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TIME PREFERENCE, THE COST OF CAPITAL AND PPPs

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Abstract

The theoretical and practical strengths and weaknesses of the main competing approaches to public sector discounting are reviewed, with some international comparisons. The comparison of public and private financing of assets to provide public services raises further questions, which have however attracted little academic interest. The comparison requires account to be taken of social time preference for marginal consumption, the cost of capital to the public sector, and the cost of capital to the private sector. This is theoretically fairly straightforward (even if in some aspects contentious). However the development of procedures acceptable for practical use calls for some pragmatic simplification.

1 Introduction

Discounting in the public sector was a source of vigorous controversy when it first emerged in earnest in the 1960s. Over the decades some issues have faded and new ones have arisen and some international consensus has been achieved within academic welfare economics. Some consensus trends are also emerging even across governments, at least in Europe. However controversy persists on some aspects, in academia and across (and quite often within) government administrations.

This paper first, in Section 2, reviews this story, excluding issues raised by private financing. The three main positions on government discounting still promoted by economists and others from different schools are summarised, together with their main strengths and weaknesses. Some international conventions are compared and a consistent analytical and practical framework is presented that has been fairly well established within welfare economics for a decade or two and is becoming fairly widely accepted in government within Europe.

Section 3 reviews the appraisal from a government perspective of proposals that include private financing, as is often the case in proposed Public Private Partnerships. This is an area that has attracted very little academic interest, exception from some financial economists.

Section 4 summarises the main observations and conclusions.

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2 Discounting and the cost capital with public financing

It is standard practice in private and public project or policy analysis to discount costs and benefits over time, usually at a constant percentage rate per year.[1]

In the private sector the discount rate is based on the cost of capital for the activity in question, namely the weighted average cost of the relevant debt and equity financing. The government cost of capital is the market cost of government borrowing. In government however the cost of capital does not in welfare economics define the social discount rate.[2]

This section reviews the three main conceptual approaches that have evolved to discounting in government.[3] Each has advocates in some government administrations.

Until the 1970s debate about public sector discounting focused on two concepts often described, then as now, as "social opportunity cost" (SOC) and "social time preference" (STP). In the 1970s these were joined by a financial markets approach, derived from the efficient markets hypothesis (EMH) underlying the then blossoming developments in financial economics. The EMH approach has been given a modest new lease of life by the development of Public Private Partnerships (PPPs).

2.1 The efficient financial markets (EMH) approach

It is uncontentious that, in a competitive market, equity risk premiums measure a cost of "systematic risk" – that is the risk of volatility that is correlated with the equity market average volatility and so cannot be diversified away.[4] Many financial economists believe that this premium measures an *inherent social cost* of the risk of the activity being financed. Thus if the activity is financed by public debt this makes little or no difference: the cost of systematic risk that would be revealed by the equity premium if it were privately financed is still there (Brealey et al, 1997, Grout, 2003).[5]

This implies that the effective social cost of capital for a publicly financed activity, and the discount rate appropriate for comparing its costs or benefits over time, should

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1 In recent years increasing concern with the very long term has made prominent the issue of discount rates that decline over time, often described as "hyperbolic discounting". This is outside the scope of this paper.

2 A few countries, notably the US OMB (http://www.whitehouse.gov/omb/circulars/a094/a94_appx-c.html), use the government borrowing cost at least for cost-effectiveness analysis and for lease versus buy comparisons, but in these countries the reasoning, as discussed on section 2.1.2 below, appears to be that this is administratively simple and politically acceptable, rather than technically rigorous.

3 This paper is not concerned with the concept described in European Commission guidance as the "financial discount rate" for publicly supported commercial projects (European Commission, 2008). A required *financial* return on public commercial assets is distinct from the cost of capital or a social discount rate.

4 This is quite distinct from the risk of, for example, optimistic bias in estimates of capital costs or of benefits.

5 In practice financial economists appear generally to accept that the systematic risk associated with public expenditure *costs* is usually very low. These therefore should be discounted at the risk free government borrowing rate (which is normally lower than estimates of the rate of social time preference). However for discounting benefits there should generally, within the EMH framework, be a significant risk premium, as revealed by the private financing cost of similar activities.

be derived, as in the private sector, by the familiar capital asset pricing model (CAPM). In the CAPM the cost of capital for an activity is the sum of the risk-free rate (generally a government borrowing rate) and a risk premium equal to the equity market average risk premium multiplied by a factor (beta) reflecting the correlation between the expected return to the investment and the market average.[6] The EMH school argue that, for a publicly financed activity, this risk premium should be derived from that expected for a similar privately financed activity.

This is asserted on the basis that financial market are so efficient that, if they reveal a cost of risk for an equity financed activity, this cost must be inherent to the activity: it cannot be a function of capital markets. The mechanics of how such a social cost would arise from a publicly financed activity are however never explained.[7]

Welfare economists generally regard the equity risk premium as a function partly of equity markets themselves. Crucial though equity markets are to market economies and to prosperity they are in this view subject to, for example, fads or fashions among investors, and to largely mean-reverting impacts from factors such as oil crises, wars, business cycles, or indeed financial crises.

In the 1960s and early 1970s these opposing views were argued among the heavyweights. An early skirmish on the implications of the EMH for publicly financed activities was a critique, by Bailey and Jensen (1972), of arguments made by Arrow (1965, 1966) that the cost of risk may be lower for government than for the private sector. The still widely quoted paper by Arrow and Lind (1970) developed these arguments, commenting for example, in contrast in particular to Hirshleifer (1966), that "many insurance markets do not exist" and on "clear evidence that the existing capital markets are not perfect". They conclude that the cost of *GDP-covariant* variability with public financing is negligible, the variance of GDP fluctuations being far less than that of equity markets. The two sides were never reconciled and it is no longer an issue of high level debate. However Arrow and Lind (1970) continues to be attacked by EMH proponents in some UK literature (e.g. Klein, 1997, Currie, 2000).[8]

Several subsequent developments support the welfare economist's scepticism about equity markets being so efficient that they reveal a hidden cost of debt financing. In the 1990s distinguished commentators such as Wadhwani (1999) set out, before the general market downturn, reasons why the market appeared at that time to be overvalued, which in the EMH view of the world cannot happen except perhaps very

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[6] CAPM is often applied to company stock, in which case beta (the covariance of the stock's return and the market average return divided by the variance of the market average) measures the stock's volatility in relation to the market. In the context of investment appraisal beta is derived from the expected project returns, either as an equity beta or as a (generally lower) project beta when gearing is taken into account.

