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March 2016

Centre for Climate Change Economics and Policy
Working Paper No. 207

Grantham Research Institute on Climate Change and the Environment
Working Paper No. 182

Grantham Research Institute on Climate Change and the Environment

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Appropriate time discounting in the public sector

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A substantial literature of social discounting has now extended over more than 50 years, but practical approaches in developed economies and international bodies continue to vary widely. This is sometimes for institutional reasons, and sometimes because of persistent differences of analytical framing. In particular New Zealand and the federal governments of Australia and Canada firmly espouse rates based on private sector rates of return, while the European Commission and some European countries are now committed to a social time preference rate. This divide was prominent in the literature in the 1960s, but this paper revisits it, in the light of the subsequent decades of development in both theory and practical application. It concludes that, while the social time preference framing is essentially correct, especially for choice of technique decisions, in cost benefit analysis it too often overlooks the opportunity cost of public funding.

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

JEL Classifications: B41, D51, D78, D99

* This Working Paper replaces a previous version of March 2015, entitled "Social time discounting: Institutional and analytical perspectives". The revisions reflect helpful comments from a leading advocate of SOC discounting, providing further important references from that literature, and further clarifying the differences today between the SOC and STP conceptual frameworks for social discounting.
The Grantham Research Institute incorporates the Centre for Climate Change Economics and Policy, which is funded by the Economic and Social Research Council (ESRC).

Abbreviations

BCR Benefit cost ratio
CAPM Capital asset pricing model
CBA Cost benefit analysis (i.e. comparing public spending with consumption benefits. Benefit cost analysis – BCA – in the US)
CEA Cost effectiveness analysis (i.e. comparing alternative streams of public spending, or alternative streams of consumption)
EMH Efficient markets hypothesis (taken here as a presumption that prices of, especially, financial assets are almost always very close to their true value)
NPV Net present value
OCPF Opportunity cost of public funding (defined here as a ratio, for comparing dollars of public spending with dollars of private spending)
OMB [US] Office of Management and Budget
SDR Social [time] discount rate
SOC Social opportunity cost (as a number, or as an approach to social time discounting)
STP Social time preference (as a number, or as an approach to social time discounting)
WACC Weighted average cost of capital

1. Introduction

The academic literature on public sector time discount rates, described here as social discount rates (SDRs), has since the 1950s seen changes in emphasis, but still evolves. Despite its superficial simplicity it throws up endless theoretical and institutional complexities, which have prevented the development of common understanding even on some fundamentals. This paper focuses on the two main paradigms that emerged in the early literature and have subsequently evolved along very different paths.

The paradigms are described here, as often since the earliest literature, as Social Opportunity Cost (SOC) and Social Time Preference (STP). The SOC approach starts from the premise that the rate of return to public investment, and hence the public sector discount rate, should be no less than the rate of return from the money being left in the private sector. The STP approach starts from the premise that the weight given by government to future marginal income should be based on how much the current population cares about future populations' marginal welfare, and on how the welfare of future marginal income declines with expected income growth.[1]

This paper is written from the perspective of a practitioner who has worked under both regimes and followed the literature over many decades, but now, with reservations, favours the STP paradigm. The paper's title is adapted from a useful paper by advocates of the SOC paradigm (Burgess and Zerbe, 2011) (B&Z).[2] It addresses the main arguments presented, in

[1] The terms 'descriptive' and 'prescriptive' are sometimes used in this context. 'Descriptive' is used to describe derivations presented as being on the basis of economic efficiency and 'prescriptive' to describe those presented as being on the basis of social welfare. These terms are not used in this paper.

[2] Burgess and Zerbe (and subsequently Burgess, 2013) also assess thoroughly another approach that has arisen more recently, described as "marginal cost of funds". This however seems unlikely to be adopted by governments and is not discussed further here.

B&Z and elsewhere, by advocates of both paradigms, with a view mainly to helping debate within institutions where it is already active.

Complexities such as taxation, diverse sources of finance, risk, ultra long timescales, understanding of people's behaviour and preferences and views on ethics provide ample scope for continuing literature on both paradigms. However this literature, while often sophisticated, almost wholly addresses complexities within one paradigm or the other. B&Z is a commendable exception.

The rest of this paper starts with a comment on how the issues tend to be handled within government. This is followed by an overview of current paradigm choices across leading national government and other public sector institutions. This is followed by an overview of areas of apparent agreement and the differences between SOC and STP advocates., including the two issues where perspectives and experience appear to differ most sharply. This is followed by an account of the application of an STP regime. A concluding discussion summarises the issues and adds further perspectives. An Appendix covers some issues that are significant but would clutter the main text.

2. Discount rates in government

Responsibility for setting government discount rates usually resides in a ministry of finance or equivalent body and it seems, anecdotally, that the decision making processes across most developed economies have much in common. There is typically some good technical input, from in-house advisers with some knowledge of the literature and probably academics. The actual decision making process then depends on power structures and often current institutional interests. Often the prevailing paradigm is so well established that it is not challenged, in which case any debate about changing the number may be driven largely by intra-government interests seeking a higher or lower number. This might be, for example, to provide a lever to help constrain or to promote public investment, or to constrain or promote private financing of public services. If the prevailing paradigm is challenged any process of change may take months or years.[3] The outcome may depend on personalities as much as technicalities. Changing the rate or rates is in any case (unless the regime is tied explicitly to market rates) often institutionally difficult and hence infrequent.

The gap between most in-house government and most academic debate is wide. Government ministers may be content to leave such an issue to senior officials. But these officials need arguments that they feel they can understand and accept and present to ministers and others easily and with conviction. There are rewards here for clear conceptual reasoning and practical examples, but none for specialised terminology, or more than basic algebra. This paper, while addressing levels of detail beyond those of high level government debate, leans towards this in-house government style.

