"ENVIRONMENT", "NEEDS" AND REAL INCOME COMPARISONS[1]

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Conventional measures of national product make no pretence of including everything that affects welfare. As increasing attention is being paid to environmental pollution, the problem of incorporating certain non-economic variables into the analysis of well-being becomes more relevant. The object of this note is to show how a difference in "needs" for, and hence expenditures on, anti-pollutants, which will show up in conventional national accounts comparisons as differences in "tastes", should be converted into differences in real income.

It is well-known that national product as conventionally measured by no means covers all the items that could conceivably affect human welfare. No pretence is made to include items such as leisure or the political, social or physical environment that may affect Mankind's happiness. There has even been much discussion in the literature of whether it is correct to treat certain economic aggregates such as expenditures on defence, law and order, or private transport, as final outputs of the economic system which add to welfare, rather than as inputs that are required solely in order to meet certain "needs" generated by the rest of the economic system. In general, it is because measured consumption excludes many items that affect a person's well-being that it is not possible to compare a person's well-being on two different days, even if incomes and prices have not changed and one knows his exact position on each day in terms of the pattern of his consumption and his preference patterns in terms of the goods and services entering into this consumption. For, as is well-known, what vitiates such comparisons is not so much the possibility that his tastes, in terms of the goods he is seen to consume, may have changed, but the possibility that his welfare has changed on account of changes in other conditions that are not normally included in the definition of his preference pattern. For example, on two different days he might be consuming exactly the same collection of goods, but between these two days the milkman may have run off with his wife.

Of course, this only vitiates the comparison of his welfare in the two situations if his wife is not included in the collection of items entering into his consumption that is subject to our measurement. If the wife is included as well, then her disappearance will show up as a fall in real income in the normal way and there is no problem. Conceptually there is no reason why the wife should not be included in the utility function and indifference surfaces drawn to show the husband's trade-offs. The indivisibility problem (in non-Muslim countries) can be overcome simply by working in units of wife/time per day; and even the most devoted husband might find that, after a time on any one day, the marginal utility of his wife has reached saturation point and becomes negative. And even in simple units of wife, many men would be willing to accept some monetary

[1]I am indebted to Anil Markandya and R. D. Portes for valuable comments on an earlier draft. I am, of course, entirely responsible for the defects of this paper.

compensation for the loss of their wives. I have heard stories that some men have actually paid to have their wives removed, though I cannot believe such stories could be true.

Now that the problem of environmental pollution has moved up in the hierarchy of current economic issues (thanks to the economic growth that appears to have partially solved certain more important problems, such as the eradication of mass unemployment, poverty, squalor, misery and disease from contemporary Western society), the problem of incorporating the creation of certain "needs" and noneconomic variables into the analysis of well-being becomes rather more relevant. The object of this note is simply to show how a difference in "needs" for, and hence expenditures on, certain anti-pollutants, which will show up in conventional national accounts comparisons as being merely differences in "tastes", should be converted into differences in real income. There is nothing particularly original about the conclusions of this note; other economists have made similar suggestions before, and, at the time, I disagreed with them. I now think that I was wrong to do so, and that the case for adjusting, say, international real income comparisons for differences in certain environmental factors is stronger than it appeared to me at the time.[2] This note sets out the lines along which, I think, variations in environmental "needs" and expenditures should be incorporated into real income comparisons that are better approximations to welfare than are usually the case.

Consider again the case of the man, Mr. C, whose beloved wife has disappeared with the milkman. There are two distinct ways in which he will be affected. First, he may just be generally unhappier, but not change his consumption pattern in any way. Secondly, he may change his consumption pattern in order to adjust optimally to his wife's disappearance. For example, he may hire a cook or a housekeeper or what-have-you, or console himself with drink, or some other wife-substitutes. In other words, if we had defined Mr. C's utility function in terms of (i) his wife and (ii) all other goods grouped together, it would be technically a "non-separable" function, in that a change in the consumption of the wife has affected the marginal rate of substitution amongst all the other goods entering into his utility function. An outside observer who did not know about Mr. C's misfortune, and who compared Mr. C's consumption pattern with that of some neighbour, Mr. A, whose wife had less appeal to the milkman, would conclude that the former had different "tastes" for wine, women and song. But, in fact, if the tastes of the two neighbours are defined in terms of ordinary goods plus wives, they may have been the same, and *cet. par.*, the real difference between them would be that the former has suffered a reduction of real income in terms of the consumption pattern more widely defined.

