David F. Burgess and Richard O. Zerbe*

The most appropriate discount rate

Abstract: The social opportunity cost of capital discount rate is the appropriate discount rate to use when evaluating government projects. It satisfies the fundamental rule that no project should be accepted that has a rate of return less than alternative available projects, and it ensures that worthy projects satisfy the potential Pareto test. The social time preference approach advocated by Moore et al. fails to satisfy either of these criteria even in the unlikely case that the private sector behaves myopically with respect to a project's future benefits and costs.

*Corresponding author: Richard O. Zerbe, University of Washington, Seattle,
e-mail: zerbe@uw.edu
David F. Burgess: Department of Economics, Western Ontario University, London, Ontario

The use of the social opportunity cost of capital (SOC) discount rate is justified by a simple and powerful rule: *no project should be accepted if its return is less than the return available on alternative projects. This rule is as basic to economics as one that requires the analyst to take into account opportunity cost generally*. The use of the social time preference (STP) rate advocated by Moore, Boardman, and Vining (2013) violates this rule, and it also fails to ensure that acceptable projects produce potential Pareto improvements. In addition, the principles and standards guidelines state clearly (pp. 247, 281, 413–418) that matters that can be separated from inclusion in the discount rate (such as the marginal utility of income) should be separated, which is not done by Moore et al. Thus, concerns about underestimating environmental values in the distant future should not be addressed by lowering the discount rate. A better approach, and one endorsed by the Principles and Guidelines (Farrow and Zerbe, 2013, pp. 413–418), is to ensure that the estimates of these future values accurately reflect willingness to pay. There are sound reasons why the standard discount rate advocated by the Office of Management and Budget, and supported by our own work, is 7% rather than the 3.5% rate advocated by Moore et al. (2013).

We understand the appeal of the argument for using the STP rate. It supposes that one should keep investing in available projects as long as the rate of return is above the STP rate (assumed to represent an appropriately weighted average of the rate at which individuals are willing to postpone current for future consumption). In the absence of capital income taxes this rate will eventually be reached as we move down a demand curve for capital using up high return

projects. However, eventually may be a very long time as there are limits on the available supply of funds at each point in time, and labor force growth and technological change are both shifting the demand curve for capital to the right. In the meantime, until these investment opportunities are fully exploited, each project should be assessed relative to the best alternative project foregone.

Moore et al. (2013) derive an estimate of the social rate of time preference from the Ramsey (1928) formula STP=δ+gϵ, where δ is society's "pure" rate of time preference (i.e., the rate of return society needs to forego a unit of consumption today when current and future consumption levels are equal), g is an estimate of the expected rate of growth of per capita consumption, and ϵ is an estimate of the (absolute value of the) elasticity of the marginal utility of consumption. Their preferred estimate of the STP rate for the US is 3.5%. This is based upon an estimate of the pure rate of time preference of 1.0%, a prediction that per capita consumption will increase by 1.9% per year, and an estimate of the elasticity of marginal utility of consumption of 1.35. But there is much disagreement among leading economists about the appropriate values for these parameters. Stern (2006) assumes that δ is equal to 0.1 based upon the small probability that society as we know it will not survive. By contrast, perhaps based upon estimates of individual rates of time preference, Nordhaus (2007) assumes a value for δ equal to 3.0. If the social rate of time preference is constructed as an appropriately weighted average of individual rates of time preference it seems that the individual rates of time preference span a wide range. Indeed, it is very difficult to isolate individual's time preference rates, let alone the joint distribution of project valuations and time preference rates, which is probably impossible to estimate.[1] In a broad survey of empirically elicited discount rates, Frederick, Lowenstein, and O'Donoghue (2002, Table 1) find spectacular disagreement among dozens of studies that purport to be measuring time preference – from annual discount rates of negative 6% to infinity.[2] The median value listed in their Table 1 is 24% with an interquartile range of 8%–158%.[3] Harrison, Lau, and Williams (2002) attempt to identify a

---

1 See Long et al. (2013). It is also challenging to identify individual's valuations of a project (whether they are expected to be alive or dead in year *t*). Since this challenge already exists for traditional benefit-cost analysis, we do not further discuss these empirical challenges, despite their importance.

