Declining Discount Rates and the Evaluation of Public Investments

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Περίληψη

Δεδομένου ότι οι συνέπειες πολλών δημοσίων έργων και προγραμμάτων εκτείνονται μέσα στον χρόνο, η προεξόφληση μελλοντικών αποτελεσμάτων είναι κρίσιμης σημασίας για τον προσδιορισμό της κατάλληλης δημόσιας πολιτικής. Παραδοσιακά, η σταθερή προεξόφληση θεωρούνταν ως η κατάλληλη βάση για την αξιολόγηση των δημοσίων επενδύσεων, τα τελευταία ωστόσο χρόνια η χρήση των πτωτικών συντελεστών προεξόφλησης αναδύθηκε ως αξιόπιστη εναλλακτική λύση. Αφενός, πολλές μελέτες στις επιστήμες της συμπεριφοράς έδειξαν ότι ένα πρόσωπο επιδεικνύει πτωτικό ποσοστό διαχρονικών προτιμήσεων. Αφετέρου, το αυξανόμενο μέλημα σχετικά με την ευζωία των μελλοντικών γενιών, ιδίως για τις λίαν μακροπρόθεσμες συνέπειες των σημερινών αποφάσεων, υπήρξε κίνητρο για την υπεράσπιση της χρήσης ειδικών συντελεστών προεξόφλησης. Η εργασία πραγματεύεται (α) τους λόγους για τη χρήση πτωτικών ποσοστών προεξόφλησης, (β) συνέπειες στην αξιολόγηση των έργων των διαχρονικά μεταβαλλόμενων κοινωνικών συντελεστών προεξόφλησης, οι οποίοι υιοθετήθηκαν πρόσφατα από πολλές χώρες, για χρήση σε αναλύσεις κόστους-οφέλους.

Abstract

Since public projects and programs have consequences that extend across time, discounting future outcomes is of special interest in determining the suitable public policy. Traditionally, constant discounting was viewed as the appropriate basis for evaluating public investments, but in the last few years the use of declining discount rates has emerged as a credible alternative. On the one hand, several studies in behavioural sci-

ences have yielded evidence that a person has a declining rate of time preference. On the other hand, growing concerns about the well-being of future generations, especially for very long term impacts of today's decisions, were on the origin of defence of the use of particular discount rates. This paper discusses (a) the rationales for using declining discount rates; (b) implications for project evaluation of the time-varying social discount rates adopted recently by many countries for use in cost-benefit analyses.

1. Introduction

A growing interest in how discounting the distant future has been recently emerged due to projects like radioactive waste disposal and long-lived infrastructure, as well to problems like global warming and biodiversity loss, which have a life cycle that impacts distant future generations. Lower or/and declining discount rates over time have important implications for equitable intergenerational resource allocation, since long-term projects yielding significant benefits for future generations become more attractive (Groom et al. 2005, OXERA, 2002). Evans and Sezer (2004) point out also a related aspect of the discount rate. Countries in European Union have used very different approaches resulting in different values when setting official social discount rates. This, in turn, may have serious implications for the EU policy co-ordination on investments, especially on sustainable development.

Discount rates are necessary in the public sector to carry out cost-effectiveness analysis and cost-benefit analysis, as well to cost public sector outputs in order to be compared with the prices of private sector outputs. The recent decisions of European countries to switch from 6%-8% to 3.5%-4% real rates (Commissariat Général du Plan 2005, HM Treasury 2003) have as direct consequence that it is more challenging to show value for money in Public Private Partnership (PPP) projects, since more private sector efficiency is required. This issue concerns also Greece since the Greek government has also adopted the PPP financing scheme (law 3389/2005).

The intent of this paper is to discuss the rationales for using declining discount rates (hyperbolic discounting, uncertainty about the future) in cost-benefit analyses and to explore potential implications of time-varying social discount rates for project evaluation. The paper is focused exclusively on the so-called social time preference approach to discounting, which is adopted recently by government bodies. The other two approaches are not discussed: (a) The actual cost of capital approach, i.e. the best estimate of the actual cost of capital for the government in real terms is the expected value of the long term real bond rate and (b) the social opportunity cost approach, i.e. a minimum discount rate is defined by the expected return on equivalent investments in capital markets.[1]