[7] Many benefits and costs of public service activities are correlated with fluctuations in GDP but, as was noted rather casually by Arrow and Lind (1970), the covariances are too small to impose any material social cost or benefit.

[8] The arguments deployed, such as the fact that per capita benefits of non-rival goods (such as national defence) do not diminish as they are more widely spread, are concisely presented by Currie (2000), with a response to each in Spackman (2001).

briefly.[9] A parallel finance literature (Mandelbrot and Hudson, 2004) develops models of financial markets based on fractal analysis, showing that equity market fluctuations are very different from the Gaussian distribution generally assumed in financial economics. Research evidence is also accumulating on the impact of investor behaviour on such markets.[10]

The insights into financial markets revealed during 2007 and 2008 may further cause some observers to doubt the hypothesis that financial markets are driven by well informed participants, generally valuing assets correctly on the basis of all the information available.

2.2 The role of social opportunity cost (SOC)

It is sometimes argued that a private commercial ("SOC") rate of return should be used for government discounting, or alternatively some weighted average of this rate and a (lower) social time preference (STP) rate.[11]

A more sophisticated, "shadow price" version of the SOC approach accepts that, for comparisons over time, the relevant discount rate is a social time preference rate (as discussed in section 2.3 below), but argues that public investment should be given a shadow price. This shadow price of publicly funded capital is the present value (discounted at the STP rate) of the benefits that investment of a dollar in the private sector would have yielded. Early proponents of this approach included Eckstein (1957, 1958, 1961),[12] Marglin (1963.2) and Feldstein (1964).

The SOC (or weighted average) discount rate version is discussed first below, followed by the shadow price version. It is argued that both versions are flawed, but that the second is flawed mainly in its seeking to shadow price public investment rather than all public expenditure.

The opportunity cost and shadow pricing of all public expenditure is also further discussed below.

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[9] For example successive editions of the leading textbook by Brealey and Myers (e.g. 2003, pp 563-4) say that "managers generally favour equity rather than debt after an abnormal price rise. The idea is to catch the market while it is high. … But *we know that* the market has no memory and the cycles that financial mangers seem to rely on do not exist." *(emphasis added)*

[10] For example Kirman (1995, p290) presents the results of a simple model of interactive investor behaviour demonstrating that the statistical tests often quoted in support of the EMH random walk (as opposed to mean reverting) model of equity markets are not robust.

[11] Sometimes the EMH approach is also presented as measuring an "opportunity cost". However the EMH approach claims to measure the direct social cost of public investment, not the opportunity cost of activities which the public investment might displace.

[12] Eckstein (1958) noted that he had advocated different conventions on different occasions, but suggested that they were equivalent.

2.2.1 A "social opportunity cost" (SOC) discount rate, or an SOC/STP weighted discount rate

It is sometimes presented as obvious that the opportunity cost of public investment is measured by the commercial rate of return that would be earned on private investment. However there are fundamental problems.

One basic problem is that, with the growth of international financial markets, public investment may have no significant impact on private investment. Lind (1990) concluded (page S-16) that, because of international capital mobility, "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".

The balance between taxation and borrowing is in any case an issue for macroeconomic optimisation. A competent government ensures that the social costs of marginal taxation and of marginal borrowing are broadly equal.[13]

A more fundamental weakness is that the opportunity cost of public investment or of other public spending is not completely measured by a rate of return. The true opportunity cost is the present value of the stream of consumption displaced by the tax (or borrowing) used to fund the public spending.[14]

In cost-effectiveness analysis – comparing alternative cost streams, to achieve given non-monetised benefits – even this opportunity cost is irrelevant, because it applies equally to all costs and benefits, as set out by Feldstein (1970). In developed economies cost-effectiveness analysis is more common than "cost-benefit analysis", in which some non-marketed outputs are valued

Another fundamental weakness is that the risk premium in private sector returns is a cost, not a benefit. Foregoing it therefore does not incur an opportunity cost.[15] This was set out by Arrow and Lind (1970, p376). However the assumption in the literature is nearly always that it is an opportunity cost. A possible rationale is that the government could invest in such a "private sector" opportunity, to earn the same return, but without incurring the equity risk premium. However the transition from public to private financing has other consequences, not least for incentives, which, as commented by Arrow (1995.2), make this an unreal option.

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[13] At least in countries where the central government has sufficient power to achieve this. Conventions such as the "golden rule", that changes in government borrowing should over the cycle be confined to the level of net investment, may affect the borrowing/taxation balance. However competent macro management still equalises the marginal social costs of borrowing and taxation.

[14] This opportunity cost is finite if the long run rate of return is less than the STP rate. This is normally the case, as indefinite compounding of the consequences of $1 of public spending cannot exceed the long term growth rate of the whole economy, which for any developed economy is less than any defensible rate of STP. It might possibly apply to an economy with a prospect of low per capita income growth and high population growth. In this case the long run economic growth rate provides a floor for the public sector discount rate.

[15] Although it is sometimes argued that the premium is "irrationally" high and that the irrational excess is not a social cost. However even if the premium revealed by the market is irrational it is still a social cost as is, for example, the fear of a person who is terrified of a Martian invasion.

Feldstein (1973) produced a strong critique of this approach to SOC. More recently Arrow, responding to a two page argument by a Harvard professor of international economics for the use of 10 percent SOC discount rate in an otherwise authoritative article on climate change (Cooper, 2000 pp152-5), commented that "for these two reasons [tax and risk] the observed rate of return in the private sector is not the correct one for assessing public investment projects" (Arrow, 2000).

