PERSPECTIVES ON DISCOUNTING THE FUTURE

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Keywords: Investment, compensation, time preference, diminishing marginal utility, risk

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Summary

Discounting is a process whereby economists and others formally assign less value to events, simply because they occur in the future. It has been supported on several arguments. However, these arguments may be challenged, particularly in relation to life support systems. Potential growth of investment funds generated early in time justifies discounting only if the value of events can be encashed and if their investment actually takes place. Human impatience, which originally gave evolutionary advantage to individuals, is less appropriate in a structured economy. It leads to serious inconsistencies in individual and social preference, and may best be interpreted in a way which does not imply discounting for earliness in time. The decreasing value of consuming extra products as the abundance of these products increases does not apply to the following: countries and individuals having static income; environmental services in static or diminishing supply; the totality of consumption. Discounting for risk also fails to reflect reasonable expectations of value through time; it yields perverse results in valuing potential catastrophes; it gives little weight to those bad scenarios which should actually be given the greatest weight.

1. Introduction

The future of life support systems is under threat because of discounting. It is also under threat because of ignorance and selfishness and carelessness and the possibility of sheer bad luck. But, as a systematic cause, it is arguably discounting that poses the greatest threat.

Discounting is the process of giving a lesser equivalent present value to a commodity, resource, service, event or experience on the grounds that its consumption lies in the future. The mathematical form which discounting has normally taken is a negative exponential function, that is:

$$[\text{Equivalent present value}] = \frac{[\text{Future value of some event}]}{(1+[\text{discount rate}])^{[\text{time lapse before event occurs}]}} \quad (1)$$

or

$$[\textit{Pr}\text{esent value}] = [\text{Future value}]\ e^{-\rho[\text{time lapse}]} \quad (2)$$

"Event" is an umbrella term for any brief process – such as consuming goods or using services or enjoying environments or experiencing sensations or expending resources – which has positive or negative value. "Discount rate" is some constant of the process of decline in value, often equated with interest rate or rate of return on investment. ρ is the natural logarithm of $(1+[\text{discount rate}])$.

For example, if the decommissioning of a nuclear reactor is expected to cost £100 000 000 in 30 years' time, and the discount rate is 6%, the equivalent present value of that is

$$\frac{£100\ 000\ 000}{(1+6/100)^{30}} = £17\ 411\ 013$$

It is important not to confuse discounting with inflation. Inflation reduces the real purchasing power of a given *sum of money* at some future date. Discounting reduces the value ascribed to a given *real purchasing power* at some future date: it would be applied even in the absence of inflation. Partly because the course of inflation is so hard to predict, most economists base calculations on current prices, and allow for inflation by discounting at a rate that is adjusted to remove its influence on monetary interest rates. This convention is adopted in the following pages: "£*X*" stands for "£*X* of purchasing power at constant prices".

Routine application of the formula demonstrates that the impact of discounting is dramatic over the kind of time periods relevant to change in global systems. Indeed, it is only by using a logarithmic scale that it is possible to encompass the orders of magnitude of change in a form that can be visualized. Figure 1 shows present gross

world product discounted from 500 years in future – the speculated time at which polar ice caps might break up – at 6% – a rate in the middle of the range normally proposed by national and international bodies. The result is an equivalent present value of a mere $10.

Formally, discounting is undertaken by economists in evaluation of resource use options. In the past it was applied by them only to cash flows. But the advance of techniques for valuing non-market benefits and costs in cash terms has also brought biodiversity, landscape, climate change, hydrological impacts, soil loss and many other effects into the discounting net. When such things lay outside the scope of the financial economy, discounting incidentally threatened them, because it favored exploitation projects with a short-term pay-off that, as it happened, were hostile to environmental conservation. Now that they are included, at least in some forms of cost–benefit analysis, discounting systematically threatens them, because they typically arise over such a long time span, that discounting trivializes their importance.

