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ANALYSIS

The sufficiency strategy: Would rich-world frugality lower environmental impact?

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ABSTRACT

One alleged weapon against unsustainable environmental impact is for the wealthy to consume less. This *sufficiency strategy* is to complement the *efficiency strategy* of lowering ratios of resource inputs to economic outputs; the former would reduce the affluence factor in *I*=*PAT*, the latter the technology factor. That the latter strategy suffers from a consumption *rebound* is widely recognized. This paper identifies a similar rebound when the affluence factor is autonomously lowered: The lower initial demand lowers prices, which in turn stimulates new demand *by others*. The strategy moreover addresses only the rich, raising questions of its theoretical maximum efficacy. Its proponents usually conflate frugality with the North–South dichotomy and *intra*generational with *inter*generational equity. Moreover, there are difficulties with the supporting arguments that frugality is good for one's own sake as well as for the environment, and that the rich should 'lead the way' to living more lightly. Personal behaviour change is furthermore not a substitute for international political efforts. Finally, since all changes in right-side factors of the *I*=*PAT* equation change other right-side factors, such indirect attacks on impact should be abandoned in favor of supply and emissions quotas.

1. Introduction

> "The institutions [of a steady-state economy]…seek to induce…a change toward resource-saving technology and patterns of living, and to a greater reliance on solar energy and renewable resources." — Herman Daly (1974, p.18)

In the *I*=*PAT* equation the causes of environmental *impact* are *population*, *affluence*, and *technology*. "Environmental strategies" here denotes groups of policies to lower resource consumption and emissions,[1] and are classified under these three headings. While population strategies are seldom discussed, much attention shines on the *T* factor, specifically the technological *efficiency strategy* meant to raise the ratio of affluence to the environmental goods used up in the economic process — through technology *per se* as well as measures such as environmental bookkeeping, life cycle analysis, mandated capital efficiency, renewable resources, recycling, legal standards, taxes, and 'consumption efficiency'. More broadly, the *T* factor is an ornery variable including

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[1] I define consumption as 'using up' (German *Verbrauch*) rather than 'use' (*Gebrauch*) – i.e. as 'taking with' or destruction – following Boulding (1949–50; 1992, 117, 129; also Princen, 1999, 355) – and conjecture that pollution is reducible to consumption of goods such as clean air or water.

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production-process efficiency, input/emissions ratios, degrees of emissions toxicity, risk, and institutions.

Affluence is consumption (depletion) or emissions (pollution) *per person*; the *sufficiency strategy* attacks this affluence (*A*) factor, seeking to lower *per capita* resource consumption in hopes of thereby lowering total – or aggregate – consumption or impact (*I*). Of course, humanism demands restricting this strategy to those who are consuming at least enough for their health, reproduction, longevity and education. Lowering the affluence of the poor would after all mean more sickness, death, and armed conflict. The strategy thus envisions cuts in material and energy consumption within the 'affluent' target group that are large enough to reduce total impact even if (hopefully) the poor consume more. In this it is thus distinct from the strategy to lower MIPS (Material Input Per unit of Service) (Hinterberger et al., 1996). MIPS computations assume that the denominator (whether expressed as monetary GDP, services, utility, or material consumption) remains constant or rises while the numerators of resource inputs are minimised, whereas sufficiency intends a lower output, a smaller denominator, lower global demand. The 'factor four' blueprint – doubling affluence while halving impact – similarly foresees no *doing without* (Von Weizsäcker et al., 1997; Schmidt-Bleeck, 1994; Grubb, 1990).[2]

One analysis illustrating the application of *I*=*PAT* and setting the stage for the sufficiency strategy is that of Ekins, which computes how much technological improvement is needed if 1) sustainability requires halving impact, and 2) population will double and affluence quadruple by 2040 – *T* would have to decrease 93% (1991, 250; Goodland and Daly, 1992, 131). The obvious difficulty of this leads Ekins to place hope in frugality: "The environmental crisis, the crisis of unsustainability, must be laid squarely at the door of northern industrial consumer lifestyles and their imitations now in nearly all the countries of the Third World." (249; [see my] Section 4.1) Rather than appeal to ethical duty he envisions the double benefit of less impact as well as, since money doesn't buy happiness, a better family life and better health without "stress and pollution". (253; Section 4.3)

In Section 2 I define and describe the strategy. Section 3 shows that like the efficiency strategy it triggers a consumption *rebound*: Whereas input–output efficiency constitutes an income effect and can lower prices of material-energy inputs, 'lighter lifestyles' of the wealthy constitute an autonomous demand reduction that lowers prices. In both cases new demand emerges, in the case of sufficiency that of new or marginal consumers who take up the 'slack' left by the previous consumers' environmentally motivated frugality. This rebound is plausible if there is latent demand and if supply functions are relatively price inelastic. Section 4 identifies four questionable strands in arguments for the strategy: the North–South dichotomy, *intra*generational ethics, selfish reasons for sufficiency, and emphasis on personal rather than political behaviour. Section 5 discusses 1) some concepts necessary for quantification of strategy goals and possibilities; 2) the costliness of co-ordinating changes in the independent variables on the right side of *I*=*PAT*; and 3) quotas as opposed to taxes.

2. The sufficiency strategy

Although the plan to lower impact by consuming less consists mainly of exhortation, and seldom of legal restrictions on consumption,[3] I nevertheless call this body of thought a 'strategy', both because a sizeable advocacy literature exists and because, however weak the means of achieving it presently are, the goal of humanity's living materially more modestly is a clear and, for many, appealing *vision*. First I define the strategy, then describe it in the form of a literature survey.

2.1. *Definition*

Starting with what it is *not*, the strategy is distinct from the correction of policies or institutions that make us consume more than we would like: e.g., settlement and zoning policies and poor public transportation bless us with unwanted hours behind the steering wheel (Røpke, 1999; Sanne, 2002). It is also not the correction of externalities and market failures that favour consumption by rendering natural resources 'too cheap'; i.e., it has nothing to do with welfare economics' *optimality*. Finally, it is not the same as *consumption efficiency*, by which is meant behaviour that achieves a given level of utility with less (energy) input: e.g., boiling *only* the amount of water needed for the cup of coffee, switching off unneeded lights, or carpooling. (Hannon, 1975; Etzioni, 1998, 630; Prettenthaler and Steininger, 1999; Princen et al., 2002, 67; Nørgard, 2006, 96) Sufficiency, in contrast, means doing without the cup of coffee, getting by with dimmer lighting, and not taking the car. That is, assuming that 'environmental concern' is left out of the utility function, sufficiency implies lower utility or welfare. (Section 4.3)

Two concepts are needed to define sufficiency behaviour. First, it presupposes *purchasing power*: Those who are to alter their behaviour towards less consumption must be *able to* consume. Their purchasing power either remains unused or is itself reduced through working and earning less. The second concept is *environmental motivation*: We all limit consumption at some point, for many reasons. I am however confining the definition to the costs of non-consumption that are voluntarily traded for the benefits of believing one is relieving human pressure on planetary resources and thus benefiting other (present or future) humans or other species.

2.2. *Literature survey*

Using the method of ostensive definition, several quotations from the literature advocating sufficiency follow. One paradigmatic statement is, "The North should stabilize its rate of

[2] It is thus incorrect to conflate the efficiency and sufficiency strategies, as when the MIPS strategy is called "a nature–human model of doing without" or when "factor four" or "factor ten" strategies are characterised as "being maximally sufficient at the existence minimum" (quoted by Luks, 2000, 61).

[3] Even the neglected population strategy often goes beyond education and propaganda to subsidise sterilisations, birth control technology, and abortions, or proscribe one-child families. During wars many societies ration (Simms, 2005), but today we are merely 'encouraged' to live more lightly.

resource consumption to free resources for the South and to free up ecological space… [by] reducing Northern throughput growth and decreasing Northern consumerism"; we must both "adjust… consumption patterns and reduce the environmental impact of each unit of consumption…" (Goodland and Daly, 1992, 131, 142; Section 4.1) This argument is partly from *intra*generational equity: "Less consumerism… in the North could be invested in much-needed poverty alleviation and growth in the South" (133; Section 4.2). As an argument from environmental quality it is moreover implicitly *inter*generational: If the rich North would at least "stabilize" its resource consumption, global resource destruction and waste will fall. The call is for "remolding consumers' preferences and steering wants in the direction of environmentally benign activities" and for less consumption by "rich countries,… whose material well-being can sustain halting or even reversing throughput growth…" (Goodland et al., 1992, xii, xv).