2 See also Anderson and Gugerty (2009).

3 They note: "[Table 1] reveals spectacular disagreement among dozens of studies that all purport to be measuring time preference. This lack of agreement likely reflects the fact that the various elicitation procedures used to measure time preference consistently fail to isolate time preference, and instead reflect, to varying degrees, a blend of both pure time preference and other theoretically distinct considerations, including: (a) intertemporal arbitrage, when tradable

distribution of time preference rates. [4] Based on experimental evidence, they find "that discount rates vary significantly with respect to several socio-demographic variables" (p. 1606). In particular, they find that discount rates are significantly lower for those with more education or who are unemployed and higher for those who are retired (controlling for categorical age indicators) or who believe they are credit constrained. These results suggest the possibility of correlation between project benefits and time preference rates for some projects that benefit particular demographic groups.[5] An attempt to take into account individuals' differences in time preference rates will lead to policy regret as shown by Long, Zerbe, and Davis (2013). They provide an example in which if individual rates are used a project that has a negative net present value, but 10 years hence the project produces positive net benefits and therefore passes the Kaldor-Hicks potential compensation test.

The mean discount rate found in Harrison et al. (2002) was 28%, well above market rates of interest. They note: "despite our extensive attempts to encourage credibility, the subjects might have doubted that we would actually follow through on the payments" (p. 1613). Thus, their estimate of a time preference rate may be biased upwards by incorporation of a risk premium of some unknown amount. Furthermore, variation in this risk premium by socio-demographic characteristics could have generated the observed variation in discount rates, even if there is no variation in pure time preference rates. Frederick et al. (2002) conjecture that "(i)f these confounding factors were adequately controlled, we suspect that many intertemporal choices or judgments would imply much lower – indeed, possibly even zero – rates of time preference" (p. 389).

With respect to the rate of growth of per capita consumption, the Moore et al. prediction that per capita consumption will increase by 1.9% a year seems particularly optimistic. Stern (2006), for example, assumes that g is 1.3, and Dasgupta (2008) believes that g is trending downward toward zero. Finally, respected economists have come to wildly different conclusions about the appropriate value for the elasticity of the marginal utility of consumption. Stern (2006) and Nordhaus (2007) assume that ε is equal to 1.0, but Dasgupta (2008) argues that

---

rewards are used; (b) concave utility; (c) uncertainty that the future reward or penalty will actually obtain; (d) inflation, when nominal monetary amounts are used; (e) expectations of changing utility; and (f) considerations of habit formation, anticipatory utility, and visceral influences" (p. 389).

4 Subsequent studies by Chapman (2003) and Groom, Hepburn, Koundouri and Pearce (2005) provide compilations of recent literature on time preference and discounting, yet do not suggest a method for identifying a social discount rate.

5 For a broader (but still partial) review of findings on time preference heterogeneity, see the many references Frederick (2003) and in, Anderson and Gugerty (2009).

the appropriate value for ε is at least 3.0. All this illustrates the difficulties that one encounters when trying to produce a credible estimate of the public sector discount rate without using data on the performance of the actual economy.

Following earlier literature on the STP approach, Moore et al. propose to take into account any private investment that is displaced by public investment using a shadow price that converts a dollar of private investment into its contemporaneous "consumption equivalent." However the concept of a shadow price of capital applied to multi-period projects is predicated on the dubious assumption that the private sector behaves myopically with respect to the project, following a simple (Keynesian) rule of saving a constant proportion of any change in disposable income that arises period by period on account of the project. For projects with multi-period costs the methodology behind the STP approach is invalid if the private sector behaves rationally and has the same information about the project's benefits and costs as the policy maker.[6]

In the end, Moore et al. conclude that calculating the appropriate shadow price of capital (and the appropriate marginal rate of return in the private sector) is essentially irrelevant on the grounds that most, if not all, public investment is financed by (income) taxes that primarily impact consumption rather than investment simply because consumption is a much greater proportion of the economy than investment. The STP approach then becomes a license for the government to undertake any project whose present value of benefits minus costs is positive when discounted at the STP rate despite the availability of projects in the private sector that offer significantly higher expected rates of return.[7]

