

LECTURE 7

Utility, Time Preference and Myopia

The word *weltanschauung* denotes a philosophy or a view of life. It is from German and it is formed from *welt*—the world—and *anschauung*—a view or an outlook. Examples of all-embracing philosophies which deserve to be described as *weltanschauungen* are those of Hegel and Marx.

Such universal philosophies have often been derided by Anglo-Saxon thinkers to whom the pursuit of a world view is a vainglorious business, typically characterised in equal measure by pomposity and absurdity. A philosophical tradition which eschews metaphysics and is deeply rooted in empiricism, as is the English tradition, finds it easy to accept that there is often a need for more than one construction of reality. To see the world from only one point of view is to run the risk of major oversights.

It is interesting to compare the ideas of two great European philosophers who were near contemporaries: the German Hegel (1770–1831) and the Englishman Adam Smith (1723–1790). Hegel strove to analyse the universal factors which are at work in human history. He entertained a metaphysical notion—and it might be called a mystical notion—of the spirit of the age; and he aimed to describe the processes which attend the birth and death of nations, and the survival and propagation of cultures. Such preoccupations must have come naturally to a philosopher who belonged to a culture which, in his own times, was endeavouring to assemble itself as a nation.

Adam Smith seems, at first sight, to have been concerned with matters of a more mundane sort than those which preoccupied Hegel. His concern was to identify and to analyse the conditions which were most conducive to the prosperity of a well-established nation state endowed with a growing commercial bourgeoisie. His purpose was to demonstrate that prosperity could best be achieved by removing the restraints to trade, such as excise duties, taxes and state monopolies, which an overpowerful government in pursuit of territorial aggrandizement was liable to impose.

In its own way, the philosophy of Adam Smith was as much endowed with metaphysics as was that of Hegel. In Smith's philosophy, the hidden hand of economic regulation replaced Hegel's spirit of the nation. There was a mystical perfection in its manipulations; but the hand lacked strength. Its operations could be hindered

all too easily by those who had no respect for the spirit of free enterprise.

The philosophy of Adam Smith appeals greatly to practical men who are not used to wasting their time on idle speculations. Its appeal has remained undiminished to the present day. Part of its strength lies in the fact that its mysticism is well-concealed. The mundane matters of trade and commerce are treated to an analysis which appears to be based in practical common sense. The concept of value, which is clothed in the garment of money, assumes the appearance of a tangible reality. It should be recognised, nevertheless, that the philosophy of Adam Smith is no less of a metaphysical *weltanschauung* than is the philosophy of Hegel.

Costs and Benefits

The modern version of Smith's *weltanschauung* is a belief that social realities, and much else besides, can be indexed by a unitary measure of value. Once a correct valuation has been placed upon economic goods and services and upon the psychic benefits and costs derived by the members of society, the major and the minor decisions of life can be made with the ease and regularity of cost-accountancy. For want of a better phrase, we shall describe this belief as the doctrine of commensurability. The phrase denotes the opinion that every aspect of life can be evaluated by use of a commercial measuring rod.

The doctrine of commensurability finds its fullest expression in economic cost-benefit analysis which is the empirical branch of welfare economics. Cost-benefit analysis is usually addressed to problems which seek unequivocal answers. Should India build a steel mill or London an urban motorway? Should a third London airport be constructed; and, if so, should it be located at Foulness, Cublington, Nuthampstead or elsewhere?

The answers, it seems, may be sought by applying hardheaded commercial logic mitigated only by the intention to take account of a variety of environmental and human factors which are not normally subject to commercial transactions and to which shadow costs and shadow prices must be attributed. When the appropriate values have been imputed to the full range of marketable and non-marketable factors on the side of the costs incurred by the project and on the side of the putative benefits derived from it, a grand reckoning can be made. If the benefits exceed the costs, then the project must go ahead. If not, it must be shelved.

This prescription, which seems, at first, to be clear-cut, is bedevilled by problems both of a practical and of a theoretical nature. The sum of these problems is so great that, far from being a common procedure of economic decision-making, a fully-fledged cost-benefit analysis is a rarity. Indeed, the textbooks of cost-benefit analysis, if they give any examples, are liable to give instances where, for want of agreement over the appropriate levels of the shadow costs and prices, the results have remained equivocal or have been contested fiercely.