[3] As an example *"OMB Circular A-4, published September 17, 2003, was developed through a multi-year process that included a collaboration of analysts at OMB and the Council of Economic Advisors, public comment, expert peer review, and formal interagency review. The result of that process was a refined OMB position on time-preference issues."* (Graham, 2007) This process, unsurprisingly, produced only a compromise between conflicting views.

Another difference between government and academic perspectives is stress on the importance of discount rates for policy decision making. Many academic studies open by stressing the great importance of the social discount rate, sometimes with a dramatic example of the effect of compounding or discounting over several decades. Reality is less dramatic. Discount rates do matter, and the choice between 'low' and 'high' single figures deserves serious debate. So too does the conceptual basis of the rate. But a variation of two or three percentage points may have no significant effect on the level of a nation's public capital spending and minimal effect on the actual choices made.[4] Big investment mistakes arise overwhelmingly from perverse political priorities, or large, optimistic errors in judgement about costs and benefits, not from poor choices of discount rate.

3. Current paradigm choices

Practical approaches to public sector discounting today can be broadly categorised under five headings as follows. All except the last rest on the SOC and/or STP paradigms. There are overlaps, and some institutions adopt different approaches in different contexts.

SOC regimes: Some countries, states and provinces, notably New Zealand and federal government in Australia and Canada, apply SOC discount rates.

STP regimes: Most European-wide institutions and some European countries apply STP discount rates.

Borrowing rate regimes: Some countries, including Norway, with other Scandinavian countries tending that way, apply discount rates based on government borrowing rates. The US Office of Management and Budget (OMB) specifies such rates for cost-effectiveness analysis (CEA). These conventions appear to be based on broad conceptual acceptance of the STP paradigm, but a choice to avoid the institutional hassle of developing an STP rate from first principles.

Dual approaches: Sometimes different rates are specified for different types of cost or benefit. The US OMB (2014) specifies for *cost-effectiveness, lease purchase, and related analyses* a rate equal to the government borrowing rate for a similar term. For *benefit-cost analyses of public investments and regulatory programs that provide benefits and costs to the general public* it specifies an SOC rate of 7%; but 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".[5]

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[4] Even with climate change, with its long timescales, discounting perhaps receives disproportionate attention. The case for global action as fast as is achievable within the severe political constraints is clear to most impartial observers from real time projections, including their uncertainty, without discounting. Social discount rates matter more for choices between technologies, but even here they are rarely decisive for major policy decisions.

[5] 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

Pragmatic regimes: Some bodies face institutional constraints on promoting a formal analytical framework. The World Bank, as an example, has for the appraisal of proposed projects long specified a real rate of 10% or higher.[6]

4. Some common ground …

There appears to be wide agreement, across both the SOC and STP paradigms, that the appraisal of a proposal from a government perspective should in principle convert all the costs and benefits into consumption equivalents and then discount these at an STP rate. And, in the early literature, both paradigms focused on the displacement by government of private investment, which would have earned a rate of return higher than the STP rate.

B&Z cite Marglin (1963), a leading early proponent of STP discounting, developing qualitatively the principle of combining an STP social discount rate with a shadow price (>1) for public investment. Such a technique, using both an STP discount rate and a shadow price derived in this way, appears not to have been seen by any government as workable in practice. The SOC approach, reflecting the cost of displaced private investment more simply, by applying a discount rate higher than an STP rate, dominated as governments adopted discounted cash flow techniques in the 1960s and 70s.[7]

Recent decades however have seen a trend towards the use of lower government discount rates, associated with some increasing practical acceptance of a simpler form of the STP approach.[8] And much of the discounting literature in the past two decades has been associated with the climate change debate in which the STP approach, while not unchallenged, remains the dominant paradigm. In this context Weitzman (1998, 2001) surveyed professional economist opinion of the appropriate social discount rate for long term benefits and the responses lay much more in low single figures than higher values.[9] B&Z (pp 11-12) cast serious doubt however on the validity of these returns as a basis for public policy. Probably most STP advocates would share these doubts. Weitzman's exercise was of some interest, but is unlikely to have materially influenced any government views on discounting.[10]

Turning to practical application, advocates of both approaches generally recognise clearly the distinction between general time discounting and use, or potential use, of the discount rate to adjust for changing values over time (notably for outputs such as environmental benefits, which might be expected to increase in real unit value over time). Both approaches normally work in real as opposed to nominal values. And, while some SOC

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and investment. OMB concurrence is required if this method is used in place of the base case discount rate."

6 Although in its backroom analytical work the Word Bank may adopt STP rates (e.g. Lopez, 2008).

7 In those early days practical application tended to mimic the private sector directly, using a discount similar to, for example, a general private sector company gross-of-tax rate of return. This was easy to present especially in the context of investment by publicly financed enterprises.

8 This trend is well summarised by a leading advocate of the SOC approach in Harrison (2010) (p 12).

9 Harrison (p 11) records that Weitzman's responses from 2160 PhD economists had a sample mean at around 4% per year, a standard deviation of around 3%, a median of 3% and a mode of 2%, with a range of -3% to 27%.

10 A more rigorous and wider ranging exercise (Drupp et al, 2015) recently produced fairly similar results, but subject to many of the qualifications that apply to Weitzman.

regimes may customise the discount rate to each practical application, more often both SOC and STP regimes apply a common discount rate to nearly all cases.

A further point of agreement appears to be doubts about most of the figures derived in the literature for the social cost of a marginal dollar of taxation. These figures, derived from estimation of the 'triangles' of lost consumer and producer surplus arising from taxes, are typically in the region of $1.2 to $1.3.[11] There are good reasons to believe that in the CBA context the opportunity cost of public funding (OCPF) is normally higher than this.[12] However, while the OPCF way is conceptually a core element of the STP paradigm, the SOC paradigm's principal approach to opportunity cost is quite different, being based on the opportunity cost of financing public capital spending.