Elsewhere the same authors observe that "OECD overconsumers" cause both *intra*generational inequality and our global "hurtling away from environmental sustainability", attesting "the wasteful and destructive practices being pursued by Northern consumption and pollution patterns" and noting in support of the sufficient lifestyle that "affluence and overconsumption do not increase welfare" (1996, 1005, 1015, 1009; Section 4). "Sufficiency" is thus a concept "which needs dissemination" and which they define as "doing more with less"[4] and "emphasizing quality and non-material satisfactions."'' (1009) Their question is: "[C]an humans lower their per capita impact (mainly in OECD countries) at a rate sufficiently high to counterbalance their explosive increases in population (mainly in low-income countries)?" (1011) Daily and Ehrlich similarly advocate the "…de-development of the overdeveloped countries,… that is, controlling runaway consumption in order to reduce the physical throughput of their economies" (1996, 1000).

In $I=PAT$ terms, Princen holds that "Consumption or, more precisely, overconsumption, ranks with population and technology as a major driver of global environmental change" (1999, 348). After decades of research into "…production, overall human or economic activity, equity, technology, or population", he urges a "comprehensive research agenda on consumption and environment…" (349, 352). He envisions "… peoples' choices *not* to purchase or to seek less consumptive, less material-intensive means of satisfying a need", and where needs cannot be met non-materially, this can be done less impact-intensively (354). He relies on a conventional concept of "normal" or "background" consumption and goes on to identify harmful ways of "material provisioning", variously termed "excessive or maladaptive consumption", "problematic consumption", or the "overconsumption" harmful to our *species* and the "misconsumption" harmful to the *individual*. He diagnoses the "inability of individuals to meet their needs in a given social context" (356–358) and pleas for lower consumption by "us Northerners and Southern elites" who can indeed change to embrace "thrift, frugality, and self-reliance" (360, 361).

Røpke's starting point is likewise that "…growing consumption in the North contributes substantially to environmental problems, and considerations about the need to change lifestyles are popping up in official publications" (1999, 401). Consumption patterns must change, through mainfold concrete measures (417–418), toward less environmental intensity. However, this move towards "labour-intensive goods and services: theatre and music performances, courses in new skills, lectures on interesting topics, art objects, high quality clothes and houses made as handicrafts, child care, and massage treatments — is not likely to take place…", and therefore there is no way around consumption *reduction* (401–402). However, this environmentally and distributionally motivated desire to "halt the forces behind… ever growing consumption" is hard to fulfill due to causes lying in the domains of economics, socio-economic institutions, socio-psychology, history, and socio-technology (402, 416). Like others including Schor (1992, 1999a, 1999b; Veblen, 1899, 111) she attests the *prima facie* reasonableness of gaining free time through consuming and working less (403), concluding that while "voluntary curtailment of consumption in the rich countries is… first of all an ethical issue," we should avoid "too much moralizing" (416–417).

Building on both Røpke and Agenda 21, Sanne identifies "reduc[ing] consumption in rich countries" as a "condition for sustainable development. This turns the searchlight on the consumer as the principal lever of change" (2002, 273; Section 4.4). "Household consumption in industrial societies like the UK must decline" and the fact that "consumption comes in packages… calls for an analysis of activities and aggregate consumption as it is realized in lifestyles" (274). "The predicament of overconsumption can only be overcome if the values behind present lifestyles change; …the green claim in this spirit is that we should combine the trend towards higher *efficiency* with a sense of *sufficiency*" — the "'ethical question of 'living lightly'" (275). Not just as consumers, but also as "citizens in the political process" (275), we are subject to "economic…, cultural, and social…structural forces driving consumption" (276, 284). He then advocates several institutional and lifestyle measures to further sustainable consumption and liberate consuming agents "locked-in by… circumstances" (282–286). A similar analysis by Spangenberg and Lorek sees "households making a difference" and uses the concept of "consumption clusters" to compute "low-impact affluence" in the interests of "eco-sufficiency" (2002, 134, 139).

Further recent works zeroing in on consumption's negative environmental[5] impact are Rosenblatt (1999) and Princen et al. (2002). Earlier, Jevons endorsed the sufficiency strategy to save coal (1865, 138), and Scitovsky's analysis of addictive "status consumption" in our "joyless economy" touched on environmental problems (1976, 144, 283–284), as did that of Leiss (1976, 98–99, 139). But the ecological critique of consumption began in earnest with Meadows et al. (1972), Schumacher (1973) and Daly (1973) and has been continued by Johnson (1985), Durning

[4] In contrast, I classify this within the efficiency strategy.

[5] Other literature on the social, ethical, aesthetic, and psychological, rather than environmental, costs of consumption includes Rae (1834), Mackenzie (1892), Smart (1892), Veblen (1899), Galbraith (1958a), Baudrillard (1970), Linder (1970), Hirsch (1976), Douglas and Isherwood (1979/96), Mason (1981), Frank (1985, 1999), McCracken (1988), Schor (1992), Fine and Leopold (1993), Cross (1993, 2000), Ramstad (1998), Waller and Robertson (1998), Kasser (2002), and Brekke et al. (2003).

(1992), Hinchliffe (1995), Lintott (1998), Duchin (1998), and Jackson and Marks (1999). Ways of manipulating people into consuming less are dealt with by Cook and Berrenberg (1981), Ornstein and Ehrlich (1989), Meadows et al. (1992), Gardner and Stern (1996), Siebenhüner (2000), Brown and Cameron (2000), and Ekins (2004).

However, there is no better statement of both the efficiency and the sufficiency questions than the early one of Galbraith (1958b). In the days when environmental protection was called 'conservation', he wrote that our

> …gargantuan and growing appetite has become the point of departure for all discussions of the resource problem…. [W]e have been busily assessing reserves of various resources and measuring the rate of depletion against the rate of discovery. We have become concerned with the efficiency of methods of recovery…. [T]he high rate of resource use has stirred interest in the technology of resource use and substitution…. [I]nzvestment in…innovation may well substitute, at more or less constant rates, for investment in orthodox discovery and recovery. This means, in less formidable language, that if a country puts enough of its resources into researching new materials or new sources of materials, it may never be short of the old ones. (90–91)

He was one of the first to move beyond efficiency to sufficiency:

> If we are concerned about our great appetite for materials, it is plausible to seek to increase the supply, to decrease waste, to make better use of the stocks that are available, and to develop substitutes. But what of the appetite itself? Surely this is the ultimate source of the problem. If it continues its geometric course, will it not one day have to be restrained? Yet in the literature of the resource problem this is the forbidden question. (92)

Presaging present challenges to consumer behavior and moves away from exclusively working on production efficiency, he notes that for instance the President's Materials Policy Commission began its report

> by stating its conviction that economic growth was important and, in degree, sacrosanct. "First, we share the belief of the American people in the principle of Growth." (It is instructive to note the commission's use of a capital G. A certain divinity is associated with the word.) *Growth* in this context means an increasing output of consumers' goods and an increase in the plant by which they are supplied. Having started with this renunciation, the commission was scarcely in a position to look critically at consumption in relation to the resource problem, and it did not (93).

His pioneering critique of high consumption's low correlation with satisfaction concludes that "if conservation is an issue, then we have no honest and logical course but to measure the means for restraining use against the means for insuring a continuing sufficiency of supply and taking the appropriate action. There is no justification for ruling consumption levels out of the calculation" (98).

3. The sufficiency rebound

This section seeks to render plausible the most important weakness of the sufficiency strategy, namely that its effectiveness is reduced by a *rebound effect*. To explain the *sufficiency* rebound stemming from autonomous frugal behaviour, it is necessary to describe the rebound concept in terms of its original domain, namely (energy) *efficiency*. This detour is justified moreover because the sufficiency literature often welcomes greater technological energy efficiency (*T*) but regards it as *insufficient* to lower impact, thus giving rise, in the first place, to the complementary sufficiency strategy (*A*). Using basic economic concepts familiar from the efficiency rebound literature, the assertion is that due to ensuing price drops, frugal behavior causes new consumption by others.