If a cost-benefit analysis is to remain true to the precepts of welfare economics and if it is to aspire to a definitive and all-embracing assessment of the worth of an investment project, then many aspects of life which hitherto have been quite untouched by commerce will need to be valued in terms of money. It is assumed that all that matters in such an assessment are people in their capacity as individual

consumers. In order to judge the effect of a project, we must rely upon each person's evaluation of its effect upon themselves alone. The question to be put to the individual is what he or she would be willing to pay to acquire the benefits of the project or to avoid the costs.

The problem of placing valuations on untraded goods and services and upon intangible factors such as environmental amenity are far more intractable than some of the proponents of cost-benefit analysis would have us believe. Often we have no clear idea of how to put a monetary value on the non-monetary aspect of life. For example, few of us would have any idea of how to place a personal value on the Norman church which lies in the path of the proposed extension of an airport runway. That many of us do value such relics is beyond doubt. When they are threatened with destruction by developers, well-organised and vociferous protests can quickly arise.

Many of the values to which individuals adhere arise within a social context rather than an individual context. The consensual opinions to which we adhere are the products of public debate, and they would never be conceived by wholly self-interested individuals. They cannot be expressed meaningfully in the manner in which an individual consumer might express his preferences amongst economic goods.

Interpersonal Comparisons

There are other issues which bedevil cost-benefit analysis which are no less intractable. Almost any sizable investment project which is worthy of the attention of the analysts will create benefits for some people and disbenefits for others. That is to say, some people will derive positive utility from the changes and others will derive negative utility. Therefore, in order to reach an overall assessment of the effects of the project upon human welfare, one must compare the gains to utility with some people experience with the losses of others.

It is clear that interpersonal comparisons of utility are liable to be invidious ones. Most people would accept that it is fairer to impose the costs of a public investment project upon the rich, who can better afford them, than upon the poor. On a more abstract level, we might entertain the notion that wealth and income have diminishing marginal utilities. A poor man's \mathcal{L} is worth more to him than a rich man's \mathcal{L} . But we hesitate to be specific about these relative valuations.

Nevertheless, if it is assumed that people have equal capacities for deriving pleasure or happiness from the consumption of goods and services, then it follows from the notion of diminishing marginal utility that the greatest happiness would be achieved for the greatest number through an even distribution of income and wealth. Thus the notion has egalitarian implications which tend to embarrass those who benefit most from the status quo.

Modern economics has all but succeeded in effacing the egalitarian implication of the theory of utility. It was demonstrated at the turn of the century, by the Italian economist Pareto amongst others, that the theory of consumer demand, which has a central place in neoclassical economics, can be derived from a very weak notion

of personal utility which is insufficient for the purpose of making interpersonal comparisons.

The so-called notion of ordinal utility, which is due to Pareto, requires only that consumers should be able to give an order of preference to any collection of economic alternatives which affect their personal welfare. There is no requirement for them to state by how much they prefer one alternative to another. When each consumer has only a relative scale of utilities and none has an absolute scale, it becomes impossible to make comparisons between the overall utilities derived by two individuals who are vying for preferment.

This careful avoidance of invidious comparisons, which has absolved the theory of demand from any unwonted social implications, also serves to weaken the force of cost-benefit analysis. Only in the rare circumstance where everyone is a beneficiary of a project is it unnecessary to make interpersonal comparisons; for, in that case, the issue of whom to compensate and by how much does not arise. If cost-benefit analysis is to have any practical scope, then a way must be found of weighing one person's loss against another's gain.

A solution to this problem, or perhaps it should be described as a way of avoiding it, was proposed simultaneously by Hicks and Kaldor in 1939. The Hicks-Kaldor criterion asserts that a project should be approved if those who gain from it could compensate those who lose and still retain some net benefit. There is no requirement that the compensation should be effected; for the analysts absolve themselves from the judgmental issues entailed in the redistribution of the benefits. These issues are consigned to the realm of the political decision makers.

In practice, compensations, other than those entailed in the compulsory purchases of properties, are made very rarely; and the reason for this may be that substantial costs would be involved in making such payments. The Hicks-Kaldor criterion gives no guidance on whether or not the costs of transacting a hypothetical compensation should be taken into account.

A powerful criticism which has been aimed at the Hicks-Kaldor criterion is that of Scitovsky (1941) who showed that, in some circumstances, the criterion would sanction a project which would lead to a situation wherein the losers would find it worthwhile to compensate those who had gained in order to restore the initial status quo. The problem can arise when the project has a significant effect upon the distribution of income and upon relative prices. The project is judged worthwhile at the initial set of prices and its reversal is judged worthwhile at the new set of prices. The only way out of this impasse is to assess the overall utility of the individuals in both circumstances; and this entails interpersonal comparisons.