It is only fairly recently (Harberger, 2007) that the concept of the marginal dollar of taxation has been introduced as "a necessary supplement … [to] … the conventional assumption of capital market sourcing". This addresses the distinction between projects that are self financing, say by user charges, and those that are not. It notes that, with no cost recovery, a project would accumulate debt, and to handle this it assume that tax is raised to recover the financing of the debt over the project lifetime. This tax raising would incur an OCPF in the sense used in this paper and in the STP paradigm. This approach to the handling of public revenue, or lack of it, is a striking illustration how the two paradigms have evolved into radically different frameworks.[13]

A field of apparent broad agreement however is the basic mechanics of public finance. Public spending in developed economies is general funded predominantly via some form of consolidated fund, which in turn is funded predominantly by taxation, with often a smaller share from net borrowing.[14] The distribution at the margin between tax and borrowing is handled as an issue of macroeconomic management, which can be assumed in microeconomic analysis to be competent, so that the social costs of marginal dollars of taxation and of borrowing are for practical purposes near enough equal.

Related to this is the distinction between capital and current public spending. The distinction is very important in public expenditure planning and management. But this is separate from the question of whether the social cost of funding a million dollars of public capital spending (or overspending) differs from that of funding a million dollars of public current spending (or overspending). In the STP literature there is no difference.[15] In the

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[11] This is not to dismiss the value of this work, of which the impressive book by Dahlby et al (2008) may be the most widely cited example. Its analysis is relevant to applications such as the comparison of fiscal regimes across federated states.

[12] The OCPF as defined here quantifies the social cost of $1 of spending funded by taxation. This cost is more than $1 because of the impacts of taxation on the economy. Differing terms are used to describe the concept. Dahlby et al (2008) uses the 'marginal cost of public funds'. Harberger (2007) also uses the term 'shadow price of public funds'. The UK government once used the term 'social opportunity cost of exchequer finance'. Feldstein (1997) expresses the concept as the 'deadweight cost of tax changes' (i.e. OCPF – 1).

[13] In the STP paradigm user charges would typically increase the BCR by appearing both as a negative user benefit in numerator and as negative public spending in the denominator.

[14] Other sources of funding include, for example, charges to users of public services.

[15] Early CBA literature focused on the comparison of public capital spending with later consumption benefits, with little attention to public operating costs. This may have led to some cultural intuition within

SOC literature the issue is less explicit, but appears at least sometimes to be seen in a similar way. A thoughtful paper cited with approval by B&Z (Sjaastad and Wisecarver, 1977) notes (p 516) that "there can be no doubt that current public expenditure must be charged not only with current consumption forgone but also with unrealized potential future consumption due to displacement of current investment in other sectors."

As a general principle it is widely agreed across all discounting paradigms that discounted present values of costs and benefits, while often a central element in policy analysis, are rarely if ever the last word. There will generally be other significant, non-monetised factors that need to feed into decision making.

5. … but two separate literatures

In recent decades the SOC and STP approaches and their associated literature have evolved in strikingly different ways.

B&Z note that, today as in the 1950s and 1960s, "While the SOC is conceptually straightforward, it is empirically challenging to arrive at a reliable estimate; not only must rates of return on alternative sources of funds be estimated, so must the proportions of funding drawn from each source". Thus the focus of the SOC literature is the effects of public fundraising on the economy and the sophistication of this analysis has developed substantially.[16,17]

In the 1950s and 1960s the STP approach was different in that it differentiated between social time preference and the opportunity cost of public funds. However the two approaches framed the issue on similar ways. In the STP approach the opportunity cost of public funds was estimated as the present value, at the STP discount rate, of the consumption lost by public fundraising, which of course faced at least as many problems as the SOC approach.

It was not until 1970, as discussed later below, that an authoritative paper noted that many applications of social discounting were to "choices of technique" (such as the comparison of coal and nuclear power generation) and that in these cases the opportunity cost of public fundraising was not important. But this had little if any effect on institutional practices. It was only in the 1980s and 1990s that the STP approach slowly gained significant traction in some administrations. This appears to have been partly because of increasing recognition of the "choice of technique" issue. It may also sometimes have been partly because the increasing use by public agencies of off-budget, direct private financing of public services, which could look very efficient with an implicit social cost of public capital in high single

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economics, now fading, that capital and current public spending are more different than the really are. Sometimes today a government may, for self-discipline of borrowing, tie its borrowing to its capital spending. But even in this case it may still be reasonably assumed that marginal taxation and marginal borrowing have similar social costs.

16 Harrison (2010) provides an exceptionally thorough, Australian exposition and analysis of the issues.

17 Another approach sometimes promoted for social discounting is that the rate of return to a public investment should be no less than what would need to be earned by a privately financed investment of similar risk in a competitive market. It implies case-specific discount rates depending upon the project's level of (systematic) risk. However the main differences between the SOC and STP paradigms apply equally to this "private sector analogue" approach.

figures, was threatening effective central public expenditure control. Subsequently the arrival of climate change (and to a lesser extent nuclear decommissioning) as major, very long term policy concerns, has further reinforced the use STP.

One consequence of these developments has been that the STP approach has in recent decades largely abandoned direct estimation of the opportunity cost of public finance (OCPF), in favour of a quite different, pragmatic approach as outlined later below. The focus of the extensive STP literature is thus the specification and quantification of social time preference.

Most STP regimes might now be fairly criticised for giving too little weight to the OCPF. Most SOC regimes might be fairly criticised for being too locked in to the perception that the OCPF can generally be handled satisfactorily by means of a discount rate.