However use of an SOC rate, or an SOC/STP weighted discount rate, has a strong intuitive appeal, which is easily sold to senior administrators or ministers, and it remains influential in many countries and international bodies, at least for presentational purposes. The US OMB rate for comparing public investment with subsequent benefits in kind of 7% (OMB, 2003) is presented as an SOC rate.[16] The UN (Economic Commission for Europe, 2003) and the World Bank (Birdsall and Steer, 1993) also, for comparing public investment with subsequent benefits in kind, adopt SOC or weighted rates.

The EC (European Commission, 2008) recommends an SOC rate for financial (as opposed to economic) analysis, but as noted above this is a required financial rate of return to public sector commercial activities, not a social discount rate.

2.2.2 Social opportunity cost as a shadow price for public investment

This more sophisticated approach, in which social time preference is used for discounting, but public investment is given a shadow price of more than unity, remains popular in some American literature (e.g. Boardman et al, 1996). It has since the 1950s generated much algebra, reflecting assumptions about, for example, how the financing of the public investment is distributed between borrowing and taxation, the consequent impact on private investment, and the subsequent social return. However this approach too has serious limitations.

At the practical level, it is difficult to apply a two stage process of this kind in a government administration, and for this reason if no other it is used very rarely. However it also suffers from the fundamental flaws of the simpler version, namely the implausible assumption of strong displacement of private investment by public investment, failure to recognise that most uses of public sector discounting are comparing public expenditures over time, so that any opportunity cost would generally apply equally to all the cash flows, and usually the false, implicit assumption that the cost of risk in returns to equity is a social benefit.

However despite its flawed theory, this approach is similar in practical terms to the use of an STP rate for discounting combined with a shadow price for ***all*** public spending or receipts to reflect their impact on taxation – a procedure that in contrast is analytically robust, as discussed in section 2.2.3.

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[16] http://www.whitehouse.gov/omb/circulars/a094/a094.html#8 , section 8.b.1

2.2.3 The social opportunity cost of public expenditure

An extra $1 of taxation is not merely a transfer between taxpayers and the government. It also imposes a social cost from the distortionary impacts on consumer, employee and corporate behaviour.

Feldstein (1997) notes that the common textbook assumption that a tax increase will reduce aggregate demand, with some consequent fall in tax revenue, does not apply in practice, because other instruments are used to maintain demand; but that many supply impacts, and distortions in the distribution of demand, are usually overlooked or underplayed. He estimates, mainly from analysis of the large reduction in US marginal income tax rates between 1985 and 1988, that spending from marginal taxation should be given a shadow price of two or more, relative to a loss of consumption. Other authors, looking at other countries, suggest much lower values of around 1.2 to 1.3 (Ruggeri, 1999), (Warlters and Auriol, 2005).

UK public sector guidance on cost-benefit analysis in transport records that "this principle might imply a 30% uplift to expenditure costs" (Department for Transport, 2004-6, paragraph 13). Australian Guidance (Department of Finance and Administration, 2006, pp 37) suggests a 25% uplift (although this is subsumed in a "social opportunity cost" discount rate, as discussed above).

It would be technically sound in cost-benefit analysis to apply a shadow price to public spending, but few (if any) public administrations generally do so. However when a public infrastructure cost is being compared with consumption benefits, all discounted at a social time preference rate, it is generally accepted that, to merit consideration for approval, the ratio of benefits to public expenditure costs has to be very much more than 1. This ratio can readily accommodate the opportunity cost of public spending (as well as possibly reflecting other concerns such as optimism bias in cost or benefit projections).

2.3 Social time preference

2.3.1 The derivation of social time preference

Social time preference (STP), as normally defined, is the time preference of the population as a whole for marginal income or consumption.[17]

Leading early exponents of an STP discount rate for public sector analysis were Eckstein (1958) and Feldstein (1964) and later an influential paper by Bradford (1975). Others, taking a growth theory perspective, were Marglin (1963.1, 1963.2) and Arrow (1965, 1966), the latter work being developed into a powerful book by Arrow and Kurz (1970). All these authors adopted the principle that the social value of a public investment is the present value of all its impacts on consumption,

[17] This is preference in a very uncomplicated sense, without any of the psychologically important factors such as regret that may influence *personal* time preference, which as noted in Appendix A has a different literature.

discounted at the STP rate for consumption. As the basis for deriving the rate of STP they mostly[18] applied equation (1).

$$STP = \delta + \eta g \qquad (1)$$

Where δ = pure time preference, per cent per year;

η = income elasticity of the marginal utility of income (with sign reversed);

and g = rate of growth of per capita income, per cent per year.

The algebra is well set out by Feldstein (1965). The term δ – time preference for marginal utility – defines the extent to which the current population (or its government) cares about future marginal utility. The term ηg measures the extent to which the utility of a marginal dollar declines with increasing income. The STP rate can equally be applied to other monetary numeraires, including public expenditure, so long as all the quantities are expressed in, or converted to the same numeraire.[19]

Valuation of δ and η is not straightforward. However there is enough consensus in the literature to derive practical values for most developed economies. Their derivation, coincidentally implying values for both variables of between 1 and 2, is discussed in Appendix A.

This approach is now a fairly uncontroversial baseline in welfare economics. It was described by Arrow (1995.2) as "the well known formula" and was noted several times at the high powered US workshop on long term discounting reported in Portney and Weyant (1999) – most clearly in the paper by Cline. Such controversy as still remains focuses on the value of δ and to so some extent the value of η, and on the extent to which conventional discounting, even with declining rates over time, is appropriate for very long term impacts such as those of climate change (e.g. Weitzman, 2008).

2.3.2 International practice

This section records some international practice with respect to government discounting in general. There appears to be no readily available international data on government practices with respect to the appraisal of private financing.[20]

Recent practice on government discounting in ten OECD countries is summarised in Table 2.1. There is some geographical pattern.

In the US, the academic powerhouse of welfare and financial economics, the welfare economists appear to have concluded by the early 1980s that the theoretical issues had

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[18] Marglin (1963.1) boldly proposed deriving an STP rate from macroeconomic optimisation of the growth rate and the level of investment, as these were variables on which politicians could be expected to express policy preferences.