Similarly, an increase in some form of environmental pollution—say a rise in the amount of smoke in the air—may give rise to a greater "need" for an expenditure on some anti-smoke, such as soap or laundry services. In terms of a utility function excluding environmental factors this would show up solely as a

[2]D. Usher, "The Thai National Income at United Kingdom Prices", *Bulletin of the Oxford University Institute of Economics and Statistics*, August 1963, and my comments thereon in W. Beckerman, "International Comparisons of Real Incomes", O.E.C.D. Development Centre, Paris, 1966.

difference in "tastes" whereas it is, in fact, a fall in welfare with equal tastes if the utility function is defined more widely to include environmental factors. And although it may be impossible, for several centuries or more, to adjust our measures of welfare for the presence or absence of wives or hosts of other so-called "non-economic variables" that affect our "needs" and hence our welfare, it may not be impossible already to take some account of certain physical indicators of environmental factors.[3]

Now, as with a conventional comparison of Mr. C's and Mr. A's welfare, the conventional approach to real income comparisons between, say, different countries has been to treat implied differences in preference patterns for the conventional goods that enter into national product measurements as differences in "tastes", even if these may really reflect different optimising adjustments to different environmental factors, such as climatic conditions. In fact, of course, basic human preferences for ultimate satisfactions may well be far more uniform than international (or inter-temporal) comparisons of consumption patterns would suggest (after allowing for differences in relative prices, incomes and any other specifically indentified determinants of consumption patterns).

This point has already emerged in connection with the extremely important contributions to demand theory made by Kelvin Lancaster. Lancaster's proposed specification of consumers' utility functions in terms of characteristics, rather than the products which are merely inputs that provide these characteristics, is obviously a very suitable framework for the distinction between products that are "good" and those that are "bad". The proposition that "preferences relating to characteristics change less over time, whether through advertising or other influences, than preferences relating to goods which supply these characteristics in different proportions"[4] probably applies equally well to comparisons over space (i.e. between countries) as to comparisons over time. However, for purposes of simplification of the argument here, there is no need to adopt the Lancaster approach, and the simplifying assumption will be made that there is a one-to-one relationship between the particular goods and characteristics with which we are concerned here. Given this assumption, it makes no difference whether the consumer maximizes utilities in a commodity space or a characteristics space, so for purposes of making the point with which this paper is concerned it is preferable to retain the more conventional description of consumption behaviour in terms of the former.

We begin by removing the usual restriction on the utility function to the effect that all the items that enter into it are "goods" in the sense that their marginal utility over the relevant range is positive, and we allow for some of the items to be "bads" in the sense that their marginal utilities are negative. Pollution is a "bad". And some products are required *only* in order to get rid of pollution, so that they can be classified as "anti-bads". Consider a consumer who is in a position such that the products he consumes can be classified into three

[3]Von Neumann and Morgenstern warned us a long time ago of the danger of assuming that there are some phenomena affecting utility that are, in principle, unmeasurable: "Even if utilities look very unnumerical today, the history of the experience in the theory of heat may repeat itself, and nobody can foretell with what ramifications and variations." *Theory of Games and Economic Behavior*, para: 3.2.2.

[4]H. A. John Green, "Consumer Theory", (1971), page 160.

classes, goods, bads, and anti-bads. Smoke would be an example of a bad, and laundry services *required to get rid of dirt caused by the smoke* would be anti-bad. Laundry required for its own sake, independently of the smoke, would be in the first class of products, namely the independent goods. Perhaps unpleasant medicine is a better example of an anti-bad, but laundry is more convenient since it is easier to conceive of its bad counter-part in the productive process than the bad counter-part of medicine (illness). In the interests of simplicity we shall also assume now that there is only one product in the bad class and in the anti-bad class (the smoke and the smoke-removing laundry). We shall further assume that the consumer's utility function is of the form:—

$$U = f\{x, (z' - z)\}$$

where x = all "goods"; z = the "bad"; z' = the anti-bad; $U_x > 0$; and $U_{(z'-z)} > 0$ over the relevant range (where $(z' - z) \leq 0$). It should be noted that the form of the item $(z' - z)$ is such that we are, in effect, netting out the bad against the anti-bad to obtain a new unit of quantity, which may be denoted as z^*, which would be appropriately described as "cleanliness".[5]