The authors claim that the SOC approach recommended by Burgess and Zerbe (2011) and Zerbe (2011), where (constant dollar values of) benefits and costs are discounted at a rate reflecting the economic opportunity cost of borrowed funds is "not favored by most interested economists," and is in any event "conceptually incorrect." With respect to the first point, we do not feel that the appropriate social discount rate is to be derived from a poll.[8] With respect to the second point, the authors make no attempt to explain why (in their view) the SOC procedure

---

6 For further details see Burgess (2013b).

7 It should also be mentioned that the financial data that Moore et al use to estimate the marginal rate of return of 6.79% depends upon assumptions about the aggregate debt/equity ratio, the inflation rate etc., and it is highly sensitive to business cycle swings (because capital is valued at market prices rather than at replacement cost). It is also less comprehensive than desired, i.e., it does not reflect the historical average performance of capital in the economy as a whole. A better estimate of the real rate of return to capital in the private sector uses national income accounts data. See Jenkins and Kuo (2010).

8 The authors do not list these interested economists. They cite Cole, a lawyer, inappropriately as an authority as follows: "Indeed, Cole (2010, personal communication), originally a member

that Burgess and Zerbe (2011) propose is "conceptually incorrect."[9] Indeed, they make no attempt to address the problems with the STP approach that we identify. The only criticism of the SOC approach that they present is that the assumption that the marginal source of funding for all projects is the capital market (rather than an increase in taxes) is inappropriate because if it were true the level of outstanding debt would explode. But this is nonsense: it mistakenly equates a marginal source of funding with an average source. The reality is that the agency of government that sets tax rates is different from the agency that approves project expenditures. Because project expenditures are typically under-estimated, government borrowing becomes the means for bridging the funding gap. The recent alarming increase in the debt/GDP ratio in the US is prima facie evidence that the level of outstanding government debt is NOT set independently of project expenditures that are then all financed by taxes.

While it is true that certain types of government expenditures- those that provide pure public goods rather than marketable private goods- must *ultimately* be financed by taxes, many projects are self-financing (i.e., they require no tax increase) because they generate sufficient revenue via user fees or from the sale of their output. Projects that are financed ultimately by taxes are typically financed *initially* by borrowing with taxes deferred to better coincide with when benefits are received. Treating the capital market as the marginal source of funds is a convention that allows project evaluation to be separated from tax policy. Rather than a specific project benefiting from, or being disadvantaged by, the use of a specific tax, all projects are evaluated on a level playing field.

More fundamentally, the authors fail to recognize that the SOC criterion measures the impact of the project on the government's budget when the private sector is kept at pre-project utility. Conceptually, the private sector is kept at pre-project utility by the government inducing the private sector to willingly postpone consumption and/or divert saving from private investment into government bonds to finance the project's costs and, whether through ordinary market transactions or (in the case of pure public goods) through (lump sum) taxes, appropriating the private sector's willingness to pay for the project's benefits. This is in contrast

---

of the Scientific Committee reviewing these principles and standards notes that "not one of those three [commissioned white papers] supports the high discount rates recommended in Professor Zerbe's report." This is incorrect. Only one paper was commissioned to address directly the issue of the discount rate and this was the Burgess paper. Other papers briefly addressed this issue in the context of broader issues but simply cited other literature. Cole resigned from both the Scientific Committee and indeed from the Benefit-Cost Society reportedly (telephone call between Zerbe and Cole) as a result of our acceptance of the Burgess view. Cole's reaction was that of an advocate committed to low discount rates, not a scientist; such an approach is ascientific.

9 The Burgess and Zerbe view has been presented more formally by Burgess (2013a).

with the STP/SPC criterion that purports to measure the project's impact on social welfare (measured at the present value of consumption discounted at the STP rate) when the government balances its budget in each period by collecting sufficient tax revenue to cover the project's cost in that period.