[19] Provided the issues are clearly understood it can be helpful to use pure time preference alone (the term δ) as a discount rate for quantities measured in a numeraire of utility, such as the QALY (Quality Adjusted Life Year).

[20] The author would be most grateful for any advice on this, or on international practice on public sector discounting generally.

been sufficiently explored[21] and chose not to become embroiled in administrative debate about federal (OMB) government practice. They were content that the government borrowing rate was near enough to a social time preference rate for practical use and content to see a higher rate (reduced in 1992 from 10% to 7%) for CBA. The latter appears to be higher for a mix of unpublished political and administrative reasons, such as helping to offset systematic optimism bias in CBA cost and benefit estimates. The US academic *financial* economics community do not appear to have expressed views on public sector discounting since the inconclusive exchanges of the late 1960s and early 1970s.

In Europe there appears to be increasing acceptance of the technically more rigorous use of an explicit social time preference rate, which is generally a little higher than government borrowing rates (although in Germany the rate of 4% used as a borrowing rate until 2004 could equally well be an STP rate). The current social time preference rate specified by the European Commission is 3.5% for developed EU member states and 5.5% for "Cohesion Fund" states, with their high per capita growth rates (European Commission, 2008).[22]

There appears in Europe to be little academic interest, and no official interest, in the EMH view of the public sector cost of capital and time preference, except for academic interest in the UK.[23] Perhaps because of the standing of the London Business School there has long been a small UK literature, by economists schooled in CAPM, advocating the EMH approach. This was considered in some depth in the UK Treasury in the late 1980s, but rejected. Academic interest in quantifying the elements of STP appears today to be mainly centred in the UK, as referenced in Appendix A.

In other developed economies, notably Australia, Canada and New Zealand, there appears to be more debate at official level, with EMH/CAPM advocates more influential than in other countries and the concept of social time preference, while accepted by many with a welfare economics background, finding limited acceptance as a practical tool.

International organisations other than the EC, as noted in section 2.2.1, appear generally to adopt the SOC approach for the cost-benefit analysis of projects that they might support, perhaps for reasons similar to those ascribed above to the OMB.

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[21] The subject came to academic life again only with the growing prominence from the 1990s of the very long term, especially in the context of comate change.

[22] This is based unconventionally on a growth rate and associated elasticity for public expenditure rather than per capita income growth, but this appears to be quantitatively important.

[23] An exception is a Dutch paper (van Ewijk and Tang, 2003), which promotes the conventional EMH view. It also explains that the Dutch government discount rate was "based on the historic average of the real yield on long-term government bonds" and at that time 4% as in Germany.

Table 2.1
Government discount rates in some OECD countries (2006)

Country	Central guidance	Standardisation across government	Discount rate	Theoretical basis of discount rate
Australia	Commonwealth Finance Ministry issues Handbook of Cost-Benefit Analysis, Jan 2006	Varies across States. Commonwealth specifies SOC rate for CBA; long term bond rate for cost-effectiveness; STP rate if only consumption; risk free rate for financing.	SOC rate (10%) annually reviewed (but higher than STP or bond rate). STP rate 3%, but rarely used.	SOC rate is "true opportunity cost of capital" and "ensures that resources are used efficiently". Also recommends CAPM for property ownership and divestment.
Canada	Treasury Board Secretariat issues 'Benefit Cost Analysis Guide': Jul 1998, modified Dec 2002.	Applied throughout national government.	10% real.	Based on traditional SOC (tracing sources of finance from foreign borrowing, foregone private sector investment and foregone consumption), with some weight given to CAPM.
France	Expert committee makes recommendations to *Commissariat General du Plan*	Each sector draws up its own methodology, using the specified discount rate.	Real discount rate set since 1960. Set in 1985 at 8% real; in 2005 at 4%.	1985 working group estimated cost of capital at 6%, but discount rate was set at 8% to keep a balance between public and private sector investment. 2005 regime based on STP with decreasing schedule of rates after 30 years.
Germany	Federal Finance Ministry publishes guidance.	Applied at federal level.	1999: 4% real 2004: 3% real	Based on federal refinancing rate, which over late 1990s was 6% nominal. Average GDP deflator (2%) was subtracted, giving 4% real.
Italy	Central guidance to Regional authorities, 2001	Regional investment	5% real	Apparently based on STP.
New Zealand	Finance ministry issues 'Cost Benefit Analysis Primer' (version 1.12, Dec 2005), supported by a Working Paper (2002).	Project appraisal on departmental basis, following central broad methodology, but many discount rates used.	Formally 10% real as a standard rate unless another sector rate is agreed.	Based on CAPM, using private sector comparators to estimate betas. But STP accepted as appropriate "in principle". The policy was in late 2006 being re-examined.

Norway	Government wide recommendations	Departmental interpretations of central guidance	1978: 7% real; 1998: 3.5% real.	Appears to be based now on government borrowing rate.
Spain	Central guidance set by sector.		6% real for transport; 5% for environmental; 4% real for water	Based on STP, having regard to EC conventions.
United Kingdom	Finance ministry issues guidance to all central government.	Central guidance, plus consistent guides written by spending ministries.	1967: 8% real; 1969: 10% real; 1978: 5% real; 1989: 6% real 2003: 3.5% real.	Traditional social opportunity cost until early 1980s; thereafter social time preference. Until 1973 applied only in nationalised industries. The 2003 regime specifies a decreasing schedule of discount rates after 30 years.
USA	OMB issues discount rates for federal programmes: Circular A-94 (Appendix C on cost-effectiveness revised Jan 2006).	Departments take note of OMB guidance but also have their own standards and guidelines.	Cost effectiveness: 2.5 - 3.0% real depending on period discounted. CBA: 7% real from 1992 (previously 10%).	Cost effectiveness rate equal to Federal borrowing rate. CBA rate derived from pre-tax return to private sector investment in 1970s/80s. Pre 1992 rate based on private return in 1960s.