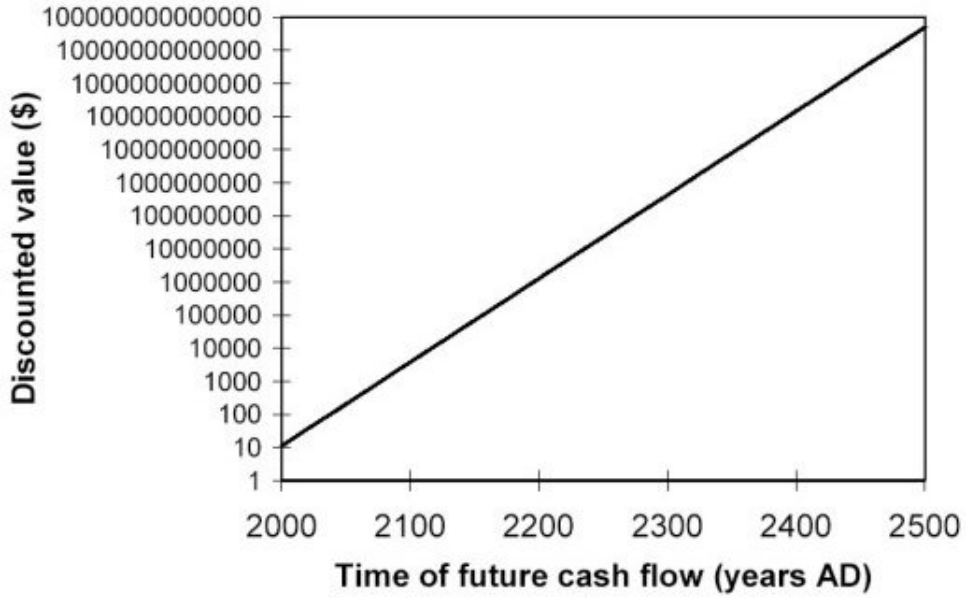

Figure 1: The effect of discounting from the distant future

Discounting is also undertaken less formally by individuals – acting for themselves or as citizens – in the psychological importance ascribed to the future outcomes of present decisions. It is undertaken by businesspeople in their more, or less, intuitive investment decisions. It is implicit in the short-termism of politics and the opportunism of human self-interest. It is observed in the instincts for immediate gratification which drive animals' behavior. This is a powerful collection of agents, to be employing a technique that threatens the planet Earth.

2. Derivation from Investment Economics

Discounting has its formal origins in banking and investment appraisal. A project offers a cash income of £X million, t years in the future. What is that worth as an offset

against the £Y required as an initial investment? The investment could be evaluated by calculating compound interest at [some appropriate] r% interest, on the original £Y, and asking, does the revenue suffice to repay this?

The alternative approach is to ask: what present sum of money, £Z, invested at r% over t years, would be *just as good as having* £X, if it was available t years in the future? Compound interest on £Z would amount to

$$£Z \times (1+r)^t \quad . \qquad (3)$$

If this has equal value with £X, then

$$£Z \times (1+r)^t = £X$$

and by rearrangement

$$£Z = \frac{£X}{(1+r)^t}, \qquad (4)$$

which is the discounting equation.

The advantages of the discounting approach over the compounding approach are as follows.

- It establishes a single, non-arbitrary point in time (the present day) at which all costs and benefits, of all projects, may be compared.
- It allows an indefinite future stream of cost or benefit to be rendered as a single, finite value. For example, £10 received at the end of each year in perpetuity has a summed discounted value of

$$\frac{£10}{1.06^1} + \frac{£10}{1.06^2} + \frac{£10}{1.06^3} + \ldots \frac{£10}{1.06^\infty} = \frac{£10}{0.06} = £167 .$$

- It gives a figure at a time – the present – to which people can easily relate, as contrasted with the compounding approach, which yields a figure, sometimes a bewilderingly large one, at a long future date with which people cannot readily identify.

The disadvantage is that it appears to involve the conceptually difficult reversal of time, moving from a future to a present valuation. However, the question "*what sum of money at present would grow to [some particular value] in future*" does offer a real interpretation of discounting. An analogy could be drawn with the growth of animal populations. Suppose a target deer population of 1000 is to be re-established in habitat offering ample carrying capacity. With an expected 30% population growth rate the managers would only need to release 73 deer to reach the target in 10 years, but if that population was required in 5 years, they would need 269.

Nor is the justifiable use of discounting in investment confined to cash economies. Investment occurs in subsistence economies: for example in improving tools and hunting weapons, which involves diversion of time from immediate pursuit of daily needs. The return on investment is given in the later improved efficiency of that pursuit. The earlier that weapons and tools are available, the greater is the stream of improvement in subsistence. This argument applies too in modern economies: ultimately it is not the cash return on cash deposits, but the physical productivity of capital, that seems to justify a premium on its early possession, and a discount on the future [see *Natural Resources, Economic Growth and Sustainability: A Neoclassical Perspective*].

It is harder to see how this argument can be applied to devaluing goods, services and non-monetary environmental values that accrue as consumption to future generations. But the case can be made, running as follows.

In justice, if the interests of future generations are harmed by present generations, the present should compensate the future for the harm [see *Essential Components of Future Ethics*]. By investing a sum at compound interest now, the present can make provision for compensation (or, to put it in physical terms, the present can compensate the future by investing in productive capital, and arranging for reinvestment of all intermediate revenues in additional productive capital). Suppose future harm, priced at $1000, is expected. If the harm arises after 50 years, a sum of about $54 would have to be invested at 6% compound in order to provide compensation (see Figure 2). But if the harm did not arise until 100 years, present investment of only $3 would suffice. Thus distant-future harm really does seem less serious than near-future harm, even when the present fully compensates the future for harm.