3.1. *The efficiency rebound*

While sufficiency means lowering *A* on the right side of $I = PAT$, efficiency would lower *T*, not in point of toxics or risk, but rather of material and energy inputs per unit of production. This technological ratio measures for instance the amount of energy put into a lumen, a ton–kilometre, a heated cubic metre of air, or tonne of steel, as well to *material* inputs like metals, stone, glass, and plastics (all with their own energy costs), and lower ratios constitute *technological efficiency increases*.[6] The belief that these relieve environmental pressure is too widespread to need documentation.

However, the efficiency strategy has an Achilles heel first elaborated by Jevons (1865, Chs. VII–XII) and known as the *backfire* problem or simply as 'Jevons' Paradox' (Giampietro and Mayumi, 1998, 24–25; Alcott, 2005). Khazzoom's modern formulation of the problem assumed positive price elasticity of demand and observed that "…changes in [household] appliance efficiency have a price content…[;] with increased productivity comes a decline in the effective price of commodities, and… in the face of lower effective prices, demand does not remain stagnant… but tends to increase" (1980, 22, 23; Brookes, 1978). Holding the *number* of consumed units constant then multiplying by the lower input–output ratio achieved by new technology *per unit* yields the theoretical quantity *engineering savings* (Binswanger, 2001, 122). Rebound is then the percentage of this 'savings' *not* realized due to income and price effects. If for example more efficient motors mean that a given number of driven kilometers is newly possible at less expense, this is the same as increased income or purchasing power — which can then be spent on further energy inputs even with no lowering of energy's relative price.

New demand for energy can also stem from the relative fall in energy's price when demand drops initially following the input-efficiency increase. In terms of production functions, if a unit of energy can produce more, energy's new relative power

[6] *T* also includes 1) organizational efficiencies like economies of scale, Taylorite factory-floor rationality and transportation infrastructures; 2) institutional ones like property rules, honesty, security, and trade; and 3) further cultural ones (Swaney, 1991; Durham, 1992). No one claims that increasing *these* efficiencies lowers resource consumption; indeed, they are seen to contribute unequivocally to economic growth.

or attractiveness results in substitution effects (Brookes, 1990; Saunders, 1992). Binswanger sums up the effects of efficiency gains: "Because the equipment becomes more energy efficient, the cost per unit of product or service that is produced with this equipment falls which, in turn, increases the demand for the product or the service" (2001, 120; Howarth, 1997; Birol and Keppler, 2000).[7]

The demand-stimulating effects of the more efficient use of any kind of input was identified by many classical economists including Say, who attributed greater overall wealth to the more productive use of "power" (energy):

> But whence is derived this…larger supply of wealth, that nobody pays for? From the increased command acquired by human intelligence over the productive powers and agents presented gratuitously by nature.… A power… before known and available is directed with superior skill and effect, as in the case of every improvement in mechanism, whereby human or animal power is assisted or expanded. (1803, 101; 295; Malthus, 1820, 49, 53–56; Rae, 1834, 29, 166, 171, 261–262; Mill, 1848, 133–134, 751)

In terms of costs of production rather than income effects, Domar similarly noted that "[A] rapid growth of [Kendrick's] Index [Total Factor Productivity] in any industry reduces the prices of its output, and thus stimulates sales…" (1962, 605; Hotelling, 1931, 137).

Estimates of the size of efficiency rebound vary wildly from nearly zero (Lovins, 1988) to insignificant (Grubb, 1990; Von Weizsäcker et al., 1997; Howarth, 1997; Greening et al., 2000; Schipper and Grubb, 2000; 4CMR, 2006) to greater than 100%, when it is called 'backfire' (Brookes, 1990, 2000; Greenhalgh, 1990; Giampietro and Mayumi, 2000; Rudin, 2000; Dahmus and Gutowski, 2005; Hanley et al., 2006; Herring, 2006). As rebound approaches 100%, both the effectiveness and cost-effectiveness of the strategy sink; if backfire pertains, the efficiency strategy is even environmentally *counterproductive*.[8] Analogously, heated 19th-century debates concerning *labour* efficiency eventually led to a consensus that backfire indeed obtains: So-called 'productivity' increases do *not* in the long run cause unemployment. (Say, 1820; Malthus, 1820, 281, 287; Mill, 1848, 756–757; Jevons, 1865, 140; Sraffa, 1951, lvii–lx; Greenberg, 1990; Alcott, 2005, 16–17) A further, similar rebound or 'feedback' effect is identified by Kaufmann, in what is perhaps a fatal challenge to the entire concept of the 'material intensity' of a good, service, or expenditure: When labour or capital are substituted for energy, these also have energy costs, which "offsets some fraction of the direct energy savings and reduces the amount of energy saved by price-induced microeconomic substitution." (1992, 49) Wages, for instance, are used to demand material and energy.

3.2. *"Efficiency is not enough"*

Sanne bolsters his argument that consumption per capita among the affluent must be lowered by agreeing with Jevons:

> Higher efficiency due to technological improvement may… create a rebound effect: saving energy or natural resources per unit of production results in lower costs which encourage increased consumption. In the end, a growing volume of activity will offset the initial gain, like futile attempts to catch one's own tail." (2002, 275)

It follows that if the environmental *efficiency* strategy is thus only weakly effective, or even counter-effective, the sufficiency strategy recommends itself all the more (assuming it is to some degree effective). Yet even many who attest the efficiency strategy's effectiveness regard it as *insufficient* for lowering impact to a sustainable level. In Ekins' view, for instance, "The energy performance of technology can be affected by regulation or, for example, minimum standards, but it is not clear that this will be sufficient to achieve the large cuts in carbon emissions that are necessary without complementing changes in personal behavior in both market and non-market choices" (2004, 1897). Smil likewise, echoing Galbraith (1958b), advocates going "beyond higher efficiency" to include changing "attitudes regarding the material consumption and the stewardship of the biosphere" (2003, 332, 368). For Princen "A productive efficiency is an undeniably, unassailably good thing", but we have too long focused on that agenda to the neglect of the consumption problem (1999, 360–361).[9]

Schor's (2005, 310–312) disaffection with the efficiency strategy includes the observation that technological solutions are popular because they promise a "free lunch" and because they are "apolitical… [Section 5.2]; intelligent design and technological innovation" shall bring us (in the curt formula of Factor Four) double the prosperity for half the resources. Her main problem with technological approaches, though, is that "…they fail to address increases in the scale of production and consumption, sometimes even arguing that such increases are not unsustainable, if enough natural-capital-saving technical change occurs;…[but] increases in scale have outpaced technological improvements." Note that Jevons' backfire theory *predicts* this scale increase; technology can save 'natural capital' only *per unit* of output, not overall.[10]

Schor goes on to adopt the Veblenian position that "in addition to the impact of rising income…competitive consumption" or "luxury fever (Frank, 1999)" increases consumption

[7] Also special issues of *Energy Policy* (28 (6/7) 2000) and *Energy & Environment* (11 (5) 2000).

[8] See further Cipolla, 1962, 49, 99; Pimentel et al. 1973, 1994; Schurr, 1982, 5; Rosenberg, 1982, 75 and 1994, 166–167; Saunders, 1992, 2000; Clapp, 1994, 161–171; Giampietro and Mayumi, 1998, 20–24; Wirl, 1997, 19–32, 41, 112, 197; Berkout et al., 2000, 426; Roy, 2000, 433; Moezzi, 2000, 524, 528; Sieferle, 2001; Smil, 2003, 68–81; Luks, 2005, 50–52.

[9] Also Sachs, 1988; Lovins, 1988, 158; Schmidt-Bleeck, 1994, 189; Daly, 1996, 219–222; Goodland and Daly, 1996, 1009; Gardner and Stern, 1996, 253; Bogun, 1997, 212; Von Weizsäcker et al., 1997, xvi, 244, 258, 292–295; Carley and Spapens, 1998, 51, 108; Røpke, 1999, 416–417; Sanne, 2000, 2002, 275; Siebenhüner, 2000, 19; Princen et al., 2002; Robinson, 2004, 379; Jackson, 2005, 20.

[10] The 'technical progress' of neo-classical growth theory is in large part greater efficiency in the use of material/energy as well as labour inputs. (Solow, 1957; 1970, 33–38) However, since this school of thought defines growth in monetary or utility terms, rather than biophysical ones, it does not necessarily support Jevons' position.

