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Social Time Discounting: Institutional and analytical perspectives

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The key analytical aspects of social time discounting were largely resolved by the early 1970s, the main developments since then being empirical studies and more emphasis, since the mid 1990s, on the very long term. However approaches to social discounting in developed economies and international bodies vary. This is sometimes for institutional reasons, and sometimes because of persistent differences of analytical framing.

Keywords: cost benefit analysis, discounting, public investment, social opportunity cost, social time preference

JEL Classifications: B41, D51, D78, D99

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1. Introduction

Academic literature on social discount rates (SDRs) grew from the 1950s into a flood that, with fluctuations and changes in emphasis, still continues.[1] The subject suffers from apparently simplicity, while beneath the surface there are endless complexities, hindering the development of shared understanding among economists. And there will always be scope for significant, reasoned debate about the best way forward in any specific institutional context. This paper reflects the perspective of a practitioner who contributed to developments in UK government from the 1970s to the 1990s and has continued to work in the field, in the UK and elsewhere. While relevant to much climate change analysis, its focus is on approaches used by different institutions to discounting in "conventional" policy or project appraisal rather than the long term.

The early literature was almost exclusively concerned with the comparison in cost benefit analysis (CBA) of public investment with subsequent consumption benefits. The main alternative approaches proposed for an SDR were widely described as Social Opportunity Cost (SOC) and Social Time Preference (STP).[2]

The SOC rate was generally defined as the marginal pre-tax commercial rate of return from private sector investment. This rate therefore served both as a time preference rate *and* as a measure of the opportunity cost of public funds, on the presumption that public funding displaced private investment. The rationale was (and essentially still is) that this displaced private sector capital could have been invested, and its returns reinvested, to produce a stream of consumption benefits over the same time profile as the consumption benefits from the public project under consideration, to give an SOC rate of return. So, it was argued, any stream of benefits from the public project giving a lower rate of return could not be justified.

The STP rate was defined as the sum of 'pure' time preference for marginal utility and an adjustment for the decreasing utility of marginal income as incomes increase over time.[3] It was accepted that, if an STP rate is used, the opportunity cost of public funds (OCPF) needed to be accounted for separately by a shadow price of public expenditure, giving dollars of public spending a higher weight than dollars of consumption.[4] It was generally assumed that this shadow price depended on how the particular expenditure was funded. However, quantification of the OCPF, as a shadow price, was not clearly resolved and this remains a weak field of literature.

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1 Prest and Turvey (1965) recorded then that "The literature on choice of appropriate interest rates for public investment projects is voluminous."

2 Nowadays the terms 'descriptive' and 'prescriptive' are sometimes used to describe these broad approaches, but these can be misleading in this context.

3 This is often expressed as $\rho = \delta + \eta g$ ('the Ramsey equation') where ρ is the rate of STP rate, δ is pure time preference, η is the elasticity of marginal utility with respect to income or consumption, and g is the projected growth rate of per capita income. Although the equation originates from Ramsey's work on growth theory its use for deriving an STP rate does not imply any particular growth model.

4 The OCPF is defined here as the factor (>1) by which dollars of public funds should be multiplied to reflect the costs arising from raising an extra dollar of taxation. They can then be compared directly with benefits expressed in terms of dollars of consumption. Many terms are used to describe this. Feldstein (1997, p 199) describes the effect as "the deadweight loss of increased tax revenue" – i.e. the OCPF minus 1.

The 1960s also saw the founding of modern financial economics, and notably the capital asset pricing model (CAPM). Some economists argued (and some still do) that equity risk premia, reflecting the cost of non-diversifiable variability risk in returns to equity, were a measure of risk inherent in the activity, regardless of how it is financed. The premia should therefore, they proposed, also be applied to activities financed by public sector debt or directly by taxation.

Over subsequent decades the SOC framework sometimes merged with the CAPM approach, and became more complex.[5] And a new field of debate arose when issues such as nuclear waste and climate change led to the very long term becoming salient in the 1990s. A wide academic consensus (and fairly wide user consensus) has since emerged that the SDR should fall over the very long term, but with no consensus on the magnitude of the decline.

Section 2 below summarises current practices, globally and in the UK, and how these are influenced by institutional constraints. Section 3 compares the Social Opportunity Cost (SOC) and Social Time Preference (STP) approaches. Section 4 addresses related issues and Section 5 concludes. An Appendix discusses the derivation and application of an STP rate.