3 Discounting and the cost(s) of capital with private financing

The explicit handling within public sector appraisal of private financing costs has become prominent in the context of PPPs where, in principle, publicly financed options are being compared with privately financed alternatives. This is discussed in section 3.1 below.

The explicit analysis of private financing costs can also be important in some other circumstances in developed economies, in appraisal to support government decision making that affects specific private sector investments. This is discussed in section 3.2.

3.1 Comparisons of public and private financing

3.1.1 First principles

Governments have for fifty years or more been comparing public with private financing for public service assets in the context of lease versus buy, mainly for property. The UK Treasury's first formal guidance on discounting (HM Treasury, 1973) recognised, as "one common exception" to use of the standard rate, "the choice of methods of financing investment once the actual decision to invest has been taken". It recommended the use in this financing case of the government borrowing rate.

Nearly twenty years later Lind suggested the same approach as obvious: "[For] a lease or buy decision … clearly, the government's borrowing rate is appropriate [for discounting] in a world where crowding out is not a significant problem. From the taxpayer's point of view, it will minimize their cost whether they choose to pay it now or defer it to the future through government borrowing" (Lind, 1990, page S-23).

For most practical cases this technically simple (if in some contexts potentially contentious) approach may often suffice. But formally it overlooks or unduly plays down two significant issues.

The three variables noted above – social time preference, the public cost of capital and the private cost of capital – are all relevant. Simply discounting at the government borrowing rate overlooks any difference between social time preference and the public cost of capital. It may also overlook taxation, to the extent that tax applies differently to public and private financing. The government borrowing rate, after an upward adjustment to avoid a bias from the inclusion in private financing costs of corporation tax, provides a rigorous comparator with the private sector cost of capital. However, if this adjusted government borrowing rate differs from the government time preference rate, the public interest is not strictly best served by also *discounting* over time at the borrowing rate.

3.1.2 A rigorous procedure

A rigorous calculation would estimate the alternative financing streams of depreciation and 'return on capital' payments over the project lifetime, for the publicly financed and the privately financed option, and then discount both at the STP rate.

The principle is partially illustrated by the highly stylised example in Table 3.1 below, which shows its application to private financing alone, for a capital expenditure of 100.

Applied to *public* financing, with a public financing cost of say 2 per cent in real terms, discounting at an STP rate of 3.5 per cent would produce a present value of *less than* 100. Discounting private and public financing costs at an STP rate understates both of their full social costs, but it does accurately measure the *difference* between the two sets of financing costs. This understating of both social costs should be unsurprising, as the fact that STP rates are higher than government borrowing rates is rarely contentious;[24] but it is not something easily explained to or accepted by a senior non-technical audience.

A typical procedure in practice today for PPPs is to discount the costs of the private finance option at he government discount rate. The present value is then compared with the present value of expenditure on the publicly financed option, where the latter includes public capital spending directly, *not* as depreciation and financing costs. If this procedure is applied with a discount rate materially higher than the government borrowing cost it will be biased in favour of private financing. The bias will be greater the higher the discount rate used, as the procedure is applying an implicit cost of capital to public financing equal to the discount rate.

3.1.3 Practical realities

3.1.3.1 Appraisal priorities

The devotion of much time to discounting and costs of capital may sometimes be a distraction from more important issues.

A government may be clearly requiring private financing, to postpone the tiresome public accounting consequences for public debt or taxation, or as a political measure to reduce the activity, if not the expenditure of government, or in some developing or transitional economies as a means of financing accepted by aid agencies as desirable at that stage of development. In this case precise comparison with hypothetical public finding may divert attention from the serious issues of establishing sensible incentives and tight and fair contracts.

Even if a fair comparison is required between public and private financing, this should not divert attention from differences in likely cost and time overruns, and how the impacts of these would be distributed between users, taxpayers and suppliers, which may be much more important the difference in the cost of capital.

3.1.3.2 Administrative acceptability and data availability

Standard appraisal procedures even in the most sophisticated governments need either to be very simple or to be heavily policed. Occasionally an issue may achieve such high policy profile, and such resources for policing, that some complexity is sustainable.[25] But the analytical comparison of public and private financing is not such an issue.

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[24] The difference is presumably because increasing debt, or decreasing savings, incurs costs in terms of reputation or reduced insurance against difficult times, both for governments and consumers.

[25] As in the UK with the shadow pricing of CO2, and some fine details of regulatory costs.

Thus the procedure outlined in section 3.2.1, that employs not only a discount rate, but also the costs of capital to the public and private sectors, is unlikely to feasible in any country as a standard, rigorous procedure. It would not be accepted by senior administrators and ministers, and if it were it would be routinely challenged by suppliers and would not be applied competently in the field. It might possibly be applied by a strong Ministry of Finance (or even a strong international Agency) to an occasional high profile case; but no more

At the practical level, the capital costs and return to capital embedded in a PPP tender is rarely if ever available to the client. However this should not be a serious obstacle as it is good practice for the client to examine seriously the level of profit that the supplier is likely to generate and retain.

3.1.3.3 Comparing public and private financing in practice

If the standard time preference rate is close to a tax adjusted[26] *government borrowing rate*, the public spending flows on both the public and the private finance options can be discounted in the normal way, with no need to identify financing costs. The procedure outlined in section 3.1.2 is in his case being applied, but painlessly.

If the standard time preference rate is significantly higher than the government borrowing rate then, as a run of the mill procedure, using the *government borrowing rate* as a discount rate should generally give a reasonably fair comparison between publicly and privately financed options. This would follow the US OMB guidance. The time preference will not be quite right, but the comparison of the financing costs would normally be broadly correct.

If the government wished to use a higher discount rate to compare the later benefits from the investment with the costs, there would still be sense in using the government borrowing rate for the public/private financing comparison.

3.2 General handling of privately financed capital in CBA

Sometimes privately financed investment needs to be handled within government cost-benefit analysis (CBA) when data is available on the capital costs but not directly on the financing costs. This is unlikely to arise in a developing or transitional economy, but in a developed economy can arise from:

- The CBA of regulatory proposals (e.g. environmental or safety) that would require substantial investment from some private enterprises;
- The CBA of some major private sector investment proposals that are subject to government approval because of planning or other requirements.