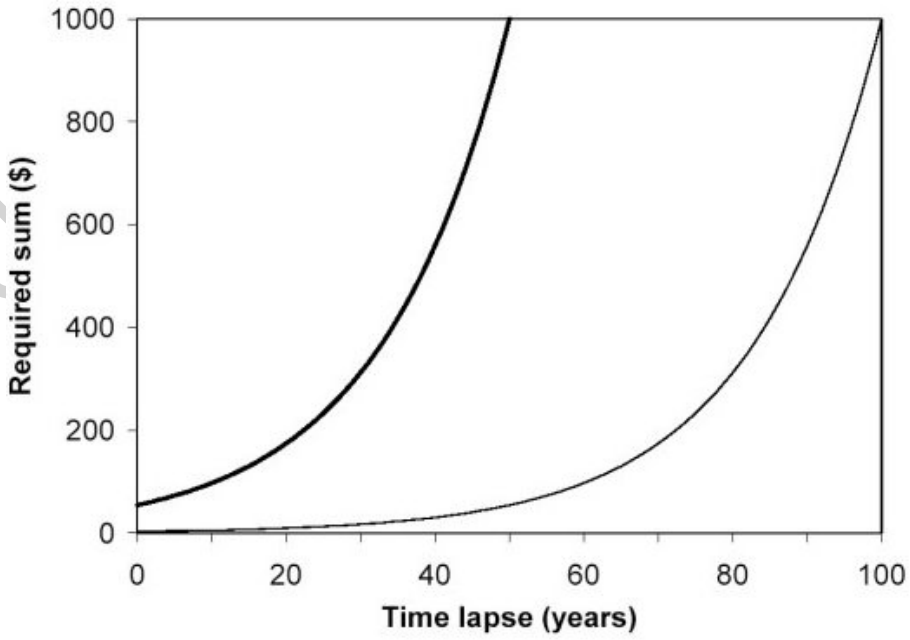

Figure 2: Growth of compensation fund to provide $1000 at two future times

This plausible account, however, has potentially lethal weaknesses.

- Physical investments, and physical reinvestment of revenues, while potentially providing goods and services to compensate the future, are not themselves neutral to environment. They may entail resource degradation and pollution, which requires *yet more* compensation to be supplied, with yet more potential side-effects.
- An ever-increasing requirement for an ever-increasing capital investment to compensate for ever-increasing future harm brings the possibility of declining rate of return from further capital investment (as in some of the models discussed in *Natural Resources, Economic Growth and Sustainability: A Neoclassical Perspective*). Thus, to supply a given amount of compensation might require a greater total amount of capital than is indicated by discounting at the present rate of return. Increasingly stringent environmental and social regulation of investment might bring about the same result.
- Benefits from investment that lie outside the market mechanism yield no revenues from which to endow a compensation fund. For example, maintaining unrestricted public access to a fragile nature reserve provides short-term aesthetic benefits, but possibly no income with which to compensate future generations for degradation, perhaps irreversible, of the ecosystem.
- It is a commonplace of present-day compensation, that the recipients publicly deny that [any amount of] money can truly make up for loss of health, fitness or aesthetic and perhaps spiritual experiences: for these there is perceived to be no purchasable substitute. Be that as it may, if money cannot be readily converted into goods and services of a directly comparable form, the trade-off between money and experiences will change in a world of increasing technology and affluence but declining ecosystem services and aesthetic quality: monetary compensation accepted as adequate at present need not be so regarded under such a future state. This point will be revisited later, under the heading of diminishing marginal utility.
- Whatever the *potential* of early revenues to endow compensation, actual compensation to the future depends on the investment's *actually being made*. And not only made, but maintained, without any creaming off of benefit over the whole period between the present and that time, perhaps hundreds of years in future, when the compensation is due. Whatever the moral integrity of those who endow the fund, they cannot guarantee that intervening generations will also act with complete propriety in leaving the fund intact. Besides, if an investment may be financially costly in the short term, environmentally costly in the long term, and beneficial only in the medium term. Then, present investors may argue that it is unjust to expect them to pay compensation, when the investment is already a net cost to them: on the other hand the recipients of medium-term benefit might argue that it is unjust to require them to pay compensation to the long-term losers, when they played no part in the original decision.
- Governments, who might be deemed the proper guardians of a national or transnational compensation fund, lie under the political desideratum of gaining quick results. To underwrite the interests of the future may incur the displeasure of the present electorate: only in exceptional times do promises of "blood, toil, sweat and tears" constitute a successful electoral slogan. Part of the present

pension crisis in the UK arises from a succession of governments' using current tax revenue to pay pensions, rather than investing national health and insurance contributions to fund future provisions. Typically, governments and corporations have reinvested, or promoted the reinvestment of, no more than 25% of receipts from previous investments. It is as if an animal population growth model were based only on fertility rates, without account being taken of mortality. A World Bank publication (*Environmental Accounting for Sustainable Development* edited by Ahmad, Y.J., El Serafy, S. and Lutz, E. The World Bank, Washington, 1989, p.16) even speaks of reinvestment of proceeds as "only a metaphor". It is this impatience for results that forms the second justification for discounting, as outlined below.

