How Can We Improve Evaluation Methods for Public Infrastructure?

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RENEWAL SERIES
PAPER 2

November 2011

ESRI

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Acknowledgements

I would like to thank the editors, the anonymous reviewers and the participants in an internal ESRI seminar for their comments on an earlier draft of this paper. I would also like to thank Regina Moore for her work in preparing the manuscript for publication.

How Can We Improve Evaluation Methods for Public Infrastructure?

Abstract

Given the smaller total budget for public expenditure and the fact that the cost of public funds to Ireland has increased, it is more important than ever to ensure that public investment is prioritised properly in order to derive maximum benefit. In order to prioritise we must evaluate. A variety of evaluation methods can be utilised, but perhaps the most widely used is cost benefit analysis. The usefulness of cost benefit analysis crucially depends on a number of parameters and inputs. This paper considers the international literature on two issues, namely, the impact of risk in the form of inaccurate cost or benefit estimates and the setting of the appropriate discount rate, both of which can impact significantly on the usefulness of cost benefit analysis. The evidence on the expected costs and benefits of projects highlights that projects often do not go according to plan and that these estimates are subject to systematic optimism bias, which, while not universal, appears to be widespread. In relation to the appropriate choice of a discount rate, a riskless rate should in general not be used unless all risks have been properly assessed and costed within the analysis. This paper concludes that the discount rates that are currently used in Ireland appear to be low. Furthermore, the paper highlights that if the conventional exponential discounting is used then costs and benefits that occur in the distant future are essentially ignored. A declining discount rate accounts better for costs/benefits that occur in the distant future and is consistent with the observed pattern of time preference of individuals. This paper recommends a hybrid approach be adopted where costs and benefits are discounted using exponential discounting up to a point at which the discounting is switched to declining discounting.

1. INTRODUCTION

An extensive literature has shown that infrastructure yields a positive long-run macroeconomic return (see Lighthart and Martin-Suarez, 2011). The return on such investment depends on the size and quality of the existing infrastructure stock and the level of demand for (e.g. congestion of) it. Thus, if the current infrastructure stock is adequate and no constraints exist then the likely return on further investment at this point is low or even negative, or as Pritchett (1996, p1.) noted - "the value of infrastructure is not equal to its cost".

The fact that a positive return to infrastructure investment is not guaranteed and that different investments have different impacts, together with the fact that the demand for resources for potential projects tends to outstrip the available public resources even during 'normal' times, implies that investment decisions should be based on careful evaluation. The economic crisis in Ireland has radically changed the fiscal environment and consequently public capital budgets have been cut successively since the NDP 2007-2013 was published. The public capital budget now amounts to just 50% of what had been planned in 2007, even when one takes into account that tender prices have fallen by about 25%[1]. Given the smaller total budget and the fact that the cost of public funds has increased it is more important than ever to ensure that spending is prioritised properly in order to derive maximum benefit. In order to prioritise we must evaluate.

There are a number of alternative evaluation methodologies that can be applied. These include macro-econometric models, input output models, multi criterion decision analysis and cost-benefit analysis (CBA). Cost benefit analysis is perhaps the most widely used method and a cost benefit analysis is required in Ireland for public projects costing in excess of €50 million (Department of Finance, 2005).[2] CBA relies on the specification of a range of parameters such as the cost of public funds, shadow cost of labour, taxation, and a discount rate. Furthermore, in order to ensure comparability across projects, common baseline assumptions about economic and demographic development need to be used, which are important inputs into estimates of costs and benefits and projects should also be tested against a range of credible counterfactuals.

This paper considers two issues in the application and usefulness of cost benefit analysis for infrastructure prioritisation namely the impact of risk in the form of

[1] These calculations are based on the figures contained in the NDP and the public capital programme that accompanied the budgets. The price deflator is that implied by the CSO National Accounts.

[2] Since January 2006 projects costing in excess of €30 million are subjected to a cost benefit analysis.

inaccurate cost or benefit estimates and the setting of the appropriate discount rate. These two issues are chosen firstly, because they crucially determine the usefulness of a CBA and secondly because there have been interesting developments in the international literature on these issues that have yet to be reflected in the application of CBA in an Irish setting. These issues are quite general and apply to all types of infrastructures (transport projects, hospitals, schools, flood defences, public offices etc.).

