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Interpreting sustainability in economic terms: dynamic efficiency plus intergenerational equity

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Abstract

Economists have confined the concept of 'sustainability' to intertemporal distributional equity. We propose a broader definition, combining dynamic efficiency and intergenerational equity, and relate it to two concepts from neoclassical economics: potential Pareto-improvements and inter-personal compensation.

Keywords: Sustainability; Sustainable development; Intergenerational equity; Kaldor–Hicks criterion; Environmental quality

JEL classification: Q01; D90

1. Introduction

There has been much debate among economists, and between economists and nearly everyone else regarding the meaning of the frequently employed concept of 'sustainability'. As one popular periodical wrote in regard to the World Summit on Sustainable Development, held in Johannesburg, South Africa, in 2002, sustainability 'risks being about everything and therefore, in the end, about nothing' (The Economist, 2002). Ecologists and many others outside the economics profession have taken sustainability to be the unique and comprehensive criterion that can and should guide global

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development. In contrast, economists have tended to define sustainability as being purely about intertemporal distribution, that is, intergenerational equity.[1] As such, economists have viewed sustainability as no more than one element of a desirable development path.

In this article, we suggest that a more normatively useful notion of sustainability, which would have broad appeal outside of the economics community, would combine two components: dynamic efficiency and intergenerational equity. This broader definition can facilitate discussions about sustainability, both within the economics community and as part of an interdisciplinary discourse.

2. Dynamic efficiency

In 1987, the Brundtland Commission placed sustainability on international political and scientific agendas with its report, ‘Our Common Future’ (World Commission on Environment and Development, 1987). The Commission proposed the widely embraced definition that ‘development is sustainable when it meets the needs of the present without compromising the ability of future generations to meet theirs’ (World Commission on Environment and Development, 1987).

We take the World Commission’s definition as our point of departure.[2] In the absence of efficiency, however, constant consumption at no more than a subsistence level could satisfy this requirement, yet it surely would not be accepted as meeting reasonable social goals for public policy. Rather, any appealing normative criterion for public policy in this domain ought to include the notion of ‘non-wastefulness’. Translated into economic terms, a meaningful definition of sustainability which has normative standing ought to include dynamic efficiency, that is, the choice of a feasible consumption path such that the economy is on the Pareto frontier. Using this path, total welfare can be evaluated as:

$$W(t) \equiv \int_t^{\infty} U(c(\tau))\, e^{-r(\tau-t)}\, d\tau \tag{1}$$

where $U(c(\tau))$ denotes the most general, idealized utility function comprising both direct consumption as well as the enjoyment of non-market goods and services, and ρ is the social rate of time

[1]For example, Arrow et al. (2002) make a clear distinction between ‘optimality’, defined as the maximized discounted present value of future well being, and sustainability, defined as ‘the maintenance or improvement of well being over time’. One exception in the current literature is provided by Asheim et al. (2001), who impose so-called efficiency and equity axioms and show that if social preferences fulfil these two axioms, any optimal path will lead to an efficient and non-decreasing path, thus implicitly including dynamic efficiency in the definition of sustainability. For an earlier discussion of sustainability and optimality, see Pezzey (1992). For a timely review of the major issues involved, see Pezzey and Toman (2001, 2002).

[2]Farrow (1998) begins from this same notion, and concludes that benefit–cost tests should be based not only upon potential Pareto-improvements but on *actual* compensation to identified sub-groups of the population. Such actual compensation is very difficult to envision in the realm of intergenerational equity (with respect to utility). We therefore take Farrow’s conclusion as our starting point, and propose an alternative operational criterion for policy.

preference.[3] So, if it is desirable to avoid unnecessarily degrading resources and if sustainability is to have normative standing as a policy goal, then dynamic efficiency is a necessary condition for (such a normatively meaningful interpretation of) this concept.[4]

3. Intergenerational equity

Although dynamic efficiency is necessary for what we consider to be the most normatively useful definition of sustainability, dynamic efficiency is most surely not a sufficient condition. It is also necessary—for consistency with widely embraced definitions of this concept—that the total welfare function not decrease over time. Formally, a consumption path fulfils the condition of intergenerational equity if

$$\frac{dW(t)}{dt} \geq 0 \tag{2}$$

where $W(t)$ represents the total welfare function from Eq. (1).[5]

So, in this broader economic definition of sustainability, an economy is sustainable if and only if it is dynamically efficient and the resulting stream of total welfare functions is non-declining over time.

