Ecological Economics 69 (2010) 2047–2052

Contents lists available at ScienceDirect

Ecological Economics

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

Commentary

# Externality or sustainability economics?

Jeroen C.J.M. van den Bergh *,1

ICREA, Barcelona, Spain

Department of Economics and Economic History & Institute for Environmental Science and Technology, Universitat Autònoma de Barcelona, Spain

ARTICLE INFO

Article history:
Received 1 January 2010
Received in revised form 10 February 2010
Accepted 14 February 2010
Available online 2 March 2010

Keywords:
Climate change
Dynamic externalities
Rebound
Spatial sustainability
Resilience
Steady-state economy
Strong/weak sustainability
Sustainability policy
Systems thinking

ABSTRACT

In an effort to develop "sustainability economics" Baumgärtner and Quaas (2010) neglect the central concept of environmental economics–"environmental externality". This note proposes a possible connection between the concepts of environmental externality and sustainability. In addition, attention is asked for other aspects of "sustainability economics", namely the distinction weak/strong sustainability, spatial sustainability and sustainable trade, distinctive sustainability policy, and the ideas of early "sustainability economists". I argue that both sustainability and externalities reflect a systems perspective and propose that effective sustainability solutions require that more attention is given to system feedbacks, notably other-regarding preferences and social interactions, and energy and environmental rebound. The case of climate change and policy is used to illustrate particular statements. As a conclusion, a list of 20 insights and suggestions for research is offered.



## 1. Introduction

Is sustainability a broader concept than externalities? Or is environmental sustainability contained in the notion of environmental externalities? If we optimize externalities, by maximizing social welfare which takes environmental externalities into account, will we automatically realize a sustainable economy or sustainable development? These are a few of the questions that have been in my head for a long time. The article by Baumgärtner and Quaas (2010) revived them, so I decided to finally try to come up with some answers. In addition, I will mention a few other issues that in my view should preoccupy "sustainability economics".

Baumgärtner and Quaas (B&Q) claim to present core questions of sustainability economics. They present a rather abstract, almost axiomatic approach to the delineation of what could be referred to as "sustainability economics". This is quite courageous, as the topic of sustainability has generated an enormous literature which has addressed basically every thinkable ethical, epistemological, biological, physical and economic aspect of it. After reading the article by B&Q one may end up being disappointed. Will their approach really help us further? Does it mean back to basics and a better start, or old wine in new bottles? The authors write as if the topic of sustainability was proposed only recently. I think that in order to move economic thinking about sustainability and related policy forward one would need to define more concrete topics for research, as well as make clear what is good and bad about current (environmental and ecological) economics. This article aims to accomplish this and arrive at a set of clear, concise insights as well as themes for further research.

The organization of the text is as follows. Section 2 examines the relationship between the central concept of environmental economics, negative environmental externality, and the central concept of ecological economics, sustainability. Section 3 discusses the distinction weak/strong sustainability and tries to arrive at clearer conclusions about which road to follow here than previous writings. Section 4 addresses questions surrounding sustainable spatial organization and interregional trade. Section 5 tries to differentiate sustainability policy from other types of policies, also drawing attention to the recent notion of transition policy and management. Section 6 mentions a few other omissions in the paper by B&Q, including the ideas of early "sustainability economists". Section 7 concludes.

## 2. The Relationship Between "Externality" and "Sustainability"

The first question I want to address is why B&Q omit any attention for the established central notion of environmental economics, "environmental externality", which has turned out useful in formulating

* Department of Economics and Economic History & Institute for Environmental Science and Technology, Universitat Autònoma de Barcelona, Edifici Cn-Campus UAB, 08193 Bellaterra (Cerdanyola), Spain.
E-mail address: jeroen.bergh@uab.es.

[1] Also affiliated with the Faculty of Economics and Business Administration, and the Institute for Environmental Studies, VU University Amsterdam, The Netherlands. Fellow of NAKE and Tinbergen Institute.