2. Social discounting in practice

2.1. The global scene

When discounting began to be used in the public sector, in the 1960s, SOC prevailed over STP. SOC had a more ready intuitive appeal to ministers, senior officials and many economists. And applying it is administratively simpler than using an STP rate and applying an OCPF. Indeed deriving an OCPF was often perceived as case-specific, complex and perhaps impracticable. But recent decades have seen the development of several broad camps as follows. Some institutions straddle more than one camp.

The 'pragmatic' camp: Some bodies face institutional constraints on promoting a rigorously analytical framework. The World Bank, as an example, for the appraisal of proposed projects, has long specified for the appraisal of specific aid financing proposals a real rate of 10%-12%.[6] In US federal government, the Office of Management and Budget (OMB) specifies for regulatory analysis and CBA what is formally an SOC rate of 7%; however it notes that, within such projects, any "Federal cost savings and their associated investment costs may be discounted at the Treasury [borrowing] rate, while the external social benefits and their associated investment costs should be discounted at the 7 percent real rate".[7]

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[5] For example the SOC approach has sometimes morphed to a 'weighted discount rate' approach, where public spending is assumed to displace mainly private capital but partly private consumption, for which a 'consumption discount rate' (such a low risk post tax savings rate) is considered appropriate. This is combined with a private commercial rate of return to give a weighted average rate.

[6] This is explicitly not based on any formal conceptual approach. It is presented as being in part a capital rationing device. In its backroom analytical work the Word Bank may adopt STP rates (e.g. Lopez, 2008).

[7] OMB(1992) also notes that, rather than discounting at 7%, "Using the *shadow price of capital* to value benefits and costs is the analytically preferred means of capturing the effects of government projects on resource allocation in the private sector. [But] To use this method accurately, the analyst must be able to compute how the benefits and costs of a program or project affect the allocation of private consumption and investment. OMB concurrence is required if this method is used in place of the base case discount

The 'STP' camp: Most European-wide institutions and some European countries have adopted STP discounting, usually apparently accepting that, in CBA, the OCPF is adequately handled by the use of benefit-cost ratios (BCRs) and the process of expenditure budgeting.

The 'low market rate' camp: Some countries, including Norway, and with other Scandinavian countries tending that way, appear generally to accept the STP rationale but choose not to use the Ramsey equation, preferring rates based on risk free market rates.[8] The US OMB specifies such rates for "cost-effectiveness, lease purchase, and related analyses".[9]

The 'commercial market rate' camp: Some countries, states and provinces, notably in Canada, Australia and New Zealand, continue to debate fundamentals, but generally apply SOC rates, derived from average private sector commercial returns or from CAPM, sometimes combined with a consumption rate in a weighted average.

The handling of risk in the discount rate varies. But some administrations consider that a modest addition to the discount rate may be desirable to adjust for risks that are otherwise normally not recognised in project appraisal.

Few institutions apply an explicit shadow price to public spending.[10]

2.2. UK practice

The UK SDR has since its origins been set centrally by HM Treasury (which is both national treasury and national ministry of finance) and the Treasury's chosen technical approach has only occasionally been questioned by academics or political advisers. There have however been periods of strong debate within the Treasury itself and these have illustrated the importance of administrative concerns.

Discounting was first applied only to nationalised industry spending, where until the 1970s the SOC approach was widely accepted as correct. However the 1970s were a period of low private sector returns and the discount rate of 5%, though based officially on SOC, became increasingly presented in the public service context as a measure of STP. This became unsustainable when private sector returns rose, leading to pressure for a higher rate.

By this time the conventional SOC argument, for reasons set out in Section 3 below, had lost technical credibility, although the CAPM argument, rejected in 1978, re-emerged to be

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rate." The figure of 7% having been unchanged since 1992, might in practice now be as close to a "pragmatic" figure as to a formal SOC figure.

8 Norway formally adopts a government borrowing rate plus a CAPM risk premium where there is information to estimate this. But it appears that in practice may major projects appraised at the borrowing rate.

9 This US Treasury borrowing rate is currently negative in real terms for three year debt, rising to plus 1.9% for thirty years or more.

10 Although Sweden applies a factor of 1.3 to transport investment (Eliasson, 2013). And OMB (1992, section 11) stated that "Because taxes generally distort relative prices, they impose a burden in excess of the revenues they raise. Recent studies of the U.S. tax system suggest a range of values for the marginal excess burden, of which a reasonable estimate is 25 cents per dollar of revenue." It explained that "It is not required for cost-effectiveness [CEA] or lease-purchase analyses", but as noted below it would be double counting to apply it to *CBA* with an SOC discount rate.

rejected again. However a driver for a high rate was the long standing concerns of relevant officials about controlling nationalised industry capital spending. On the public services side, while the technical STP argument was accepted, the case *against* a "high" rate was further supported by concerns, among officials responsible for general expenditure control, that this would excessively promote costly private capital financing of public services.