B&Z explain the justification of the SOC approach as follows: *"The SOC approach is justified by the straightforward principles of applied welfare economics – demand price measures marginal benefit, competitive supply price measures marginal cost, and adding up (i.e. dollars of benefits and costs are valued independently of to whom they accrue) (Harberger 1971). The basic exercise is the extraction of resources from the economy, which displaces investment and stimulates saving and in an open economy attracts additional foreign funding. The discount rate should be consistent with choosing a project that is more productive over another that is less productive. The rate then must cover the productivity that is forgone as a consequence of displaced investment and the net-of-tax supply price of the newly induced savings and the marginal cost of incremental foreign funding. Any lower rate than the weighted average represented by the SOC will fail this test. Though one can find a number of ways to motivate lower rates, one cannot escape the penalty of ignoring the correspondingly higher social productivity of investment funds. Any higher rate will forego desirable projects."*

STP advocacy today starts from a different platform. It too would claim to be "justified by the straightforward principles of applied welfare economics". But while "the extraction of resources from the economy" is important it is not seen as "the basic exercise". It agrees that public investment criteria "should be consistent with choosing a project that is more productive over another that is less productive". But it does not accept that this is generally achieved by applying an SOC discount rate.

B&Z note that *"The STP approach plays a prominent role in the academic literature on the social discount rate. Because our ultimate position is in support of the SOC approach, we will focus on comparing how the STP and SOC criteria perform in simple situations."* Few if any STP advocates would question the comparisons then made in B&Z, in which the SOC and STP approaches (with simple derivations of an OCPF to use with STP discounting), give the same division of projects into those with positive and negative NPVs. But these simple situations are far from most real applications. They do not justify a supposition that the SOC and STP paradigms, as now applied, are equivalent. They are in practice very different, in theory and in application.

The following two sections discuss two areas in which the approaches differ especially widely, namely comparisons over time of alternative public spending profiles and the costing of systematic risk.

5.1. Cost benefit analysis versus cost effectiveness analysis: The Feldstein simplification

Towards the end of the very active period of academic debate on social discounting in the 1960s (which had included the transformation of financial economics), Feldstein (1970) published a short, but academically rigorous exposition of an insight that STP advocates now often take for granted. This was that, in Feldstein's words *"in an important special class of expenditure decisions the problem of evaluating the social opportunity cost of funds transferred from the private sector can be ignored; in these cases only the social time preference rate is relevant"* (emphasis added). The special class of decisions Feldstein described as *"the choice among alternative techniques of producing a given output when project expenditures are equal or proportional to the social costs of the resources used. The most obvious examples include the degree of capital intensity, the planned durability of equipment, the timing of replacements and maintenance, the choice of fuels and materials, and other specific aspects of the choice of technique."*

In such cases, widely described as cost effectiveness analysis (CEA), public spending is compared over time with public spending (or consumption with consumption). Cost benefit analysis (CBA), in contrast, compares public spending with consumption (or the consumption equivalent value of, for example, environmental impacts). CEA in at least some developed economies is very common, perhaps more common than CBA. The fields of public policy, such as transport and environmental spending, where monetisation of the main consumption benefits is often feasible, are still fairly limited, and even in those fields there are often 'choice of technique' options to be compared.

That Feldstein article was followed by a wider discussion of circumstances to which the logic applied (Feldstein, 1973), but the issue attracted little further literature at the time. The point was however made again in a low key by Bradford (1975) and this, 40 years later, has prompted a helpful response from B&Z.

B&Z explain that *"Bradford (1975) argued that for projects whose costs displace investment in the same proportion as the benefits induce investment, the appropriate discount rate is the STP rate with no need to shadow price benefits or costs. However, his result depends upon two critical assumptions."* These two critical assumptions, and a third point also made by B&Z, are recorded here verbatim, but labelled A, B, C to help subsequent exposition: (A) *"first, that the private sector behaves myopically so its saving is not governed by optimizing behavior but rather by a simple rule of thumb whereby a constant proportion of (disposable) income is saved independent of the rate of return;" …* (B) "*second, that investments in the private sector are not feasible options for the government, because otherwise scarce resources should be invested in such projects rather than in any project that can pass muster only at the STP rate."* (C) *"Even if private sector investments are off limits for the government, whenever there is public debt outstanding debt reduction is always an option and the rate of return on debt reduction is the SOC rate."*

The crux of Point (B) – that private sector investments are off limits for the government – would probably be accepted by all but a few STP advocates. A general argument, that if government has a truly cheaper cost of capital it should be financing the whole economy, has long been posed as a *reductio ad absurdum* by strong 'efficient market' advocates, to defend their belief that the social cost of capital cannot be reduced much if at all by government financing (e.g. Currie, 2000).[18] However most developed country governments seem now to believe that, even though it might save financing costs, public financing of marketed activities tends to weaken or destroy the competition and entrepreneurial initiative that drives good service and economic progress.

Point (A) may be difficult for many STP advocates to understand as it focuses so heavily on the consequences of financing the initial public expenditure, with no similar regard for the consequences of the subsequent public expenditure savings. The impact of public expenditure costs or savings on private saving and private investment is covered in Feldstein's exposition by the variables denoted by *S* ('the shadow price of one dollar of forgone private investment') and *p* ('the proportion of public spending that would otherwise be invested [by the private sector]'). Feldstein's analysis assumes that *S* and *p* remain constant through time. He justifies this by suggesting that *"The factors which determine S and p – the social return on private investment, the incidence of taxes, the social time preference rate – are likely to remain constant or change only slowly. The resulting small changes in S and p would be of only second-order importance."* Thus the nature of private sector behaviour, myopic or otherwise, is relevant to the Feldstein logic only to the extent that it changes over time. As Feldstein suggests, such changes are likely to be of only second order importance.

Point (C) further illustrates how far the STP and SOC approaches and perceptions have drifted apart. To STP advocates the benefit of debt reduction cannot be fully described by a percentage rate of return.[19] They would see it in terms of the present value (at the STP discount rate) of the net resources that the debt reduction would generate.

