001

for lower *I*. It is not even a necessary condition, because if *A* and *T* decrease sufficiently, *I* could decrease even with rising *P*.

There are two main reasons why population size is nevertheless relevant for ecological economics. (1) Any particular environmental problem – *e.g.* overdrawn groundwater or toxic emissions into groundwater – is easier to solve when there are fewer groundwater consumers. To lower impact the required adjustments in affluence (greater frugality) and technology (greater efficiency) would be physically and psychologically less burdensome; the costs of the benefits of lower impact would be lower. (2) Even if no impact reduction results from population reduction, it raises affluence, and if accompanied by policies for less economic disparity helps alleviate poverty — another goal of ecological economics.

2. Population matters

Because dozens of studies have demonstrated the significant role of (change in) population size in (change in) impact severity, usually by means of regression analysis,[5] this section does not attempt any further proof. It merely looks at several of these studies to show their methods and quantitative results, concluding with challenges to the positions (1) that population doesn't matter and (2) that we must *either* reduce population *or* rich-world consumption.

Using $I = PAT$, Shi (2003) analyses CO_2 emissions in 93 countries between 1976 and 1995. After noting that *A* itself is partly a function of *P* he submits evidence not only for the obvious result that impact rises with population, but for the hypothesis "in the Malthusian tradition" that impact rises disproportionately with population: using the further variables GDP *per capita*, percentage of manufacturing in GDP, and percentage of population in the work force, the population elasticity of CO_2 comes to 1.42 — moreover higher in developing than developed countries.

Brown and Kane (1994, p 56) compare grain production in Western Europe and Africa from 1950 to 1993. Europe saw a 152% (2.5-fold) rise in grain output, Africa one of 118% (2.2-fold). Yet whilst *per capita* output in Europe more than doubled, in Africa it fell, "leaving millions of Africans hungry and physically weakened." Since the ratio of rates of change of total production (2.5:2.2) is much smaller than that of the rates of change in *per capita* production, Africa's higher population increase is a strong explanatory variable.

For deforestation and water use McNeill likewise shows that population size usually outstrips consumption per person (2011, pp 185–187), and decomposition analyses by Bongaarts show that population growth is a key factor in GHG emissions growth (1992, pp 309, 316). MacKellar et al., covering the years 1970–1990 at world scale, attribute roughly one-third of CO_2 emissions to population, a percentage that more than doubles when *P* is households rather than individuals (1995, p 860) — although one could of course subsume smaller households under the affluence rather than the population factor.

Engelman similarly deduces from the simultaneous decrease of *per capita* emissions and increase of total emissions that the number of emitters must be a significant factor (2010, pp 12–13, 27). Raskin, although emphasising large differences in *per capita* resource consumption (affluence), finds that the "impact of population growth in the more developed regions, acting on much higher intensities, was 2.6 times greater than in the less developed regions." (1995, p 230). This in fact suggests that from an environmental point of view population stabilisation in richer countries should take priority over that in poorer countries (*see* Section 5, Fig. 1).

Some voices nevertheless play down the role of population. Princen et al. for example claim that affluence is the main driver of depletion and pollution, boldly stating "It's not population." (2002, p 6). However, not only is there no evidence denying population's contribution, a *reductio ad absurdum* invalidates this view: if 'it's not population', then the next human being has no environmental impact and neither would the 400-billionth. Other economists more explicitly assert the compatibility of limitless growth in population with the planetary resource base (*e.g.* Simon, 1996, pp 11, 579–580, *passim*).[6]

In fact Princen et al.'s empirical findings support neither their extreme conclusion nor their vaguer claim that "increases in resource use can only be explained in part, and often only in small part, by increases in population." (2002, p 6). Their own graphs show worldwide increases between 1965 and 1995 in population compared with (1) forest-products consumption, (2) meat, milk and fish consumption, and (3) water withdrawals. Although regression results are lacking, their own animal-food example shows that *without* the 70% population increase, and holding eating habits (affluence) constant, much less meat and milk would be consumed.[7] For forest products and freshwater as well, population change explains more than a "small part" of total consumption change, and for the claim that affluence growth is "eight to twelve" times as strong a factor as population growth (p 4) no proof is offered.

Satterthwaite similarly negates the population factor after noting the low *per capita* greenhouse gas emissions of the world's two billion poorest (2009, pp 545–548). He rejects *IPAT* in favour of *ICAT* (Consumers) because the poorest purportedly consume nothing at all.[8] To do justice to the kernel of truth in this observation, one could differentiate within $I = PAT$ between various *P*s: each additional person would be given a co-efficient proportionate to their likely (future) affluence, setting at 1 the co-efficient of the poorest new-born child living at subsistence, or "weighting" a country's population growth proportional to its affluence (Lucas, 1976, p 20). Both theory and empirical work indicate, though, that playing off lower consumption among the rich against lower fertility among the poor is illegitimate, if only because population is also increasing in most rich countries, and the affluence of the poor born today is likely to increase (Engelman, 2010, pp 9–10; 26–27).[9]

[5] *See* Commoner (1971); Ehrlich and Ehrlich (1990); Smil (1990); Holdren (1991); Ehrlich (1991); Bongaarts (1992); Hardin (1993); Brown and Kane (1994); Jørgensen (1994); Dietz and Rosa (1994, 1997); Cohen (1995); Engelman (1995, 2010); Harris and Kennedy (1999); Seidl and Tisdell (1999); Turner and Tschirhart (1999); DeHart and Soulé (2000); Brown et al. (2000); Shi (2003); van Vuuren and Bouwman (2005); Atkinson and Gundimeda (2006); Pimentel and Pimentel (2006); Pan et al. (2007); Heinberg (2007); Gonzalez-Martinez et al. (2008); Timah et al. (2008); Feng et al. (2009); Krausmann et al. (2009); McNeill (2011); Brown (2011); Fox (2011).

[6] The journal *Ecological Economics* has published similar work. For Binswanger (1998, p 10) a positive rate of consumption of a non-renewable resource is "sustainable", with the resource "lasting forever". Turner and Tschirhart (1999, p 163) call ever-increasing population not absurd but merely "optimistic". Bazhanov (2007, p 192) asserts that "long-run consumption… can grow infinitely." Krutilla and Reuveny (2006, p 264) seem to regard only "exponential" population growth as inconsistent with a steady-state economy. Cheviakov and Hartwick (2009, pp 2969–2970) allow "never-ending population growth [even assuming] a finite stock of the essential resource input."

[7] Population grew 70% from 3 to 5.1 billion, meat consumption 140%. If, say, 1965 meat consumption was 60 billion kg/year, it would thus rise to 144 billion in 1995. Since per capita consumption rose from 20 to 28 kg/person (+40%), *without* population increase total consumption would be only 84, not 144 billion kg (Princen et al., 2002, p 7).

[8] Apparently unaware of the overwhelming academic consensus, single-solution authors include Monbiot (2009), who relies on Satterthwaite's article to claim that "Population growth is not a problem — it's among those who consume the least." The New Economics Foundation likewise disregards population because it is a "distraction from tackling overconsumption in wealthy countries… — the real problem." (nef, 2009, pp 2, 13) Pearce (2008, 2010a) weighed in with the claim that "green fascism" is expounding "the overpopulation myth."

[9] Many emphasize one *PAT* factor without denying the others: *e.g.* Fox (2011) and to some extent Commoner (1971, pp 133–136, 235) focus on technology; Durning (1992, pp 58–60) and Engelman (1995) weight affluence; Ehrlich and Ehrlich (1990) and Brown and Kane (1994) attribute much to population.