It follows that the appropriate measure of the SOC rate is the social opportunity cost of *borrowed* funds, not the social opportunity cost of funds raised by an increase in the income tax or some other broad based tax. Admittedly, It is empirically challenging to arrive at reliable estimates of the weights that enter into the SOC measure (i.e., the proportions of an increment of borrowed funds that displace investment versus consumption and, in an open economy, net exports), but the consensus of those who have looked carefully at the matter is that investment is much more sensitive to the rate of return than consumption or net exports, so the bulk of an increment in borrowed funds displaces investment.

If the private sector is as well informed about the project's benefits and costs as the policy maker it is in a matter of indifference whether one chooses to measure the project's impact on the government's budget (present value of government revenue discounted at the SOC rate) holding the private sector at preproject utility or to measure the project's impact on social welfare (present value of consumption discounted at the STP rate) when the government maintains inter-temporal budget balance. However, the STP procedure fails to measure the project's impact on social welfare with the government's inter-temporal budget balanced. A recent paper by Liu (2011) shows the conceptual flaw in the STP procedure applied to projects with multi-period costs. The problem arises because the STP procedure assumes that the shadow price of capital for any project is the same no matter when the project's expenditure occurs. Thus a dollar of project expenditure that occurs in period 0 is supposed to have the same contemporaneous consumption equivalent as a dollar of project expenditure that occurs in any other period. For a multi-period project, expenditure in each period is treated by the private sector as an unanticipated shock even though the time stream of expected project expenditures is well known to the policy maker. While the notion that the private sector behaves as a rational, forward looking utility maximizing agent is certainly contestable, the myopic behavior represented by a constant marginal propensity to save in the STP approach is even more problematic.

Even if one were to accept the constant marginal propensity to save assumption of the STP approach, a simple argument shows that the STP criterion fails to ensure that scarce tax dollars are spent in the most productive way. Suppose that a project requires C0 dollars in period 0 and yields benefits worth B1 dollars in period 1, and that the private sector treats a dollar's worth of benefits just like a lump sum transfer of a dollar. According to the STP criterion the project is worthwhile if B1 (1-s +sV) /(1+r) – C0 (1-s+sV) >0, where r is the STP rate, V is the

shadow price of capital and s is the marginal propensity to save. A worthy project must increase the present value of the private sector's consumption stream discounted at the STP rate. The procedure assumes that the project's cost is financed by an increase in the income tax and a proportion represents displaced investment, which is converted into its consumption equivalent by multiplying by V.[10] Because the project's benefits are "just like income" a dollar of benefits has the same consumption equivalent as a dollar of costs. It is therefore unnecessary to apply a shadow price to any investment displaced or induced (because the conversion parameter for a dollar of costs is equal to the conversion parameter for a dollar of benefits). The project is worthwhile according to the STP criterion if net benefits are positive when discounted at the STP rate.

The problem with this result is that it ignores alternative uses of the tax revenue that yield higher returns. It is important to recognize that *these alternatives are available even if the government is unable to invest directly in the private sector* for political reasons as long as part of the private sector's wealth is held as government debt.[11] Suppose the funds collected for the project are used instead to reduce the outstanding government debt. Debt at the beginning of period 1 will be reduced by C0 dollars, which will "crowd in" C0 dollars of private investment and increase capital income tax revenue by $\tau\rho C0$ dollars, where τ is the capital income tax rate and ρ is the pre-tax rate of return (assumed to be exogenous). In addition, debt service costs will be reduced by r dollars so the government will be able to reduce the income tax in period 1 by $(1+r+\tau\rho)$ C0=$(1+\rho)$ C0 dollars (note that $\rho(1-\tau)=r$) while maintaining inter-temporal budget balance. The private sector will prefer the project costing C0 dollars and yielding benefits worth B1 to spending the funds on debt reduction yielding benefits worth C0 $(1+\rho)$ only if B1/$(1+\rho)$ > C0. This is the SOC criterion. Thus the Moore et al. approach fails to take into account the opportunity cost of funds, the most fundamental requirement of a correct approach.[12]

---

10 An income tax is assumed to be equivalent to a lump sum tax in the STP approach because there is no accounting for the efficiency cost of the tax.

11 Bradford (1975) and Lind (1982) rule out the rate of return in the private sector as the relevant opportunity cost for public investment whenever direct government investment in the economy is not feasible on political or other grounds, but they neglect the ability of the government to induce additional private investment through debt redemption.