0921-8009/$ – see front matter 
doi:10.1016/j.ecolecon.2010.02.009

environmental policy theory? If one desires to develop an alternative economics, one should make clear how it differs from, or links up with, the old economics. I would immediately want to take away a possible confusion, namely that the notion of externalities implies entering the domain of neoclassical economics. Although in many cases it does, I think it does not generally hold true. Invoking the concept of externalities–whether positive or negative, i.e. external benefits or costs–does not in any way require the assumptions of rational and representative agents or market equilibrium. Such assumptions, defining neoclassical economics, are independent of the conceptualization (and reality) of externalities. The notion of externality merely conveys the idea that human interactions or interdependencies extend beyond formal markets characterized by prices and exchange. The presence of an externality means that someone's (a victim's) utility or production (co)depends on factors that are not under his/her control, but are decided by other humans or organizations ("polluters"). The notion of externalities reflects the adoption of a systems perspective by a researcher. This has been most clearly elaborated in neoclassical economics' systems approach, namely general equilibrium theory (Baumol and Oates, 1988). This systems perspective of externalities already illustrates the possible connection with sustainability, which is also an expression of systems thinking, namely emphasizing the dynamic character of combined environmental–social systems.

Unsustainability denotes the lack of long term environmental sustainability, which is characterized by falling stocks of natural resources, increasing concentrations of pollution in environmental media, or loss of nature and biodiversity. Unsustainability means that the future is affected by current decisions, so that there are unavoidably dynamic or intertemporal externalities involved. In fact, without such externalities the problem of unsustainability vanishes, unless sustainability is defined to cover resource or environmental stocks that bear no relation whatsoever to human welfare.

However, the reverse causality is less clear, that is, whether sustainability implies zero externalities, or, alternatively, whether some positive level of externalities is consistent with sustainability. The answers better be "no" and "yes", respectively, otherwise we are in serious trouble. The reason is that a zero level of externalities is generally not a wise or even realistic goal, as externalities are a fact of life, due to scarce space or high population density (resulting in competition for space, land, clean air, water, etc.) and thermodynamics (suggesting the inevitability of waste, pollution and a decline of resource quality and quantity). Anyway, a certain positive level of environmental externalities up to a threshold can be consistent with sustainability, where the threshold will depend on the type of environmental, pollution or resource problem at hand. The reason is that the environment possesses regenerative capacity meaning that it can handle some positive level of disturbance, which translates into externalities or welfare loss. Sustainability in welfare terms (anthropocentric) might further be realized by substitution of declining qualities or quantities of environmental resources by manufactured or human capital. Not surprisingly, the debate about sustainability is all about regenerative capacity of the environment and substitution potential in the economy. In the case of climate change, the capacity of the atmosphere and biosphere for adsorption of GHG emissions has been exceeded, while substitutes for fossil fuels are still expensive. For both reasons the climate problem ranks on top of all sustainability concerns.

In line with the recognition that externalities reduce social welfare (or in a more restricted sense are not Pareto optimal), neoclassical economics has developed a theory of environmental policy that comes down to optimizing negative externalities, namely by optimizing social welfare which includes environmental externalities. Optimal externalities generally have positive levels, except when they concern trivial problems that can be easily solved. The latter is rare, as reducing one type of externality usually generates another, due to problems being shifted from one area to another. An example is reduction of air pollution using filters leading to solid waste. In theory, if low-entropy energy is available in large amounts, it might fuel waste reduction, pollution abatement and recycling so as to reduce externalities far below their current levels, which could assure sustainability.

An optimal level of externalities that results to be positive is not necessarily contradictory with environmental sustainability, at least if the externalities cover all relevant intertemporal effects on the welfare of humans. Indeed, if a positive level of externality would imply an unstable dynamic effect (resource exhaustion, or accumulation of pollution) that could be characterized as unsustainable, then this would not be optimal from a welfare angle, unless one highly discounts future effects (see further discussion on this below). From another angle, note that a certain positive level of pollution-related environmental externalities, despite causing some negative utility (by definition), could well be within the capacity of the biosphere to absorb or neutralize pollution — meaning that no sustainability problem is created. Of course, a sufficiently high level of environmental externalities will be associated with unsustainability, i.e. loss of nature of depletion of environmental resources or capacity to adsorb pollution.