(2005, 310). However, if consumption indeed ends up higher than it would have been *without* energy efficiency increases, the conclusion is mistaken that "technological change is a necessary, but not sufficient condition for achieving sustainability" (310). A correct conclusion is that the less efficate the efficiency strategy proves to be – and especially if technological efficiency is part of the problem due to rebounds greater than unity – the more necessary are the further strategies of sufficiency, consumption efficiency, population limits, energy taxes, or quotas.

Further writers warn of backfire. Røpke for instance writes:

> Obviously, the environmental benefits of a change in consumption practices in one area can easily be counterbalanced by increased consumption in other areas, if overall growth is not limited [Sections 4.2 and 4.3]. For instance, a successful policy to reduce private motoring would imply the saving not only of energy, but of money [the income effect], which could be converted into extended weekends by plane to interesting places entailing increased energy consumption…" (1999, 401)

Reijnders similarly attests that "improvements in technology may be counterbalanced by increases in affluence and/or population", but then contradictorily asks whether "improvement of technology is sufficient" to lower impact to a sustainable level (1998, 17).

3.3. *The sufficiency rebound*

The position that efficiency is 'not enough' for sustainability thus makes sense only if the efficiency rebound is less than 100%, i.e., only if efficiency does not contribute to physical macroeconomic growth. This subsection claims, however, that the sufficiency strategy likewise suffers in point of efficacy: In constituting a drop in demand, it initially lowers prices, and this in turn raises others' demand, so that in the end some of what was 'saved' through non-consumption is consumed after all — merely by others. Analogous to the *engineering savings* theoretically achievable through technical change, the environmentally motivated drop in consumption is here called *sufficiency savings* and is likewise only theoretical; *marginal consumers* (Inhaber, 1997, xii; Wirl, 1997, 32) take up the slack left by the newly frugal people who have left the market. The analysis in this subsection holds for consumption of raw materials (metals, energy); whether it applies equally well to other consumption items such as food, water, or clothing is an open question.

The description of the sufficiency rebound in terms of price and income changes is simpler than that of the efficiency rebound. The chain of economic events here under discussion starts with an autonomous reduction in demand for or consumption of natural resources. In economic terms it amounts to a change in consumers' 'tastes' wherein they exchange, on average, some materially-derived utility for the emotional or ethical utility of reducing their own pressure on the environment. Instead of thinking in terms of small increments, imagine an overnight behavioural change: Moved by the desire to ease up on the environment OECD consumers decide to buy, say, 20% less fossil fuel than before. This sufficiency *shift* initially leaves 20% of their purchasing power unused; because these ex-consumers, *ceteris paribus*, work less, at this point in the dynamic demand is destroyed. The sufficiency rebound then amounts to a passive, rather than intentional, *transfer* of purchasing power to marginal consumers. The mechanism at work is that of price reductions of goods, services, and energy inputs themselves.

Fig. 1 shows, in terms of classical economics' laws of supply and demand, the results of a leftward sufficiency shift in the OECD demand function from $D_{0\ \mathrm{OECD}}$ to $D_{1\ \mathrm{OECD}}$. The graph shows $Q_{0\ \mathrm{WORLD}}$ ($=Q_{0\ \mathrm{OECD}}+Q_{0\ \mathrm{OTHER}}$) and P_0 (World price) given by the intersection of S with $D_{0\ \mathrm{WORLD}}$ (itself the sum of $D_{0\ \mathrm{OECD}}$ and $D_{0\ \mathrm{OTHER}}$). Holding both World supply function and price constant, then the sufficiency lurch, entailing as it does a

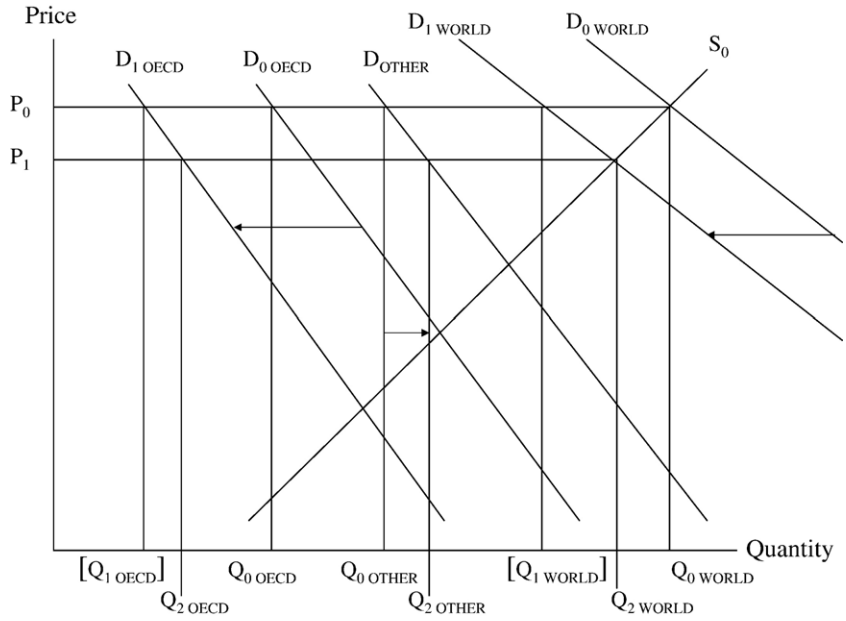

Fig. 1 – Fossil fuel demand OECD, non-OECD and World.

leftward shift from $D_{0\ WORLD}$ to $D_{1\ world}$, yields the theoretical quantities $Q_{1\ WORLD}$ and $Q_{1\ OECD}$, both of which are less than the original Q_0 quantities.

That is, the sufficiency shift in the OECD demand function is such that by definition ΔQ_{OECD}=a reduction or (theoretical) 'sufficiency savings' of 20% of $Q_{0\ OECD}$: Prices fall and non-OECD ('Other') demand rises; to what height depends on non-OECD price elasticities of demand; technology and S are held constant.

The imagined overnight demand reduction by OECD consumers shifts the world demand function of which it is a part from $D_{0\ WORLD}$ to $D_{1\ WORLD}$. The intersection of S and $D_{1\ WORLD}$ yields the new lower price P_1. For non-OECD countries (D_{OTHER}), the new, lower price (P_1) yields $Q_{2\ OTHER}$ which is *greater than* $Q_{0\ OTHER}$. Part of the resource savings realized by the OECD consumers is thus 'taken back' or wiped out by the classical economic behavior of others. At this price OECD countries consume $Q_{2\ OECD}$. (Note that there is no $Q_{1\ OTHER}$ because there was no shift in Other's demand function. Note further that at (the lower) price P_1, $D_{1\ OECD}$ would yield some increase in consumption, namely $Q_{2\ OECD}$ minus $Q_{1\ OECD}$; but we have assumed this away: regardless of price, OECD consumers consume 20% less than before.) Total consumption $Q_{2\ WORLD}$ (given by the intersection of $D_{1\ WORLD}$ and S) now results from the 20% reduction in consumption of the OECD countries plus the increase in consumption of other countries. The sufficiency *rebound* is $Q_{2\ OTHER}$ minus $Q_{0\ OTHER}$. The theoretical quantity 'sufficiency savings' ($Q_{0\ OECD}$ minus $Q_{1\ OECD}$) is exactly the same as the theoretical quantity $Q_{0\ WORLD}$ minus $Q_{1\ WORLD}$. The overall effect, or real savings ($Q_{0\ WORLD}$ minus $Q_{2\ WORLD}$), is smaller: Worldwide real savings *must* be lower than the savings initially achieved by a successful sufficiency strategy.

Wackernagel and Rees attest this same rebound in terms of *nations* as consumer units (and without mentioning price changes):

> Indeed the very integration of the global economy mitigates against any individual country adopting the ecological alternative: the marginal global benefits resulting from one nation's restraint would quickly be dissipated by non-cooperating countries, all of which have open access to the ecosphere (1997, 22).

In conclusion, insofar as the sufficiency strategy expects consumption to remain at the level reached by subtracting the OECD frugality alone ('sufficiency savings') it is unrealistic.

