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A Model for Sustainability Using the Rawlsian Principle

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Abstract

There is a substantial and growing literature on the topic of sustainability, but no consensus on a working definition has emerged yet. The rational pursuit of sustainability is only possible if we can develop a working definition consistent with the principles of justice and inter-generational welfare.

This paper uses the Rawlsian principle of justice to develop a working definition of sustainability in the context of a simple aggregative model. The implications of the definition on issues like the choice between current consumption and future economic growth are examined. It is shown that sustainable growth limits the range of this choice, but does not determine it. Alternative ways of clinching this choice are discussed.

The model used is only illustrative, and ignores many details. It may be useful as a measure for future research and comparison of sustainability modelling techniques.

Keywords: *Sustainability, Utility, Endowments*

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Contents

1. Introduction

Sustainability is an increasingly popular concept in the areas of economic development, environmental policy and economic research in general. It has been used as a pivotal concept in issues of ecosystem maintenance, the preservation of genetic diversity and natural resources. However, a consensus on a working definition of the concept has not been achieved yet. This renders theoretical modelling difficult, and impact assessment of environmental actions indeterminate. Symptomatic of this lack of a clear definition is a 1989 United Nations' survey. It reveals that, in spite of their concern, in general governments were not sure what constitute environmentally sound development policies (United Nations, 1989). Without an unambiguous definition, sustainability risks becoming a transcendent term, reminiscent of "appropriate technology" or "environmental quality" which are difficult to measure and rarely defined explicitly.

Perhaps the best known working definition of sustainability is the one given by the Brundtland Report, which advocates, *growth and development that meets the needs of the present without compromising the ability of the future generations to meet their own needs* (World Commission on Environment and Development, 1987, pp. 43).

Using a Rawlsian framework, this paper proposes a working definition of sustainability in the context of a simple aggregative model. Section II below presents a brief discussion of the theoretical positions proposed in the literature on the concept of sustainability, and develops a working definition of the concept based upon the Rawlsian principle of justice. Section III, employing a social decision framework, looks at the implications of this definition on the choice between current consumption and future economic growth. The last section concludes with a brief discussion of the limitations of the model.

2. Sustainability: A Theoretical Background and a Proposed Definition

The literature on the topic of sustainability is growing. In spite of the lack of a definition of the concept, there is no denying that sensitivity to the needs of future generations is the key element in analysing sustainability issues. The perspective that the current generation has an ethical responsibility to sustain the economic and environmental welfare of future generations appears to be increasingly accepted.

Kavka (1978) suggests that future generations and contemporary strangers are worthy of broadly similar treatment. Therefore the current generation has similar obligations in both cases. In addition, whatever the uncertainty about the extent of future preferences, it is clear that basic needs will exist and will not be substantially different from contemporary ones. This view introduces the argument that intergenerational welfare theory should be explored as a basis for defining sustainability. Attfield (1983), for example, advocates a variant of the *total utility* version of utilitarianism, as the basis for a theory of normative ethics capable of supplying a coherent treatment of obligations to future generations.

Against this position, some have argued that current generations do not have to worry about future generations because the latter will be better off than the current generation as they will inherit enhanced stocks of capital, technology and knowledge. However, this would depend on the true nature of the so called *environmental risk and uncertainty* situation that advanced technologies seem to breed (Page, 1978). If global life-support systems are seriously impaired, future generations may have little opportunity to ameliorate or to adapt to the grossly polluted world. To put it differently, since man-made capital is not a good substitute for environmental capital, it cannot be taken for granted that future generations will be better off because of previous accumulation only.

Kavka (1979) suggests that in terms of the resource base inheritance, current generations should leave enough and qualitatively no worse resources for future generations. This intergenerational equity ruling will involve policies that will enhance the conservation and preservation of renewable resources,and will enhance substitution technology and recycling innovation (Howe, 1979; Page, 1983, Pearce and Turner,1984). Because of current global inequities, the pressure on existing resources is greater than in the hypothetical case of equality. In deciding intergenerational allocation of resources, distributional factors should therefore be also taken into consideration. Accordingly, the current generation should compensate future generations via improved technology and increased capital investment designed to offset the impact of depletion, degradation and destruction.These considerations naturally lead to programs towards "sustainable growth and development" (International Union for the Conservation of Nature, 1983). While the concern for future generations' welfare emerges from these suggestions quite clearly, the difficulty of making intergenerational comparison of utilities would prevent precise quantitative criteria or definitions from these considerations alone.