Note that the link between sustainability and externalities has been illustrated most clearly in the analysis of common pool resource problems. Since users here share a production factor, namely the resource, use or extraction of it by one will negatively affect the productivity or marginal production by others. In other words, use creates a negative externality via the joint resource, which is in fact a dynamic externality as resource use reduces the size of the resource which alters resource conditions in the future. This holds in any case for a non-renewable resource (e.g., an oil reservoir or an ore mine). For a renewable resource the external effect arises when total use exceeds the level of sustainable use, which equals the rate of regeneration.

Taking the case of climate change, sustainability would mean a stable climate associated with $CO_2$ not above 450 ppmv (or some regard even 350 ppmv for all GHG in $CO_2$e terms as a safe threshold). If we optimize externalities will we realize such a safe level? This depends practically on one's estimation of the external cost associated with GHG emission. Agreeing on such an estimate has turned out to be difficult, in view of the strongly right-skewed distribution of climate change damage costs estimates with a median $14/tC, a mean $93/tC, and a 95 percentile $350/tC (Tol, 2008). One is inclined to think that the real external cost is in the range of $300/tC or higher, for two reasons. First, only the higher estimates are based on studies that include serious attention for extreme climate change scenarios. Moreover, these studies still omit many possible extreme scenarios as well as difficult-to-monetize effects like conflicts over resources (e.g., water), migration and biodiversity loss due to climate change. With a carbon tax in this high range it is not unlikely that climate sustainability is realized.[2] Such a high tax could be interpreted then as taking into account long term risks and damages, and in this sense actually reflects well sustainability concerns. Note that if no finite carbon externality tax were to realize climate sustainability, this would mean that damages are so large that the optimal tax is unbounded from above ("infinite").

The use of time discounting in estimating the external cost of climate change would reduce future damages. A high rate of discounting could create an inconsistency between externality-based and sustainability-based policy. In view of this, one might interpret the debate between those who propose a social discount rate equal to a market rate of interest and those who believe the social time

[2] In order to calculate the optimal Pigouvian carbon tax one would have to translate this into a marginal external cost in the hypothetical, non-observable social optimum. This is generally not expected to alter the magnitude of the cost very much.

discount rate should be equal or close to zero as an opposition between those supporting short-term market efficiency and those supporting long term sustainability (van den Bergh, 2010a). From this angle, one might propose that if the aim of sustainability is politically supported, this can be translated in policies which discourage discounting or time preference at the level of society (social discounting) and perhaps even at the level of individuals and organizations. Alternatively, one might see the discount rate merely as an endogenous market price resulting from demand/supply for money, and in line with the ideas of Howarth and Norgaard (1995) create intergenerational funds to assure sustainability which in turn will affect the "discount price". In this way the debate on social discounting can be avoided.

## 3. Strong Versus Weak Sustainability Revisited

The paper by B&Q makes no reference to the distinction between weak and strong sustainability (Eyres et al. 2001; van den Bergh, 2007). This is quite surprising, since the economics of weak sustainability looks very different from the economics of strong sustainability. Most likely, the opposition is a bit farfetched, and what is really required is an estimation of the degree of "weakness/strongness", and relatedly the degrees of substitution between different types of capital (manufactured, natural, human, or within natural). The reason is that these make up critical factors behind one's expectation of, and optimism about, sustainable economic systems and developments.

Weak sustainability has been defined using the concepts "economic capital" and "natural capital". The first includes labour, machines and knowledge. The second covers the environment and natural resources. Weak sustainability can then be defined as maintaining "total capital", which is the "sum" (aggregation) of economic and natural capital. This goal allows for substitution of natural capital by economic capital. This approach has been most clearly elaborated using growth theory (Hartwick, 1977), which translates weak sustainability into a constraint of intergenerational equity, or more concretely non-decreasing welfare.