The eventual compromise was a discount rate of 8% for the nationalised industries and 6% for the public services. These figures were both initially presented as being derived from private sector returns, but subsequently the 6% was officially a "top of the plausible range" STP rate and the rationale for the 8% was explained in pragmatic terms.[11]

In 2003, by which time the nationalised industries had nearly all been privatised and were no longer an issue in the SDR debate, the STP rate was reduced to 3.5%, with a declining schedule over the long term.[12]

3. The SOC and STP approaches compared

An 'obviously correct' case for the STP approach is as follows:

The costs and benefits of a proposed policy or project are, or can be, converted to equivalent consumption costs and benefits over time. The relevant discount rate for this time distribution is by definition society's time preference for consumption, R_{STP}.

An 'obviously correct' case for the SOC approach is as follows:

The public expenditure costs of a proposed policy or project could alternatively be invested in the private sector to produce a stream of consumption, with the same distribution over time, and giving an internal rate of return (IRR) of R_{SOC}. The proposal is therefore justified only if its consumption benefits yield an IRR of at least R_{SOC}.

This section, with some supporting issues postponed to section 4, discusses the main problems with each.

It is here taken as read that discounting generally covers only those factors that can be monetised and that final decisions usually reflect many other facts as well. And for brevity the term 'project' is used to cover policy, programme and project analysis.

3.1.1. *Problems with the STP approach*

i) STP is not easy to quantify precisely

As noted above an STP rate is conventionally derived as the sum of a small pure time preference rate for utility and a larger factor to adjust for the decline in the marginal utility of income or consumption as income increases. The issues are outlined in the Appendix. It might be possible today, in a fully developed economy, to justify an STP

[11] A more formal and fully referenced account of this history can be found in Spackman (2013). There was for a short period a convention that, as in OMB (1992), the higher number should be used for CBA and the lower number for CEA.

[12] This large reduction seemed consistent with the then Government's enthusiasm for public investment, but as noted below it is unlikely that the change materially affected the total level of public spending.

rate for the next few decades as high as 5% or as low as 3%. This degree of uncertainty does not however appear to be an obstacle to its practical application.

ii) The explanation of STP entails concepts that are to many people unfamiliar

This is likely to prevent the adoption of the STP approach in any body where those responsible for the methodology are uncomfortable with the STP concept, or for other reasons wish for a "high" rate. It can also be a weakness in application when economists themselves do not recognise that funding a dollar of public spending has a social cost of more than one dollar of consumption. This calls for appropriate guidance.

iii) In practice there is no widely accepted methodology for directly converting public expenditure dollars into equivalent consumption dollars

For cost effectiveness analysis (CEA), where virtually all the costs and benefits are public spending, this is not an issue. But the opportunity cost of public funding (the OCPF) is more than $1 of consumption per dollar of tax, and in CBA account needs to be taken of this. As explained in the Appendix, this implies using benefit cost ratios rather than NPVs as the normal criterion for comparing CBA options. Once established this is straightforward, but it is different from the simpler use of NPVs with the SOC approach.

3.1.2. Problems with the SOC approach

i) An appropriate R_{SOC} is not easy to quantify precisely

The challenges in quantifying an SOC rate are well set out in Harrison's excellent exposition of the SOC approach for the Australian Productivity Commission (Harrison, 2010). This degree of uncertainty appears to be of the same order as that in quantifying an STP rate and, again, does not appear to be an obstacle to its use.

ii) Many projects are comparing public expenditure not with consumption but with public expenditure savings

This is a fundamental problem for many, though not all applications.

It is sometimes suggested, with good reason, that for *CBA*, where public spending is being compared with future consumption benefits, the SOC and STP approaches often give near enough the same answer. For example Harrison (2010, p98) describes a 'shadow price approach' that is very close to the STP approach, with all costs and benefits converted to consumption-equivalents, and discounted at a consumption rate of interest, with the comment that *"It turns out that discounting ordinary cost and benefits flows using a weighted average [SOC] discount rate (usually) gives the same answer"*.

