# "Poverty and Progress" Revisited

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### *Introduction*

The title of this paper derives from the fact that it is primarily an exposition of ideas which are either explicit or immanent in R G Wilkinson's *Poverty and Progress: An Ecological Model of Economic Development* (31). The ideas are not widely known among economists.[1] Here I have adopted a mode of exposition which is very different from that of Wilkinson. I hope that in so doing the potential contribution of the ideas to our understanding of the fluid potential contribution of the ideas to our understanding of the fluid relationship between economic activity, environmental conditions and human welfare is made more readily apparent. The intention here is to raise some pertinent questions rather than to provide definitive answers. This intention should be kept in mind in reading what follows, since brevity requires that I put things in a more positive and assertive way than is properly justified. The argument being offered is that to regard economic development as a process primarily involving adaptive response to environmental change is a useful, and neglected, perspective on a very complex set of phenomenon. The argument is not that all economic history can be understood, and only understood, within such a framework: the message is not ecological determinism. Again, it will not be possible explicitly to instance in what follows all of the particular qualifications that this general caveat implies.[2] I imagine that the interpretation of the development process to be outlined here is sufficiently at odds with the standard economic interpretation that there is little danger of its uncritical acceptance.

### *Production and the Environment in Development*

The point of departure is the concept of economic development as a process which is essentially about adaptation to a changing environment, while being itself a source of environmental change. As Wilkinson ([31], p.105) puts it:

'Looking at economic development in its ecological setting... we see that it is a process of solving a sucession of problems which from time to time threaten the productive system and the sufficiency of our subsistence. In effect, human societies out of ecological equilibrium have to run to keep up; their development does not necessarily imply any long term improvement in the quality of human life.'

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I shall first use simple numerical illustrations, in the framework of input-output analysis, to expand on these summary statements.

Initially society is in a state of ecological equilibrium, in that its population size is constant and adjusted to the carrying capacity of its ecological niche. The constant population size is 100, and each individual has subsistence requirements of 0.55 units of "food" and 0.3 units of "clothing". The technology by which this society exploits its environment is shown in I of Table 1; entries above the dashed line are intermediate input requirements per unit of output of food and clothing, entries below the dashed line are primary input coefficients. The primary input R1 is some renewable resource, for which the maximum sustainable yield is 100 units. The subsistence requirements for 100 individuals are 55 units of food and 30 units of clothing, requiring primary inputs of 260 units of labour and 100 units of R1.[3] It is in this sense that the society is in ecological equilibrium: its size is the maximum that its niche can support on a sustainable basis.

**Table 1.**

| | | | | | |
|---|---|---|---|---|---|
| I | | *Food* | *Clothing* | | |
| | Food | 0.25 | 0.4 | | |
| | Clothing | 0.14 | 0.12 | | |
| | Labour | 0.8 | 3.6 | | |
| | R1 | 0.5 | 1 | | |
| II | | *Food* | *Clothing* | *Fuel* | |
| | Food | 0.25 | 0.4 | 0.1 | |
| | Clothing | 0.14 | 0.12 | 0.05 | |
| | Fuel | 0.1 | 0.2 | 0.1 | |
| | Labour | 0.8 | 3.6 | 1 | |
| | R1 | 0.4 | 0.8 | 0 | |
| | R2 | 0 | 0 | 1 | |
| III | | *Food* | *Clothing* | *Fuel 1* | *Fuel 2* |
| | Food | 0.25 | 0.4 | 0.1 | 0.1 |
| | Clothing | 0.14 | 0.12 | 0.05 | 0.05 |
| | Fuel 1 | 0.1 | 0 | 0.1 | 0 |
| | Fuel 2 | 0 | 0.2 | 0 | 0.1 |
| | Labour | 0.7087 | 3.1889 | 3 | 1 |
| | R | 0.4 | 0.8 | 0 | 0 |
| | R2 | 0 | 0 | 1 | 0 |
| | R3 | 0 | 0 | 0 | 1 |

The development process is initiated by some disturbance to this state of affairs.[4] There are two possible sources of such disturbance: an increase in population following a breakdown of the cultural system for controlling human numbers, or a decrease in the sustainable resource yield. Wilkinson himself emphasises the former source of disturbance to ecological equilibria, and discusses the cultural practices for population regulation at some length. He does, however, note that it appears to be fairly widely agreed that the emergence of agriculture, the point of departure for the historical experience of economic development, followed climatic change which adversely affected the yields available from hunting.[5] For present purposes, it is the fact of rupture to ecological equilibrium which matters, rather than the origin of such rupture. Assume, then, that the population size increases to 110. The technology of I in Table 1 cannot provide a society of this size with subsistance on a sustainable basis, since its requirement for R1 is greater than maximum sustainable yield. The society must adapt or perish. Adaptation takes the form of enlargement of the ecological niche by technological change which makes it posible to expoit new resources. By expoiting the non-renewable resource R2 and producing the commodity "fuel", as shown in II of Table 1, the input requirements of R1 per unit of food and clothing output are reduced. With subsistence for 110 individuals requiring deliveries to final demand of 60.5 units of food and 33 units of clothing, primary input requirements are 91.6 units of R1, 25.4 units of R2 and 322.9 units of labour.