The same principles apply as in section 3.1 above, but with the simplification that there is no publicly financed option. The requirement is simply for the capital asset costs to be properly included in the CBA. To do this informed judgements are needed about the relevant cost of capital for the asset in question and about how the return will be distributed over time.

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[26] The tax adjustment is obviously country specific but is probably always fairly small. In the UK it no more than one percentage point.

As a highly stylised numerical example, suppose that:

§ the (gross of tax) cost of capital for the private asset is 6.5 per cent or, as an alternative assumption, 4.5 per cent in real terms;

§ the social time preference rate, also in real terms, is 3.5 percent;

§ the capital is repaid (typically by consumers) in two equal instalments after 10 years and 20 years, each time with the accumulated cost on capital.

If the initial capital investment is 100 in year 0, the present value including financing costs can then be derived as in Table 3.1.

Table 3.1
Illustrative calculation of the social cost of private financing costs

Year	0	10	20
Capital spending	100		
Capital repayment		50	50
Cumulative return @ 6.5% (or 4.5%)		88 (or 55)	44 (or 28)
Total payment of capital + return		138 (or 105)	94 (or 78)
Discount factor @ 3.5%		0.709	0.503
Present value in year 0		98 (or 74)	47 (or 39)
Total present value in year 0	145 (or 113)		

Thus in this example the financing cost adds 45 per cent to the social cost of the investment with a private cost of capital of 6.5 per cent, and adds 13 per cent with a private cost of capital of 4.5 per cent. As noted in section 3.1.2, discounting financing costs in this way somewhat *understates* the full social cost of the investment and its financing, but any further adjustment for the difference between the government borrowing rate and STP would seem impractical.

If a rigorous comparison were being made with public financing, the same procedure would in principle need to be carried out with the public cost of capital, as described in section 3.1.2.

4 Conclusion

4.1 Government discounting and the opportunity cost of public expenditure

- In public sector analysis the analytically sound way to handle the opportunity cost of public expenditure is to apply a shadow price to public expenditure. The analytically sound way to handle time preference is normally to discount over time at a social time preference (STP) rate, derived from the familiar equation $STP = \delta + \eta g$.

- In practice, a procedure that explicitly applies both operations explicitly at the same time will be, for most if not all public administrations, too complicated for application as standard practice. However:

  - for cost-effectiveness analysis, the opportunity cost of public expenditure is irrelevant, as it applies equally to all the figures that are being compared;

- and for cost-benefit analysis, where public expenditures are being compared with impacts valued in terms of consumption, a benefit/cost ratio can be estimated with public expenditure as the denominator. The opportunity cost of public expenditure then simply defines a floor below which approval should not be considered.

- If for political or administrative reasons the concept of social time preference is not acceptable, the government borrowing rate will usually be the best of the alternatives that are likely to be available.

- Other alternatives sometimes supported are the application of CAPM and the application of a general discount rate derived from private sector returns.
  - The relevance of CAPM to publicly financed investment is quite often supported by economists schooled in its application to private investment and appears to be universally rejected by welfare economists. These positions are unlikely to be reconciled in the foreseeable future. However the equity risk premium appears to be largely a feature of equity markets and no mechanism has ever been advanced to explain how an equity risk premium could be generated by a publicly financed investment. There is a systematic risk effect with public financing, to the extent that the costs or benefits of public investment are often correlated with national income; but this effect is negligible because the fluctuations of national income over time are so small (relative in particular to fluctuations in equity markets).
  - Private sector returns expressed as a percentage rate do not fully describe the opportunity cost of displaced private investment. That opportunity cost is the present value of the stream of benefits that the investment would produce over time. In practice the opportunity cost of public expenditure is in any case attributable more to other distortionary impacts of taxation than to the displacement of private capital investment.

- In the US the OMB adopts the government borrowing rate for cost-effectiveness analysis, including public private comparisons such as lease versus buy. This appears to be the best that is achievable given the constraints within US federal administration, although US academic opinion appears now to accept the concept of STP as long since uncontroversial. The more explicit adoption of (somewhat) higher STP rates appears to be achievable fairly widely in European administrations.

- The OMB and some international organisation adopt much higher rates for cost-benefit analysis. These are presented publicly as derived from private sector commercial returns; but appear to be set to take account of other factors, such as concern about optimism bias and perhaps the opportunity cost of public spending. Setting a high rate is a very crude mechanism for handling such factors, but appears to be the best that can be done in the circumstances of these bodies.

4.2 Comparing the costs of public and private financing

- The comparison of public and private financing costs requires inputs that at least implicitly include these two financing costs, the public financing cost being defined by the cost of government borrowing. In a rigorous analysis the public financing costs would be adjusted slightly upwards to offset the profits tax charged on private returns, and the difference between these two streams of financing costs over time would then be discounted at the STP rate.

- In practice this would generally be too complex as a standard procedure. However, if the government uses a discount rate that that is similar to the government borrowing rate, then discounting the private financing costs at this rate and comparing these with the public capital spending is generally sufficient. In practice countries adopting STP rates do now generally derive rates that are reasonably close to government borrowing rates.

- It the government applies this simple procedure using a discount rate materially higher than the cost of government borrowing this will bias the present values in favour of private financing. How much this matters will depend upon the context. Concern about such bias should not unduly displace concern about other crucial issues such as optimism bias and contract design and enforcement. But there is an obvious case for estimating the extent of the bias in at least some cases.

Appendix A: The estimation of δ and η to derive a value for social time preference

A.1 Pure time preference (δ)

The value of pure time preference for marginal utility – the term δ in equation (1) – is mainly an ethical choice about the relative weighting of the marginal utility of today's population and future populations. However there is no solid empirical data on people's preferences in this respect.[27]

Pigou (1920) and Ramsey (1928), like a minority of later authorities[28], considered that discounting future marginal utility was irrational for individuals and ethically unsatisfactory for governments. This was applied in the Stern Review (Stern, 2006) and attracted much criticism (which appears to have been accepted). As set out by Schelling (1995) people in general have concern for future generations (and for those in other countries), but this is evidently less than their concern for those with whom they have a closer affinity.