There does not appear to be any literature systematically testing this equivalence. However the two approaches are compared in Table 1, which takes typical values for STP (3.5%) and for a weighted average SOC discount rate (7%), and an OCPF of 2.0.[13] In practical application the consumption PVs in rows (i) and (ii) would be compared with PVs of public spending. In the SOC approach the 'cut-off' criterion would be a benefit

[13] Valuation of the OCPF is discussion in section 4 below.

cost ratio of 1. In the STP approach the corresponding cut-off ratio would be the OCPF. Thus Row (iii) shows row (ii) divided by row (i), and then multiplied by the OCPF.[14]

Table 1
Comparison of SOC and STP discounting in CBA

	Discounting period, years:	0	10	20	30	50	100
(i)	PV of $100 consumption benefit with 3.5% discount rate, $	100	71	50	36	18	3.2
(ii)	PV of $100 consumption benefit with 7% discount rate, $	100	51	26	13	3.4	0.12
(iii)	Ratio of (ii) to (i), multiplied by an OCPF of 2	2.00	1.43	1.03	0.74	0.38	0.07

The Table suggests that, for a broad range of public investment projects, with consumption benefits stretching mainly over thirty years or so, the project rankings and absolute net benefits may often be similar with the SOC or the STP approach.

However, many applications of social discounting, perhaps most, are in practice not CBA, but cost effectiveness analysis (CEA), comparing alternative public spending schedules. This applies for example to optimising engineering designs, to the comparison of alternative programmes to meet a projected growth in electricity demand, and to alternative financing options (e.g. lease versus buy) for public services. In these cases all or nearly all the costs **and benefits** are public spending.

Thus, in CEA, the OCPF applies to both costs and benefits and need not complicate discounting at an STP rate: the OCPF has no material effect on benefit cost ratios (BCRs), nor on the relative present values of alternative options. However, as reflected in the USA's OMB guidance since the early 1990s, the SOC approach is not appropriate for CEA. It treats future dollars of public expenditure benefit as if they were dollars of consumption benefit and therefore gives them too little weight.

This was set out with academic rigour in Feldstein (1970), and included as part of a subsequent paper that also noted other applications for which the SOC approach is similarly not appropriate (Feldstein 1973). The point appears never to have been challenged, but is often overlooked.

iii) Returns from private investment do not grow indefinitely at R_{SOC}

The future social cost of a dollar of taxation may grow indefinitely at the economy's economic growth rate; but not at any higher rate.

Rabl (1996) noted that "any [indefinite] rate greater than the GNP growth rate [is] clearly an absurdity" and that this growth rate is a measure of the opportunity cost of public funding. Rabl saw this as a *maximum* discount rate. But the social impacts of a marginal dollar of tax can have an internal rate of return of any higher figure, depending

[14] An OCPF of 1.5 or 2.5 would change the figures in row (iii) by a factor of 0.75 or 1.25.

largely on their distribution over time, with some of the return being consumed. For this reason it is only as a present value that the OCPF can be described by a single number.[15]

iv) The approach takes only limited account of the distortionary effects of taxation

As note under (ii) above, the SOC approach has the virtue, in CBA, of giving relatively more weight to earlier (typically public) spending and less to later (typically consumption) benefits. However this follows from the assumption that the funding of marginal public investment (or all public spending) is mainly diverted from private investment, which does not appear to have a persuasive empirical basis.[16] The approach does not usually address the ways in which taxation distorts the economy other than by diverting resources from private investment.[17]

4. Supporting issues

This section develops issues relevant to the discussion in Section 3 that were postponed for clarity of exposition.

4.1. Variability risk

4.1.1. Non-systematic risk

Variability risk that is not substantially correlated with income (for projects that are publicly financed) or with business cycles and hence with equity market fluctuations (for projects financed by private equity) is regarded in the literature as for most practical purposes costless in the public and in the private sector. Private investors can spread such risks across a diversified portfolio, giving an expected aggregate variability low enough to be insignificant. For public sector projects such risks are generally spread across taxpayers, again reducing the variability faced by any individual to a small fraction of individual income.

Of course there are exceptions. The variability risk imposed by public investments on some individuals – such as the planning uncertainty following a provisional proposal for an infrastructure project – can be a significant social cost. On a global scale, non-systematic variability in the possible impact of some exceptionally uncertain outcomes, notably of climate change, may be large enough to increase the expected utility impact well above the utility impact of the expected income impact (Dietz et al, 2015). But such issues are handled directly, rather than via the discount rate.