2. Intertemporal choice

2.1 The standard discounting

At least as far back as Aristotle, scholars have remarked that the value, which we assign on various outcomes, depends on their spatial and temporal proximity to us. By assuming that future consequences have a lower "value" relative to more immediate facts, economics captures this fact by applying a less weight to future consequences than to immediate ones, i.e. by "discounting" the future. If we denote by $(x_0, x_1, \ldots, x_T)$ an intertemporal sequence of outcomes, the intertemporal utility function $u(x_0, x_1, \ldots, x_T)$ is given by

$$u(x_0, x_1, \ldots, x_T) = \sum_{t=0}^{t=T} d^t \times u(x_t)$$

In this formulation, $u(x_t)$ is the utility of the outcome occurred at time t *(u(.)* is supposed to be concave in order to reflect diminishing marginal utility); and

$d^t = \frac{1}{(1+r)^t}$ is the *discount factor* applied to the utility in period t, where the discount rate r represents the individual's pure rate of time preference (supposed to be positive reflecting positive time preferences). The discount factor is the weight that the individual attaches in period *0* to the outcome occurred in period t. In other words, present utility is simply the weighted sum of discounted instantaneous values over a given time horizon.

Accepted both as a valid normative standard and as a descriptively accurate representation of actual behaviour, the discount utility model is employed extensively in investment and firm valuation, government policy appraisal, and even personal decision-making. However, Frederick et al. (2002) show in their review of the literature that the discount utility model is problematic to all of its assumptions and implications.[2]

In spite of philosophical controversies about the rationale for discounting, the central assumption in intertemporal choice is *positive time preference.*[3] Positive time preference refers to the "pervasive devaluation of the future" that is to our tendency to downgrade future costs or benefits. People prefer rather have one apple now than two apples tomorrow; they prefer "100□ immediately" over "110€ in 4 weeks" Thus, individuals are willing to accept a small sum of money today in exchange for a larger sum in the future, individuals are willing to purchase cheaper air conditioners with higher future operating costs instead of more expensive units that are cheaper over their lifetime, and individuals almost always underestimate the effort involved in doing tasks as trivial as mailing a package for a friend (Soman et al. 2005).

Notice that there is an enormous variability in estimated discount rates, ranging from negative to several thousand percent per year and then it is unclear what rate should be used (Frederick 2006, Frederick et al. 2002, OXERA 2002). Moreover, the estimated discount factor varies widely across experimental studies, across individuals across choice domains and across time. However, the major challenge comes in the form of dynamic inconsistency.

2.2 Hyperbolic discounting

The literature documents numerous findings that challenge the descriptive accuracy of the discount utility model. A strong consensus has recently emerged around the notion that the discount rate is not constant but rather a function *f(t)* of time and the hyperbolic discounting has been accepted as the standard for studying how people actually weight future outcomes.

Constant discounting theory is based on the principle of stationarity that is the choice between two payoffs depends only on the absolute time interval separating them. There is, however, strong empirical evidence that people are more sensitive to a given time delay if it occurs closer to the present than if it occurs farther in the future, i.e. people's impatience is decreasing. In other words the discount rate that applies to near-term consumption tradeoffs is higher than the discount rate that applies to long-term consumption tradeoffs. For example, an individual often prefers "one apple today" to "two apples tomorrow"; but he prefers "two apples in a year and a day" over "one apple in a year" O'Donoghue & Rabin (1999) give the following example. When presented a choice between doing a painful seven-hour task on April 1 versus a painful eight-hour task on April 15, if asked on February 1 virtually everyone would prefer the seven-hour task on April 1. However, come April 1, given the same choice, most of us are apt to postpone the work until April 15. Thus, we behave as though we discount the later pain more as time grows short. This anomaly, which is sometimes called the time preference reversal phenomenon, is also true when people approach rewards in time. Many individuals, for example, might prefer a larger-later reward to a smaller-earlier reward when they are both in January. However, when they get temporally close to the smaller-earlier outcome, it looms large and they switch their preference. It is as though they have become more impatient than they were back in January. Since failure to wait for a reward creates an opportunity cost while postponing a loss incurs an out-of-pocket cost, implicit discount rates will be higher for gains.