Strong sustainability requires that each capital type is maintained separately, that is, economic and natural capital, or even at a lower level of disaggregation. Maintenance can mean integrally or only up to a critical threshold. This view can be motivated in different ways. Certain natural resources may be identified as supplying essential inputs to production, consumption or welfare for which no manufactured substitute is available. Life-support functions of nature and environment fall into this category. Another motivation is environmental integrity and "rights of nature" (bioethics). "Very strong" sustainability, as supported by deep ecology and movements stressing "right-to-life" of other species, would imply that every component or subsystem of the natural environment, every species, and every physical stock must be preserved. A compromise version of strong sustainability focuses on preserving ecosystems and environmental assets that are critical for life-support or unique and irreplaceable.

A third motivation for strong sustainability is based on recognizing the risk of irreversible changes in natural systems or their functions. In this context reference is made to terms like ecosystem health and stability, resilience and biodiversity. This has received more attention in ecological than in mainstream environmental economics. Resilience (resistance to change, or robustness) is defined at the system level and refers to maintenance of organization or structure and functions of a system in the face of stress. One view or indicator is the time necessary for a disturbed system to return to its original state (Pimm 1984); another is the intensity of disturbance that a system can absorb before moving to another state (Holling 1973). In line with the latter interpretation resilience has been phrased "Holling sustainability" which pays much attention to the sensitivity of ecosystems at a micro level, as opposed to weak "Solow–Hartwick sustainability" (Common and Perrings, 1992). The two approaches to sustainability can give rise to complementary as well as contradictory insights.

A sustainability economics should address such contrasting views and more generally the opposition between strong and weak sustainability. It ultimately comes down to a question about the substitutability between the products and services supplied by the market economy and those directly provided by the environment. Such substitution has often been reduced to the context of production processes (with reference to the work by Nicholas Georgescu-Roegen). However, it is also relevant to consumption and individual welfare. Here the notion of lexicographic preference orderings, also captured by the notion of Maslow's pyramid, can be invoked, as it denies universal substitutability (Stern, 1997). The flexibility of human consumption, i.e. substitutability in consumption without losing much welfare or happiness, deserves attention as well. This means linking up with happiness research.

With regard to resilience, it seems interesting to think about what this notion implies at the macro level, also in view of the recent financial–economic crisis. Resilience may be linked to financial institutions and norms as well as the role of scarce, high-priced oil resources (and in the future high climate-energy taxes). Traditional environmental economic models do, however, not give attention to resilience or related issues. A link to business cycle theories might be useful in this respect (Young, 1996). Undoubtedly the work by Holling and associates on resilience and "panarchy theory" already offers many clues (e.g., Gunderson and Holling, 2002).

## 4. Sustainability, Space and Trade

Whereas global sustainability and sustainable development have received an enormous amount of attention, spatial sustainability and sustainable trade are grossly neglected issues. The large and growing literature on international trade and environment adopts essentially a static perspective. The analysis of spatial sustainability requires an integration of insights and approaches from economic development theories, international trade theory, urban/agglomeration economics, and environmental and resource economics. No one has yet succeeded in accomplishing this, and it seems likely that analytical approaches will fall short. The theoretical work by Nobel Laureate Paul Krugman may offer the best starting point. Grazi et al. (2007) offer a first approach to such a line of research.

A relevant question about sustainability in an open system context is whether trade can substitute for lack or sustainability of environment and nature at the national/regional/local level. Countries with a history of resource depletion and ecosystem damage may look sustainable. Indeed, numerical results in Pearce and Atkinson (1995) show that this is the case for The Netherlands and Japan. However, both of these have hardly any forest land left, that is, they have already gone through a phase of unsustainable regional development. This hints at the problem of sustainability of open regions or countries, which evidently can surpass local sustainability limits by engaging in international trade.

Daly and Cobb (1989) have expressed the opinion that insights from traditional comparative advantage theory have less relevance these days as the assumption of immobile capital flows no longer holds. They conclude, referring to statements of Maynard Keynes, that production of products should, whenever feasible, take place in the home country. An additional argument for this view is that sustainability at a regional scale can be better controlled in an autarchic than open region.

In order to "measure" regional unsustainability, Wackernagel and Rees (1996) have formulated the "ecological footprint" (EF). They conclude that many countries, in particular small ones, use directly and indirectly more surface area than is available inside their national boundaries. Evidently, this is compensated by international trade. The

EF indicator and applications have however received strong criticism from various corners.