The Discount Factor in Commercial Project Appraisal

The costs and the benefits of a project are bound to be distributed over time. In the world of commerce and industry, the funds which finance an investment project are often borrowed from banks or finance houses, in which case they are subject to a schedule of repayments with interest. Even if the investment funds are generated internally by the enterprise which undertakes the project, they should be regarded in the same light as borrowed money. The internal funds could be lent to banks or

to other enterprises at the prevailing rate of interest. Their use in the investment project entails the loss of this opportunity; and the foregone earnings are identical to the costs of borrowing the same funds from the market.

Suppose that a project has a duration of n years and that its net return in year t will be $B_t - C_t$ where B_t are the benefits and C_t are the costs. In assessing the worth of the project, we need to reduce the expected stream of future returns to a present value. It may be assumed that a constant rate of interest of r will prevail over all n years. A \mathcal{L} invested today would become $\mathcal{L}(1+r)$ in a year's time and $\mathcal{L}(1+r)^2$ two years hence. By the same token, a \mathcal{L} due to be received in a year's time has a present worth $\mathcal{L}(1+r)^{-1}$ and a \mathcal{L} promised in two year's time has a present value of $\mathcal{L}(1+r)^{-2}$.

In general, in order to determine the present value of a receipt scheduled for payment t years from now, we should apply a discount factor of $d_t = (1+r)^{-t}$. Future payments and costs should be treated in the same way as future receipts and benefits. Therefore the present value at time $t = 0$ of a project which has a duration of n years, and which has costs and benefits of C_t and B_t for $t = 0, \dots, n$, is given by

$$(1) \quad V_0 = B_0 - C_0 + \frac{B_1 - C_1}{1+r} + \frac{B_2 - C_2}{(1+r)^2} + \dots + \frac{B_n - C_n}{(1+r)^n}.$$

The project should be undertaken only if $V_0 > 0$.

The Consumer's Choice

Neoclassical economics applies commercial logic to the analysis of human welfare. It envisages an ideal world in which commercial interests and individual interests are synonymous. In this world, the quantities of the goods and services which are produced and the prices at which they are traded are determined equally by the preferences of consumers and by the technology of production. Interest rates, which can be construed as prices, are determined in likewise.

To reveal those aspects of the neoclassical model which are particularly relevant to the evaluation of costs and benefits which are distributed over time, we may begin by examining the simple picture of a consumer whose only economic provision for the next two years is an endowment of $\mathcal{L}M$ which must be spent in that period. Our aim is to show how he might adapt his consumption in view of the opportunities provided by a market which allows him to invest his wealth in return for interest payments at a fixed rate.

The consumer may choose to invest C_0 of his endowment at the start of the first period and to consume the remainder, which is B_0 , within the period. In return for his investment, he will receive B_1 at the start of the second period. Given a rate of interest of r , it follows that $B_1/C_0 = 1+r$, which is to say that

$$(2) \quad M = B_0 + C_0 = B_0 + \frac{B_1}{1+r}.$$

This equation represents the so-called budget constraint of the consumer.

Let the total utility derived by the individual from his consumption over the two periods be denoted by $W = W(B_0, B_1)$. Then the object of maximising this utility leads to the following Lagrangean function:

$$(3) \quad L = W(B_0, B_1) - \lambda(B_0 + \delta B_1 - M),$$

where $\delta = (1 + r)^{-1}$. The first-order conditions for a maximum are

$$(4) \quad \frac{\partial L}{\partial B_0} = \frac{\partial W}{\partial B_0} - \lambda = 0 \quad \text{and} \quad \frac{\partial L}{\partial B_1} = \frac{\partial W}{\partial B_1} - \lambda\delta = 0;$$

and it follows that

$$(5) \quad \left\{ \frac{dW}{dB_0} \bigg/ \frac{dW}{dB_1} \right\} = \frac{W'(B_0)}{W'(B_1)} = 1 + r.$$

On the left-hand side is the ratio of the marginal utility of today's expenditures and the marginal utility of tomorrow's expenditure evaluated today. The ratio can be represented by

$$(6) \quad \frac{W'_0 - W'_1}{W'_1} + 1 = \rho + 1,$$

where ρ is described as the marginal rate of time preference. Thus equation (4) indicates that $\rho = r$; which is to say that utility maximisation is characterised by an equality between the consumer's rate of time preference and the market rate of interest.