4. Sustainability

We acknowledge that the above definition provides a demanding pair of decision criteria, and some might argue that this is too demanding to be useful as a guide for public policy. The same is true, however, of the benchmark of a Pareto-improving policy—one which makes some members of society better off, but makes *no one* worse off (Pareto, 1896). Actual Pareto-improvements are exceptionally rare, of course, perhaps even non-existent. Hence, the strict Pareto criterion is virtually never taken as a guide for public policy, despite its considerable normative appeal. Economists resort instead to seeking 'potential Pareto-improvements' in the Kaldor–Hicks sense—the world is viewed as being made better off if the magnitude of gains and the magnitude of losses are such that the gainers can fully compensate the losers for their losses and still be better off themselves.[6]

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[3]This formulation and the notation used in Eq. (2) are consistent with Arrow et al. (2002), who refer to the solution of this problem as the 'present value of felicities'. Weitzman (2002) refers to it as a measure of 'welfare-equivalent sustainability'. Of course, $W(t)$ must capture total welfare. Omitting contributions to welfare of any kind of capital will lead to an underestimate, and omitting any form of capital depreciation will lead to an overestimate. The theoretical implications of technological and population change have been examined in this context, and the theory regarding ideal measures of $W(t)$ has been explored extensively. Heal (1998, 2001), Solow (1991), and Weitzman (2002) also give reasons why narrow definitions of 'economic' capital should be expanded to include, for example, human and natural capital.

[4]Despite being the ultimate goal, *maximization* of $W(t)$, that is, intertemporal *optimality*, is too much to require of a normatively useful criterion.

[5]Note that this condition does not assure that felicity U in each future period will be as high as its current level. It only refers to a given aggregation (discounted value) of felicities.

[6]The notion that a welfare improving change ought to be associated with a 'potential Pareto improvement' was introduced by Kaldor (1939) and Hicks (1940).

What is key is that the Kaldor–Hicks criterion is a necessary condition for satisfying the strict Pareto criterion. If a policy proposal fails the Kaldor–Hicks test, it cannot pass the Pareto test. If a proposed change is not a potential Pareto-improvement, it cannot be a Pareto-improvement. This is the fundamental theoretical foundation—the normative justification—for employing benefit–cost analysis, that is, for searching for policies that maximize the positive difference between benefits and costs.

Similarly, we can think of an economy as having the *potential* to become sustainable if it fulfils the criterion of dynamic efficiency. It can then, in principle, be made sustainable by appropriate intergenerational transfers to achieve a non-declining total welfare path. One such economy that *can* be made sustainable has been formalized by Hartwick (1977), in which there exists the *possibility* of turning exhaustible resources into capital stock, a particular type of intergenerational transfer. If the Hartwick rule of investing all rents from exhaustible resources in reproducible capital is followed, the economy can be made sustainable.[7]

Much as economic analysis has long focused on potential rather than actual Pareto-improvements, leaving the allocation of net gains among individuals (and, hence, the resolution of debates regarding distributional equity) to the political process, similar reasoning may lead to an analogous approach to sustainability debates. In theory, it may be argued that sustainability is ultimately the most desirable policy goal, but in practice it may be more reasonable to aim for potential sustainability in the form of dynamic efficiency (of an all-encompassing societal welfare function).[8]

This may open us to criticism for being excessively focused on efficiency rather than equity.[9] Our view, however, is *not* that economists should ignore distributional issues, whether cross-sectional or intertemporal, but rather that potential sustainability—that is, dynamic efficiency—provides a reasonable focus for much (but not all) economic analysis of long-term public policies, because it is a necessary—though not sufficient—condition for sustainability.

5. Conclusion

Sustainability is a broad concept, but it does not need to be 'vague', as Solow (1991) has argued. Interpretations that are acceptable both to natural scientists and economists should be possible. We find that sustainability can be conceptualized in a way that has intuitive appeal both to economists and non-economists by viewing a sustainable growth path as one which is both dynamically efficient and non-decreasing over time. Much as a potential Pareto-improvement in the Kaldor–Hicks sense can

[7]The conditions under which the Hartwick rule holds, however, are restrictive, as discussed by Asheim and Buchholz (2000).

[8]Except for the elusive case of the Hartwick economy, utility transfers between generations are difficult to operationalize. Their abstractness provides an additional reason why more useful policy statements can be made by being satisfied with potential transfers.

[9]One of the most prominent critiques of the traditional focus of economics on efficiency has been offered by Sen (1970). He points out that a society may be efficient 'even when some people are rolling in luxury and others are near starvation, as long as the starvers cannot be made better off without cutting into the pleasures of the rich. In short, a society can be Pareto optimal and still be perfectly disgusting'. Our definition of sustainability involves the notion of distributional equity by including both dynamic efficiency and intergenerational equity. We argue only that the comparative advantage of economics may lie in its focus on the first element, without trying to diminish the overall importance of the latter.

yield Pareto optimality when combined with appropriate compensation of losers by winners, so too can dynamic efficiency lead to the more ambitious goal of sustainability when it is combined with appropriate intergenerational transfers. And much as practical economic analyses often resort to seeking potential Pareto-improvements, leaving the final allocation to the political process, so too may intertemporal analyses focus on dynamic efficiency, leading to the possibility, at least, of actual sustainability.

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