Now, while this adaptation clearly involves innovation, it is not necessary to assume that it involves invention or the acquisition of new knowledge. Using this R2 exploiting technology to satisfy the subsistence requirements of 100 individuals would require 293.5 units of labour input, i.e. 2.935 units per capita compared with 2.6 units per capita under the technology which did not involve R2 exploitation. Given the knowledge of the means to and consequence of R2 exploitation, a society of size 100 would not rationally have exploited R2, given the objective of minimizing the labour costs of providing subsistence. The available evidence on pre-agricultural societies is consistent with the hypothesis that they do have cultural systems for regulating their numbers, and do adopt technologies which minimise the costs of subsistence: see Wilkinson (31) and references cited there, and, for example, Sahlins (26). For any society concerned only to meet some fixed amounts of deliveries to consumption, it would presumably be irrational to do so in other than the least cost manner, given the operative constraints. The question of the fixity of the per capita required consumption levels is one I return to below.

With the population size at 110 individuals, the least cost, sustainable, method of providing subsistence requires the input of 2.935 units of labour per capita, compared with 2.6 in the original situation. The society is worse off than if formerly was. This deterioration will prompt an interest in labour-saving technological innovation. To the extent that this occurs, and population size remains constant and there are no adverse environmental changes, economic welfare improves. If, for example, labour saving innovations can be found, which involve the use of no additional quantities of commodities or primary inputs, such that the labour input coefficients become 0.7087 for food, 3.1889 for clothing, and 0.89 for fuel, then per capita labour input requirements are restored to 2.6 units. The deterioration in economic welfare accompanying the adaptation to the rupture of the initial ecological equilibrium is, that is, conceivably reversible if the adaptation results in the achievements of a new, sustainable, ecological equilibrum. In such a situation the society can give its attention to the realisation of labour saving technological change.

However, even in the absence of environmental disturbance exogenous to the socioeconomic system's operation, the new situation will not be a sustainable ecological equilibrium. This statement does not require the assumption that population growth resumes after the initial adaptation, though clearly such would necessitate further adaptation. Rather, the point is that, even for constant human numbers, the initial adaptive response creates a situation in which further adaptation to environmental change, arising from economic activity, will be required. The new technology gives rise to the need for further adaptation in response to resource depletion and environmental pollution. In the context of the particular illustrative example now under consideration the emergence of pollution following adaptation is not compellingly obvious. But generally it should be apparent, via the materials balance principle, that a higher level of environmental exploitation in an extractive sense means a higher level in an assimilative sense also. Residuals discharge in excess of assimilative capacity impairs ecosystem function! In the illustrative context here, the operative case would be the use of fuel in the production of food and clothing giving rise to pollution which reduces the maximum sustainable yield from R1 below the required level for technology II to deliver subsistence to 110 individuals, creating the requirement for further technological adaptation. Such would most obviously take a form similar to that involved in the transition from I to II in Table 1, i.e. involve the exploitation of new resources. It could, alternative or additionally, take the form of modifying the processes by which food and clothing are produced, using fuel in such a way as to reduce the quantities of residuals discharged per unit of output. In either case, the new adaptation will involve some reversal of the improvement in economic welfare associated with the labour saving technological change initiated after the initial adaptation and will imply the need for further adaptation.

The resource depletion part of the story has more obvious appeal in the illustrative context here. It is not necessary to assume that the society actually runs out of the non-renewable resource R2. It is only necessary to assume that R2 is exploited down a decreasing quality gradient, so that the labour input requirements per unit of fuel output rise as depletion proceeds. If, for example, the technology II in Table 1 is modified so that the labour input coefficients are 0.7087, 3.1889 and 3, the use of this technology to meet the subsistence needs of 110 individuals requires a labour input of 3.09 units per capita. Assume that 3.00 units per capita is the upper limit on tolerable labour requirements for this society, and that the possibilities for labour saving innovation within the existing mode of production have been fully exploited, so that the problem can only be solved by a change in the mode of production. In the technology

III in Table 1, two types of fuel are produced from two non-renewable resources R2 and R3. Fuel 2 can be used in clothing production on the same terms as fuel 1, but requires only 1 unit of labour input per unit of output. Switching from the technology II to the technology III to deliver 0.55 units of food and 0.3 units of clothing to each of 110 individuals reduces the per capita labour input required from 3.09 to 2.86 units, and "solves" the society's problem with respect to the labour constraint.

Again, this situation cannot be a new, sustainable ecological equilibrium on account of environmental pollution and resource depletion. This, then, is what economic development essentially is - a process of shifting through a succession of ecological niches, the shifts being necessitated by the fact that the means by which a new niche is created are such that eventually it will no longer serve. Of course, some niches may serve for longer than others. Also, it must be noted, a niche may be destroyed by means other than those inherent in a society's own development process - the intrusion of another society, for example, or an exogenous environmental shift. The course of economic welfare during the development process is not, even as a trend, monotonic. With the requirement of meeting fixed per capita subsistence needs, economic welfare is measured unequivocally by per capita labour inputs.[6] Niche shifts primarily involve welfare reduction as the price of social survival: with the mode of production stable during the occupancy of a given niche, the dominant movement is welfare improving as innovation is directed in labour saving directions. Clearly, some niches will be more favourable contexts for labour saving innovation than others, and different niche shifts will have different implications for labour input requirements. Consequently, this interpretation of the development process implies no particular view on the historical record in respect of economic welfare. It does, however, imply the existence of two closely related monotonic trends, i.e. of two hypotheses about the historical experience of development. First, over time, the level of environmental exploitation increases, in both the extractive and assimilative senses. Second, the means by which final demand requirements are met became more indirect, the production structure becomes more roundabout. Both of these trends are illustrated in Table 1 in the progression I, II, III.