The situation above is commonly represented in terms of a diagram of so-called indifference curves. An indifference curve is a contour of the utility function $W(B_0, B_1)$ which is defined as a set of points (B_0, B_1) over which the function is constant. A movement (dB_0, dB_1) along such a contour is characterised by the equation

$$(7) \quad dW = \frac{dW}{dB_0} dB_0 + \frac{dW}{dB_1} dB_1 = 0.$$

This gives

$$(8) \quad \left\{ \frac{dW}{dB_0} \bigg/ \frac{dW}{dB_1} \right\} = \frac{W'(B_0)}{W'(B_1)} = - \frac{dB_1}{dB_0}.$$

Thus, utility is maximised at a point where the slope of the indifference curve coincides with that of the budget line.

The equality of the two slopes indicates that the individual has distributed his consumption over the two periods in such a way that his own preferences are precisely attuned to the rate of exchange between today's goods and tomorrow's goods

which is offered by the market. In order to forego 1 unit of today's consumption, he requires to be compensated by no less than $1 + \rho$ units of tomorrow's consumption. The market offers him $1 + r$ units; and, since $r = \rho$, he is in an optimal position and he has no incentive to make any further changes to his planned consumption.

The amounts which the individual consumes in the two periods are determined by two factors which it is impossible to disentangle without knowing the precise nature of his utility function. The first of these factors is the extent to which, in any period, his marginal utility declines with increasing consumption. The fact that he can exchange £1 worth of today's goods for £ $(1 + r)$ of tomorrow's poses an incentive to defer consumption. However, if marginal utility is a steeply declining function of consumption, then the individual would wish to consume more-or-less-equal amounts in the two periods.

The second factor which may influence the individual's inter-temporal distribution of his consumption is what is sometimes described as the myopic tendency. This is the tendency to prefer immediate gratification to deferred gratification. The tendency may be attributable to a lack of intelligent foresight, or it may be the product of a well-grounded optimism that the future can look after itself. It may be a reflection of the fear that what has been promised for tomorrow might not materialise. A bird in the hand is worth two in the bush.

To avoid any pejorative connotation in naming it, economists usually prefer to describe the myopic tendency as the consumers's time preference. The value of ρ , which is the same as that of the interest rate r when the consumer has maximised his utility, is described as the marginal rate of time preference.

The Choices of Society

In describing the choices which are faced by an individual consumer, we have assumed that he is bound to accommodate himself to the rates of exchange which are offered by the market. As an individual, he is unable to alter these aspects of the economic environment. According to the doctrine of Adam Smith, when each individual seeks his personal advantage within such a context he is led, as if by an invisible hand, to promote an end which is no part of his intention. The end in question is the welfare of society as a whole. Although no single individual should be empowered to set prices or to determine the quantities in which goods and services are provided, it is precisely the aggregate of unfettered individual choices which, according to the doctrine, should be relied upon to determine these parameters.

Although a neoclassical economist might eschew the notions of society and of social choice, he should be proud to demonstrate how the aggregate of individual choices reaches an optimal accommodation with the processes of economic production. Such a demonstration is usually based upon the assumption that a social preference function is generated automatically from the aggregation, by the mechanisms of markets, of the preferences of individuals. The latter contribute towards the aggregate in proportion to the incomes which the individuals have at their disposal. By a slight change of terminology, which is by no means as innocent as it seems, the aggregate function is often described as the social welfare function; and

it is apt to be assumed that such a function is similar in most respects to the utility functions of the individual consumers from which it is derived.

It is worth our while to pursue such a demonstration. The purpose is to show that some of the conclusions which arise from it are plainly disregarded by cost-benefit analysts. For the sake of the demonstration, we assume that, in each period, the social welfare function is characterised by a diminishing marginal utility with respect to consumption. We shall assume that society is faced with making a choice between current consumption and deferred consumption.

Let the social welfare function for the current period be given by

$$(9) \quad U(B) = \alpha \frac{B^{1-\theta}}{1-\theta},$$

where B is the level of consumption. The derivative of the function, which manifests the declining marginal utility of consumption, is

$$(10) \quad \frac{dU(B)}{dB} = \alpha B^{-\theta}.$$

The social welfare function which spans the two periods is given by

$$(11) \quad W = U(B_0) + \delta U(B_1),$$

where $\delta = (1 + \rho)^{-1}$ is a discount factor which reflects a pure time preference on the part of society.