12 Moore et al. do not regard debt reduction as an alternative use of tax dollars. Debt problems are presumably solved by economic growth, not by diverting taxes to debt reduction. But debt problems arise because project expenditures exceed tax revenue. Since the cost of debt is the SOC rate and debt results because spending exceeds tax revenue, spending going forward should only be approved if it satisfies the SOC criterion.

It is important to note that the above argument does not depend upon the existence of a capital income tax. Thus suppose the wedge between the STP rate and the rate of return to capital reflects a "defective telescope" whereby the representative individual's rate of impatience exceeds the social rate. If the rate of return in the private sector is ρ then government bonds must also offer savers this rate of return. So when the government uses a dollar of tax revenue to redeem a dollar of debt it will "crowd in" a dollar of private capital whether or not there is a tax on capital income.[13] Since the government's borrowing rate must equal ρ the tax increase of one dollar in period 0 will make possible a $1+\rho$ dollar tax cut in period 1 while holding the level of public expenditure fixed. The private sector will prefer a one dollar project yielding benefits worth B1 to debt reduction only if $B1>1+\rho$.

So far we have ignored inter-generational effects. For projects with effects that span many generations, Moore et al. recommend a discount rate that declines through time. In our view the appropriate discount rate for any government project, whether or not it has inter-generational effects, is the SOC rate. While it is conceivable that the rate of return to capital in the private sector may decline in the future, thereby lowering the appropriate SOC rate, there is no evidence that the rate of return to capital is trending downward at the moment. Until there is such evidence we recommend using a constant social discount rate in the range of 6%–8% for all government projects.

It is worth emphasizing that discounting benefits and costs at the STP rate in an inter-generational context will result in some projects being accepted that fail the Kaldor-Hicks compensation test. In our simple example of a project that costs C0 dollars in period 0 and yields benefits worth B1 dollars in period 1, unless the project passes the SOC criterion it will not be possible for the project to make all generations better off. Thus to ensure that those currently living are not adversely affected the project must be debt financed. The debt is purchased by the current young generation who are owed principal plus interest. Suppose the project benefits the next young generation whose willingness to pay is B1. The debt that is issued to fund the project diverts saving from private investment that would yield a rate of return of ρ. If there is a capital income tax and government bonds are tax exempt the government can borrow at rate r, but it will also lose capital income tax revenue of $\tau\rho$. To compensate the current young generation the government must repay the debt they purchased with interest plus make up for the loss of capital income tax revenue (presumed to fund existing programs such as retirement benefits). The government can raise taxes on the next young

---

13 Government debt displaces private capital one for one only if the rate of return to capital in the private sector is exogenous. In the general (closed economy) case government debt will displace both private investment and consumption so the appropriate SOC rate is a weighted average of ρ and r.

generation by as much as their willingness to pay for the project's benefits before leaving them worse off. Therefore the project satisfies the K-H compensation test only if B1 > C0 (1+r+ τρ). This is the SOC criterion.

Conclusion: There is perhaps no issue in benefit-cost analysis more urgent than coming to some agreement, even if rough, on the appropriate discount rate to be used for government spending. Our hope is that the present article, and the recent article by Burgess (2013a), will contribute to this agreement. Our further hope is that Moore et al. will come to agree with us.

The discounting procedure recommended by Moore et al. is conceptually flawed. It fails to ensure that worthy projects represent the best available use of tax dollars, and it fails to identify projects that can produce potential Pareto improvements. They claim that it is wrong to treat the marginal source of funds for all projects as the capital market, and they continue to maintain that all projects should be viewed as tax financed rather than debt financed despite the obvious fact that this is not historical reality. They don't realize that treating the capital market as the marginal source of funds is merely a reflection of the fact that the SOC criterion looks at the project's impact on the government's budget holding the private sector at pre-project utility. If the project can result in an increase in the present discounted value of government revenue (discounted at the SOC rate) while the private sector is held at pre-project utility then the project is worthwhile undertaking.