### *Agricultural Development*

Turning from illustrative expository examples to actual experience, I consider first agricultural development in relation to these two hypotheses. Norgaard (24) considers agricultural development from what he terms a "coevolutionary perspective", which he sees as providing "a linkage between ecological and economic perspectives".[7] From this perspective: '...agricultural development can be viewed as a coevolutionary process between a sociosystem and an ecosystem that, fortuitously or by design, benefits man. Indeed, if the gains from agricultural development are real, not simply this generation living at the expense of the next or one region or group living at the expense of others, it is difficult to imagine how the gains from development could arise other than by a process of positive feedbacks between the sociosystem and ecosystem, whereby these systems coevolve in a manner favourable to man. In this view, sociosystem options compatible with coevolutionary development are constrained by characteristics of the ecosystem: but development is not simply ecologically determined.'

Norgaard does not claim that all coevolutionary feedback is beneficial to man, and uses the term "coevolutionary development" to refer to coevolution that benefits man. He notes that with coevolutionary development "maintenance feedback systems frequently shift from the ecosystem to the sociosystem", which means more roundabout production! In the same connection, Norgaard argues that the "idea that the sociosystem frequently assumes the complementary activities and regulatory functions that were either previously endogenous to the ecosystem or maintained by the individual farmer cannot be overstressed". Regarding the level of environmental exploitation, Norgaard recognises that this increases with much of what is conventionally known as agricultural development, and that '... many scientists are persuaded that man is currently exploiting the accumulated low entropy of his environment, through both extraction and pollution, to the detriment of future generations far faster than he is coevolving with nature to the benefit of future generation. Georgescu-Roegen may be quite correct, most of the technologies we associate with development may simply allow us to utilize low entropy stocks faster.'[8]

Of course, this does not necessarily mean that further coevolutionary development, in the sense defined by Norgaard will not occur. However, it is Norgaard's view that since "not only the research but the social organisation of the developed and developing world are being structured around the exploitation of low-entropy stocks and the correction of related social and environmental problems", a "coevolutionary path of progress will not easily be found or followed".

Clearly the level of environmental exploitation cannot be expressed in a single number, since many different resources are extracted and many different residuals returned to the environment. A system of aggregation weights derived from the economic system will not serve to provide a single environmental exploitation index over the course of development if development is essentially about a changing economic system. There is, apparently, no completely satisfactory solution to this problem. The economic system's energy use can be used as a reasonable proxy for its level of environmental exploitation. A full argument in support of this contention is impossible here, and I will simply note that environmental exploitation involves moving and transforming things, for which purpose energy use is necessary. I will also take it that for the purpose at hand, aggregation across energy sources on a purely energetic basis is a satisfactory procedure.[9] If, then, there is anything in the interpretation of the historical experience of development set out above, it should show up in the history of the way agricultural systems use energy. This history is far from well documented. However, over recent years quite a lot of work has been done on the study of extant agricultural systems, in energetic and other respects.

Table 2 here is taken from Leach (16) who brought together the results of much of this work. The figures in Table 2 are the results of measuring all of the inputs, direct and indirect (other than solar radiation, rainfall, etc.) in terms of energy equivalents. Notwithstanding the possibilities for disagreement with some of the conventions adopted in the accounting and the complications of local environmental conditions, etc., the general picture which emerges is really very clear in relation to the hypothesis that, at least in agriculture, development has been about increasing environmental exploitation.[10] In purely energetic terms, this has gone with increasing labour and land productivity. It is of some interest to note, however, that energetic efficiency, as measured by the output/input ratio in Table 2, does not apparently increase monotonically with development. Figure 1 reproduced from Leach (16), shows that I have not in these respects used an unrepresentative sample from the full set of energy budgets that he reports.[11]

I stated above that the second hypothesis about development generated by the interpretation being offered here is that it is a process involving the increasing roundaboutness of the production structure, so that as it occurs the means by which final demands are met become more indirect. This is apparent in the agricultural context, in that whereas in societies where agriculture is either not in being or in the pre-industrial stage its output is typically a direct input to consumption, in societies where agriculture

**Table 2. Agricultural Energy Budgets**

| | *1* | *2* | *3* | *4* |
|---|---|---|---|---|
| Labour | 0.37 | 5650 | 460 | 20 |
| Animals | | 960 | 2180 | |
| Machinery | | 230[a] | 1010 | 18590 |
| Fertiliser | | | 450 | 11660 |
| Pesticides | | | 60 | 1090 |
| Drying | | | | 4480 |
| Irrigation | | | | 29620 |
| Total Inputs | 0.37 | 6840 | 4160 | 65460 |
| Output | 2.90 | 281100 | 22900 | 84120 |
| Output/Input | 7.8 | 41.1 | 5.5 | 1.3 |
| Output/Labour Input | 7.8 | 49.7 | 49.8 | 4206 |

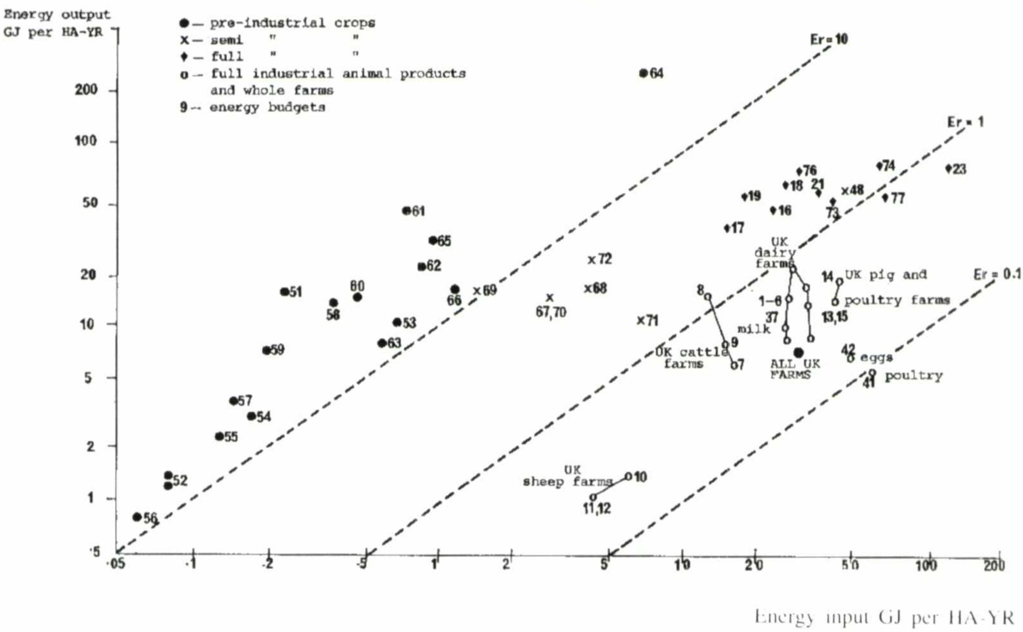
Units are MJ per Hectare per annum (1 MJ 0.28 kwh)