2. Evaluation Methodologies

Before turning to the two specific issues that will be considered below it is useful to consider why CBA is perhaps the most widely applied methodology. This is most readily achieved by considering some of the strengths and weaknesses of other evaluation methodologies as well as CBA.

Fully specified macro-econometric models have been used to evaluate the impact of programmes of investment (e.g. Bradley et al. 2003, Roeger, 1996), but in principle they could also be used to evaluate individual projects. They are particularly suited to identify the overall short-run and long-run impacts including the wider impacts such as those on prices. However, they are sensitive to the theoretical underpinnings used, as these can have an important bearing on the impact estimates[3], and are not well suited to assess alternative projects within a specific investment area as they lack the required detail.

Computable General Equilibrium (CGE) models are theory based multi-equation models that are parameterised using estimates from the literature and calibrated to actual data. They have been used by a number of researchers for project evaluation particularly in the context of regional impacts where the data required to estimate fully specified macro-econometric models is not available (e.g. Gillespie et al 2001 or Törmä, 2008). Their advantage is the general equilibrium nature that captures all effects, their theoretical consistency and the reduced need for data. However, the latter, along with the fact that the parameters are taken from the literature or where appropriate parameters are not available these are assumed, risks that the model does not reflect the real structure of the economy. Furthermore, as the structure is imposed, this approach is less well suited to the estimation of long-run impacts that arise from structural change.

[3] For example in the QUEST model (Roeger, 1996), crowding out mechanisms reduce the overall estimated impact of the Structural Funds.

Another approach to project evaluation is to use an input-output (I-O) model. I-O models identify the interconnection of input and output of different sectors and/or regions of an economy. They have been used for the evaluation of individual projects (e.g. Juri and Kockelman, 2006) and programmes of investment (e.g. Beutel, 2002). The I-O approach is ideally suited to analyse the short term impacts, such as the employment impact and the wider distributional impact a project a programme of projects. However, I-O models are less well suited to the evaluation of the long-term supply side impacts as it is difficult to incorporate supply-side (or neo-classical) adjustment mechanisms into a static input-output framework.

A less technical evaluation methodology is multi criterion decision analysis, which has been used in Ireland (see Honohan, 1997, Fitz Gerald et al, 2003) and which has become more popular in other countries in recent years (see Bradley et al., 2006, Cundric et al, 2008, Brucker et al, 2011). Multi-criteria analysis (MCDA) describes any structured approach used to determine overall preferences among alternative options, where the options accomplish several objectives. This methodology is used to make a comparative assessment of alternative projects or heterogeneous measures. It involves scoring each project or programme of investment using a common set of criteria, which each are given a weighting according to the range of objectives, constraints and rationale for investment. MCDA allows decision makers to take account of a full range of social, environmental, technical, economic, and financial criteria simultaneously. Therefore, it is particularly applicable to cases where a single-criterion approach falls short, especially where monetary values are difficult to estimate. However, it can suffer from subjectivity and requires a degree of knowledge of the performance of projects, which is not usually available for new projects.

Cost benefit analysis aims at comparing costs and benefits of government policies. It involves calculating a comprehensive set of costs and benefits accounting for the fact that these do not necessarily arise simultaneously, that the public intervention can have a range of distortionary effects and reflecting the fact that market outcomes are not necessarily efficient. As such it is a method that identifies whether a project passes basic investment criteria, namely that a project is expected to yield a positive net return. Perhaps more importantly, it is a methodology that can be used to compare alternative projects and variations of the same project in order to identify that which yields the highest return. CBA is well grounded in welfare economics although the degree to which a particular CBA conforms to welfare economic theory is highly dependent on the thoroughness of the analysis and the assumptions and parameters that are chosen. While making all the costs, benefits and distortions explicit is a great strength of cost-benefit analysis, the requirement to quantify all of these can be very onerous and does involve the choice of specific parameters. As such this methodology is more readily applied to a smaller number of projects rather than a large number of diverse projects (see Morgenroth and Fitz Gerald, 2006). Furthermore, by relying on the choice of parameters and the quantification of costs and benefits the choice and accuracy of these has an important bearing on the results. Consequently some researchers have cautioned against blindly following the results of a CBA and have highlighted that it is important to address the shortcomings of CBA (e.g. Hahn and Dudley, 2007 and van Wee, 2012). However, CBA is the cornerstone of project evaluation in many countries (e.g. Australia, UK, USA) and is also used as the key appraisal method in Ireland.