Given incompatible views and approaches more integrated research is needed on the issue of spatial sustainability. An adequate approach to assess spatial sustainability and sustainable trade should not start from any biases but instead allow addressing the question of whether concentration of people in space is desirable from a global sustainability perspective. Positive externalities of concentration (e.g., agglomeration effects) and of trade (comparative advantages) should be taken into account and traded-off against negative environmental externalities. In addition, the various negative impacts of trade in social and political dimensions, such as weakening community structures, and hindering individual human perception of ecological impacts of consumptive decisions, should be taken into account. On the other hand, attention needs to be given to the negative consequences of reducing international trade, such as destabilising of international agreements, trade wars, and less diffusion of knowledge and technology. This complex web of considerations and links illustrates both the importance and difficulty of this line of research.

## 5. Sustainability Policy or Environmental Policy?

On sustainability policy B&Q are not very explicit. This is surprising as the main aim of sustainability economics should be to offer useful insights for policy. At the same time, one needs to clarify what is wrong with, or missing from, current policy advice, and what are specific sustainability policy measures, as opposed to more general environmental policy measures — and before that one may ask if such a distinction makes any sense. One view might be that sustainability policy includes all environmental regulation since this will affect degrees of (un)sustainability. Following the discussion of Section 2, sustainability policy insights and advice should take account of "externality policy theory", notably addressing dynamic externalities, cumulative pollution issues, and falling resource stocks.

Another view is that sustainability policies or instruments are specifically focused on long term sustainability issues. Specific policies to foster long term sustainable development can be based upon theoretical insights already mentioned, such as investment rules that stimulate constant total capital (Hartwick, 1977) and intergenerational transfers to compensate for environmental changes (Howarth and Norgaard, 1995). Both fit the weak sustainability approach, as substitution of natural capital is allowed for. What is empirically relevant is to estimate the degree of substitutability or "sustainability weakness".

Sustainability policy can perhaps also be interpreted as an initial, transitory phase of "transition policy" to foster a transition to a sustainable development path or sustainable system, followed by a permanent phase of (optimal) environmental policy. First, if it is recognized that a transition from the current unsustainable system to a sustainable one is prevented by the lock-in of certain technologies, notably fossil fuel based, then un-locking policy is needed. Price corrections may be insufficient as increasing returns to scale play a dominant role. Stimulating diversity, for example, through innovation subsidies, support of niche markets and public R&D are important elements of carbon un-locking policy (Unruh, 2002).

Costanza (1994) mentions three concrete instruments of what he considers to be a real sustainability policy. First, a natural capital depreciation tax would stimulate consumption in a more sustainable direction. The result would be a shift from use of (and investment in) non-renewable to use of renewable resources. Second, a "precautionary polluter pays principle" could stimulate caution in making decisions with much uncertainty about the occurrence and size of environmental damage. Third, a system of ecological tariffs as countervailing duties would allow countries or trading blocks to apply strict policies (including the previous suggestions) so as to make sure that producers would not be stimulated to move overseas. The result would be that ecological costs would be reflected in prices of both domestically produced and imported products.

A number of instruments have been proposed to address the uncertainty and complexity surrounding ecosystems and sustainability. The notion of "safe minimum standards" (Ciriacy-Wantrup 1952) conveys the idea that efficiency implies exploring borders whereas under uncertainty it would be better to take account of safety margins. A flexible instrument to do this is an "environmental bond" (Perrings, 1989; Costanza and Perrings 1990). This functions as a deposit that is completely or partly refunded (with interest) depending on the amount of environmental damage that has resulted from the respective investment project. This instrument might be applied to land reclamation, investment in infrastructure, transport and treatment of hazardous (toxic, nuclear) substances, and location of agriculture and industrial activities near sensitive nature areas. Due to environmental bonds, the expected private benefits of risky activities will drop, causing investors to decide more conservatively.