The problem underlying points (A) and (C) may lie at least partly in an assumption that Feldstein perhaps believed to be too obvious to need stating. When a private investment yields a return of, say, 8%, this means that it generates a cash flow with an internal rate of return of 8%. The time profile of the cash flow may in some years grow rapidly. And it may continue to grow into the indefinite future. However Feldstein's algebra assumes that <u>it cannot continue to grow into the indefinite future at an exponential rate that exceeds the growth rate of the economy</u>. Thus if the cash flow is discounted at a discount rate higher than the growth rate it will have a finite present value.[20] This is a necessary condition not only for Feldstein's simplification but also for the concept of a finite OCPF as proposed by

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[18] David Currie, a distinguished economist, wrote this list of comments on private financing while based in the London School of Economics, then a prominent centre of efficient market hypothesis (EMH) thinking. It usefully describes this thinking at that time. Each point is addressed in a response from a more mainstream or finance ministry perspective in Spackman (2001).

[19] Of course a financial benefit to the government is the saving of debt interest, normally expressed in percentage terms, but this is common ground.

[20] In a developed economy a conventionally derived social time preference rate will virtually always exceed the projected long term economic growth rate. If it were not, there would be a case for using the projected growth rate as a social discount rate.

Marglin and others. Indeed the validity of the STP approach to public sector discounting depends upon this.

5.2. Systematic risk and public sector discounting

Public expenditure and regulatory appraisal are faced with many categories of risk. Some of these, notably the following, should not raise contentious differences between the SOC and STP approaches:

a) Non-project-specific risks, such as global catastrophe. These are implicitly included in private sector and hence SOC rates. With the use of an STP rate they need to be explicitly addressed.

b) Project-specific or institution-specific risks of optimism in estimates of costs, technical performance, or demand. These are significant in the cost of all private debt finance except high grade sovereign debt. And they will be prominent in investment decisions by venture capitalists. However, while they may figure weakly in an SOC social discount rate, they will not figure at all in an STP rate. They need to be addressed, but in other ways.

But one aspect of risk on which the SOC and STP approaches start from different premises is the cost of systematic risk – that is the cost arising from the covariance of costs or benefits with, depending upon the context, variations in equity market yields or national output.[21]

The transformation of financial economics in the 1960s included the emergence of the Capital Asset Pricing Model (CAPM), which quantifies the return required on an investment (whether in stock market securities or in business operations) as the sum of a risk free rate and a risk premium arising from the investment's systematic risk.[22] CAPM is now widely used in analysis of the costs of activities that are at least partly equity financed. And economists expert in private financing costs sometimes argue that this equity risk premium does not arise from the use of equity finance, but is an inherent function of the activity being financed. In other words, for a public sector investment financed by government, the true financing cost is the same, or nearly the same as the cost of financing it privately.

This is asserted as a matter faith in the efficiency of financial markets. Ministries of finance may take the different view that, while equity markets are essential for a prosperous modern economy, and are in many respects efficient, their very freedom leads them to fluctuate extremely widely around their "true" values, driven in large part by human sentiment and short term market incentives. It is difficult to see how and on whom an

[21] There is also the issue of non-systematic, random variability about expected values, which may sometimes be more costly with private than with public financing, but this is not further discussed here.

[22] CAPM is usually expressed by the formula: $E(R_i) = R_f + \beta i\{E(R_m) - R_f\}$, where $E(R_i)$ is the expected rate of return on capital asset i; R_f is the risk-free interest rate; $E(R_m)$ is the expected average market rate of return, so the term in curly brackets is the "market risk premium". βi (beta) is a factor equal to $\text{cov}(R_i, R_m)/\text{var}(R_m)$, relating the variability of the asset's returns to that of the market. R_i may be defined in terms of the cost of equity finance alone or in terms of project risk: the latter, when diluted by a debt element in the project finance, will have a lower beta.

"equity risk premium" (typically of several percentage points) would fall in the case of say a publicly financed, untolled road.[23]

Systematic risk does arise with public investment from their frequent correlation with variations in the economy. Correlations between public service impacts and per capita income are often strong. However the *covariances* are normally extremely small and would very rarely justify and addition to a public sector discount rate of more than a very small fraction of a percentage point. This is discussed quantitatively in the Appendix.

The SOC rate, in contrast, incorporates a significant equity risk premium, on a market average or project specific basis.

This difference in approach to systematic risk accounts for most of the numerical difference between SOC and STP discount rates. However this difference is less fundamental than the 'Feldstein simplification' noted above. That simplification would apply no less if the equity risk premium were assumed to be present with public financing. Adjusting costs and benefits in cost-effectiveness analysis for this extra cost of risk (while retaining an STP time preference rate) would modesty affect absolute present values, but would generally have little effect on the comparative NPV rankings of alternative choices of technique.

6. The estimation and application of social time preference

6.1. Social time preference, government borrowing rates and personal time preference

It is uncontroversial that market prices (in a competitive market) are a preeminent indicator of public preferences, and there is no quantitative shortage of data on market interest rates and rates of return on investment. But there is no market interest rate that provides a convincing measure of the extent to which the current population prefers to weight the marginal income of future populations less than its own marginal income.

Long term government borrowing rates may be the strongest candidate, but they have many limitations. They are usually nominal rates and expected inflation can be hard to measure. They are influenced by short to medium term government policy. They do not extend beyond a few decades. The market players are only a narrow section of the population.

Perhaps most fundamentally, both individuals and governments benefit from lower rather than higher levels of indebtedness, or from the security and flexibility of higher rather than lower stocks financial assets. Thus the benefits of financial assets and the costs of debt both exceed the expected financial returns or financial costs. Real long term government

[23] Two further points here have substance, but are not important enough to divert attention from the points in the main text. First, as noted earlier, it is sometimes suggested that, if public financing avoids the equity risk premium, conventional public investment is foregoing potential for government to finance higher yielding private investment. This would be fair, were it not that government financing in practice restrains private entrepreneurial initiative. Second, the equity risk premium is a social cost. If it is not incurred by public financing then the equity premium in the price of displaced privately financed output cannot reasonably be seen as lost benefit or opportunity cost.

borrowing rates, at least in normal economic times, might therefore at most be seen as a downwardly biased estimate, or lower limit for social time preference.

As for personal time preference, the range of market rate rates at which individuals save and borrow is extremely wide. And it seems implausible that, in most cases, these individual choices bear much relationship to people's concerns about future populations.