1 Pre-agricultural, !Kung Bushmen, Kalahari, Africa
2 Pre-industrial agriculture, Chinese peasant farming
3 Semi-industrial agriculture, rice growing, Philippines
4 Industrial agriculture, rice growing, USA

a Land tools and ploughs

Source: G Leach (16), Budgets 49, 64, 72, 74.

**Figure 1. Energy inputs and outputs per unit of land area in food production (World)**




Source: *Energy and Food Production,* by Gerald Leach, IIED, 1975.

is industrialised (and highly productive on conventional accounting conventions) its output is rarely a direct input to consumption. As Leach (16) notes, the data reproduced here in Table 2 and Figure 1 concerns the production of food within the agricultural system: in present-day UK terms, the inputs recorded are those arising up "to the point where food reaches the farm gate".

**Table 3. Energy Inputs to UK Bread Production**

| | *MJ* | % |
|---|---|---|
| Tractors, etc. | 1.47 | 7.3 |
| Fertilisers | 2.34 | 11.6 |
| Other | 0.08 | 0.4 |
| Total, Farming | 3.89 | 19.3 |
| Direct Fuel Use | 1.49 | 7.4 |
| Packaging | 0.44 | 2.2 |
| Transport | 0.28 | 1.4 |
| Other | 0.40 | 2.0 |
| Total Milling | 2.61 | 13.0 |
| Direct Fuel Use | 4.76 | 23.6 |
| Packaging | 1.67 | 8.3 |
| Other | 2.90 | 14.4 |
| Total Baking | 9.33 | 46.3 |
| Heating and Lighting | 1.73 | 8.6 |
| Transport | 2.46 | 12.2 |
| Total Retail Distribution | 4.19 | 20.8 |

Source: Chapman (7), Figure 8.

Commenting on this convention, Leach says: 'This allows agriculture to be separately analysed and provides information that may be useful for developing countries, where large populations still live close to the land. For the industrial world one must look further. Urbanisation, industrialisation and other changes, largely spurred by changes in agriculture itself, have vastly increased the scale of the food chain from the farm to the mouth in every sense, including energy usage. In those societies (and increasingly in the developing world) much more energy is now used to transport, package, sell, cook, store and process (or merely titivate) foodstuffs than are used to grow it."

Leaving aside Leach's specifically energetic approach, the point, once made, is in general terms an obvious one, and is part of many peope's direct experience. Table 3 here gives a breakdown of the energy inputs to the production of the commodity that is a UK standard white loaf on the shelf in a shop.[12]

### *Economic Structure and Development*

The hypothesis that one essential feature of the development process in the increasing roundaboutness of production concerns the production of all commodities, not just food commodities and agricultural output. Any attempt to test the general hypothesis faces two problems: the measurement of the roundaboutness of production, and the lack of historical data on the input-output structure of economies as they develop. While it is not apparent that either of these problems can be fully overcome, I think it is possible to make some progress by adopting as a measure of the roundaboutness of production the ratio of the value of total gross output to the value of deliveries to final demand.[13] If this measure is adopted, some relevant data can be found. In (29), Table 4 gives figures, by industry, for gross output, intermediate consumption, and value added, in current and constant prices. Not all countries provide such data. Those that do are listed in the lower half of Table 4 here. For these countries the information available varies from figures for just one year to a complete run of annual figures from 1970 to 1980. In Figure 2 I have plotted the average for each country of the available ratios of total gross output value to total value added against the corresponding per capita national income in 1976.[14] I take per capita national income as the measure of progress along the process of development. The regressions 1 and 2 reported in Table 4 use the data of Figure 2. They do not lead to the rejection of the hypothesis that the roundaboutness of production increases with development. In Figure 3 the horizontal axis measures energy consumption per capita in the mid 1970s (source of data (11)). Recall that the hypothesis that environmental exploitation increases with development has been advanced, and energy use suggested as a proxy for the level of environmental exploitation. The regressions 3 and 4 in Table 4, using the Figure 3 data, indicate that the level of roundaboutness of production is positively associated with the level of environmental exploitation. Also, it is clear that energy consumption and income are highly correlated.