Sustainability policy further should account for bounded rationalty and other-regarding preferences of economic agents and organizations. Otherwise policies may turn out ineffective as well as inefficient or overly costly, and therefore more difficult to sell to politicians or voters. Doing this is not easy as bounded rationality and other-regarding preferences take many different forms (van den Bergh et al., 2000): "satisficing", lexicographic preferences, relative welfare, status seeking, habits and routines, imitation, reciprocity, myopia, changing and endogenous preferences, and various types of behavior under uncertainty. The presence of social interactions means moreover a step away from representative agents to populations of agents, leading to (co-)evolutionary models. These allow for studying previously unattended policy instruments like status taxes, prizes/awards for good behavior/initiatives and information diffusion (Nannen and van den Bergh, 2010; Safarzynska and van den Bergh, 2009). This is consistent with a systems approach which is essential to identify sustainability policies. More theoretical and empirical research seems needed into which sustainability policies match the various types of bounded rationality, other-regarding preferences and generally psychological limits of humans, to avoid that we become too idealistic or utopian in our policy making.

Energy and environmental rebound effects are another point of concern. The importance of this is insufficiently recognized in both mainstream environmental and ecological economics. Rebound is a partly inevitable and partly avoidable consequence of well-intended actions to reduce pollution. We see currently a lot of attention for voluntary conservation of energy use which unfortunately will turn out to be an ineffective strategy if rebound is not controlled for. Rebound can only be well understood if a systems perspective is adopted which is consistent with the sustainability aim. Rebound effects should be minimized through adequate policies, most likely by setting hard limits or ceilings to pollution, in the case of climate change to $co_2$ or more generally GHG emissions worldwide. Voluntary, bottom-up solutions unguided by higher energy prices and regulation should be regarded with skepticism as they will go along with considerable rebound (Sorrell, 2007).

## 6. Additional Suggestions

Here I would like to raise three final considerations about sustainability economics. In the first place, I was surprised to see that Kenneth Boulding and Herman Daly's works were not mentioned in the article of Baumgärtner and Quaas. Boulding's (1966) metaphor of a "spaceship economy" as opposed to an unsustainable "cowboy economy", and Daly's (1968, 1977) notions of a "steady-state economy" are the first clear and still prime examples of sustainability economics. Boulding's notion can be seen as a precursor of the modern view on sustainability at a global, planetary scale. Mill, Soddy and of course

Georgescu-Roegen might also be included in the list of early "sustainability economists".

I further think that the axiomatic approach of B&Q misses out on relevant conflicting views, ideologies and dogmas. Of major influence is the dogma of GDP growth and the search for sustainable growth? It unnecessarily restricts our search for possible sustainable systems and developments. As I have argued elsewhere, we should relax about growth, ignore GDP and as a result be completely indifferent or neutral about growth. We should simply not be interested in changes in GDP. However, the search for GDP growth is an ideology, a dogma. How to counter it cleverly needs more attention in research — following the tireless efforts of, and many strategies employed by, Herman Daly. Possibly, drawing insights and inspiration from happiness research by economists, psychologists and sociologists is an effective strategy to both point at cumulating evidence against the relevance of GDP information as well as identify economic developments that contribute to real human welfare (van den Bergh 2009, 2010b).

Finally, Daly (e.g., Daly, 1992) has repeatedly argued that traditional economics addresses allocation problems but has neglected the issue of optimal physical scale of the economy. This seems to be widely accepted in ecological economics. But Daly may be wrong here (for once). Environmental economics deals with physical interactions captured by externalities. Proposed policies will constrain relevant physical dimensions of the economy (such as fossil fuel throughput) as these correlate strongly with the level of externalities. Tradable permit systems as have been since long proposed by economists are the best example perhaps. The ceiling which is part of them implies a hard limit on the size of the economy in environmentally-relevant dimensions, such as emissions of greenhouse gasses. If implemented well, this will realize the steady-state economy of Daly (interestingly, in his steady-state proposals Daly mentioned tradable birth rights to keep population constant). So traditional (environmental) economics really does address the physical scale of the economy, and the gap between mainstream and ecological economics is not as wide perhaps as some tend to think. This is not to deny that there are differences. One fundamental one may be that mainstream policy thinking focuses on optimality using the criterion (welfare) efficiency and in practice optimal cost–benefit analysis to evaluate developments, policies and projects. Sustainability policy in the areas of climate change and biodiversity conservation instead may be seen as more motivated by a "precautionary principle". However, the two are not necessarily inconsistent (van den Bergh, 2004 and van den Bergh, 2010a, Section 3).