3.4. *Empirical measurement*

Whether any net worldwide real savings results – i.e. how close $Q_{2\ WORLD}$ is to $Q_{0\ WORLD}$ – depends on many things, but the necessary and sufficient conditions for the rebound itself are only 1) any amount of latent demand by marginal consumers and 2) any amount of supplier profit (any upward-sloping supply function). That is, price elasticities must merely be non-zero. When the utility curve of anyone is such that a purchase happens at the incrementally lower price, and the profit situation of any producer is such that supply continues at this price, the level of consumption cannot remain at the level computed by subtracting the foregone consumption of newly frugal people, but must rebound.

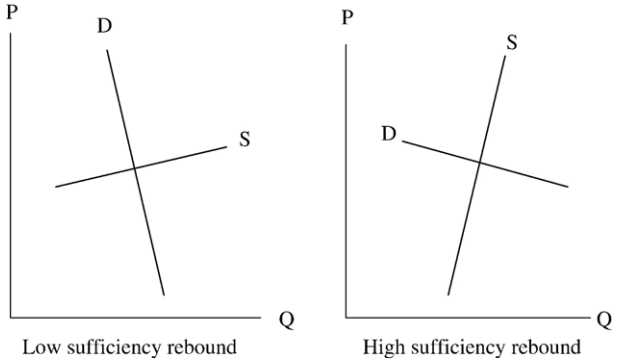

Fig. 2 – Possible new equilibrium.

But how could one measure sufficiency rebound? Assuming that the sufficiency behavior itself were measurable – the previous section simply assumed a 20% reduction in consumption [Section 5.1] – what would be the *magnitudes* of more demand and/or less supply of fossil fuels worldwide? Quantification would have to estimate the initial price fall and the slopes of the respective supply and demand functions, predicting the new equilibrium. Fig. 2 shows extreme cases of low and high sufficiency rebound, its size being some function of the ratio of the two elasticities (see also Larsen and Nesbakken, 1997). Keep in mind that the appropriate scope or scale of empirical studies must be the world economy, not any individual country or group of countries such as the OECD.[11]

First, how would producers react? Although estimates of the price elasticity of supply vary widely, much opinion holds that rents and profits in the fossil fuel sector are large enough to tolerate a considerable price fall (Katzner, 1987, 555; Wirl, 1991, 242; 1994, 79; Shim and Siegel, 1995, 322; Noreng, 2002, 9–10, 14; Salameh, 2003, 1090; Horn, 2004, 269, 271, 275; but see Kaufmann and Cleveland, 2001; Noreng, 2002, 8–9; Smil, 2003, 87) Second, is a historical worldwide demand curve feasible? Research is found for instance in Smil's analysis of total consumption of electricity and fossil fuels over long periods, showing rising quantities alongside (despite?) falling relative energy prices in terms of purchasing power (2003, 6–10, 82–84, 149–153; also Schurr and Netschert, 1960, 156; Cleveland et al., 1984, 896; Cleveland and Kaufmann, 2003, 486). Variability in elasticity estimates seems to depend on scale of study and economies studied. Also relevant is the cause of the price decline — in our case a sufficiency shift as opposed to technological efficiency increases, quantity of remaining reserves, or political (e.g. OPEC) decisions.[12]

[11] Market globalisation and the global nature of depletion and emissions damage lessen the usefulness of country studies. (Saint-Paul, 1995; Brown et al., 1998, 114; Cleveland and Ruth, 1998, 44–45; Dahlström and Ekins, 2006) In the efficiency-rebound literature this is often acknowledged (Grubb, 1990, 195, 235; Greenhalgh, 1990, 298; Hinchliffe, 1995, 94; Howarth, 1997, 4; Greene et al., 1999, 28; Roy, 2000, 433; Greening et al., 2000, 392; Saunders, 2000, 439; Binswanger, 2001, 124; Rhee and Chung, 2006).

[12] Also Harris, 1984, 40; Krautkraemer, 1998; Cleveland and Kaufmann, 2003. Most literature unfortunately starts with price *rises* like those of the mid-1970s.

3.5. *Backfire?*

Is a sufficiency rebound greater than unity possible? Some writers mention the possibility that, per unit of affluence at the margin, the consumption of the poor could be more environmentally damaging that of the rich. (Khazzoom, 1980, 26; Goodland and Daly, 1996, 1013; Schipper, 2000, 353; Binswanger, 2001, 126; Shi, 2003, 32, 38–39). A bus ride in Colombia might burn more fuel per kilometer than one in Switzerland, or – eschewing the North/South imagery – a museum visit might use up fewer resources than a hungrier person's eating a meal. In terms of Environmental Kuznets Curves,[13] the sufficiency shift might move the world economy to a position where consumption rises more steeply over against income.

Deciding whether the strategy is efficate or counter-productive thus entails testing for the theoretical conditions for a sufficiency backfire, using worldwide data. However, Section 3 has merely attempted to enrich the discussion with the concept of the sufficiency rebound, whose existence is a certainty. While *efficiency* rebound is conceptually established and increasingly corrected for (4CMR, 2006; Allan et al., 2006), post-frugality rebound is as yet unacknowledged. Discussions concern motivations for frugality, psychological and social barriers to it, how to sell the idea, and how to garner the same number of consumer satisfaction units in spite of it but now we should examine interdependencies within the affluence (A) factor itself — the necessary rise in the affluence of marginal consumers.

4. Weaknesses in argumentation

Section 3 showed that the strategy cannot be effective to the full extent of the original 'sufficiency savings'. Yet since it remains possible that the strategy is to some degree effective, i.e., that rebound is lower than 100% of sufficiency savings, the next four sections explore weaknesses either in the *arguments for* the strategy, or in estimates of the attainability of the initial, voluntary change in behaviour towards frugality.

4.1. *'North' and 'South'*

Most expositions of the sufficiency strategy conflate the categories of rich and poor with those of North and South or developed vs. developing countries. As Leiss paradigmatically wrote,

> The one-third of the human population in the industrially developed nations currently uses 90% of the available resources; it is the exponential increase of their demands, not those of the human population as a whole, which is the real and immediate cause of the emerging global crisis…. It is the unforgivable squandering of resources in the developed countries…that currently determines the general direction of the global 'political economy' and that constitutes the source of potential future disasters for the entire human population." (1976, 98, 99)

He quotes Paul Ehrlich: "The most serious population growth occurs among the affluent whites of the USA, and their analogues in Western Europe, the Soviet Union, and Japan. These people are the prime looters and polluters of our planet." (139)

'North' is here surrogate for 'rich', and since for ethical reasons the strategy aims only at the rich, the target becomes, as expressed by Sanne, "Northern consumption as overconsumption and unsustainable" or the "Western consumption pattern" (2002, 282, 274). Daly and Goodland similarly write that because rich countries consume more per capita, we must "look at consumption patterns in the North" (1996, 1015). Røpke, incidentally avoiding the mistake of arguing in *per capita* terms, writes that "the growing consumption of the North constitutes an important part of global environmental problems" (1999, 399, 401). The implicit syllogism is that the rich consume more than the poor; the rich are (predominantly) in the North; therefore Northern consumption must be lowered (also UNCED, 1993, Ch. 4; Hinterberger et al., 1996, 85; Homburg and Matthies, 1998, 121; Kasser, 2002, 92).

However, openness between economies means that sufficiency-induced lower prices are known everywhere. Goods, services, fossil fuels, and people cross borders increasingly unhindered. Marginal consumers taking up the slack are wherever there is purchasing power. Higher demand in recent years from 'developing' economies supports this view. Yet the relevant metric for environmental impact is only the total amount of depleted resources or ambient amounts of emissions: Nature does not 'care' which countries pollute, or what per capita pollution is. "Because of the universal nature of world trade, the concept of 'carrying capacity' is difficult to apply to a nation or region." (Bartlett, 1994, 26) We should thus follow Princen in adding "southern elites" and the "rich in developing countries" to the rough concept of 'Northern' (1999, 360), or Myers in writing neutrally of "affluent communities" (1997, 53; Spangenberg and Lorek, 2002, 127).