**Table 4**

1 RATIO = 1.5837 + 0.0001 INC $\bar{R}^2$ = 0.4492 D.W. = 1.59 26 observations
(22.37) (4.62)
2 RATIO = 1.5913 + 0.0001 INC $\bar{R}^2$ = 0.6679 D.W. = 1.67 24 observations
(29.06) (6.88)
3 RATIO = 1.5550 + 0.0001 EN $\bar{R}^2$ = 0.6793 D.W. = 1.66 24 observations
(26.90) (6.83)
4 RATIO = 1.5896 + 0.0001 EN $\bar{R}^2$ = 0.7310 D.W. = 1.99 22 observations
(30.25) (7.62)

RATIO = ratio of gross output to value added (from (29))
INC - 1976 per capita national income, US \$ (from (10)
EN - 1975 per capita energy consumption, kg of coal equivalent (from (10))

With respect to these results, numerous caveats are, of course, in order. Perhaps the major mismatch between the story told earlier here, in terms of Table 1, and the data behind the regression results concerns the final demand vector. Whereas that was, in per capita terms, unchanging in the illustrative examples, it definitely does change in the actual historical experience of development. In the latter case, it changes in scale and composition. Indeed, it is only because it changes in scale that it is possible, as immediately above, to use per capita national income as an index of development. Changes in the scale and composition of the final demand vector, even on a per capita basis, are not necessarily inconsistent with the productive system always delivering subsistence requirements. There are two aspects to this. First, an unchanging subsistence requirement may be met in different ways. Second, as the productive system changes so subsistence requirements may change. These are not mutually exclusive tendencies.

### *Consumption and Development*

The distinction here can be clarified in the context of the numerical example used above. Consider the economy at the stage of development given by the technology II in Table 1. Recall that with per capita subsistence requirements of 0.55 units of good and 0.3 units of clothing, and 110 individuals, labour input requirements were 2.935 units per capita. Suppose that in meeting subsistence requirements fuel can be substituted for clothing, such that per capita either (0.55 0.3 0) or (0.55 0.2 0.1) represents subsistence. With fuel consumed directly the subsistence final demand vector for 110 individuals is (60.5 22.0 11.0), and with the technology II the per capita labour requirement to deliver this is 2.55 units. Substituting fuel for clothing in consumption will, in this case, reduce the costs of subsistence. Presumably where such cost reducing substitutions are available they will be adopted, and the continued delivery

**Figure 2**

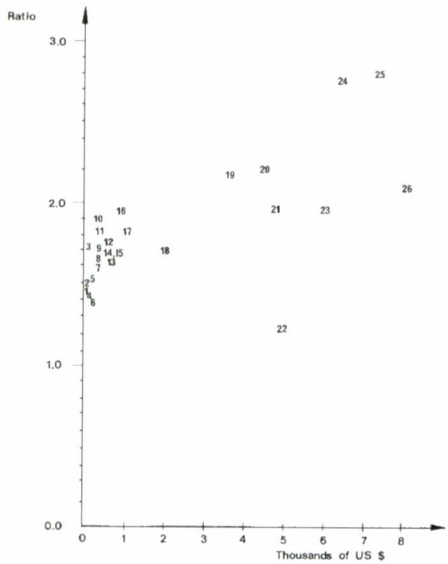
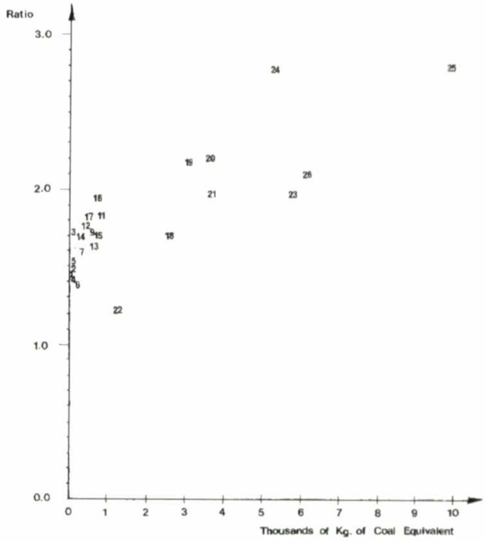



**Figure 3**




**Country Coding for**

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 1 | Upper Volta | 7 | Bolivia | 14 | Jordan | 20 | Japan |
| 2 | Rwanda | 8 | Swaziland | 15 | Algeria | 21 | Austria |
| 3 | Burma | 9 | Zambia | 16 | Chile | 22 | Libya |
| 4 | Benin | 10 | Botswana | 17 | Fiji | 23 | Netherlands |
| 5 | Haiti | 11 | Zimbabwe | 18 | Venezuela | 24 | W Germany |
| 6 | Ghana | 12 | Ecuador | 19 | New Zealand | 25 | Canada |
| | | 13 | Peru | | | 26 | Sweden |

Note: Countries 18 and 22 are not used in regression 2; countries 8 and 10 are not used in regression 3 (EN data n.a.); countries 8, 10, 18 and 22 are not used in regression 4.

of an unchanging subsistence will be consistent with a changing pattern of deliveries to final demand. It should be noted that in this illustrative example, the substitution in consumption will speed up the depletion of the non-renewable resource. Also, it can be noted that the substitution reduces per capita national income, while it improves welfare in the sense that subsistence requirements are met at lower labour input cost.[15]