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[15] A special case would arise if the STP rate were less than the GDP growth rate, as it would then not define a finite present value for the OCPF. In this (extremely improbable) situation a case can be made that the GDP growth rate (an SOC rate) would be the optimal social discount rate for consumption or for public spending. But it defines a minimum figure, as opposed to Rabl's conception of it as a maximum.

[16] As noted long ago by Lind (1990, p S-19), "the crowding out [of private investment by public investment] that has been the focus of most of the closed economy models does not appear to be very important to the analysis of the social discount rate".

[17] Jenkins, Kuo and Harberger (2011, Chapter 14), advocates of the SOC approach, do however recommend the use of an OCPF. They describe it as the 'shadow price of government funds' and estimate a 'low' value 1.2, derived by the 'small triangles' approach criticised by Feldstein (1997). It is applied however to give more weight to public expenditure than to consumption in CBA, in combination with an SOC discount rate, which already achieves this effect.

4.1.2. Systematic risk

With the SOC (or CAPM) approach to social discounting an equity risk premium is embedded in the SDR. This premium measures the extent to which equity investors require a higher rate of return as compensation for the typically major and often long lasting fluctuations of equity markets. With the STP (or risk free market rate) approaches no such premium is automatically embedded.

It is sometimes argued that the premiums revealed by equity financing cannot be a function of equity financing, because financial markets are so efficient, but must be a social cost inherent in the activity. There appears however to be no analysis of how and to whom this premium would apply in an activity financed by public debt or taxation. Recent climate change literature, as noted below, sometimes presents equity market risk premiums as possibly relevant. However the argument is not widely accepted in the literature, nor, it seems, widely accepted in public sector institutions.[18,19]

Setting aside equity markets, there is still a case for including in any social discount rate a factor for any covariance over time of flows of public costs or benefits with per capita income. Indeed correlations between public service impacts and per capita income are often strong. However the *covariances* are normally extremely small. The premium for costs or benefits that varied proportionately with per capita income (i.e. a 1% increase in income is associated with a 1% change in the impact) would be given by $\eta\sigma^2$, where σ is the proportional standard deviation of the income growth rate.

Gollier (2013, Table 3.2) presents values for σ for five developed countries for 1969-2010, ranging from 1.74% (US) to 2.21% (Japan). Taking the UK figure of 2.18% and a range of values for η of 1 to 2 gives a discount rate adjustment for such costs or benefits of 0.05% to 0.1%. Some impacts vary more than proportionally with income, but even if their percentage fluctuation were more than twice that of income this would still imply a discount rate premium of 0.1% to 0.2%. UK government convention since the 1980s has been to acknowledge that a premium of the order of 0.1% is implicitly embedded in the discount rate, but that it is insignificant relative to other uncertainties in its derivation.

Climate changes needs now to be acknowledged as an exception (Gollier, 2013; Kolstad et al, 2014; Dietz et al, 2015). Dietz et al for example derive, on the basis just described, a discount rate premium for projected, very long term variances in income and climate change impacts of about 0.6%. These studies also give weight to the premiums displayed in equity markets. But it is unclear why the very large, often largely behaviourally driven, and often long lasting equity market variations, imposing asset value fluctuations of which investors are very much aware and can set against well defined counterfactuals, have useful

[18] Public sector institutions do usually accept that, despite the higher financing cost, private financing can facilitate better incentives and overall value for money. However very few institutions, the New Zealand public sector being perhaps the major exception, appear to rely heavily on the CAPM rationale in determining social discount rates.

[19] Another angle on the equity risk premium and the SOC rationale is that this element of private sector returns is not a social benefit but a cost, compensating shareholders in part for systematic equity market risk. It is not clear that it contributes to the social opportunity cost of lost private investment.

relevance to the costs of variabilities such as those associated with most government policy interventions.

Sometimes costs or benefits, especially in overseas development projects, are significantly correlated with the income of those affected, but not necessarily with income growth rates over time. For example a scheme may improve crop yields more in years of drought than years of plenty. But such case-specific impacts have historically been normally handled outside the discount rate.[20]

4.2. Optimism bias

Guidance on public or private sector practice is usually that project-specific optimism bias should be handled by adjustments to cost and benefit data rather than to the discount rate. An SOC rate may also subsume wider risks that are normally not addressed explicitly in project appraisal. An STP rate however will not automatically include such risks. This is discussed in the Appendix.

4.3. Public investment versus public consumption

It is still sometimes assumed that the public funding of investment affects the economy differently (e.g. in its effect on private investment) from the public funding of current costs. However in modern developed economies the procedures for public expenditure allocation are such that the funding of an extra dollar of public capital spending usually imposes essentially the same cost on the economy as funding an extra dollar of public current spending.