In many countries a difference between planning outcomes and the policy decision making process can be observed and there is no convergence on best practice in terms of planning methods and institutions (Short and Kopp, 2005). Thus, while it is recognised that infrastructure decision making is often suboptimal it is difficult to identify the best system of decision making. In the absence of clear evidence that one system of decision making is superior, the focus should be on improving the quality of decisions made within the existing system, which is the focus of this paper.

3. Project Risks – The Accuracy of Cost and Benefit Estimates

Projects are subject to a range of risks. For example time delays can arise during construction resulting in cost escalation (construction risk), the operating costs can be underestimated or the output of the infrastructure can be overestimated (operating risk), the demand for and 'willingness to pay for' an infrastructure can be overestimated (demand risk), there can be significant financial risks if the project needs to be refinanced or if at an early stage the cost of funds changes, consumers may also choose alternatives (e.g. un-tolled roads or a bus rather than rail) and finally projects are also subject to political risk in that political priorities may change due to changed circumstances or a changed government. Nevertheless, projects are typically promoted on an "everything goes according to plan" basis.

A large number of studies have considered whether costs, demand and land-use impacts of transport infrastructure projects have been mis-estimated and whether they have been systematically biased in order to improve the likelihood that decision makers will support a particular project. Interestingly, there appear to be no such papers for other types of infrastructures even though there are numerous examples of other types of infrastructure where costs were underestimated and benefits were not realised.

Flyvbjerg et al (2003) analysed 258 projects from 20 countries covering rail, bridge, tunnel and road projects. They found that 90% of projects were subject to cost overruns. The average cost overrun for rail projects was 45%, bridges and tunnels were subject to an average 34% cost overrun and roads cost on average 20% more than initially estimated. Another large scale study by Bain (2009) found traffic forecasts to be 23% higher than outturn and that this bias is not confined to first year forecasts, which are difficult to make but also into the medium term.

The degree to which demand for infrastructure is accurately predicted at the planning stage was investigated by Pickrel (1990) with respect to ten rail projects in the USA. He found that for nine projects the actual passenger numbers were 50% lower than expected while for one project the passenger numbers exceeded the predicted level by 50%. Flyvbjerg et al (2004) analysed 210 projects from 14 countries and found that the passenger numbers for rail projects were overestimated in 90% of projects with the overestimate compared to the actual outturn averaging 51%. For roads the estimates on average understated traffic by 9.5%, but there was a large spread with some over-estimates and some underestimates. A more recent study by Parthasarathi and Levinson (2010) considered 391 road projects in Minnesota constructed in the 1960's and compared the traffic forecasts with the traffic counts taken in 1978. They found that on average traffic on roads was underestimated by 19.5% and that the deviations of actual from projected traffic ranged from -60% to +57%. They found that the deviations varied across road types with traffic on major roads being under-predicted at the time of planning while that for smaller roads was over-predicted. They also highlight that the inaccuracies arise out of the failure of the underlying models to incorporate behavioural change and flaws in demographic forecasts.

Given the strong evidence that there is systematic optimism bias, particularly on costs and also on demand for rail, it is important to consider why this bias emerges, which has been the subject of a number of studies and a number of explanatory factors have been identified. Flyvbjerg et al, (2003) consider the impact of the length of the project implementation phase, the size of the project and the type of project ownership on cost escalation. Specifically, they found that an additional year from the decision to build a project and the end of construction adds 4.6% to costs. For bridges and tunnels larger projects are found to have higher cost escalation and that roads projects were found to increase in size over time. Finally they also found that there was no systematic difference in cost overruns between traditional public projects and public private partnerships (PPPs).

Mackett and Edwards (1998) argue that the objectives of decision makers and the legislative and planning framework are important determinants of optimism bias. They highlight that often it is easier to get support from central government for more 'high-tech' discrete projects than more incremental improvements of existing systems. Furthermore, they contend that decision makers prefer to support what they term 'glamorous' projects instead of simpler less visible projects. Pritchett (2002) constructs a simple political economy model where projects/programmes are support by "advocates" who are more committed to pursuing their project than the general public and where the latter is split into three groups according to their attitudes towards the project. He finds that except in the case where advocates know that the project will have the desired outcome, they will prefer not to evaluate the project i.e. they will prefer ignorance.