That is, as long as both smoke and laundry services are defined in constant physical units, the subtraction of the smoke from the laundry corresponds to some constant quantifiable units of "cleanliness", and it is this unit of cleanliness that enters into the consumer's utility function in the manner shown. But this does not preclude a declining marginal utility of z^* as the amount of it increases, but it does mean that whatever the level of z^* the marginal utility of adding one unit of z' is equal to the marginal utility of subtracting one unit of z. What this means is that, for any one consumer, the efficiency with which he can get rid of dirt (from smoke) with the aid of laundry is independent of the levels of smoke and laundry that he consumes. To derive an aggregate utility function for many consumers in terms of x and physical units of z^*, however, we need to assume that all consumers are equally efficient in transforming "laundry" services into less dirt. Otherwise a given increase in, say, laundry services would not correspond to a unique increase in the quantity of cleanliness, z^*, since it would depend on how the laundry services were distributed. This is a much stronger assumption, and whilst it might be unacceptable in some contexts its rejection here would merely complicate the analysis without changing the basic character of the conclusions.[6]

[5]Some soap or laundry services would be consumed even in the complete absence of smoke but such soap or laundry must be regarded as a different product, having the nature of a pure "good" and hence being included in class x. In the same way that Mr. C may drink some alcohol before his wife deserts him, but drinks a lot more in order to drown his sorrows when she does leave, the extra alcohol is the anti-"wife-absence" and if this is split off from the initial alcohol the latter is left in the class x in his utility function, whereas the extra alcohol is the anti-bad. Anti-bads are not products *some* of which may be useful for combatting bads. They are products, the marginal utilities of which are only positive for positive amounts of "bads".

[6]In any case, if the assumption were thought to be unacceptable the following analysis would still apply to the individual consumer, so that the conclusion reached concerning the comparability of real incomes between individual consumers subject to different environmental conditions would still hold. Aggregative real income comparisons are already subject to so many strong assumptions concerning community indifference curves, income distribution and the like, that the one postulated above is hardly likely to stretch the consciences of anybody prepared to accept the standard aggregate real income comparisons.

Given this assumption and starting from a situation in which the utility function is defined in terms of the three products, x, z and z', we are able to transform it into one in which utility is a function of two products, x and z^*, which can be represented on an indifference map in two dimensions as in Diagram 1 below. In order to operate in terms of the familiar and conventional diagram the vertical axis represents net cleanliness (i.e. $z' - z$), so that movements upwards (northwards) represent greater satisfactions in the usual manner. $U_{z^*z^*} < 0$, since the marginal utility of cleanliness declines up to some saturation point at which it would become negative, but this saturation point must be at a level of net cleanliness that is not positive, given our postulate that consumers never do more than eliminate the dirt from the smoke, so that they never purchase sufficient of this particular kind of laundry to make net cleanliness positive. Hence the indifference curves must slope in such a way that, whatever the price of laundry and the income of the consumers, equilibrium could not be at a positive level of net cleanliness, which requires that the locus of points of $U_{z^*} = 0$ lies below the horizontal line representing zero net cleanliness.

The consumer's optimum position in Diagram 1 is, as usual, where the ratio of the prices of x and z^* are equal to the ratio of the marginal utilities of x and z^*; which means that, where P_i equals the price of the ith product,

$$p_x/p_{z^*} = U_x/U_{z^*} = U_x/U_{z'} = U_x/-U_z = p_x/p_{z'}.$$

The last equality arises because there is a zero price of smoke, so that the price of net cleanliness is equal to the price of laundry.

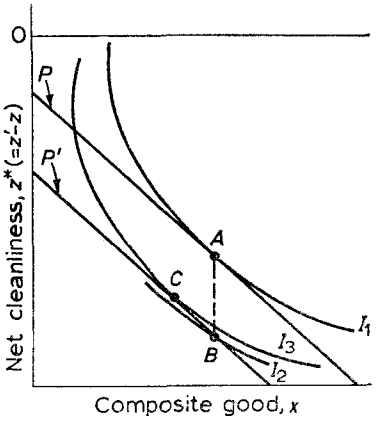

DIAGRAM 1.

Consider now the case where the consumer had been in equilibrium at point A and there is an exogenously determined increase, AB, in the amount of smoke. Before the consumer adjusts to a new optimal equilibrium point this would be represented, in the above two dimensional diagram, as an increase in z by an amount AB and hence as a fall in the cleanliness dimension from the indifference curve I_1 to the point B on the lower curve I_2. But at the point B the consumer would not be in equilibrium. For the ratio of the marginal utilities of z^* and x

is no longer equal to their relative prices given by the line P, and this equality can only be restored if the consumer gives up some of the ordinary goods x in order to spend more of his income on anti-bad—i.e. he is obliged to buy more laundry. He will move along the line P', parallel to P, representing the relative price of laundry to other goods, until he has reached the point C where he is once more in equilibrium. At this new point he will consume less of x and more laundry than before. He will still suffer more smoke, but not the whole of the initial exogenous increase in smoke.