4.4. Pricing versus appraisal

Some public sector activities sell their output in the open market.[21] There is an efficient-markets case for such activities being required to set prices to earn a financial return that provides fair competition with other marketed goods and services. Such a return would be based on an analysis of commercial returns, similar to the process of deriving an 'SOC' (or CAPM) rate of return.

But a requirement of efficient market pricing for the output of a given set of public assets is distinct from the social optimisation of choice of technique in designing these assets, and from the social CBA of the public body's investment options.[22]

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[20] Noting that the absolute amount by which the certainty-equivalent value of a monetised cost or benefit C is reduced by its covariance with income Y is given by $\delta C = \eta \mathrm{cov}(C,Y)/Y$.

[21] In the UK this applied to the old nationalised utilities and applies today to some activities of trading funds such as the Met Office.

[22] A feature of the UK nationalised industries regime was that the SOC discount rate (later called a 'required rate of return') was in most industries used exclusively for choice of technique, for which it was not technically appropriate, while the setting of financial returns from sales, for which an 'SOC approach' would have been technically appropriate, was constrained by political factors, dictating much lower rates of return.

4.5. Valuing the opportunity cost of public funds (OCPF)

It is uncontentious that raising a dollar of taxation (or increasing public debt that has to be redeemed) does not merely transfer a dollar from the private to the public sector. It also imposes administration costs and the costs arising from tax and debt-induced market distortions, including impacts on private sector investment. This cost of a dollar of taxation is the present value (at the STP discount rate) of the consumption lost from the withdrawal of the dollar from the economy.

Estimation of the OCPF is not a subject for leading academic journals. Published work on it tends to focus on triangles in demand and supply diagrams indicating the loss of welfare caused by taxes, in particular on the demand for labour, and this consistently produces values in the region of 1.2 to 1.3.[23]

However this is persuasively challenged by Feldstein (1997), who notes (pp 209–210): *"many economists believe that an increase in tax rates would cause only a small deadweight loss. This view is based on thinking about the deadweight loss as a 'small' triangle, the size of which reflects the small effect of a tax rate change on the supply of labor and on the rate of saving."* He questions this reasoning on several counts. One is that *"the deadweight loss caused by a change in tax rates is not a small triangle but a much larger trapezoid because we start with an existing tax distortion."* This can increase the distortionary cost of a marginal tax increase by a factor of ten. Another is that *"The relevant labor supply elasticity is much larger than the traditional estimates imply*": productivity and income are affected by many factors influenced by tax rates, including education, occupational choice, effort and location. Higher tax rates also distort compensation packages, and the small triangle reasoning omits impacts on savings across assets and over time, and on other consumer spending patterns.

Usefully precise quantification of these individual impacts is impossible. However opportunities sometimes arise to estimate the aggregate effects of substantial changes in aggregate taxation. Feldstein presents some analysis of the effects of the 1986 tax reductions in the US, based on comparison of tax returns for 1985 and 1988, and comparing impacts on goods and services procured by pre-tax income with those procured by post-tax income. That work implied a much higher OCPF, of more than 2.5. But no other comparable work appears to have since been published.

A more direct approach is to observe the OCPF implied by government decisions. This is possible when a government uses an STP discount rate and allocates expenditure at least partially according the benefit cost ratios (BCRs) of net social benefits to public spending. For the UK this would imply an OCPF of at least 2. [24]

[23] A recent review, still leaning towards the traditional low range of figures, is Massiani and Picco (2013).

[24] This based on personal experience. However a remarkably high average BCR of 12:1 is publicly claimed for flood protection schemes (Environment Agency, 2014, p17). Dodgson (2009, Tables 1 and 2) reports average BCRs greater than 4 for UK road schemes, greater than 2 for rail schemes and just under 2 for local public transport schemes .

4.6. The very long term

The handling of costs or benefits over the very long term (beyond say 30 or 40 years, and extending to centuries), continues to be debated. Portney and Weyant (1999) remains a much cited conference record. A more recent study is Gollier (2013). However recent academic debate is well summarised in a short report published by Resources for the Future (Arrow et al, 2012), on a conference promoted by the US Environmental Protection Agency.

Arrow et al record agreement that "*the Ramsey formula provides a useful framework*" and note the academic quibbling over the values of the parameters. More substantially, they explain the reasons why "*theory provides compelling arguments for a declining certainty-equivalent discount rate*".