For the economics of global consumption and pollution the terms 'Western', 'Northern', and even 'developed' are largely gratuitous, as recognized by both Ayres (2000) and Opschoor (2000) in questioning the value of computing national or regional 'ecological footprints', and the simpler taxonomy of relatively rich and relatively poor is preferable. One strategy framed accordingly in worldwide terms is that of "contraction and convergence", whose premise is that the atmosphere is a limited global commons and that "Anything less than a global deal cannot solve climate change" (Simms, 2005, 167, 173); while rich people have a moral "ecological debt" – taking more than their *fair* share – there will always be "…the problem of uncontrollable greenhouse gas emissions from free-riding countries." (173) Poor free-riders can also ruin the deal, and it is not sufficient for the rich to consume less; rather, everybody must be democratically mutually coerced.

While emissions do not carry source labels, politics may require that rich nations reduce first. (Goodland and Daly,

[13] The vertical axis (dependent variable) of such curves must be in absolute rather than per capita units (Opschoor, 1995; De Bruyn and Opschoor, 1997; Luzzati and Orsini, in press).

1996, 1009) But this is not equivalent to the common claim that rich nations must morally "take the lead" towards sufficiency. (UNCED, 1992, Ch. 4) A country that involuntarily lives 'sufficiently' cannot be expected to adopt the role of a follower, just as it is unproven that the poor emulate the rich in 'overconsumption'. The paternalism and the donning of the hair shirt implicit in this concept of 'leadership' do not support the case for sufficiency.

4.2. *Sufficiency is morally good*

Yet not only could voluntary 'Northern' frugality under certain conditions result in a rich, overconsuming 'South'. Even when 'rich' is not equated with 'North', the common claim that the rich are responsible for negative impact is ambiguous, as when Spangenberg and Lorek write that "…there is a consensus that particular responsibility for the level, composition and impact of consumption" rests with this "class" of affluent consumers (2002, 128): 'Responsible' means both 'causally efficacious' and 'morally culpable'. (also Siebenhüner, 2001, 23) In the first, causal or non-normative sense that the rich are consuming the lion's share, the claim is tautological. The concepts of marginal consumers and sufficiency rebound in Section 3 imply furthermore that the affluent are easily replaced by the slightly less affluent, who would then in their turn assume this 'responsibility' *ad infinitum*.

In the *ethical* rather than biophysical sense, on the other hand, the claim that the rich *should* consume less is straightforward and arguable as a moral assertion (also Goodland and Daly, 1996, 1009). Both for traditionally ethical reasons of human equity and on the newer ethical grounds of environmental concern, Smil too writes that "…shaping the future energy use in the affluent world is primarily a moral issue…." (2003, 370), while Greenhalgh sardonically observes that "The fear of environmental damage… has introduced an ethical or moral dimension into the argument [over continued economic growth]. Excessive or wasteful consumption and associated pollution which it causes is sinful; frugality is a virtue" (1990, 293).

The exact bearing of the moral goodness of frugality on the fight to lower impact, however, is not clear. Let us distinguish three ethical goals: 1) *intra*generational equality or justice, especially alleviation of poverty; 2) *inter*generational justice; and 3) the preservation and health of non-human species and the biosphere in general. Let us further distinguish the ethical *motivation* for frugality from its consequences. Judged according to motivation, voluntary frugality is on all three counts 'good'. But unless eschewed consumption is accompanied by an explicit transfer of purchasing power either to present poorer people or in general to future people does the envisioned good consequence of greater *intra-* or *inter*generational equality actually happen. (Pearce, 1987) Without this explicit transfer, the beneficiary of the income effect could be an affluent neighbour who heats his swimming pool more often. As Robinson notes (albeit concerning efficiency rather than sufficiency), it is "…easy to imagine cases where the gains from such approaches are appropriated disproportionately by those who already are well-off…" (2004, 379) When combined with a gift to a poorer person conditions are at least fulfilled for *intra*generational ethical behavior. But a personal shift to frugality guarantees neither less impact, nor more present equality, nor more *inter*generational equality. Moreover, even explicit transfers fall short of sustainable impact to the extent that either higher population results, or the consumption patterns of the poorer recipients are somehow environmentally more detrimental than those of the previous consumers. (Siebenhüner, 2000, 19; Section 3.5). Brown and Cameron similarly make

> …an important conceptual distinction between prosocial values and proenvironmental values: Individuals may be prosocial (altruistic and cooperative) but not proenvironmental (value sustainability of environmental resources). It is possible, however, that a well-developed pro-environmental position must include prosocial values involving: (1) altruistic motivations to sacrifice personal gain by limiting resource consumption in order to promote environmental integrity; and (2) cooperative orientations to use only one's fair share of resources and to act in ways to ensure that others are allowed their fair share. In effect, prosocial values may be necessary, but not sufficient conditions for guaranteeing proenvironmental values.' (2000, 38–39)

One way of acting on proenvironmental values, that of frugal personal behavior, is in any case weakened by the sufficiency rebound.

The other two goals above – more equal distribution towards future humans and less impact on non-human nature – thus require further conditions. The view that "… justice implies sustainability" (Pearce, 1987, 13) is true only if "justice" is meant *inter*generationally. Put otherwise, a perfectly just present distribution of resources is consistent with crassly unsustainable consumption of resources as well as crass disregard for future people. *Intra*temporal equality, at a too-large scale of the economy, can amount to unjust *inter*temporal material standards of living. And again, the sufficiency rebound weakens any connection between avoided consumption on anybody's part and sustainability. Pearce is right, though, that leaving all future generations a quantity and quality of resources necessary for life is more or less the same as respecting biophysical constraints in the present.

Judged both by motivation and consequences, one type of ethically good transfer from rich to poor is the purchase of emissions certificates held by poorer countries in 'Kyoto' schemes. But since the latter can and do buy fossil fuels with the proceeds,[14] such transfers in the name of equity do not *ipso facto* reduce impact. Thus it is true that "Wasteful consumption in rich countries must be reduced to allow for needed growth in poor countries…", but it does not follow that "more equitable and efficient patterns of energy use… close the gap between rich and poor and reduce environmental damage compared with that which will result if current trends continue". (Ehrlich, 2000, 322) *Intra*generational equity and the

[14] Because the emissions of most poor countries are not capped, the Delhi version of the Kyoto agreement undoubtedly results in higher consumption in the remaining nations, a step for equality but not one for lowering impact.

level of impact are two separate things. Perhaps for such reasons Princen writes, "If the problem is one of inequity, no analytic advantage is gained by calling it consumption. Adding the environment and calling the problem consumption only muddles the longstanding debates of North and South, haves and have-nots, rich and poor, powerful and powerless, to include environmental inequities." (1999, 352) Or as Pearce says, "…the design of an economy such that it maximizes some measure of social (human) welfare but subject to biophysical constraints will assist in, but will not be sufficient for, attainment of the notion of extended justice." (1987, 10) In other words, a sustainable human economy could be presently unjust as well as indifferent to non-human nature.

For Goodland and Daly poverty reduction "will require considerable economic growth, as well as development, in developing countries. But global environmental constraints are real, and more growth for the South must be balanced by negative throughput growth [sic.] for the North if environmental sustainability is to be achieved." (1996, 1004). But since this "balancing" could leave impact unaffected, this conflates ethical goals with sustainability. Lower *A* and *T* among the rich is necessary but not sufficient for lower-impact-cum-justice, and even "large-scale transfers to the poorer countries" (1004) do not suffice because, again, "sustainability" and "intragenerational equity" (1005) are not the same. The sufficiency strategy does not suffice to solve conflicts between the humanist goal of present-day material equality and that of sustainable (eternally reproducible) impact.

4.3. *Two birds with one stone*

Many arguments for living lightly, downshifting and shrinking one's environmental footprint appeal not to ethics or environmentalism but to one's own good. Riding a bicycle is not only environmentally friendly but healthy; working and spending less, eating less, and in general possessing less leaves us with more free time, less noise, less stress, less body weight and less local pollution. In the early 1960s I eavesdropped on the discussions of business executives 'dropping out' of the 'rat-race'; in the late 1960s 'everybody' acquired this wisdom, captured by Etzioni's diagnostic term for the costs of a high-consumption lifestyle – "affluenza" (1998, 626). Insights from this line of thought, appealing to one's selfish interests, are mobilized in socially marketing the sufficiency strategy; two birds can be brought down with one stone.