No profession has a special claim to pronounce on this ethical judgement. Kopp and Portney (1999) comment on the coverage of discounting by the Intergovernmental Panel on Climate Change that "The [IPCC's] prescriptive approach is premised on the view that there is an ethically or morally 'correct' rate of discount to use in project evaluation – a rate that is independent of the views of the present generation (save, of course, those who get to determine what the morally just rate is). Yet those of us who teach benefit-cost analysis and advocate its use … we argue that BCA is attractive because it is based in the preferences of all those around today". Eckstein (1957, p75), expressly refuting Ramsey, made the same point 50 years ago: "I assume [discounting of future utility] because I believe that a social welfare function based on consumer sovereignty must accept people's tastes, including their intertemporal preferences". Marglin (1963.1) says similarly: "I consider it axiomatic that a democratic government effects only the preferences of the individuals who are presently members of the body politic".

A more pragmatic, but powerful objection to a zero rate of pure time preference is that it implies a patently unrealistic level of investment, as was first noted by Ramsey (1928, p 548), set out in qualitative terms by Hayek (1936, p 46) and explained clearly by Arrow (1995.2, p 16) and argued recently by Dasgupta (2006) and others.

Aside from those who believe that pure time preference should be zero, there is some consensus in the literature on a value over a few decades of around 1.5% per year, if an element is included for the risk of natural or man made catastrophe eliminating many of the prospective benefits.[29]

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[27] Much work has been done on *personal* time preference (e.g. Frederick et al, 2002), generally yielding values at least approaching double figures and often very much higher, but there are reasons to doubt the relevance of these measures to preferences about how the government should weight the future.

[28] Including the distinguished names of Harrod, Koopmans, Solow, Broome, and Cline.

[29] Few authors, apart from those advocating a zero rate, commit themselves to an explicit estimate of δ. Little and Mirrlees (1974, p266), while expressing sympathy with the zero rate view, suggest that "in any case it would probably not mean an addition [to time preference] of more than 2% or 3% per year". More widely quoted is Scott, who supposed that, in periods of stable inflation, STP has been indicated by the post tax return on low risk savings. Scott

A.2 The elasticity of marginal utility (η)

A.2.1 The moral dimension

Equation 1 combines one term, δ, which is essentially ethical, with another, ηg, which as usually applied is wholly utilitarian, ignoring any moral aspect of transfers from poorer to richer populations. Yet many might argue that "fairness" or "egalitarian" concerns would justify rather less redistribution of marginal utility (and certainly no more) from poorer to richer than implied by the simple utilitarian criterion of maximising the sum of individual utilities. As argued by Dasgupta (2006), this would imply for STP purposes a higher value of η.[30]

A.2.2 Derivation of η from the personal tax regime

Derivation of η from personal tax regimes conventionally assumes that the schedule of income tax rates against income is based on the principle of "equal absolute sacrifice" (i.e. an equal loss of utility for each marginal dollar of tax paid). Combining this principle with a constant-elasticity utility function yields an implicit value for η.

Strengths of this approach are its conceptual simplicity and measurability, and that it may also include concern about fairness as well as marginal utility; but it has important limitations.[31] Social concern about contemporary inequality might differ from concerns about inequality over time; and personal taxation in many countries is influenced by concerns about incentives and personal freedom as well as fairness. Concern about incentives will bias downwards estimates of η based on the assumption of equal absolute sacrifice. Problems also surround the inclusion or exclusion of the standard personal allowance or other allowances, and the significance of other policy instruments geared to income distribution, as discussed by Evans (2005).

Cowell and Gardiner (2000) use this method to derive UK values for η in the late 1990s of 1.42 if applied just to income tax, and of 1.29 if applied to income tax and National Insurance Contributions (NIC).[32] Evans and Sezer (2005) and Evans (2005) present results for large number of OECD countries, deriving an average value close to 1.4 with a perhaps surprisingly narrow spread of about $\pm$ 0.2.

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and Dowley (1997), on the basis mainly of data for the half century before World War I, estimate a value for δ of 0.5%, but suggest, "since the risk of total destruction of our society has increased", "a best estimate" for δ of 1.5.%. Subsequently, using post WW II and pre WW I data on post tax returns to equity, Scott (1989, pp 230-231) estimates a value for δ of 1.3%, and also examines (p233) a higher value for δ of 2.5% suggested by Stern (1977). Arrow (1995.2, p17) suggests that "very tentatively, it would seem that the pure rate of time preference should be about 1%".

[30] Dasgupta argues for a value for η of perhaps 3. This contrasts with a comment by Newbery (1992, p11) that"[HM Treasury's] preferred value of [η] is 1.5, which is quite egalitarian, and one might quite reasonably defend a value of 1.0 or even less." However, despite the implication in the latter comment that the value of η incorporated an ethical judgment, this was not part of the Treasury's logic at that time.

[31] Many other qualifications apply to this and to all other methods of estimating η. One which applies to many methods is the assumption that the utility function is additively separable.

[32] Evans (2005) suggests that NICs should be ignored because the notionally insurance-based rationale for such deductions is "completely different" from that underlying income tax rates. In practice the contributions are widely seen to serve in effect as a (politically convenient) form of income tax, but, as Evans implies, it is hard to believe that the regime was ever designed other than to minimise disincentives for a given total NIC revenue. This however has for many years been increasingly the objective of income tax regimes as well!

The derivation by Stern (1977) for the UK income tax regime in 1973-74, before concerns about tax incentives became so prominent, may give a better measure of social judgments about the utility of marginal income marginal across the income distribution. Stern derived a value for η of 1.97, although Evans (2005) suggests that Stern's inclusion of the standard personal tax allowance gives a strong upward bias to η at relatively low levels of income. For US income tax from 1948 to 1965, Mera (1969, p469) found that "for a major portion of the income range" the rates implied a value for η of 1.5.