The main reason for this is that the future state of the world, including per capita growth rates, is uncertain, and so too therefore is the appropriate discount rate. In this case the effective discount rate, corresponding to expected present values, declines towards the bottom of the plausible range as the discounting period lengthens.[25] At present however there is little empirical data to help assessment of the rate of decline.

A reason for decline in *pure* time preference is the widely held presumption that people discriminate less between more distant time intervals. For example people in 2015 may empathise more with the future population of 2020 relative to that of 2030, and more also, but to a lesser extent, with the population of 2090 relative to that of 2100.[26]

But discounting of large social costs or benefits beyond four or five decades can divert attention from possibly very large uncertainties, for example about future technology. Presentation as cost and benefit flows in real time may sometimes be better.

4.7. The importance (or otherwise) of the SDR

The importance of the social discount rate to public sector decisions tends to be overstated.

Adoption by a government of a higher or lower discount rate might have little or no effect on the level of public capital or current spending.

It might nonetheless change the prioritisation of some projects and would affect engineering design trade offs between capex and opex. It might also have some marginal effect on perceptions of very long term issues such as that of climate change. It is thus usually worth some effort to derive and apply a rate that is technically robust. But poor spending decisions usually arise from overoptimistic estimations of costs or benefits that would have led to approval even under a very different discount rate.

[25] For example, if the true rate were equally likely to be 2% or 6%, the average of the PVs of $1m discounted over 1 year and over 100 years would be respectively $0.962m and $0.070m. These average PVs would be derived from discount rates of 3.96% (i.e. very close to the average 2% and 6%) and 2.69% (i.e. much closer to 2%).

[26] There is also evidence (Bradford et al, 2014) that people's intuitive perception of future time periods may be more logarithmic than linear (as is the case with physiological perceptions of for example sound, heat, and light). But the extent to which this, if correct, should influence social discounting seems debatable.

5. Conclusion

The SOC convention arose when, 50 years ago, debate about government discounting was almost wholly confined to comparing public investment with subsequent consumption benefits. In this context an SOC rate may often be a reasonable approximation.

Over time it has become clear that the need to adjust separately for the OCPF is not a serious obstacle to using a discount rate that more accurately reflects social time preference. And the application of SDRs has extended to major areas that are far removed from CBA and to which SOC discounting is not appropriate. The increasing profile of the very long term has further limited the role of SOC.

The SOC concept can however appear so obviously correct that it can be difficult to accept that it merits critical examination. Lawrence Summers, when chief economist at the World Bank, wrote: *"Once costs and benefits are properly measured, it cannot be in posterity's interest for us to undertake investments that yield less than the best return. At the long term horizons that figure in the environmental debate, this really matters. A dollar invested at 10% will be worth six times as much a century from now as a dollar invested at 8%."* (Summers, 1992)

But sixteen years later Summers stated with approval the following, having moved perhaps too far:

"Two widely held conclusions [of the more recent literature] *are that market rates of discount are not the appropriate indicator when considering projects undertaken on behalf of the society as a whole and that market rates are well above society's true discount rate. The implication is that social investments should weight the future far higher than do private projects"* (Summers and Zeckhauser, 2008).

Social discounting is such a deceptive issue that different mindsets seem likely to persist. Long term discounting in the literature has become predominantly STP territory. In general public policy, STP (or risk free interest rates) and the use of BCRs for CBA have become established in much of Europe, and the use of STP for CEA also in the US OMB. Meanwhile the focus in Australia and several other advanced economies remains with SOC.

There may however be scope for wider recognition that the SOC approach to social discounting is not appropriate for cost-effectiveness analysis, which covers a wide range of public sector appraisal; even if applying STP also to cost benefit analysis, with reliance on BCRs rather than NPVs, may be a bigger step.

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Appendix

The valuation and application of an STP discount rate

Valuing STP

Pure time preference

Some authorities, including big names from the past (e.g. Pigou, Ramsey, Harrod), assert that the only ethically sound position is to give the same weight to all future as to present populations. Others, notably Schelling (1995, 1999, 2000)[27], suggest that government analysis should generally reflect people's preferences, and that people mostly care more about the marginal welfare of those with whom they empathise more closely, which implies a declining weight over time for future populations. The former, super-altruistic line appears to be more popular among academics than among public sector practitioners, especially economists.

There is little empirical evidence on how much people care about the marginal welfare of future populations. Early studies suggested implausibly high time preference. More recent work has explained this anomaly (Frederick, 2006). But no authoritative study appears yet to have been designed to estimate people's views precisely. Casual discussion suggests that 2 per cent per annum, giving a weight to marginal welfare in 35 years time only half that of today, is too high, but 1 per cent, giving half today's weight in 70 years time, might be widely accepted.