In fact, the SOC criterion applies whether or not "Ricardian Equivalence" holds. If RE holds the private sector recognizes that deferring a (lump sum) tax increase to a future date to fund a project does not affect the worthiness of a project. Moore et al. clearly believe that RE does not hold because they claim that it matters whether a project is (lump sum) tax financed or debt financed, and specifically that it will be easier to satisfy the STP criterion if the project is tax financed. Our point is that even if one could fool the public by the choice between tax finance and debt finance it would still be necessary to consider whether the use of scarce tax dollars on the project is superior to using those tax dollars to pay down the debt, and this comparison results in the SOC criterion!

References

Anderson, C. Leigh, & Gugerty, Mary Kay. (2009). Intertemporal choice and development policy: new evidence on time-varying discount rates from vietnam and Russia. *The Developing Economies, 47*(2), 123–146.

Bradford, D. F. (1975). Constraints on government investment opportunities and the choice of discount rate. *American Economic Review, 65*, 887–899.

Burgess, D. F. (2013a). Reconciling alternative views about the appropriate social discount rate. *Journal of Public Economics, 97*, 9–17.

Burgess, D. F. (2013b). *Project evaluation and the folk principle when the private sector lacks foresight*. Unpublished working paper, Department of Economics, University of Western Ontario, March.

Burgess, D. F., & Zerbe, R. O. (2011). Appropriate discounting for benefit-cost analysis. *Journal of Benefit-Cost Analysis, 2*(2). DOI: 10.2202/2152-2812.1065.

Chapman, G. B. (2003). Time discounting of health outcomes. In: G.Loewenstein, D. Read, and R. F. Baumeister (Eds.), *Time and decision: economic and psychological perspectives on intertemporal choice*. Russell Sage Foundation.

Dasgupta, P. (2008). Discounting climate change. *Journal of Risk and Insurance, 37*, 141–169.

Farrow, S., & Zerbe, R. O. (2013). *Principles and Standards for Benefit-Cost Analysis*. Cheltenham UK: Edward Elgar.

Frederick, Shane. (2003). Time preference and personal identity. In George Loewenstein, Daniel Read, and Roy F. Baumeister (Eds.), *Time and decision: economic and psychological perspectives on intertemporal choice*. New York: Russell Sage Foundation.

Frederick, S., Lowenstein, G., & O'Donoghue, T. (2002). Time discounting and time preference: a critical review. *Journal of Economic Literature, 40*(2), 351–400.

Groom, B., Hepburn, C., Koundouri, P., & Pearce, D. (2005). Declining discount rates: the long and the short of it. *Environmental and Resource Economics, 32*(4), 445–493.

Harrison, Glenn W., Lau, Morten I., & Williams, Melonie B. (2002). Estimating individual discount rates in denmark: a field experiment. *The American Economic Review, 92*(5), 1606–1617.

Jenkins, G. P., & Kuo, C. Y. (2010). The opportunity cost of capital for Canada: an empirical update. In D. F. Burgess & G. P. Jenkins (Eds.), *Discount rates for the evaluation of public private partnerships*. Kingston: McGill Queen's University Press.

Lind, R. C. (1982). A primer on the major issues relating to the discount rate for evaluating national energy options. In R. C. Lind (Ed.), *Discounting for time and risk in energy policy*. Washington D.C.: Resources for the Future.

Liu, Liqun. (2011). From the shadow price of capital to the marginal cost of funds: in search of the implementation of a principle. *Journal of Public Economic Theory, 13*(3), 369–389.

Long, Mark, Zerbe, Richard, & Davis, Tyler. (2013). The social discount rate as a function of individuals' time preferences: elusive theoretical constructs and practical advice for benefit-cost analysts. Working paper.

Moore, M. A., Boardman, A. E., & Vining, A. K. (2013). More appropriate discounting: the rate of social time preference and the value of the social discount rate. *Journal of Benefit-Cost Analysis, 4*(1), 1–16.

Nordhaus, W. D. (2007). The stern review on the economics of climate change. *Journal of Economic Literature, 45*(3), 686–702.

Ramsey, F. P. (1928). A mathematical theory of saving. *Economic Journal, 38*, 543–559.

Stern, N. H. (2006). *The stern review of the economics of climate change*. Cambridge University Press: Cambridge.