It is difficult to believe that subsistence requirements, broadly and properly interpreted, do not change with changes in the system of production. Indeed, such changes are part of the everyday experience of those who are in economies where the productive system is changing, and are for the UK, for example, well documented and widely commented on. Given, for example, changes in the methods of food production and distribution over 1950 to 1980 in the UK, use of a refrigerator is a subsistence requirement in 1980 but not in 1950. It seems plausible that by the end of the century a home computer, or computer terminal, will be a subsistence requirement. Clearly, the representative individual's subsistence requirements depend upon the technology and culture of the society he belongs to (the culture itself being strongly influenced by the technology), and it seems plausible that subsistence requirements increase as development proceeds and production becomes more roundabout.[16] The possible implications of this can be seen by assuming that the use of the technology II means that individuals need to consume 0.3 units of fuel for subsistence, over and above the 0.1 units consumed to reduce clothing consumption. Then the final demand vector for 110 individuals' subsistence is (60.5 22 44) and labour input requirements are 3.05 units per capita. Recall that for the original subsistence final demand vector (60.5 33) the labour input requirements were 2.94 units per capita. The point is that while the economy is still delivering subsistence, a combination of a change in the way subsistence requirements are met and an increase in subsistence requirements has resulted in an increase in the cost of meeting subsistence, a welfare loss, and an increase in per capita national income. This is, of course, in numerical terms purely illustrative. I am not arguing that, in fact, it is the case that as development proceeds so changing subsistence requirements plus changing ways of meeting those requirements must always work to increase labour input requirements. Clearly, in some circumstances things might work out otherwise. Also, I have discussed the possibilities for labour saving technological change in the course of development.

The point that I am making is that the observation that development is, in fact, accompained by a changing final demand vector is not itself inconsistent with the proposition that at all times the productive system, which is becoming more roundabout and more expoitative of the environment, is delivering subsistence requirements. Also, this is not inconsistent with an increasing per capita national income. If it is accepted that it is subsistence that is always delivered, then the history of economic welfare is the history of per capita labour input requirements. In the light of the earlier discussion of development and the production system, and of this discussion of changing subsistence requirements, it is not to be expected that history would show a monotonic downward trend in labour requirements, i.e. un upward trend in economic welfare. One would expect different trends as particular circumstances differ.

This is not the conventional view, which regards the basic situation to be one in which economic development and progress are synonymous. I use the word "progress" rather than "improving economic welfare" (or some variant thereof) here deliberately, in order to make a distinction between two types of expectable reaction to the interpretation of development offered here, which I can label the "non-economic" and the "economic". It is possible to reconcile the idea that all the economy ever does is to deliver subsistence with the idea of economic development as progress by taking the view that some subsistence patterns are preferable to others, on non-economic grounds, and that in development preferable succeed less preferable patterns. The criteria of preference here could be philosophical, religious, or aesthetic.[17] A single example will have to serve to indicate what I think is involved here, that of education and knowledge. It might be conceded that as development proceeds, so it is the increasing complexity of the productive system required to deliver subsistance that necessitates that individuals have more education and that nature is more fully understood. Higher levels of education and knowledge are, that is, new subsistence and production needs and do not imply higher levels of economic welfare. However, it might be argued that more education and knowledge mean greater self-awareness for individuals, and that increasing self-awareness represents progress on philosophical grounds.

Economists would not, on the whole, be happy with this line of argument. They would argue that, given proper measurement (a major caveat in practice), economic welfare increases with development that results in increasing per capita national income or expenditure. Essentially, the argument here is that some representative individual would himself prefer his situation as it existed with higher per capita national income to his situation as it existed with lower per capita national income.[18] The problem with this argument is that it requires that the representative individual is taken to have a preference system which is independent of the situation to be evaluated. This is not, I suggest, an appealing assumption in the context of a view of development which takes it that its essential characteristic is that it is a process of adaptation to changing environmental conditions. With respect to the relevant arguments, individual preference systems cannot reasonably be regarded as genetically determined, but must rather be seen as being, at least partially, learned. If development involves changing the context in which individuals learn their preferences, it will presumably result in changing preferences. The point at issue here can be illustrated with an extreme example. In comparing the situations of an Australian aboriginal prior to European incursion and a present-day inhabitant of the Sydney suburbs, whose (revealed) preferences should be used?

### *Concluding Remarks*

The interpretation of economic development suggested above can, I suggest, integrate many of the criticisms of the growth objective raised in recent years.[19] The limits to growth argument of, for example, Meadows et al. (20) is essentially the argument the world economy's accupancy of its current niche will be temporary, and that the transition to a new one will be painful. With respect to this issue, I suspect that recent work by theoretical and applied ecologists on the relationship between the complexity of an ecosystem and its response to shocks might be fruitfully used to examine the prospect of "doom" at this particular niche transition.[20] The advocacy of the "steady state economy" by, principally, Daly (8) is essentially an argument for the deliberate selection of a new niche of a particular kind, which, it is thought, would offer the prospect of more prolonged occupancy. Another type of anti-growth argument concerns the costs associated with it, rather than its feasibility.[21] The environmental costs of growth - pollution and resource depletion - are signals that niche occupancy is transitory. The social costs of growth are manifestations of the increasing indirectness of consumption and of the increasing complexity and roundaboutness of the productive system.

One of the few attempts to study how those affected feel about economic growth is the work of Easterlin (10).[22] He summarises his results as follows: 'The concern of this paper has been with the association of income and happiness. The basic data consist of statements by individuals on their subjective happiness, as reported in thirty surveys from 1946 through 1970, covering nineteen countries, including eleven in Asia, Africa and Latin America. Within countries there is a noticeable positive association between income and happiness - in every single survey, those in the highest status group were happier, on the average, than those in the lowest status group. However, whether any such positive association exists among countries at a given time is uncertain. Certainly, the happiness differences between rich and poor countries that one might expect on the basis of the within-country differences by economic status are not borne out by the international data. Similarly, in the one national time series studied, that for the United States since 1946, higher income was not systematically accompanied by greater happiness.'

Easterlin's proposed explanation for his results is that preferences are inter-dependent, as in the relative income hypothesis of Duesenberry. An alternative, but related, explanation could be developed in terms of the rôle of positional goods, as in Hirsch (15). Easterlin's results are also consistent with the interpretation of economic growth and development offered in this paper. While inter-dependent preferences and positional goods no doubt play some rôle, their significance need not be very great. The reason why development does not deliver what economists (in the main) expect of it is simply that it is essentially about adaptation.