Unlike conventional discounting, which is exponential, in hyperbolic discounting the weight w_t assigned to each period t, declines as a hyperbolic function of time (Loewenstein & Prelec 1992). Such preferences are described by the following generic hyperbolic discount function

$$f(t) = w_t = \frac{1}{(1+at)^{h/a}} \quad a, h > 0 \text{ and } g(t) = \frac{h\ln(1+at)}{a\ln(1+r)}$$

The function $g(t)$ is the time perception function and concave g(t) yield hyperbolic discounting models. The parameter a measures the deviation of the hyperbolic discounting function from the standard exponential model. As $a \rightarrow 0$, f(t) approaches the exponential function, $a(t) = t$. When a is very large, $f(t)$ approximates a step function, implying that all periods after the first receive approximately equal weight. The parameter h indicates how fast time is perceived to pass and the individual is timing indifferent. The higher h the longer will one time period be perceived to last. If $h \rightarrow 0$, time periods are perceived as passing extremely fast. As $h \rightarrow \infty$, time is not perceived to pass at all and the discount factors of all periods $t > 0$ are zero.

A special case is obtained when $h/a = 1$:

$$f(t) = \frac{1}{1+at} \text{ and } g(t) = \frac{\ln(1+at)}{\ln(1+r)}$$

Figure 1 shows the discount factors for $a = 0.21$ and r = 2, 4, 6, 8%. The hyperbolic discount function $f(t)$ lies below the exponential function at low values of t and above it at high values of t.

Notice that, although hyperbolic discounting gives evidence for the declining discount rate, there is a difference between discounting one's own future utility and discounting the utility of others who will be alive in the future, i.e. between intrapersonal time preference and intergenerational discounting (Frederic 2006, Schelling 1995). The allocation of resources over time within a generation is usually addressed by adopting a social discount rate with the adjustments for market distortions. The allocation of resources (wealth) across generations is more subtle and must be addressed under a different perspective.

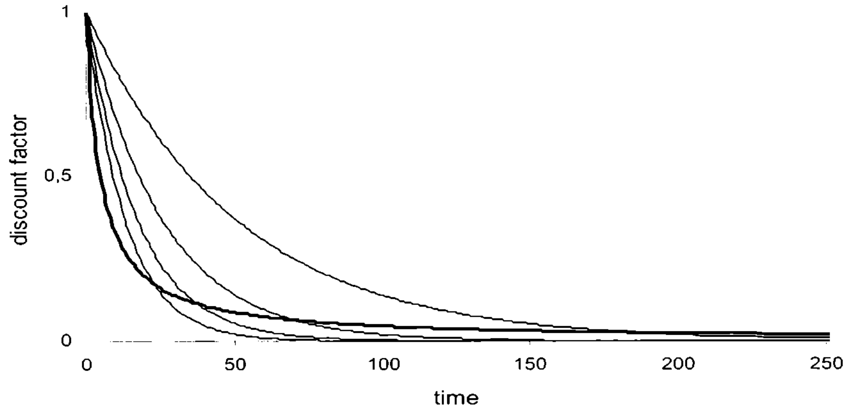

Figure 1: A comparison of hyperbolic rate with exponential rate

2.3 Social discount rates

Deriving from optimal growth models, the standard formula for determining the social discount rate is given by the Ramsey equation $\rho = \delta + ng$ (Ramsey 1928, Groom et al. 2005, Henderson & Bateman 1995, Lind 1995). We suppose that this result is derived by solving the optimization problem of a representative infinitely lived individual or a constant population of identical individuals with the same utility function over time.

In this formulation the social rate of time preference ρ reflects the rate of decline in value that society places on units of consumption at adjacent periods of time. It depends on three parameters. The pure time preference (or the rate of impatience) δ reflects the impatience of the current generation. Since there is no ethical justification for weighing less the utility of future generations, a value $\delta = 0$ is often chosen for this parameter. The other two parameters reflect the wealth effect $n \times g$, i.e. the value of a good today is larger than its value for the future generations. The per capita rate of growth of consumption $g = \dot{c}/c$ is a specification of the scenario or forecast of the path of future consumption. The elasticity of marginal utility of consumption n is the percentage change in the well-being derived from a percentage change in consumption (or income) and reflects that an additional unit of consumption will be worth less for the future generations than for the present as they are richer. In fact, given that the percentage per-annum growth in GDP per capita is estimated for various countries to have been about 1.5-2% for the last 100 years, if we project this trend in 100 years the level of consumption will be seven times larger than of today. Therefore, it is ethically justified that additional consumption opportunities counts less for future generations than for the present.