Tietenberg (1988, pp. 3) claims that "the sustainability criterion suggests, that at a minimum, future generations should be left no worse off than current generations". This implies that the actions of current generations in using resources should not reduce the standards of living of future generations below that of the current generation. The ethical basis of Tietenberg sustainability criterion is based on John Rawls' (1977) principle of justice. In developing our own definition of sustainability, we propose to use this Rawlsian principle. As we hope to show below, an extension of Tietenberg's criterion can provide a concrete and workable definition of sustainability.

Suppose the current period of the economy has inherited a stock of material capital, K and renewable environmental capital E from the last period. The production conditions are characterised by:

(1) $$y = \min\left(\frac{K}{v_1}, \frac{E}{v_2}\right)$$

1

where y is the material production during the period and v_1 and v_2 are the “capital output ratios” of aggregate output with respect to material and environmental capital stocks respectively.

The formulation implies that either of the two types of capital can become a bottleneck in production, and they are not substitutable. Even though the two types of stocks are substitutable in a limited manner in reality, we believe that the problem of sustainable growth basically arises because of poor substitutability of the two. If it was possible to transform man made capital completely into environmental stock at a future date, the problem of sustainability would disappear. To highlight the issue of sustainability, therefore, it is useful to treat the two components of capital stock as non-substitutes.

Production y entails W amount of waste generation; and wy amount of current resources are required to treat and dispose of this waste. The society has a choice of y in the range of 0 to the upper limit given by (1). The choice of y defines a growth rate g over the last period's production y_{-1} such that $y = y_{-1} (1+g)$. The same growth rate g can leave different amounts of stocks and waste levels for the next period, depending on the allocation of current product y among consumption, investments and waste disposal activities. So sustainable growth will be defined by reference to the growth rate as well as the associated allocation of output. Let i denote investment in material capital, r in environmental capital and d the expenditure on waste disposal out of current production y.

Definition: A programme (g, i, r, d) is called sustainable if it leaves

(i) for the next period a material capital and environmental capital stock that, in view of Equation (1), make it possible to have a growth rate no less than g, and

(ii) no more stock of waste than the period began with.

This definition needs some explanation. Welfare comparisons for different generations are generally done by contrasting their consumption levels. However, present generations can not pre-empt the choice of future generations except in a deterministic central planning model. It is for this reason that we decided to impose the rule that future generations should be left with enough stocks so that they can increase their total production at a rate no less than the present generation's. The allocation of this product between consumption and investment is a prerogative left to the future generations. Imposing this rule causes growth rates of successive generations, rather than their consumptions, being interlinked through available resource considerations. This also eliminates the usual indeterminacy characterizing inter-temporal choice models resulting from the inability to compare utilities across generations on a common scale.

3. A Proposed Model for Sustainable Development

The definition proposed in the earlier section will be used in a model illustrating a relationship between growth rate and consumption. This relation restricts the choice of consumption and growth rate compared to an economy without concern for sustainability. Properties and implications of this restriction are discussed. It is further noted that while a sustainable program restricts the possible growth rate and consumption choices, it does not determine the choice uniquely. So even after enforcing sustainability, there is room for choice of growth rates for the society. We may now examine the characteristics of a sustainable programme (*g, i, r, d)*. Condition (i) in the definition implies:

(2) $\left(\frac{K + i}{v_1}\right) \geq y(1 + g) = y_{-1}(1 + g)^2$ 2

(3) $\left(\frac{E + r}{v_2}\right) \geq y(1 + g) = y_{-1}(1 + g)^2$3

These two conditions show that a higher growth rate *g*, to be sustainable, requires larger investments *i* and *r*, leaving a smaller output for current consumption.
Condition (ii) of the definition implies:

(4) $d \geq wy = wy_{-1}(1+g)$

If *c* denotes current consumption, then we may write the national accounts identity

(5) $c = y - i - r - wy$

Treating (2), (3), and (4) as equations and using them in (5) will provide for maximum possible consumption for any sustainable growth rate g. Accordingly we may rewrite (5) as

(6) $c = y^{-1}\,(1+g) - v_1 y_{-1}\,(1+g)^2 - v_2\, y_{-1}\,(1+g)^2 - wy_{-1}\,(1+g) + K + E$

Equation (6) summarises the possibilities for consumption for the present period. Since y_{-1}, v_1, v_2, *w*, *K* and *E* are all givens, it describes current consumption as a function of different growth rates if the programme is sustainable according to the definition above.

As opposed to (6) an unrestricted relation between c and g will be the following:

(7) $c = y_{-1}\,(1+g) - i - r – d$

where *i*, *r* and *d* are unrestricted choice variables. Clearly for any *g* the maximum possible *c* on (7) will be higher than on (6).