The conventional derivation of a social time preference rate is therefore concerned with other ways of estimating:

a) the extent to which the marginal utility of consumption or income to future populations declines as per capita income increases over time; and

b) 'pure time preference' – i.e. the extent to which the present population is (or perhaps should be) concerned about the marginal utility of future populations.

Element (a) is generally the larger, and has an extended and disparate literature. It is derived as the product of the projected growth rate of per capita consumption or income and the rate at which the marginal utility of consumption or income declines with income growth (i.e. the elasticity of marginal utility).

Element (b) has a literature no less extended over time, but often presenting little beyond the particular author's personal, subjective opinions. It is often seen as the sum of an element for risk (e.g. of the end of civilisation) and an element for the extent to which the population (or the particular author) chooses to weight the marginal utility of future populations.

Both elements are discussed in turn below.

6.2. The term cu''(c)/u'(c) and its multiple interpretations

The term *cu''(c)/u'(c)*, which is negative, defines the *elasticity of marginal utility of consumption*. And it is in this sense (with its sign changed to positive) that it is normally used in deriving an STP discount rate (as outlined in the following section). The term used in this latter sense is denoted hereafter by η.

However the term, with a negative sign, is best known in economics textbooks as the Arrow-Pratt measure (or index, or coefficient) of *relative risk-aversion*.

It is also sometimes presented as an index of *inequality aversion*.

It is also the inverse of the *elasticity of intertemporal substitution*, which can arise in studies of savings behaviour and in growth theory.

These different concepts, of elasticity of marginal utility, risk aversion, inequality aversion and elasticity of intertemporal substitution, all have uses, but the relevance of each depends on the context.[24] Human preferences are too complex to justify a general assumption that a value derived for one concept provides a useful estimate for another.

[24] Useful discussion of the first three of these uses is provided by Atkinson et al (2009).

Many methods, of varying plausibility, all with their own strengths and weaknesses, have been used over man years to estimate the elasticity of marginal utility, η, and some of the more plausible ones are well presented in Groom and Maddison (2013). There has been some convergence of estimates over recent decades to values between 1 and 2.

6.3. Myths about "the Ramsey equation"

A social time preference rate is conventionally expressed algebraically as STP = $\delta + \eta g$, where δ is pure time preference and ηg is the product of the elasticity of marginal utility and the growth rate of per capita income. This equation was first proposed by Ramsey (1928) as a young star in the early development of growth theory. The name of Frank Ramsey, who died in 1930 at the age of 26, deserves the fame brought by the wide use of the equation in this context. His work on savings and growth has had an enduring impact on the development of economic theory. However it is sometimes suggested by critics of the STP paradigm that the use of a social discount rate derived from this equation implies some particular growth model, with many associated restrictive assumptions. But this misunderstands the STP paradigm's pragmatic basis.

The Ramsey equation is a useful hook on which to hang an intuitively satisfactory and largely uncontentious way of constructing a value for social time preference. But its use in this way implies no restrictive assumptions beyond those obvious from the algebra – such as the assumption for practical purposes of constant values for δ, η and g, except in special cases, where the equation may be further developed.

6.4. The valuation of pure social time preference, δ

As noted above, the pure time preference element in social time preferences is generally seen as the sum of small elements for risk and for declining social concern for the marginal utility of increasingly distant future populations.

Risk is sometimes seen here in terms only of some small but catastrophic risk that destroys civilisation. A low end estimate of this risk is the Stern Review figure of 0.1% per year, set at this level on the perhaps fragile basis that, as civilisation has survived for thousands of years, it is unlikely to collapse any time soon. A less rosy view is that of Martin Rees, the UK Astronomer Royal, who 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% per year.

Practitioners might also consider two further risks.

- Severe adverse impacts that are unlikely to have been otherwise considered during even a well conducted investment appraisal – one possible example is the premature, political termination of German nuclear power generation following the Fukushima tsunami.
- Systematic risk. This is discussed quantitatively in the Appendix, noting that UK government convention since the 1980s has been that a premium of the order of 0.1% is implicitly embedded in the discount rate, but that, while presentationally significant, this is insignificant relative to other uncertainties in the rate.

Combination of these three factors suggests a premium for risk of no less than 0.5%.

Quantifying social concern for future populations raises the questions of whether the relevant preferences should be the considered views of the current population or the views of an informed elite. Many, perhaps most academic economists with an interest in the issue see no ethical case for giving any less weight to expected future marginal utility and, of those holding this view, many maintain that this view should be imposed by government. Economists in government tend to see the issue more as one of estimating the informed preferences of the population they are serving. This is generally taken to imply a slow decline over time, maybe of around 1% per year, as increasingly distant future populations command less empathy. Perhaps in time there will be robust empirical data to refine this.[25]

6.5. Handling the OCPF with STP discounting

As noted above, the early literature of both the SOC and STP paradigms focused on the displacement by government of private investment, which would have earned a commercial rate of return higher than the STP rate. Application of an STP discount rate would in this case be combined with an explicit, perhaps case-specific multiplying factor for publicly financed investment (and perhaps other public spending); but this was too complex for general use.

The revival of the STP paradigm as a serious contender in the 1970s largely ignored the opportunity cost of public funding (OCPF). Indeed some practitioners still overlook it. That this can happen is a weakness of the STP paradigm. It is however not catastrophic for two reasons. One is that, as noted earlier, in at least some government administrations, much or most appraisal is cost effectiveness where the OCPF is not material ('The Feldstein simplification'). The other reason is that, when it comes to cost benefit analysis, it is rare for a ministry using an STP rate to regard a positive NPV, or a BCR greater than one as a measure of acceptability. Aggregate budgets are set by a high level political process and in comparing projects a BCR much higher than one will typically be needed for approval.

The making of public policy decisions without explicitly quantifying the OCPF is a very long way from the SOC paradigm.