There is a case for a further element in this *"δ"* term in the Ramsey equation to reflect optimism biases, including global catastrophe, that would generally not otherwise be included.[28]

The elasticity of marginal utility

There are several approaches to valuing this elasticity (η) and all are open to criticism. But the more plausible methods have over recent decades given a broadly consistent picture.

Some academics[29] believe that η should have an egalitarian dimension, with its value increased to give relatively less weight to the marginal utility of richer future generations. However economists in government generally see η as ethically neutral.

Some approaches to estimating η are prima facie unpromising and produce implausible figures.[30] The two most promising approaches may be those based on the progressivity of

[27] The 1999 reference repeats earlier work, but is followed by a Comment (Rothenberg, 1999). Rothenberg is critical of Schelling's presentation of climate change policy as being largely an issue of overseas aid from developed to developing economies, but endorses Schelling's concept of "empathic distance" as a criterion for determining the weight that the current generation should give to the welfare of future generations.

[28] Martin Rees, the UK Astronomer Royal, has written that *"I think the odds are no better than fifty-fifty that our present civilisation on Earth will survive to the end of the present century"* (Rees, 2003). This would imply an addition to the SDR of 0.7%.

[29] For example Atkinson (1996), Beckerman and Hepburn (2007), Dasgupta (2008), Newbery (1990).

income tax scales and on demand through time for an additively separable commodity. The recent approach of subjective wellbeing may also have promise. A fourth approach, more tenuous but sometimes given weight, derives a value for η from studies of life-cycle household saving behaviour. Reviews of the first and last of these approaches were set out by Cowell and Gardiner (2000). A recent substantive work, currently still at working paper stage, with new work on the first two and the last approach, is Groom and Maddison (2013), using UK data but including discussion of the wider literature.

There has in American literature been for many decades some consensus around values for η, in the context of STP, of about 1.5.[31] In the UK literature there has been convergence over time towards a similar figure.[32]

The application of STP

The use in government of an STP approach to discounting rather that an SOC (or CAPM) approach involves more than just the choice of a standard discount rate (or rates).

In CBA, where public spending is being compared with benefits valued in terms of consumption, an SOC rate may account adequately for both time preference and the opportunity cost of public funds (OCPF). And with an SOC rate (setting aside non-monetised factors) the NPV will normally be used as the main decision criterion, with a positive NPV implying a prima facie acceptable proposal.

Use of an STP rate will provide a comparison of costs and benefits over time that better reflects social preferences, but then separate account needs to be taken of the OCPF. One way to do this is to estimate benefit cost ratios (BCRs), where costs are defined as the PV of public spending, and benefits as the PV (in dollars of consumption) of all other costs and benefits. To be acceptable, the BCR will have to be large enough to stand up against other current or prospective expenditure options.

In CEA the use of an STP rate to derive an NPV is in principle sufficient, as the OCPF applies to both costs and benefits.

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[30] This includes direct measures of individual intertemporal substitution and of individual relative risk aversion to income variability. It is sometimes supposed that, because the elasticity of marginal utility and coefficients of risk aversion and inequality aversion are all represented by the same algebraic term, estimation of one applies to the others. But when it comes to risk and inequality, this simple algebra does not capture important aspects of human preferences (Atkinson et al, 2009).

[31] Eckstein (1958) considered a range of 0.5 to 2.0, and Feldstein (1965) a range of 1 to 2. More recently Cline (1999) opted for 1.5. Boscolo et al (1998) concluded that "the few available estimates suggest that the elasticity of marginal utility [ranges] from 1 to 2". Arrow (1995) suggested, on the basis of "rather thin evidence", 1.5 to 2.0.

[32] Little and Mirrlees (1974) suggested that "we guess that most people would put [η] in the range 1-3". Stern (1977) concluded that the evidence then pointed to the range of 1 to 10. Scott (1989), working back from market rates, estimated a value of 1.5. Cowell and Gardiner (2000) concluded that the evidence supports a value in the range of 0.5 to 4, within which they give most weight to the range of 1.2–1.4. Evans (2005) proposed a figure of 1.4 as plausible for many countries, on the basis of personal tax regimes of a large number of countries, and broad consistency with derivations from food income and price elasticities. Groom and Maddison (2013), from the four approaches they consider, propose a value for the UK of 1.50.