The set of all combinations (B_0, B_1) of the consumption levels in the two periods which are available to society are no longer determined by a simple budget constraint as they were in the case of the individual consumer. Instead, they now lie on the locus of a production-possibility frontier. Nevertheless, the options which face society are similar to those which face the individual consumer. The difference is that society as a whole cannot pursue its options without affecting the terms of trade by which they are related one to another. Thus future consumption must be traded for current consumption on ever-worsening terms.

The issue is to what extent present consumption B_0 should be restrained in favour of the investments which will enlarge future consumption B_1 . If $B_1 > B_0$, then we may say that society has chosen to invest sufficiently to cause the economy to grow. If $B_1 < B_0$, then lack of investment is leading the economy to shrink with time. If g denotes the rate of growth in the economy, then

$$(12) \quad \frac{B_1}{B_0} = 1 + g.$$

The marginal efficiency of investment, which is the rate at which present consumption can be converted into deferred consumption, is given by

$$(13) \quad \frac{dB_1}{dC_0} = -\frac{dB_1}{dB_0} = 1 + r.$$

The maximisation of social welfare proceeds in exactly the manner in which the consumer's utility was maximised. We find the derivatives:

$$(14) \quad \frac{dW}{dB_0} = \alpha B_0^{-\theta}, \quad \frac{dW}{dB_1} = \delta \alpha B_1^{-\theta}.$$

Their ratio is

$$(15) \quad \frac{W'(B_0)}{W'(B_1)} = (1 + \rho) \left(\frac{B_1}{B_0} \right)^\theta.$$

Since $B_1/B_0 = 1 + g$, this is

$$(16) \quad (1 + \rho)(1 + g)^\theta \simeq (1 + \rho)(1 + g\theta) \simeq 1 + \rho + g\theta.$$

Here the first approximation $(1 + g)^\theta \simeq 1 + g\theta$ is from a Taylor-series expansion, whilst the second comes from disregarding the term $\rho g\theta$ which is liable to be negligible if ρ and g are small.

When social welfare is maximised, the marginal utility ratio of (15) is equal to the marginal efficiency of investment of (13). Using the approximation of (16), we find that

$$(17) \quad r \simeq \rho + g\theta.$$

In the world of neoclassical economics the value of r , which we have attributed to the marginal efficiency of investment, is synonymous with the market rate of interest. When an adherent of neoclassical economics poses as a cost-benefit analyst, he is liable to take the market rate of interest—perhaps modified somewhat in view of the imperfections of the actual economy—as the discount factor which is to be applied in the evaluation of the future costs and benefits of the project in question.

In practice, a cost-benefit analyst may be doing nothing more than applying the commercial criteria of project appraisal to a non-commercial project or to a project which needs to be sustained by subventions of public money. Nevertheless, if he is aware of the propositions and proofs of neoclassical economics, then he is liable to believe that the commercial criteria have been sanctioned—if not exalted—by the doctrines of an all-embracing social philosophy.

Macro-Environmental Issues and Cost-Benefit Analysis

In recent years, attempts have been made by economists to assess the likely impact upon the world economy of the global warming due to the anthropogenic emissions of carbon dioxide and other so-called greenhouse gasses. The methods which have been used are those of cost-benefit analysis. There are several respects in which these applications represent an unprecedented extension of the scope of this methodology.

The first issue concerns the global nature of the analysis. Usually it is true of an ordinary commercial project appraisal that most of the costs and prices which enter into the analysis can be regarded as data. The project in question is unlikely to have major effects beyond the enterprise in which it has arisen and a few associated enterprises. In the case of any action taken to limit the emissions of greenhouse gasses, the effect must be considered in global terms.

The second issue in applying cost–benefit techniques to the problem of global warming concerns the length of time which is necessarily spanned by the analysis. At the very least, the effects of current economic activities upon the lives of several human generations must be taken into account.

The third issue concerns the highly uncertain nature of the effect of the emissions of greenhouse gasses. We are unlikely to be able to ascertain the precise effects much in advance of the time when they actually materialise. Moreover, the processes of climatic change are liable to acquire a degree of momentum which will make it impossible to reverse them quickly. In short, we are faced with great risks and we are ignorant of their precise nature.

Notwithstanding the scale of the issues and the uncertainties involved, economists have tended, in the main, to make reassuring assessments which, whilst they do not recommend in so many words that the problems should be ignored, provide little spur to action. The insouciance of economists contrasts markedly with the anxieties of professional climatologists and of earth scientists; and an explanation for this contrast must be sought.