A.2.3 Derivation of η from personal savings behaviour

Many studies of household savings behaviour over the life cycle estimate the inter-temporal elasticity of substitution of household consumption. Under fairly restrictive assumptions, as set out by Cowell and Gardiner (2000, Appendix A3), the reciprocal of this quantity is equal to the household elasticity of marginal utility. Cowell and Gardiner consider some of this work, in particular Blundell et al (1994) on UK data. They note that the two principal models in Blundell et al imply, for η, values of 1.2 to 1.4, or of 0.34 to 1.0 (both sets of values increasing with income). However, as noted by Evans (2005), the sample period of 1970-1986 ends in the year in which UK retail financial markets were deregulated. It is unclear what either model would produce with data for the deregulated environment.

Barsky et al (1997) measure the inter-temporal elasticity of substitution directly by means of survey questions from the US Health and Retirement Survey. They obtain a mean value of 0.18, which implies a high value for η of 5.6.

The savings ratio, together with assumptions for δ and for the long run rate of return, yields an implicit value for η. Stern (1977, p220) records that, taking plausible figures for the UK in the 1960s, and δ = 2.5%, the implicit value of η was approximately 5 (or higher for lower values of δ).

These studies suggest however that personal savings behaviour has little relevance to changes in the marginal utility of income to society over time.

A.2.4 Derivation of η from direct evidence on personal risk aversion

Barsky et al (1997) report empirical measures of η (defined in this case as relative risk aversion) of US respondents between the ages of 51 and 61. The authors give most weight to measures of the reciprocal, which they define as relative risk tolerance, for which the arithmetic average value was 0.24, implying a value for η of 4.2. This high value relates however to very significant risks to income, where factors such as the potential for regret would be expected to increase risk aversion.[33] They found no correlation across individuals between their risk aversion and their inter-temporal elasticity as described above.

A.2.5 Derivation of η from income and price elasticities

An approach with a long history (Fisher, 1927, Frisch, 1932, 1959) estimates η from the income and price elasticities of a preference-independent good such as food (i.e. a good that contributes an additively separable component to the users' utility). Frisch (1959, equation

[33] They may therefore be more relevant to the equity risk premium.

64) shows that $h = -E_i(1-a_iE_i)/(e_{ii}+a_iE_i)$, where E_i is the income elasticity of demand for the *i*th good, a_i the budget share and e_{ii} the own (uncompensated) price elasticity.

Brown and Deaton (1972, p1206) report studies by other authors of data from several countries, together with work of their own on UK data for 1900-1970 that gave a value of for η of 2.8. They conclude that "though estimates obtained this way [from linear expenditure systems] fluctuate considerably and some are very large, an average value of -2 for [-η] seems consistent both with most such studies and with the results from fitting other models".

Kula (1984) reports values for η derived in this way for the US of 1.89 and for Canada of 1.56. For the UK, Kula (1985) derives a markedly lower value of 0.71. More recently Evans and Sezer (2002) derive for the UK a value of 1.6. Subsequently Evans (2004.1) has examined alternative specifications, deriving values for the UK of 1.6 (as above) by a CEM (constant elasticities model) and 1.2 by an AIDS (almost ideal demand system), and for France (Evans 2004.2) values of 1.8 and 1.3.

The validity of assumptions such as the constancy of the relevant demand functions over time and income is difficult to assess, and there are problems of data and definitions. The substantial effect of the model specification sounds a note of caution. This approach has nonetheless the merit of being a direct measure of η and it has been subject to empirical studies in many countries and over different goods.

A.2.6 Derivation of η from international happiness data

Recent year have seen the development of the new literature, now evolving into several strands, on the measurement and determinants of happiness. Much work has been done on international measurement. Layard et al (2007) use data from six surveys to derive a combined estimate for η of 1.26, with highest and lowest values of 1.34 and 1.19. The results are similar for subgroups in the population.

A.2.7 Derivation of η from intuition

A value for η of 1 implies that an extra \$1 to someone with an income of \$x gives twice the utility of an extra \$1 to someone with an income of \$2x. Values for η of 1.5 and 2 would imply factors of respectively 2.8 ($2^{1.5}$) and 4 (2^2). However although the judgement required is conceptually fairly simple, there are few points of reference by which to judge what is plausible.[34]

Scott and Dowley (1977) advance the argument, maintained in Scott (1989), and which they report has the support of Little and Mirrlees and of Stern, that "it is reasonable to suppose that there is a maximum level of utility which anyone can derive from income", in which case "*[η]* must exceed one at least above some income level …".[35]

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[34] Although Stern's (1977) comment (p243) that a value "of around 5 does not seem ludicrously large" might for most applications be questioned.

[35] One obvious counterargument is that the ultra rich may gain utility from knowing that they are relatively richer even than the super rich. However it is hard to imagine that this is material to the personal utility impact of a marginal change in taxation; and in any case such comparative concerns apply more weakly to a nation as a whole than to individuals within it.

A.2.8 Expert views on η

In the American literature there is some consensus around values for η, in the context of STP, of about 1.5. For example Eckstein (1958) considers a range of 0.5 to 2.0, and Feldstein (1965) a range of 1 to 2; Cline (1993) opts for 1.5; Boscolo et al (1998, p7) conclude that "the few available estimates suggest that the elasticity of marginal utility [ranges] from 1 to 2"; and Arrow (1995.1, p 6) suggests, on the basis of "rather thin evidence", 1.5 to 2.0.

In the UK literature, Stern's review of 1977 concludes that the evidence then pointed to the range of 1 to 10, with measurements based on consumer behaviour pointing to the middle of the range, and those based on government behaviour to around 2. Scott (1977, 1989), working back from market rates, estimates a value of 1.5. Little and Mirrlees (1974, p 240) suggest that "on admittedly extremely inadequate evidence, we guess that most people would put *[η]* in the range 1-3". Cowell and Gardiner (2000) conclude 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 derived, as explained above, from the personal tax regime of the late 1990s. Evans (2005) regards a figure of 1.4, derived from the personal tax regimes of a large number of countries, and not inconsistent with derivations from food income and price elasticities, as plausible for many countries.

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