## 7. Conclusions and Recommendations

The main insights about, and research topics of, a "sustainability economics" as suggested in this essay are as follows:

1. Both externalities and sustainability reflect systems thinking.
2. The notion of environmental externalities does not imply entering the domain of neoclassical economics. Assumptions like rational agents and equilibrium are independent of it.
3. Unsustainability means that the future is affected by current decisions, implying the presence of dynamic/intertemporal externalities.
4. Without environmental externalities the problem of unsustainability vanishes. But sustainability does not require zero externalities in general. Zero externalities is not a realistic goal anyway, as externalities are a fact of life, due to scarce space and thermodynamics.
5. In line with this, optimal externalities generally have positive levels, except when they concern trivial problems. However, eliminating one type of externality usually generates another.
6. It is well possible that a price/tax on $CO_2$ realizes climate sustainability, namely if it is in the high range of available estimates of $CO_2$ external costs, which reflect the possibility of long term and extreme climate changes.
7. The aim of sustainability might translate in policies which discourage time preference at the level of social and even individual discounting.
8. The opposition strong/weak sustainability needs further study as it is fundamental to views on sustainability policy. This involves assessing the degree of substitutability of critical resources and environmental services, both in production and consumption.
9. The flexibility of human consumption, i.e. substitutability in consumption without a serious loss of welfare or happiness, deserves more attention in research. This means linking up with insights and methods of happiness research.
10. It is worth to examine what the notion of resilience at a macro level implies, in view of the recent financial–economic crisis as well as threats posed by potential peak oil and climate crises.
11. Whereas global sustainability and sustainable development have received much attention, spatial sustainability and sustainable trade are grossly neglected issues. A good theoretical framework for studying them is lacking. The work by P. Krugman offers one starting point.
12. Given that there are incompatible views and approaches to spatial sustainability and sustainable trade, this topic deserves more integrated research which extends economics with insights from sociology and political sciences.
13. The relevance of traditional comparative advantage theory versus absolute advantages is in need of theoretical study as well as empirical evidence.
14. The aim of sustainability economics should be to offer insights for policy. This involves clarifying what is wrong with current policy advice, and what are specific sustainability policy measures, as distinguished from conventional views on environmental policy. A connection with transition policy/management thinking may be useful.
15. Research is needed on which sustainability policies match various types of bounded rationality and other-regarding behavior, to avoid utopian or ineffective policy suggestions.
16. The presence of other-regarding preferences and social interactions means replacing representative agents by populations of agents, giving rise to (co-)evolutionary models. These will allow examination of new policy instruments such as diffusion of information, network formation and discouraging status seeking.
17. Energy and environmental rebound effects deserve more attention in searching for sustainability solutions. The current widespread focus on "easy" solutions like voluntary energy conservation does not guarantee an effective sustainability strategy unless rebound is controlled. Hard global limits on pollution are needed (Daly's steady-state economy). Voluntary, bottom-up solutions unguided by regulation should be regarded with skepticism — they are no substitute for an international climate agreement or higher energy prices.
18. Taking account of other-regarding preferences, social interactions and rebound effects are all part of a systems approach needed to identify effective sustainability policies.
19. Boulding's "spaceship economy" and Daly's "steady-state economy" are the first clear and still prime examples of sustainability economics. Elaboration of these to address complications and test policy instruments might be useful.
20. Sustainability studies should deal with conflicting views, ideologies and dogma's. A major barrier against sustainability policies is the dogma of GDP growth and the search for sustainable growth. These unnecessarily restrict our search for possible sustainable systems and developments. We should instead be relaxed about growth, ignore GDP and as a result be completely indifferent/neutral about growth. Modern happiness research can offer inspiration for alternative guidelines and indicators.

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