In recent decades, in some regimes applying STP time discounting, there has been an increase in emphasis on commercial (or 'financial') appraisal as an activity to perform in

[25] For many years studies of how much people said they cared about future utility impacts implied implausibly high pure time preference rates (e.g. Cropper et al, 1994). However Frederick (2006) replicated these results and identified methodological flaws that explained them. A more reliable study was too imprecise to provide a robust figure, though it would not have been inconsistent with zero.

parallel with 'economic' CBA or CEA. EC guidance (European Commission, 2015), specifies for the financial appraisal a discount rate that "reflects the opportunity cost of capital", albeit a rate of return that might be achieved from a financial portfolio including significant lower risk assets as well as equity.

7. Concluding discussion

The SOC and STP paradigms for social time discounting now diverge widely. Debate within finance ministries and in the literature about the fundamental methodology of social discounting (as distinct from development of the separate paradigms) is barely less confused today than it was forty years ago. Mutually inconsistent positions are now entrenched. Within each paradigm there are issues, such as the valuation of pure time preference, which may for ever elude a wide consensus or even open minded debate. However there are aspects of the wider SOC/STP debate where some fundamental analytical and practical issues are widely misunderstood, on both sides of the debate.

The SOC approach incorporates in one instrument (the discount rate) both a time preference rate and a measure of the opportunity cost of public funds (OCPF). With an STP discount rate, the OCPF needs to be taken into account separately. But the SOC paradigm generally assumes that the opportunity cost rate of return subsumes or displaces social time preference; it also focus on the social cost of public investment much more than the social costs of subsequent expenditure savings. And advocates and practitioners of the STP paradigm often forget about, or even do not understand, the importance of the opportunity cost of public spending – that a dollar of public spending costs society more than a dollar of lost consumption.

As a pragmatic approach to handling these issues in a politically complex environment the US Office of Management Budget (OMB) stands out as perhaps the most thoughtful and structurally sophisticated example. The government borrowing rate, which is a far from perfect, but politically fairly uncontroversial rough estimate for social time preference, is specified for choice of technique analysis. As discussed above, under the heading of the Feldstein simplification, this is robustly defensible. For CBA, where public spending is being compared with consumption benefits, it specifies a much higher rate, presented in SOC terms, which offsets the tendency of STP practitioners to ignore the opportunity cost of the spending. But there is a proviso that if an agency wishes and has the capacity to apply a more sophisticated methodology, such as using a government borrowing rate discount rate and an extra weighting for public spending relative to consumption, it may do so with case by case OMB approval.

Other regimes generally adopt either an STP regime or an SOC regime, albeit with assumptions that vary widely across regimes.

The UK Treasury STP regime appears to have evolved in a form that is fairly robust, by essentially abandoning NPVs and focusing on benefit/cost ratios where the denominator is the PV of net public spending and the numerator the net consumption value of everything else. An alternative would be to explicitly quantify an OCPF, which would be analytically

convenient, but establishment of a politically and intellectually robust methodology for precisely quantifying such a number may be unrealistic.[26]

For conventional CBA, the SOC approach may often give results similar to those from using STP with a sensible OCPF. But for very long term analysis, with substantial impacts more than a few decades ahead, an SOC rate will discount the future by much more than seems justified by informed social preferences.

The comparison of public and private financing raises interesting questions, as discussed in the Appendix. Applying an SOC rate to an agency's alternative streams of public spending will discount too strongly, in favour of private financing.[27] This may commit the government or its agencies to excessive future burdens of high financing costs. Applying an STP rate (or a government borrowing rate) will give a more reliable, though still slightly distorted comparison.

A perspective that can help to focus the difference between the SOC and STP paradigm mindsets is the distinction between government appraisal and government pricing. The SOC framework, with its emphasis on capital markets, is appropriate for pricing the output of a government enterprise in a competitive market. This and the political aspect of pricing are discussed in the Appendix.

The SOC / STP debate has many angles, but with respect to SOC the crux probably lies with "the Feldstein simplification". At the same time, advocates of the STP paradigm sometimes dismiss, as technically obscure, concerns about the opportunity cost of public funding. Institutions responsible for setting such regimes might do more to correct such oversight. Mindsets are so entrenched that experts in the field tend to address criticisms of their favoured paradigm, if at all, only in terms of where the criticism "must be wrong".

There are important gains to be made from establishing a robust conceptual framework, to help the analysis of special cases (such as private financing) where different approaches can give very different messages; to better inform the literature; and to better focus the expert resources sometimes consumed within government (and academia) by reinvention and oversight of historical arguments. The social discount rate is also important for its routine use in prioritising choice of technique and other spending decisions. But the debate should still be seen in the context of an earlier comment – which can offend academic readers – that, while important, the social discount rate is less crucial than it is often declared to be in determining the level and distribution of public spending.

Acknowledgments

I am much indebted to the advice of Hugh Batrouney, recently of the Australian Victoria State government.

[26] Feldstein (1977) tried nearly twenty years ago to stimulate academic study of this, with no success.

[27] Except in the eyes of those, often expert in financial economics but less familiar with government, who believe that a substantial equity market risk premium "must" somehow arise from activities financed wholly by government borrowing or taxation.

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Appendix

This Appendix contains four sections on issues that in the main text are very compressed. The first two relate to the comparative nature and handling of public and private financing costs. The third compares pricing and appraisal. The last addresses very long term discounting.

Systematic risk with publicly financed investment

The social benefits of publicly financed investments are often correlated with national income. The value of a given change in fatality risk, or an environmental impact may increase as increasing per capita income increases people's willingness to pay for such benefits. And the usage of transport infrastructure will typically increase as the economy grows. Such correlations mean that the real monetary value of the consumption benefits is higher when incomes are high and lower when incomes are low.