The implications of the findings of this literature are best illustrated by applying them to an example of a rail project with benefit to cost ratio of 2:1. For rail projects the findings are that the benefit (demand) is overestimated by 50% and that costs are underestimated up by 40% at the time of project proposal. Adjusting the benefits and costs accordingly reduces the Benefit to Cost Ratio (BCR) to less than 0.75:1.

In the UK it is considered best practice to make an explicit allowance for optimism bias at the evaluation stage. The UK Department for Transport published a set of guidelines (see Flyvbjerg and COWI, 2004). These guidelines recommend that a fixed percentage be added to the costs for the purposes of a cost benefit analysis. These guidelines make explicit allowance for the fact that the cost overruns vary considerably. For example in order to ensure that the final costs of a rail project are on budget with a 50% certainty then the initial cost estimate should be increased by 40%[4]. To ensure the project ends up on budget with an 80% certainty 57% should be added to the initial cost estimate (and 68% if a 90% chance of staying on budget is necessary)[5]. For roads the recommended uplift is smaller reflecting the lower optimism bias found in research.

4. Discount Rate

Given that costs and benefits do not accrue immediately, but rather are spread over time it is necessary to account for the fact that the value today of these future streams is not equal to their value in the future i.e. a euro to be received in 10 years time is worth less than a euro received today. Converting future values to a present value is accomplished using a discount rate.

[4] Of course setting such rules runs the risk that the initial cost estimates are adjusted downwards accordingly. The degree to which this happens in practice does not appear to have been investigated yet.

[5] They also highlight that the ex-post bias on IT projects can be particularly large and recommend that the initial costs are increased by between 10% and 200%.

Setting the appropriate discount rate has been a topic of countless research papers (e.g. Stiglitz,1994) and long literature reviews, so that a full review of this literature is beyond the scope of this paper[6]. Instead this section considers the appropriate rate of discount and the valuation of costs and benefits that arise in the distant future.

It is useful to set out the implication of setting different discount rates, which is best done by considering a simple example of €1000 received at different points in the future discounted by different discount rates, as shown in Table 1[7]. The first column shows the valuation today of €1000 received in the future without discounting. The first row clearly shows that €1000 received in one years' time would be valued today at less than €1000 euro, but even with this short time horizon, the discount rate has a significant impact on the valuation. For the 20 year horizon the valuation of €1000 using the 4% discount rate is just over twice that using the 8% discount rate which in turn is just over twice that for the 12% discount rate, which shows the implication of different discount rates over a typical time horizon[8]. Once the discount rate is positive, the valuation today of €1000 received in 100 years is zero or very close to zero regardless of the discount rate once the traditional model of exponential discounting is applied, where the discount rate remains constant over time. This has important implications since the very long run benefit of projects is often put forward as a reason to go ahead with projects with modest short to medium term benefits. On the basis of Table 1 these benefits would be irrelevant.

Table 1. Variation in the Value Today of €1000 received in the Future using alternative Discount Rates

	Discount Rate			
Years	**0%**	**4%**	**8%**	**12%**
1	€1000	€962	€926	€893
10	€1000	€676	€463	€322
20	€1000	€456	€215	€104
50	€1000	€141	€21	€3
100	€1000	€20	€0	€0

Note: These are derived using the conventional exponential discounting.

6 Harrison, 2010 provides a very comprehensive review of the literature and identifies its implications for setting discount rates in Australia.

7 The table applies what is referred to as exponential discounting, which is formally stated as $\theta = 1/(1-\delta)^t$, where θ denotes the discount factor by which the value is multiplied in order to convert it into a present value, δ denotes the discount rate and *t* denotes the number of years into the future when the cost/benefit occurs.

8 The choice of discount rate can also have a significant impact on certain types of public private partnerships. For example Vassallo (2010) considers the impact of the discount rate on a flexible-term highway concession known as least present value of revenues (LPVR), where the concession is awarded to the bidder that offers the lowest present value of revenues discounted by the discount rate set by the government. A lower discount rate was found to increase the traffic risk to the concession holder.

Alternative approaches to explain and derive the discount rate have been put forward. Firstly, the discount rate is argued to reflect the rate of time preference of individual with respect to consumption decisions. This corresponds to the fact that the benefits of public projects are typically enjoyed by consumers, and that the public resources expended could have been used for other consumption. Another approach is to consider the discount rate as a measure of the opportunity cost of funds that could have been invested in alternative projects would have a return which is foregone. The alternative measures point to different proxies to measure the discount rate.