3. Behavior and Discounting

Human beings did not wait for the development of investment theory before they started to discount. The process can be supposed to have its functional origins in evolutionary self-interest, as expressed by animal behavior. A food source offered now, or a mating opportunity, is assured: leaving it for later risks that other individuals will annex it. Discounting future resources is a functionally successful strategy in a world without durable property rights. This conditioning might be expected to become ingrained in animal behavior, and indeed thirsty laboratory rats appear to discount, in experiments where a small dose of water is preferred to a larger, assured, but delayed quantum.

Humans, however, have a capacity for mentally modeling the world. This enables them to envisage the consequences of innovative actions, for which evolution has implanted no helpful pre-programming. In taking account of expected future consequences of present actions, humans generally give less weight to those consequences than they would give to similar consequences arising immediately. This reducing perspective on future values is professionally referred to as *time preference*, and more vernacularly as *impatience*.

Time preference and return from financial investment seem to come together in the behavior exhibited in investment markets. Individuals (and collective agencies) invest in order to secure future dividends, in cash or in goods and services (as in house purchase). But they would not be expected to do so, if the discounted value of those future flows of benefit were less than the value of the sum invested. In other words, classically, investment will be made only where the percentage rate of return on the investment is not less than the rate of time preference discount. An equilibrium is very likely to arise in this situation, given that rate of return from investment declines with the volume of investment in the economy, while time preference rises with individual volume of investment (as investment cuts deeper into funds available to finance present consumption).

Nonetheless, judgments made in the investment market may not be representative of those appropriate to society. Investment is dominated by rich people, who typically exhibit a lower time preference than poor people (because not so hard pressed by the needs of subsistence). On the other hand, experiments and behavioral studies typically find the individual discount rate to be lower for important than for trivial decisions; and

for environmental values than for material ones. There is evidence of "collective long sight", in that a lower rate appears to be favored for public than for private decisions. And the decisions reflected in investment markets impart information only about how *a little more* or *a little less* are evaluated as time elapses. Thus time preference is a phenomenon that ought to be quantified in its own terms, not judged indirectly from an investment market that in many ways is atypical of the circumstances in which individuals, agencies and societies make choices about timing.

4. Pure Time Preference

When people make decisions that evince impatience, what exactly is it that induces them to forgo improvement in their future condition, in order to gain a *smaller* improvement in circumstances presently? There may be many expectations about how circumstances may change in future. With passing time individuals lose some capabilities and learn others; they become wealthier, or more impoverished; their tastes alter; ultimately, they die. But the standard format of discounting is rather inflexible, and makes no reference to these specific circumstances and how they are likely to change. It models only a vague belief that individuals take account of them, and make rational and consistent judgments based on their understanding. In a democratic world – it is argued – governments, agencies and supra-national bodies should respect those judgments, and reflect them in the weighting which they, in turn, give to costs and benefits accruing over an extensive future.

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Biographical Sketch

Colin Price holds a masters degree in forestry and a doctorate in land use economics from Oxford University. After short periods teaching town planning economics in Oxford Polytechnic (now Oxford Brookes University) and land use economics in Oxford University, he moved to the University of Wales, Bangor, where he is now Professor of Environmental and Forestry Economics. His research interests have covered many aspects of forestry, land use, environmental and urban economics, specializing in silvicultural economics, cost–benefit analysis and economic development, and the valuation of landscape, recreation, CO_2 fluxes and biodiversity. He has about 170 publications spread through all these fields. His most abiding research concern has been with the economics of time: his first paper on discounting was published in 1973, and his major contributions summarized in the book *Time, Discounting and Value* (Blackwell, 1993). He is also author of *Landscape Economics* (Macmillan, 1978) and *The Theory and Application of Forest Economics* (Blackwell, 1989). He has research links in Canada, Denmark, Finland, Malaysia, Norway and Uganda, and is a frequent speaker in international conferences. He has acted as consultant on landscape and land use evaluation to the Countryside Commissions of England and Wales and of Scotland, and the former Department of the Environment (UK); and on forestry economics to FAO, the Forestry Commission (Wales), the Countryside Council for Wales and the South-West Region of England.