Qualitatively this has similarities with the correlation of the value of and equity market portfolio with equity market variations. It is often noted that the cost of such variations, which takes expected equity yields several percentage points above the expected risk free rate, is much more than that derived from a simple textbook derivation from a function of utility against wealth or income. The textbook derivation starts from a concave function, so that a gain of $x brings less extra utility than is lost by a loss of $x. It is common convention to define such functions in terms of a constant elasticity of marginal utility, now generally valued, as noted in the main text, at between (minus) 1 and (minus) 2. Such figures imply a very small equity risk premium and the failure of this elementary theory to predict reality is still described and often seen as the equity premium "puzzle".

This discrepancy is unsurprising, especially with the higher profile in recent years of behavioural economics. The basic calculation may be reasonable for marginal changes of which the individual is not consciously aware. But it is not plausible for situations where the individual is aware (as will be most active equity investors) and thus subject to loss aversion that far exceeds that implied by the simple utility function. Equity market fluctuations can be so large that they threaten lifestyles and reputations.[28]

Correlations between public service impacts and per capita income can be strong. However the *covariances* are normally extremely small, and in contrast to changes in equity shareholdings they are not consciously perceived as gains and losses. It is therefore sound to value these variations by reference to the conventional function of utility against wealth or income.[29] The premium for costs or benefits that vary proportionately with per capita income (i.e. a 1% increase in income is associated with a 1% change in the cost or benefit) is given by $\eta\sigma^2$, where σ is the proportional standard deviation of the income growth rate.

[28] The UK FTSE 100 index fell by nearly 50% in 1999-2000 and by over 40% in 2007-2009. It has also never risen in real terms to its level at the turn of the century, so any long term trend is very uncertain.

[29] Although there is sometimes reluctance to abandon private equity data as a source for estimating the cost public project covariances with per capita income. For example Ewijk and Tang (2003) describes a Dutch Commission that recommended the use a CAPM beta derived from a public cost or benefit's covariance with national income, but the 'whole market risk premium' to which beta is applied is the private equity market premium, the relevance of which is not explained.

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 fluctuations 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.

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.[30]

Social discounting of project-specific private financing

Private financing costs are not normally addressed explicitly in social CBA. They are merely one element in the market price of privately supplied goods and services. They do however need to be explicitly addressed in two cases. One case is where alternative financing costs are being compared, as for example in comparing the public and private financing of public infrastructure, such as a public road or hospital. The other case is where private sector bodies to would be required to undertake significant investment to meet a proposed new regulation.

The simplest approach to this latter, regulatory case would be to ignore financing costs and to count only the capital cost of the new asset, as if it were publicly financed. A more justifiable approach would be to estimate the private financing costs over the accounting life of the project and discount this cash flow at an STP rate. If the private weighted cost of capital (WACC) exceeds the STP this will of course give a social cost greater that the simple asset capital cost.[31]

The former case – comparing public with private financing of a given asset – brings in three percentage rates: a public cost of capital the private WACC and a social time preference rate. It is unlikely that any government could in practice maintain a regime incorporating all three functions, except perhaps for exceptional 'mega-projects'.

One simpler approach is to discount the private financing costs (i.e. the cost stream to the public sector, or consumers in the case of user charges) and the capital spend in the public finance alternative, at a government borrowing rate. This would follow the US OMB guidance. It is the most obvious practice adopted in regimes that use a government borrowing rate as a social discount rate. (It was also advocated by the UK Treasury

[30] 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 $\delta C = \eta \text{cov}(C,Y)/Y$.

[31] This technique is now used by UK regulators (Joint Regulators Group, 2012).

accountants in the early 1970s, when the general discounting regime was based on SOC.) Use of a government borrowing rate in this way will bias the comparison slightly against private financing, insofar as government borrowing rates are normally less that social time preference.

Another simple approach is to discount the private financing costs, and the capital spend in the public finance alternative, at an STP rate. This will be the most obvious practice for regimes that use a government borrowing rate as a social discount rate. This will bias the comparison slightly in favour of private financing, which may make it more acceptable to a strongly market friendly government.

A more rigorous approach, involving the public and private costs of capital and an STP time discount rate, would apply the logic described for regulatory analysis to both public and private costs of capital, the public financing costs being distributed over time in the same way as that assumed for the private costs.

Pricing versus appraisal

As noted in the main text, the SOC framework, with its emphasis on capital markets, is appropriate for pricing the output of a government enterprise in a competitive market. It is also appropriate, and widely applied, to the regulation of private sector monopolies such as energy grids. It is one option even for pricing the output of a monopoly government enterprise or public service, although the use of a government borrowing rate or an STP rate might in these cases be no less defensible. A government accounting system that incorporated a notional interest charge on departmental assets might also use a borrowing rate, although in the UK a social time preference rate is used, which is technically anomalous, but provides stability.

The comparison of pricing and appraisal regimes illustrate more generally the difficulty of maintaining analytical consistency in some political contexts. In the UK from the mid 1960s to the 1980s there were many public enterprises, mostly monopolies, for which were specified an appraisal discount rate and pricing regimes. The appraisal rate was for many years in high single figures, or even 10% (largely to help restrain investment spending). But the pricing regimes specified real rates of return, explicit or implicit, of at most low single figures, and often negative real rates. Thus choice of technique decisions, such as engineering design, were appraised giving too little weight to future cost savings. While prices were set at inefficiently low levels (so increasing demand and pressures for excessive investment) – a topsy-turvy regime, that was for years never effectively questioned.

The very long term and climate change

Over the very long term there is a compelling case for applying a declining social discount rate, mainly because of uncertainty about the optimal number. If the present values of a dollar are calculated for ever more distant future years, the effective discount rate falls ever closer to the lower end of the plausible range of rates. (For example the present value of $1k, discounted over 100 years at 2% or 5%, is $138 or $8. If these were equally likely their average value of $73 would imply an effective discount rate of 2.6% – much closer to 2% than 5%.)

Climate change is a (modest) exception with respect to systematic risk (Gollier, 2013; Kolstad et al, 2014; Dietz et al, 2015). Dietz et al for example derive a discount rate premium for projected, very long term variances in income and climate change impacts of about 0.6%.