There are many reasons why economists have overlooked this perspective on economic development. Among these must be reckoned an historical and cultural myopia, shared with most inhabitants of the "advanced" or "developed" countries. Some brief remarks on Australia may sharpen this point. There, the currently dominant industrial culture is preparing to celebrate its bi-centennial. Most members of that culture regard its current economic performance as, at best, unsatisfactory: in 1986 the Australian Prime Minister expressed the view that the economic situation was the gravest crisis that the country had faced since World War II. The hunter-gatherer socio-economic system displaced 200 years ago in Australia had a history of at least 40,000, and possibly upwards of 50,000, years. I take these figures from Blainey's history of the Australian aboriginals (2), in which the author remarks in his preface: "I used to begin a course on Australian economic history in the accepted manner with the European explorations of the eighteenth century until one day the archaeologist, John Mulvaney, in conversation enquired what I said about the earlier 99 per cent of time embraced by the human history of Australia."

In a chapter entitled "The Prosperous Nomads", Blainey notes (p.223) that "Australia has perhaps fifty times as many people now as in the last phase of the nomadic era, and produces perhaps 100 times as much food as the aboriginals produced in a normal year". Of course there was then no exportation of foodstuffs from Australia, and according to Blainey (p.223): "It is probable that on the eve of the European invasion, food was normally abundant in every Australian region except the central deserts". Nor does it appear to be the case that the Aboriginals found it, in normal circumstances, necessary to work hard to provide themselves with their sustenance. Sahlins (26) reports data which suggest that they actually worked a lot less than Australians do now: the title of the relevant chapter in this book is "The Original Affluent Society". There is now available evidence for hunter-gatherer societies from many parts of the world that requires us, at the least, to question the implicit conventional appraisal of their economic performance. Many such societies appear to have enjoyed economic contentment over very long periods of time. The view that "To date, the hunting way of life has been the most successful and persistent adaptation man has ever achieved..." is not an obviously unreasonable one.[23] It does, however, raise a question: why did such a successful adaptation have to give way to agriculture, and that in turn (in a relatively short time) to industrialisation?

## Notes

(1) Reviews of "Poverty and Progress" by economists were relatively few, as are references in the economics literature. It is noted in Mishan (21) and discussed in Boulding (5) and Flammang (12).
(2) I make this explicit in order to avoid the sort of misunderstanding apparent in, for example, Desai's review (9) of "Poverty and Progress". Desai accuses Wilkinson of offering a "unicausal explanatation of a complex process", and of setting out a "deterministic thesis" according to which "any disturbance in equilibrium *necessitates* economic development" (italics in the original). In fact, in his preface Wilkinson states that he is concerned with "three distinct sources of change: the breakdown of ecological equilibrium, the demands of technical consistency and the development of new forms of need as the real costs of living are changed" and remarks that "None of them will on its own explain all change". Also, in chapter 10, "Explanations of Undervelopment", Wilkinson discusses the question of why some societies out of ecological equilibrium do not experience economic development. See also Boulding (4).
(3) The primary input requirements are given by $L = 1x$ and $R1 = r_1 x$ where $x = (I-A)^{-1}f$, 1 is the labour input coefficient vector, $r_1$ is the R1 input coefficient vector, x the gross output vector, f the final demand vector, and A is the matrix of inter-industry coefficients.
(4) More properly, some disturbance to ecological equilibrium is necessary, but not sufficient, for the initiation of the development process.
(5) See also Smith (27) for example.
(6) In saying this, I am assuming that longevity, health, etc., are maintained constant by the unchanging subsistence. As already noted I deal with changing deliveries to final demand, and changing subsistence needs (possibly to maintain longevity and health), later. Note also that I am, implicitly, assuming away problems associated with social inequalities, whatever the basis for such.
(7) See also Norgaard (23). In both of these papers Norgaard notes the relevance of Wilkinson's work, and also that of Boserup (3), for the coevolutionary perspective.
(8) The reference is to Georgescu-Roegen (13).
(9) Ecologists find energy accounting one useful way of analysing ecosystems: see, for example, Phillipson (25) by way of introduction. For a discussion of the laws of energy use, thermodynamics, in relation to economic activity, see Georgescu-Roegen (13) and (14).
(10) It is of interest to quote some of Leach's notes accompanying the data for the !Kung Bushmen. Apparently these "hunter-gatherers secure a good diet (93 g protein and 8.27 MJ per day on average) but require 1040 ha land (10.4 $km^2$) per person. Time required for good gathering is not excessive. Lee found that 156 man days were needed for 668 population days of consumption: in other words, while 65% of the population spent 2.5 days per 7 day week gathering food, the remaining 35% did no work at all".
(11) It should be noted that in some of the budgets for full-industrial agriculture covered by Figure 1, human labour input is ignored, being negligible in energetic terms.
(12) It can also be noted that some recent trends in retailing in advanced societies are tending to shift costs from what appears in the accounts as production to what appears in the accounts as consumption. An example is the growth of supermarkets and central shopping malls at the expense of small local stores.
(13) With $x = (I-A)^{-1}f$ and $p = (I-A)^{-1'}1'$, where p is the price vector, the value of total gross output is $x'p = f'(I-A)^{-1'}1'$ and the value of deliveries to final demand is $f'p = f'(I-A)^{-1'}1'$. Clearly, for given A, multiplying either f of 1 by a scalar will change both f'p and x'p by the same scalar, so that the ratio of x'p to f'p will be unchanged.