In terms of this diagram, the initial exogenous increase in smoke shows up clearly as a fall in real income in terms of product z^*, for the consumer moves from the real income level represented by the budget line P to a lower real income line measured by the budget line P'. In doing so he moves along this budget line to a pattern of expenditures that represents a higher indifference curve than if he had passively remained at the initially worse point B. How far he will trade off other goods as a whole for the anti-bad depends, of course, on the relative price of laundry in terms of other goods and his marginal rates of substitution of x for z^*. If laundry is very expensive he will have to put up with a lot more dirt, and conversely. This corresponds to the fact that the loss of welfare caused by a given amount of some pollutant, such as noise, depends on how expensive is the optimum anti-pollutant. Crude indicators of environmental pollution, therefore, can give a very misleading picture of comparative effects on welfare insofar as the accessibility of cheap private anti-pollutants varies from place to place or from one period of time to another.

The implications of all this for comparisions of economic welfare between different countries (or time periods) in which there are exogenously determined differences in the environment, which create different "needs" for anti-bads, are obvious. For in the context of the above presentation of the consumers utility function, there is no sharp distinction between bads such as smoke, which creates a need for laundry, and bads such as a cold climate, which creates a need for heating. In other words, a need is simply a "bad", and a "bad" is simply an element in the utility function which has negative marginal utility. And if we can regard an exogenously determined rise in smoke as having a counterpart in a fall in real income in the way set out above, why not regard an exogenously determined colder climate, or some other need-creating "bad", as having a real income counterpart in terms of conventional indifference curve analysis?

Consider two countries of which one (only) is free of smoke. If the price ratios and the utility functions were the same in the two countries the consumers in the smoke-ridden country would be in equilibrium at, say, point C of the above diagram, and the consumers in the smoke-free country would show up clearly as having a higher real income in terms of the diagram on account of being at point A. But on a conventional indifference map, and hence in a conventional national accounts statistics real income comparision, they would appear as having the same real income but different utility functions. Suppose we had drawn the situation of the consumer who, in Diagram 1, moved from point A to point C via point B, on a conventional diagram (such as Diagram 2 below) which would have x along the horizontal axis and *only* laundry along the vertical axis. That is, the vertical axis would be in terms of only z', not z^*. He

would begin at point A' in Diagram 2 below corresponding to his beginning at point A in Diagram 1 above. When there is the exogenous rise in smoke he substitutes laundry for X as before. But as his money income has not changed and there has been no change in the relative prices, this would have shown up on the conventional diagram simply as a shift from point A' to a point such as C' in Diagram 2. This will look as if he has changed his "tastes", and that the indifference curves must cross as shown.

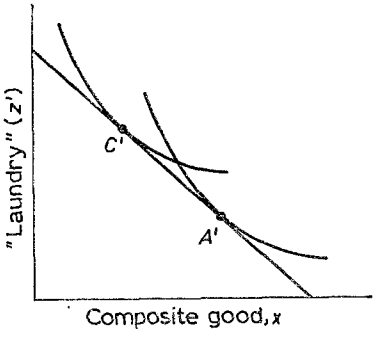

DIAGRAM 2.

But we have seen that exactly the same story told in terms of the net product "cleanliness" shows up clearly as a fall in real income which ought to be measured as AB (in prices of laundry in Diagram 1). Since there is no analytical difference for present purposes between changes over time for the consumer we have been describing and international differences, points A' and C' can be taken to represent the different countries; country A' having no smoke and country C' suffering from smoke. Using the conventional "goods", we would measure real income in the two countries corresponding to the points A' and C' as being equal though corresponding to different tastes when, in fact, they are unequal though corresponding to identical tastes.

Ideally, we would like to be able to correct for this and to say that though the countries appear to be equal we know that the extra purchases of laundry (heating etc.) in country C' really represent some extra anti-bad which cannot compensate fully for its extra exogenous bad. But this would require some knowledge of the ratio to convert that extra laundry which is judged to be purely an anti-bad into the loss of real income associated with the extra bad that gave rise to the extra laundry. Of course, we do not have this knowledge; but this does not detract from the validity of the concepts, and hence from the need to try to use environmental indicators and related data in a manner designed to match these concepts.