The knowledge that material wealth doesn't buy happiness is as old as the hills (De Botton, 2000, 56–72, 97–99; Easterlin, 1973; Hirsch, 1976; Argyle, 1987; Diener et al., 1993; Kasser, 2002; but see Veenhoven, 1991) From Thoreau on, environmentally concerned writers have regarded this argument as an ally in pursuing environmental goals — recently Boulding (1949–50, 1966), Linder (1970), Scitovsky (1976), Schor (1992), Durning (1992), Goodland and Daly (1996), Orr (1999), Princen et al. (2002), Sanne (2002) and Jackson (2005). In bolstering an argument for rationing, one author argues:

> Research shows that people's happiness rises along with conventional wealth only up to the point that our needs for basics like adequate warmth, food, clothing, and shelter are met. After that our well-being depends on other things like friendships, opportunities for creativity and the quality of our family relationships. This means that with better awareness of what really gives us a sense of well-being, by ignoring the adverts, we could actually consume less and be happier. (Simms, 2005, 187)

Simms backs his case up with evidence from World War II Britain, where both legal and voluntary frugality left people fitter (155–164).

While pointing out the personal, selfish advantages of riding one's bike, or the aesthetic beauty of natural landscape, or the disadvantages of breathing dirty street air are useful parts of the story, there are some difficulties with this argument. First, the jury is still out concerning this hypothesis that, above a certain level, greater affluence does not mean greater happiness: Much 'luxury' consumption fulfills deep psychological desires, e.g. for prestige, thus contributing to 'happiness'. Second, even if the thesis is somehow true, evolutionary forces may interfere with our doing what we rationally see as our own good; the everyday examples of overeating and unrequited love suffice for illustration. Evolutionary forces seeking 'status' or 'display' or 'conspicuous' consumption may indeed be virtually ineradicable; and the bad consequence for the environmental sufficiency strategy is that since the purported benefits of such prestige consumption are *relative to* others' consumption, the sky is the limit (see Veblen, 1899; Ornstein and Ehrlich, 1989; Konrad, 1990; Low and Heinen, 1993; Morrison, 1999; Frank, 1999; Jackson, 2002; Alcott, 2004).

Third, the argument maintains that the great majority of human beings has for centuries or millenia acted to its own detriment — a strong claim based on no discernable theory that challenges evolutionary theory at its roots. On this view materialistic, 'overconsuming' behaviour is not selfish after all, but rather anti-selfish and pathological also. Again, from the vantage of human ethology, this claim that we systematically act in certain ways even though costs outweigh benefits bears the burden of proof. Alternatively, one must claim for instance that those with economic and political power force us, in *their* own interest and perhaps subtly through advertising, etc., to 'overconsume' (Galbraith, 1958a; Packard, 1959; 1960). Some authors recognise that they owe us an explanation of why, judged on these apparently simple, selfish criteria, we choose to live so stupidly (Schor, 1999a,b, 138; Frank, 1999, 7; Cross, 1993, 2000). Others offer selfish reasons for frugality apparently without this awareness (Mirrlees, 1991, 64; Ekins, 1991, 253, Princen, 1999, 357; Kasser, 2002). At the least, sufficiency strategists who enlist this argument for environmental ends must 1) offer a more careful rendering of the hoary concept of human welfare than hitherto, and 2) *explain* 'overconsumption'.

4.4. *The political vs. the personal*

The sufficiency strategy is most often conceived as a sum of individual behavioural changes. The view of Meadows et al. is representative: People who "care about other people" thereby contribute to staying within the limits; they advocate "fifty simple things you can do to save the planet" such as to "buy an energy-efficient car [and] recycle your bottles and cans"

perhaps at the cost of some speed, time and effort (1992, 218–19; Durning, 1992; Orr, 1999; Green Media, 2007; Union of Concerned Scientists, 2007). To the extent that the personal is local, the slogan 'Think globally, act locally' captures this philosophy. British politician Gordon Brown similarly asserts the necessity that

> …decisions made by national governments must be matched by individual actions. We all have a responsibility to do what we can to tackle environmental degradation. So I believe what we do as a community nationally and internationally must be matched by a new sense of personal responsibility.' (2006, 2)

This regards the personal and the political as equally valuable, but I hope to have shown that personal behavioural change is at most a necessary condition for sustainability and that it is thus questionable whether it adds significantly much to "decisions made by national governments."

The position of this paper, that personal responsibility resulting in changed consumption behaviour is not an *alternative* to collective measures, is seemingly shared by Sanne (2002). He clearly distinguishes between the consumer and the citizen and advocates collective, non-personal measures like "halting (or reducing) production volumes — as radical greens propose…" (285), just as we as *citizens* already force ourselves to pay taxes, go to school, and obey traffic lights and public smoking bans (275, 281 [but see 273]; Sagoff, 1988). Indeed, the income tax is a good example of such mutually agreed-upon mutual coercion: No one argues that we should *want* to pay them, but we politically agree to — i.e., provided everybody else must. Worldwide reduction of affluence, to be achieved by world citizens, thus requires a philosophy of 'Think globally, act globally.' Only prescribed caps leaving no room for free-riders or marginal consumers to take up slack are not subject to an affluence rebound (also Ornstein and Ehrlich, 1989; De Young, 1993; Stern et al., 1995; Milbraith, 1995; Gardner and Stern, 1996; Siebenhüner, 2000). In spite of these reservations, however, there is truth in the sufficiency strategy's insight that one can say of any person who newly lives lightly, 'One down, 6,499,999,999 to go.'

5. Discussion

Three further questions to be briefly discussed are: 1) What amount of depletion-and emission-reduction is possible and/or expected by those who urge greater frugality? 2) What can be said more generally about the advisability of strategies aiming *indirectly* at impact by altering population, affluence, and technological factors as opposed to strategies, like the Kyoto Protocol, that aim *directly* at impact? 3) Finally, how are consumption taxes to be classified?

5.1. *Quantification*

Sections 3.4 and 3.5 raised questions on measuring rebound; different ones arise concerning measurement of the theoretical sufficiency savings itself, of which rebound is a percentage. As established earlier, these are limited by the ethical criterion that only the rich shall cut consumption. But definitions of 'rich' and 'sufficient' are needed in order to quantify both the number of people targeted by the strategy as well as how much per person counts as 'over'-consumption. Indeed, without some criterion based on the traditional distinction between needs as opposed to mere wants, no consumption is less necessary or justified than any other, and the sufficiency appeal simply targets those who may feel altruistic. That is, the whole concept of sufficiency would lose meaning. To better define and measure this building block of the strategy design, a rich literature is available: In addition to the classical economists and the 19th-century socialist tradition of Owen and Ruskin, as well as Maslow (1943), Baudrillard (1970), and Kasser (2002), writers who have pursued this in the economics tradition are Hobson (1929), Max-Neef (1995), or Jackson and Marks (1999). For overviews see McAdams (1992) and Brekke et al. (2003, 30, 38).

Common ostensive definitions of dispensable or at least negotiable consumption include that of meat, cosmetics, air travel, large houses, and SUVs, and it is not difficult to calculate amounts of joule inputs, or emissions, per unit of these physical outputs. Alternatively, computations could be monetary, in terms of purchasing-power-parity; perhaps corrected by a material-intensity co-efficient. As is required of any global environmental strategy, this calculated amount of maximum possible sufficiency savings would then have to be measured against a level of impact deemed to be the maximum consistent with sustainability — e.g., perhaps 450 ppm for CO_2 (Wackernagel and Rees, 1997; Hinterberger et al., 1996, 84–88). It is beyond the limits of both my knowledge and this paper to cite any rigorous research quantifying sufficiency savings (before price changes and rebound). But at the least it seems mistaken to talk merely of curbing the demand of "humanity" (Wackernagel and Silverstein, 2000, 394).

Quantifications of sustainable consumption, yielding some maximum per capita affluence at a given population, could however challenge our humanistic belief that large numbers of people can live not only healthily but comfortably. Only such an honest comparison of quantified *sufficient* consumption with quantified *sustainable* consumption can help us to judge whether hopes for this win–win situation between ecology and economy are justified. Gordon Brown for instance claims:

> We can and should demonstrate that economic growth, social justice and environmental care can and must advance together. For years no international concensus has been possible that recognises how our global duty of stewardship to the environment can be discharged while delivering economic and social progress. (2006)

However, political acceptability aside, all environmental strategies must face the empirical possibility and emotional dilemma that some combination of population and affluence would have to be lowered to *intra*generationally unacceptable levels if justice toward future humans and other species is to be achieved.