The rationale for declining discount rates comes from uncertainty.[4] Gollier (2002) analyses the effect of the uncertainty about future growth on the social discount factor. Based on the concept of prudence, i.e. an individual is prudent if his willingness to save increases with future income risk, Gollier shows that prudence justifies taking a smaller discount rate than the one that a certain growth justifies.

One reason to discount the future is related to the wealth effect, that is, the expectation that the quantity of available consumption goods will increase over time. Since individuals have preferences for the smoothing of consumption over time, a project in a growing economy should be accepted only if its rate of return is large enough to compensate for this negative impact on welfare. The larger the growth rate of the eco¬no¬my is, the larger is the social discount rate. However, there is a potentially counterbalancing precautionary effect: the increased risk of longer horizons due to the accumulation of period to period growth risks. The longer the horizon is, the larger is the uncertainty on future wealth, the smaller should the discount rate be.

Therefore, there are two opposing effects on the discount rate, desire for income smoothing and attitude to risk. The magnitude of the effect depends upon the degree of prudence and the degree of uncertainty on growth. Gollier shows that the precautionary effect dominates the wealth effect when relative risk aversion is decreasing and when there is no risk of recession, and he concludes that it is socially efficient to reduce the discount rate per year for more distant horizons.

Based entirely on social time preference, the tight range of discount rates for six major countries (Australia, France, Germany, Japan, UK, and USA) is estimated at 3.5%-5% (Evans and Sezer, 2004). HM Treasury (2003), based on the assumption that the main rationale for declining long-term discount rates results from uncertainty about the future, recommends that for costs and benefits accruing more than 30 years into the future, appraisers must use the discount rates 3%, 2.5%, 2% 1.5% and 1% for the periods of years 31-75, 76-125, 126-200, 201-300 respectively. The Commisariat General du Plan in France has also recently revised its discount rate recommendation from a uniform 8% to 4% in the first 30 years and to a continuous declining rate thereafter, limited to a fixed floor value of 2%.

4. Project appraisal

The technique of discounting is used in the public and private sectors to compare amounts (costs or benefits) occurring at different points in time. Following the *net present value* (NPV) rule, i.e. the total of present values of all the relevant costs and benefits of a project, an investment proposal with positive NPV is accepted; and, when many alternatives are to be considered, the proposal with the highest NPV is preferred because it maximizes wealth. Investments decisions in the private sector are concerned with maximizing shareholder wealth, whereas in the public sector such decisions are concerned with improving social welfare.

Higher (lower) rates make long-term projects, with costs (benefits) in the distant future, appear much less (more) attractive relative to short-term projects with immediate costs (benefits) than they would be if a lower (higher) rate were used. Since there is a bias in favour of the present in discounting, the choice of the appropriate discount rate to be used is crucial at least for two reasons.

First, under the condition that a PPP project should only be accepted when it delivers Value for Money (VfM) (Akintoye et al. 2003), discounting has implications for the relative costs of the two methods of financing the project, i.e. financed under conventional procurement methods and under PPP. VfM is measured by the difference of the net present costs of the two methods of financing. However, the capital costs are occurred during the construction period under the traditional grant system, whereas the costs are spread over a long period under PPP. Therefore, a relatively lower discount rate increases the net present cost of the procurement under PPP. The discount factors obtained using a discount rate of 3% (5%) for the 3rd and 25th year are equal respectively to 0.915 (0.864) and 0.478 (0.295). A decrease of the social discount rate from 5% to 3% implies a relative increase of 6% and 62% respectively of the present costs for the two cases. Consequently, a low discount rate implies a bigger difference between the cost of public capital and private finance than a high one, so more private sector efficiency is required to show value for money in PPP projects.

Second, a lower rate of discount has important implications for the allocation of capital funds between short-term and long-term uses (roads and railways), especially for those very long-term projects yielding important benefits for future generations, for example, investments supporting sustainable development. For a project discounted at a constant social discount rate of 3% and 6%, the present values of 1,000,000€ at year $t = 150$ are respectively equal to 11,869€ and 160€. The 1,000,000€ of benefit is reduced effectively to nothing for $r = 6\%$.