Equation (6) is a quadratic relation. But by restricting *g* in the meaningful range $g = 0$ to $g = g_{MAX}$ where g_{MAX} is the maximum sustainable growth rate, it can be seen that *dc/dg* is negative throughout that range if v_1 and v_2 are greater and *w* smaller than unity. Both are valid assumptions in real situations.

Equation (6) can then be seen as a trade off between consumption and growth rate, that the society has to be conscious of in a choice about the combination (*c*, *g*). Thus sustainability as such does not exhaust the possibility of choice between current consumption and growth rate, but limits the choice compared to an unrestricted growth path.

The choice between *c* and *g* can be closed in a variety of ways. First of all the government, having imposed a set of physical, fiscal and regulatory price-and-fine schemes in the system, may withdraw from the economy. The choice then is determined by atomistic choice under these given restrictions (e.g., by capital market considerations). Secondly, it may be closed purely by *ad hoc* choice reflecting a political decision or compulsion.

Thirdly, it may also be closed by some macroeconomic policy considerations like employment. For example, if labour force is growing at the natural rate *n*, and if $0 \leq n \leq g_{MAX}$, then *n* can be looked upon as a growth rate that maintains a steady rate of (un)employment of the labour force. It can be easily checked that if *n* is sustained with supporting *i*, *r* and *wy* programmes, then consumption also grows at the rate *n*. This can be called a steady rate of sustainable growth as long as inequalities (2), (3), and (4) are maintained every period.

Finally the choice may be effected by using a political decision function. The choice between current consumption and growth often presents itself as a political decision problem for the government. While current consumption has immediate political spin off, the growth rate is important for a government that is concerned about its whole term and looks beyond it. The consumption level of a composite set of goods and services at the current period (c_t) is the first argument of the decision function. The second argument is the rate of growth of the economy ($g_{t,t+1}$). From the government's view point both variables are important. The decision function will provide a quantitative statement of the relative importance of these two variables. For illustration, we will use a Cobb-Douglas specification for the decision function:

(8) $D_t = a \ ln(c_t) + (1 - a) \ ln(g_{t,t+1})$

where D is a decision variable to be maximised, and a is a parameter of the function. The functional form (8) is a monotonic transformation of the more usual Cobb-Douglas specification.

But economic compulsions create a trade off between the two, so that higher growth target will depress current consumption. The trade off on a sustainable trajectory is shown by equation (6). The decision consists of maximising (8) under the restriction (6).

Maximise: $D_0 = a \ ln(c_0) + (1 - a) \ ln(g_{0,1})$

Constraint: $c_0 = y_0 - v_1 y_0(1 + g_{0,1}) - v_2 y_0(1 + g_{0,1}) - wy_0 + K + E$

We have assigned t=0 to the current period and t+1 = 1 to next period to simplify our notations.

Deriving the first order and second order conditions for this constrained maximisation problem, the solutions for the optimal c_0 and $g_{0,1}$ are:

$$c^* = a (1 - w) K / v_1$$
$$= a (1 - w) E / v_2$$

and

$$g^* = \frac{(1 - a) (1 - w)}{(v_1 + v_2)} 4$$

Alternative values of a can be used to find out their implications for consumption and growth rate. Such exercises may be useful, because the solution (c , g) usually determines other important variables for the system, eg government revenue, components of government expenditure and employment. By parametric variation of the decision function, the government can evaluate the economic implication of its own alternative political choices.

4. Limitations of the Proposed Model

The limitations of this model arise from its one commodity nature, which forces some important issues out of consideration. Perhaps, the most important limitation is that neither ecological safe minimum standards nor permanent ecosystem damage is addressed. Safe minimum standards could be addressed through Stone-Geary utility and production functions. In modelling a more permanent ecological damage, both the environmental amenity function and the rate of renewable resource growth as endogenous to the total accumulation of wastes and extraction of exhaustible resources must be addressed.

It may also be noted that the second condition of our definition imposes that the stock of waste should not increase form one generation to the next. However, it is conceivable that improvements in the future standards of living are possible with larger stocks of environmental waste, provided that future generations have access to adequate technologies to handle them. In expanding the model to allow for cross-generation technological variations, the second restriction of the definition would have to be reformulated. The growth rates of relevant technology and research and development activities should feature in that reformulation. Also, with respect to technology, Krutilla and Fisher have argued that improvements tend to exert an asymmetrical effect on environmental amenities and consumption (Pearce and Turner, 1990). This should be taken into consideration.

In summary, future improvement of the proposed definition and model should therefore include a treatment of issues of ecological safe minimum standards, permanent ecological damages, and technological innovations pertinent to the environment.

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