5.2. *Right-side vs. left-side strategies*

The $I=PAT$ identity, implying as it does that changes in affluence or technology *directly* change impact, holds only aggregately —

as a static description of the environmental state of the world. However, any change in population, affluence, or technology changes the other two factors: Agricultural technology allows a larger population, higher affluence can lower (or raise) the birth rate, high consumption ($P \times A$) makes us use more efficient technologies, etc. Bartlett for instance writes,

> Reductions in the rates of consumption of resources and reductions in the rates of production or pollution can shift the carrying capacity in the direction of sustaining a larger population…. When resources are used more efficiently, the consequence often is that the 'saved' resources are not put aside for the use of future generations, but instead are used immediately to encourage and support larger populations.' (1994, 21, 23; Jevons, 1865, 9, 196, 200, 457, Ch. X; Cipolla, 1962, 49–53, 94–95, 105; Giampietro, 1994; Daly, 1996, 220; Smil, 2003, 55)

Due to these interdependencies we must therefore abandon $I=PAT$ and write $I=f(P,A,T)$. Moreover, Section 3.3 showed shifts of demand among consumer groups *within* the affluence term A. That is, the sufficiency rebound is described by $A_1=f(A_2)$: A value-induced reduction in the affluence of person 1 enables the affluence of person 2 to rise, and the 'sufficiency savings' does not necessarily ever 'get over to' the left side of the equation to lower impact.

'Direct' or 'left-side' strategies do exist, exemplified by the UNFCCC attempt to set *global* greenhouse-gas emissions caps within which country caps are politically allocated, leaving each political unit to decide on the most desirable and/or economically efficient mixture of population, affluence, and technological measures. Once the exo-market country caps have drawn the 'Plimsoll line' of each economy, then adjustments in the right-side factors follow with little further detailed regulation, perhaps through tradable rations. (Fawcett, 2004, 1077–1078; Ophuls, 1977; Pearce, 1987, 17; Daly, 1991, 42; Røpke, 1999, 401)

On the other hand, in the absence of overall caps on the system right-side strategies must depend on and integrate flanking or complementary strategies regarding the other right-side factors. Perhaps it is possible to compute a super-strategy of simultaneous and co-ordinated changes between and within all three factors, effectively lowering *I*. But as with all environmental strategies, the costs of design, administration, transaction and implementation must be scrutinized in order to measure *cost*-effectiveness.[15] The intuition here is that direct measures – by definition effective – are likely to show the better *cost*-effectiveness ratio than indirect ones, in line with Daly's suggestion that "…throughput [be] controlled at its input (depletion) rather than at the pollution end because physical control is easier at the point of lower entropy" (1974, 20).[16]

[15] The project of balancing life-cycle efficiency, renewable energy, green taxes, sufficiency, and population control has been criticized as tinkering and social engineering (Sachs, 1988; Rudin, 2000). But it does provide us with lessons of how to maximize welfare once limits are politically set.

[16] Analogously, within smaller political units, it is infrastructure limitation which most cost-effectively lowers impact: Road traffic can be controlled by laws limiting parking spaces and air traffic by airport runway capacity.

5.3. *Taxes*

Taxes, for instance on fossil fuels, in effect force us to increase technological and consumption efficiency as well as lower our personal sufficiency standards. In common with other right-side measures, however, these resource or depletion taxes only *contingently* lower impact. Again, when we react by making production more efficient or consumption more sufficient, prices (including the tax) fall and some of the effect is "taken back" (Pearce, 1987, 14). Eco-taxes would accordingly have to be periodically raised. Moreover, when the government refunds the revenue or spends it itself, a *tax rebound* results because demand is thereby generated for, among other things, the taxed fossil fuels. Hannon, therefore, while discussing the possible energy savings of large "consumption shifts", writes that "…the amount of net energy savings might be small because of the respending effect…. In any event, there is a limit to the savings that can be realized by such lifestyle changes which preserve the national income" (1975, 100). The concept of the sufficiency rebound shows that such limits to savings also exist when the changes do *not* preserve the national income.

Wackernagel and Rees accordingly maintain that the environment can "afford cost-saving energy efficiency…only if efficiency gains are taxed away or otherwise removed from further economic circulation" (1997, 20; Greene, 1992, 118; Binswanger, 2001, 131). The purchasing power newly in the hands of government, or restored to citizens through refunds or lowering other taxes, would somehow have to be destroyed or perhaps invested in renewable resources.[17] For these reasons Hannon prefers left-side measures: "Another method that would conserve energy, and that is more fundamental than taxation, would be energy rationing through the use of coupons" (1975, 101). This subsection merely suggests that such tax rebound problems be formally integrated not only into the 'double-dividend' debate but into environmental policy generally — to date seldom the case (e.g. Goodstein, 2003; Parry and Williams, 2004; Sterner and Isaksson, 2006).

6. Conclusions

The environmental sufficiency strategy of greater consumer frugality has become popular in ecological economics, its attractiveness increasing along with awareness that not much can be done to stem population growth and that energy-efficiency measures are either not enough or, due to backfire, part of the problem. Concerning the strategy's feasibility, effectiveness, and common rationale, several conclusions can be drawn.

- The consequences of the strategy's frugality demand shift – price reduction and the ensuing consumption rebound – are not yet part of mainstream discussion.
- Contrary to what is implied by the strategy's advocates, the frugality shift cannot achieve a one-to-one reduction in

[17] One reviewer made the neglected point that higher fossil fuel prices increase the pressure on biomass, e.g. forests.

world aggregate consumption or impact: Poorer marginal consumers increase their consumption.
- The size of the sufficiency rebound is an open question.
- The concepts of 'North' and 'South' are not relevant to the consumption discussion.
- Even if the voluntary material consumption cuts by the rich would effect some lowering of total world consumption, changing human behaviour through argument and exhortation is exceedingly difficult.
- While our moral concern for present others is stronger than that for future others, this *intra*generational equity is in no way incompatible with non-sustainable impact.
- Since savings effected by any one country or individual can be (more than) compensated by other countries and individuals, the relevant scale of any strategy is the world.
- No single strategy to change any given right-side factor in $I=f(P,A,T)$ guarantees any effect on *impact* whatsoever.
- Right-side strategies in combination are conceptually complicated and perhaps more costly than explicitly political left-side strategies directly lowering impact.
- Research emphasis should be shifted towards measures to directly lower impact both in terms of depletion and emissions.

Lower consumption may have advantages on the individual, community, or regional level. There is for instance some truth in the view of Diogenes that happiness and quantity of consumption do not necessarily rise proportionally. Living lightly can offer not only less stress and more free time but also the personal boon of a better sense of integrity, fulfilling the Kantian criterion that one's acts should be possible universally (worldwide). Locally it could mean cleaner air, less acid rain, less noise, less garbage, and more free space. And in the form of explicit, guaranteed shifts of purchasing power to poorer people it would enable others to eat better or to buy goods such as petrol and cars.

However, given global markets and marginal consumers, one person's doing without *enables* another to 'do with': In the near run the former consumption of a newly sufficient person can get fully replaced. And given the extent of poverty and the temptations of luxury and prestige consumption, this near run is likely to be longer than the time horizon required for a relevant strategy to stem climate change and the loss of vital species and natural resources.

Efficiency and sufficiency strategies both offer relatively painless solutions to non-sustainability.[18] The former is praised by 'negawatt' advocates not only as a free lunch, but one you are paid to eat. The latter appears to many of its addressees tolerable — switching off a few lights, riding a bike, or eating less meat, and here, too, a lunch you are paid to eat comes in the form of various health and happiness benefits. Supply-side or other impact-side strategies, on the other hand, are hard. They confront us with the neglected question of the carrying capacity of the planet. But strictly following sustainability logic by capping extraction and/or emissions – 'cost' what it may – collides with our hopes and humanism. Efficiency deals with the 'how', the material and social technology, of our wealth-making; sufficiency speaks to us at the border between our needs and our (mere) wants, and to our inborn desire for justice. Neither addresses the taboo of population size. Both strategies distract us from the insight that nature limits us.

[18] The business community welcomes efficiency (but not sufficiency) research.

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