For given A, that is, changing the scale of the economy or changing labour productivity in the same proportion across all industries, will not affect the ratio of gross output value to final demand value. It is not clear that anything can be said analytically about the effect on this ratio of non-scalar changes to the vectors f and l for given A, or of changes in the structure and/or dimensionality of A. However, I find it intuitive that the ratio should increase as A increases in dimension. For the technologies of Table 1, the ratio of gross output value to final demand delivery value gives 1.5385 for I, 1.9344 under II, 2.0317 under III for scalar changes to the initial f vector. I also find it intuitive that the ratio should increase for A of constant dimension but changing so as to have fewer zero elements. In this connection the work of Carter (6) on structural change in the USA economy is of interest. Carter finds that the total intermediate output requirements for delivering the 1961 final demand vector are, in millions of 1947 dollars, \$324,288 using the 1939 technology, \$336,296 using the 1949 technology, \$336,941 using the 1958 technology, and \$334,160 using the 1961 technology. Carter comments, in chapter 4, on these figures as follows. "Note that the dollar volume of intermediate inputs (in constant prices) is quite stable, growing slightly over time - the total volume of inputs required to produce the same final product tends, if anything, to be a little greater with newer, than with older, techniques of production over this time interval. At first glance, this may appear paradoxical. If technological change is to be considered technological progress, how can more inputs have been required to produce the same deliveries to final demand at a later date? Actually, an increased volume of intermediate inputs means an increase in specialisation... If, as Adam Smith suggests, division of labour depends on the extent of the market, then this tendency is to be expected as the total volume of production expands. Perhaps one should ask why apparent division of labour has not increased more." A partial answer to this question is given in chapter 11: "In part, intermediate structure remains relatively stable because production is organised so that many rapidly changing 'intermediate inputs' are not reported as transactions at all. Adaptive change appears small because establishments combine those activities that are most sensitively attuned to each other. When two activities are combined in a single establishment, the statistical reporting system gives no evidence of their interdependence".

It should also be noted here that, in terms of an economy's historical experience of development, 22 years (1939 to 1961) is a small timespan!

(14) In some cases there are 10 observed ratios to average, in some cases there is just one observed ratio. Where several observations existed I regressed the ratio on time with very mixed results - in some cases the time coefficient was positive and significant, in others negative and significant, in others non-significant. Bearing in mind that at most the time period here is 10 years, the purpose at issue, and the results obtained by Carter (6) (see previous footnote), I considered it most appropriate to use the simple averages. The data on per capita incomes come from (11).

(15) Since $L = lx = l(I-A)^{-1}f$ is the total labour input requirement, and the value of deliveries to final demand is $f'p = f'(I-A)^{-1}l'$.

(16) Two points can usefully be made here. First, I explicitly consider only private consumption in final demand in the text. But, deliveries to final demand are also, on conventional accounting conventions, to meet the needs of public consumption and the capital stock. These needs algo would be expected, on a per capita basis, to increase as production becomes more roundabout. Also, I am implicitly assuming that subsistence is defined to encompass certain standards with respect to longevity and health. To the extent that pollution problems increase with development, i.e. that production processes are adopted which involve residuals discharges in excess of the relevant assimilative capacities, then so will subsistence needs change - the consumption of medical services will increase. Second, the idea that, culturally defined, subsistence requirements for private consumption increase with economic growth is, essentially, the motivation for the approach to the definition of poverty in advanced economies taken by, for example, Townsend (28). This approach yields, among other things, the policy recommendation that levels of welfare payments should be increased in line with average earnings rather than inflation. Clearly, if subsistence requirements increase with growth, it is not difficult to understand why the record on poverty amelioration has been so disappointing in most advanced economies in the post World War II period. It is not necessary to invoke, as Hirsch (15) does, the concept of positional goods to explain why that he terms "the distributional compulsion" has not diminished in such economies as per capita consumption has spectacularly increased.

(17) It is, of course, possible that on some philosophical, religious or aesthetic criteria earlier stages of development would be preferable to later stages. However, those adopting such criteria appear generally to be regarded as "odd".

(18) In this context it is of some interest to note some remarks made by W A Lewis in an Appendix entitled "Is Economic Growth Desirable?" to his major work on economic development, (18). These remarks are quoted in Arndt (11) and described there as being "still one of the best statements of the case" for economic growth. According to Lewis "the advantage of economic growth is not that wealth increases happiness, but that it increases the range of human choice... We certainly cannot say that an increase in wealth makes people happier. We cannot say, either, that an increase in wealth makes people less happy, and even if we could say this, it would not be a decisive argument against economic growth, since happiness is not the only good thing in life. We do not know what the purpose of life is, but if it were happiness, then evolution might just as well have stopped a long time ago, since there is no reason to believe that men are happier than pigs or fishes. What distinguishes men from pigs is that men have greater control over their environment: not that they are more happy. And on this test, economic growth is greatly to be desired. The case for economic growth is that it gives man greater control over his environment, and thereby increases his freedom". This is, in my view, a non-economic argument for development as progress. What Lewis calls greater control over the environment, I interpret as an increasing level of environmental exploitation. I do not see any meaningful connection, necessarily, between such and greater freedom.

(19) For a review see Arndt (1).

(20) See especially May (10) and also Westerman (30) for further references.
(21) For a recent contribution to this literature see Zolotas (32), where an attempt is made to construct an "Economic Aspects of Welfare" index for the USA. This exercise is in the spirit of Nordhaus and Tobin (22) but allows for more sources of adjustment to the initial national accounting measure, which is for Zolotas private consumption expenditures.
(22) For further references to work of this type see Zolotas (32) chapter 4.
(23) The quotation if from two anthropologists, Lee and De Vore (17).

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