Most of the cost–benefit analyses of global warming to date have confined their attention to advanced industrial countries, such as the United States; and it is admitted that a full assessment must include other regions—see, for example Nordhaus. However, the preliminary assessment is that other advanced industrial countries will experience modest impacts similar to those forecast for the United States and that some may even have net economic benefits. Frankhauser estimates that the losses from the doubling of atmospheric CO₂ to be 1.4 percent of the gross national product of OECD countries and 1.5 percent for the rest of the world.

Such analyses assume the nature of cost accountancy. A list of agricultural, industrial and consumer activities is drawn up and a cost or a benefit is attributed to the impact of the temperature change and of the consequence climatic disturbances—floods, storms and droughts. The idea is to determine how normal business might be affected by a series of seemingly minor discomforts.

As Nordhaus observes, thanks to modern technology, humans today can live and thrive in virtually every climate on earth. The bulk of economic activity, ie. variables such as wages, unionisation, labour force skills and political factors swamp climatic considerations. Indeed, when a manufacturing firm decides between investing in Hong-Kong or Moscow, climate will probably not even feature on its list of factors to be considered. A few degrees centigrade here or there are surely fit to be ignored.

Having dealt in such a manner with the expected losses and gains from global warming, attention is turned to the costs of averting it and to the advantages of so doing. The costs, it is envisaged, are to be born largely by consumers in consequence

of the carbon taxes aimed at reducing the consumption of fossil fuels. It is no part of the analysis to consider the possibilities of pursuing alternative energy strategies which might reduce the dependency on fossil fuels. It is assumed that the necessary substitutions will occur at the margin to replace the fossil fuels which, as a result of the taxation, will become relatively uneconomic.

A typical analysis is that of Nordhaus. He examines three options: (1) The stabilising of greenhouse gasses at their 1990 levels, (2) The stabilising of the climate so that changes in global average temperature are limited to no more than 0.2°C per decade, with an ultimate limitation of 1.5°C, and (3) An economically optimal time path of global warming based upon an inter-temporal maximisation of a global welfare function. A rate of discount of 4% per annum is applied in order to reduce the costs and the benefits to a present value. According to Nordhaus, these strategies represent, respectively, losses of 1.4 and 8.2% of today's annual gross world output and a gain of 0.05%. The preferred outcome would be achieved by very moderate carbon taxes rising from about \$5 per ton of carbon to around \$20 at the end of the next century.

It may be worth aiming a few criticism at this kind of analysis even in advance of our attempts to depict in more detail the likely effects of of global warming upon the world's populations and their livelihoods. The first feature of the analysis which commands attention is the disregard of the circumstances in which the majority of the world's population is constrained to live.

The notion that business corporations in the advanced industrial world are capable of disregarding climate as a factor in their location decisions, even if it were true, has little bearing upon the circumstances of the majority of humans. It is certain that the most dramatic effects of climatic change, such as the acceleration of desertification and the flooding of low-lying fertile plains and river deltas, will be experienced in areas where people are already miserably impoverished.

It is remarkable that an economist should think of applying a cost-benefit analysis on a global scale without taking account of the distribution, or rather the maldistribution, of income. It is not enough to think vaguely, along the lines suggested by the Hicks-Kaldor criterion, of compensating the world's poor for the losses they might suffer without ever intending to do so. In this connection, there can be no avoidance of interpersonal comparisons.

The second *prima facie* criticism which can be aimed at the analysis concerns the use of a discount rate. It is apparent from equation (17) that the discount rate r is compounded from two elements. The first is the rate of time preference ρ and the second is the product of the rate of growth g times a factor θ which, in technical terms, represents the elasticity of marginal utility with respect to changes in the level of income:

$$(18) \quad \theta = \frac{\partial W'}{\partial B} \frac{B}{W'}$$

In practice, the latter serves to differentiate between the effects on the utility of different generations of an inter-temporal redistribution of income. The factor reflects the notion that, in the absence of a time preference which foreshortens

our perspectives, the purpose of maximising human welfare would be achieved by transferring benefits from rich generations to poorer ones.

It ought to be recalled that the time-preference factor ρ is present in the equation (17) only because we have chosen to accommodate within our analysis the recognised human foible of temporal shortsightedness. We are not bound to give any sanction to this characteristic. We are surely inclined to dismiss it when we are engaged in contemplating the futures of several generations. In such a context, a positive rate of discount represents a principle of interpersonal comparison which discriminates again those who are as yet unborn.

In the absence of time preference, the outcome of a cost–benefit analysis of global warming might reach a very different conclusion. Far from being virtually negligible, the costs which our present consumption of fossil fuels will impose on mankind are bound to become enormous.

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