The decision of public authorities to lowering the discount rates has provoked a debate about the consequences. First, the rationale for supporting the high discount rates in the past was partially justified that a prime of risk might be integrated in cost-benefit analyses (Gollier 2005). However, this argument is only justified if all publicly financed projects shared comparable risks, otherwise a high uniform rate penalise the less risky projects. In any case, the discount rate reflects the exchange between current and future consumption, so risks must separated from the discount rate. In this case, it is predicted an increase of fiscal pressure and of deficits, because of a considerable financing of publicly projects, in particular those with long term benefices. However, this choice is justifiable because risks must be integrated in the certain equivalent cash flows. Second, the disposability of public funds and the consequences for the public finances must be taken into account in cost-benefit analyses. Given the budget constraints, endogenous or exogenous, and the limited capacity of financing, it is recommended that this fact must be taken into account. A solution to this problem is to use as selection criterion the discounted net benefice per dispensed public euro (Commissariat Général du Plan 2005). Third, since taxation provokes distortions and efficacy losses, the opportunity cost of public funds must be also taken into account. The real cost of taxation is the distortions provoked in incitation of private actors. This in turn may provoke a reduction on the rentability of some projects, especially those with weak capacity of autofinancing. In this context the integration of opportunity cost of public funds in cost-benefit analyses is especially appealing for the PPP projects, given that a justification must found VfM.

5. Conclusions

Despite the importance of the social discount rate for the appraisal of a project, there is no agreement on how to estimate it. In any case, a more rational long-term discounting policy is needed to take account of the implications of today's decisions for the very long term. For this purpose, recent advances that support the declining discount rates over time seem to provide better alternatives to the standard discounting.

The choice of a social discount rate for a project sector or the society as a whole is mostly a political decision. In many cases discount rates may be the result to satisfy narrow interest groups. The recent changes in social discount rates by European governments reflect to a large extent the emergent concerns in contemporary societies about the intergenerational equity and sustainability. However, a consistent framework may help to rationalize the debates, clarify the legitimacy of particular practices and refine normative models of intertemporal choice. This is of particular interest for many sectors, such as construction industry, that depend significantly on the publicly financed projects.

In fact, a low discount rate makes less attractive long-term projects yielding significant costs for future generations and procurement through PPP more expensive in today's terms. Even though this paper has emphasized the choice of the social discount rate, we must remember that "there are many issues in appraisal and evaluation which are much more important than the choice of discount rate... Profoundly important too, of course, are the quality of contracting, of project management during construction, and management of subsequent operation and maintenance" (Spackman, 2001, p. 245).

Notes

1. It seems that there is no significant contemporary support for an actual cost of capital approach. The opportunity cost approach to the cost of capital for the government, which usually leads to a much higher discount rate, assumes that the discount rate applied to public investments should be the rate of return of private investments, that is, the expected return on the same or similar investments in the capital markets, because funds are diverted from potential use of the private sector to public investments. As the government receives all tax revenues, the before-tax rate of return on private investment must be applied to discount before-tax cash flows (Brealey et al., 1997). According to Spackman (2001), however, for two reasons a government must use the same rate instead of two rates, i.e. a general discount rate based on social time preference and the cost of capital. First, the use of different real rates would be administratively extremely difficult. Second, it seems likely that in many countries the cost of capital and the time preference rate are close enough to be set equal to the same number. In any case, this rate will be greater than the interest rate on government borrowing.
2. The special assumptions underlying the discounted utility model (for example, the integration of new alternatives with existing plans and sta-

tionarity, i.e. discounting is based on the difference in time between two events), as well as its "anomalies" (the best documented anomaly being hyperbolic discounting) are commented at length in Frederick et al. (2002).

3. Although discounting is an essential assumption for intertemporal decisions, it is not clear why we would take less utility now over later. Thus, the fundamental question is if discounting is rationale. Some writers believe that discounting utility is irrational (Broome 1991, Broome 2006, Ramsey 1928, Rawls 1971). In their view our personal identity is "simple", that is we are the same person through time, despite our physical and psychological changes; and, then, it is irrational to prefer a smaller immediate pleasure over a greater future pleasure. On the other hand, the philosopher Derek Parfit has given the only valid argument to justify true impatience. He was argued that there is no enduring, irreducible entity over time to which all future utility can be ascribed, i.e. we can be described as a sequence of "selves" distributed over time (Frederick 2006, Frederick et al. 2002, Parfit 1984). Since it is not ethically unjustifiable to care less about the utility of other people than about ourselves and the various "selves" of our life may be as profound as the distinctions between individuals, we can justifiably value the utility of our current self more than that of our future selves.
4. Weitzman (1998) holds a similar position. However, for Weitzman uncertainty is reflected in uncertainty about future interest rates. For Gollier, the uncertainty is about the state of the economy.

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