If the underlying approach is based on the opportunity cost of funds then financial market rates can be used. For example, the most common measure of the riskless rate of return is the long run government bond rate. For Ireland the real rate of interest on long-run bonds over the last 35 years has been 3.3%[9]. For Germany, the UK and the US the respective rates have been 3.7%, 3.3% and 3.1%. Of course most projects are not riskless so that a rate incorporating risk should be used to evaluate projects

The real after tax rate of return on private capital in Ireland for the period 2002 to 2009 averages 10%, which is slightly higher than the 8.5% found by Harrison (2010) for Australia over a four decade period[10]. The difference might be explained by either the higher return in Ireland or an upward bias due to the importance of foreign multinational companies in Ireland and their ability to shift profits. An alternative would be to consider a share index. However, as an index implies a degree of diversification the rate of return should be considered an intermediate between the riskless and the risky rate of return.

Using the consumption approach the common estimate of the discount rate is calculated as the sum of the pure rate of time preference and the rate of consumption growth multiplied by the elasticity of marginal utility of consumption[11]. Over the period 1970 to 2010 per capita real consumption growth in Ireland has averaged 4.1% per year[12]. Evans (2005) provides estimates of the elasticity of marginal utility of consumption for Ireland that range from 1 to 1.47. There is much debate about the correct value of the pure rate of time preference, but a range of 1% to 3% is often used. Utilising these estimates yields a social discount rate between 5.1% and 9% using the consumption growth over the full period.

[9] This is the average long-run interest rate taken from the OECD data base OECD.Stat.

[10] The real after tax return was calculated as the ratio of the net operation as published in the CSO Institutional Sector Accounts (2010) and the capital stock as published by the CSO Estimates of the Stock of Fixed Assets (2011).

[11] This is the so called Ramsey equation based on the Ramsey growth model (see Ramsey, 1928)

[12] For the period 1970 to 2000, excluding the boom years, real per capita consumption growth averaged 4.7%.

The current official test discount rate in Ireland is 4% (used to discount future costs and benefits), with financial discount rates ranging from 5.82% to 6.7% (used to discount project cash flows) depending on the type and length of project (Department of Public Expenditure and Reform, 2011).

The underlying model of discounting used in Table 1 is exponential discounting where the rate does not vary across years. As was shown, the consequence of this is that costs or benefits that occur in the distant future (e.g. 100 years) have almost no impact at all on the results of the analysis. For example the cost of storing nuclear waste that has to be borne for thousands of years into the future is largely removed from the analysis of the costs and benefits of the construction of a nuclear reactor if the exponential approach is used. Likewise, any climate change impacts of a project (e.g. the emission reductions of a public transport project) that accrue in the long-run will be virtually eliminated if the exponential discounting approach is used. It is therefore not surprising that the parameters and calculation of the discount rate have been subject to substantial debate particularly in the context of valuing climate change (see Anthoff, Tol and Yohe, 2009).

While there has been a particular focus on discounting the distant future more recently due to the interest in the effects of climate change, the issue is not new and substantial experimental and empirical work suggests that individuals apply a declining discount rate which is captured well using a hyperbolic curve[13]. A range of papers in the 1970’s and 1980s showed that observed decisions by individuals deviated from what would be expected by conventional theory, with empirical studies finding both extremely large discount rates and even negative rates (Loewenstein and Thaler, 1989). Using experiments Thaler (1981) showed that individuals did not use a constant discount rate but rather that their rates decline for more distant events. Viscusi et al (2008) found strong evidence for hyperbolic (declining) discounting in a study of visitors to water bodies.

Weitzman in a series of papers (e.g. 1998, 2001, 2010) made an important contribution to this literature. He showed that if future discount rates are uncertain then the expected net present value should be used, which implies a decreasing term structure with the discount rate approaching the lowest possible rate. He further argued that since discount rates are not known ex-post this uncertainty should be explicitly reflected in any model. A common approach to incorporating such uncertainty into a model is to assume that the outcomes are distributed

[13] The most general form of the hyperbolic discount is formally stated as $\theta = 1/(1+\alpha t)^{\gamma/\alpha}$

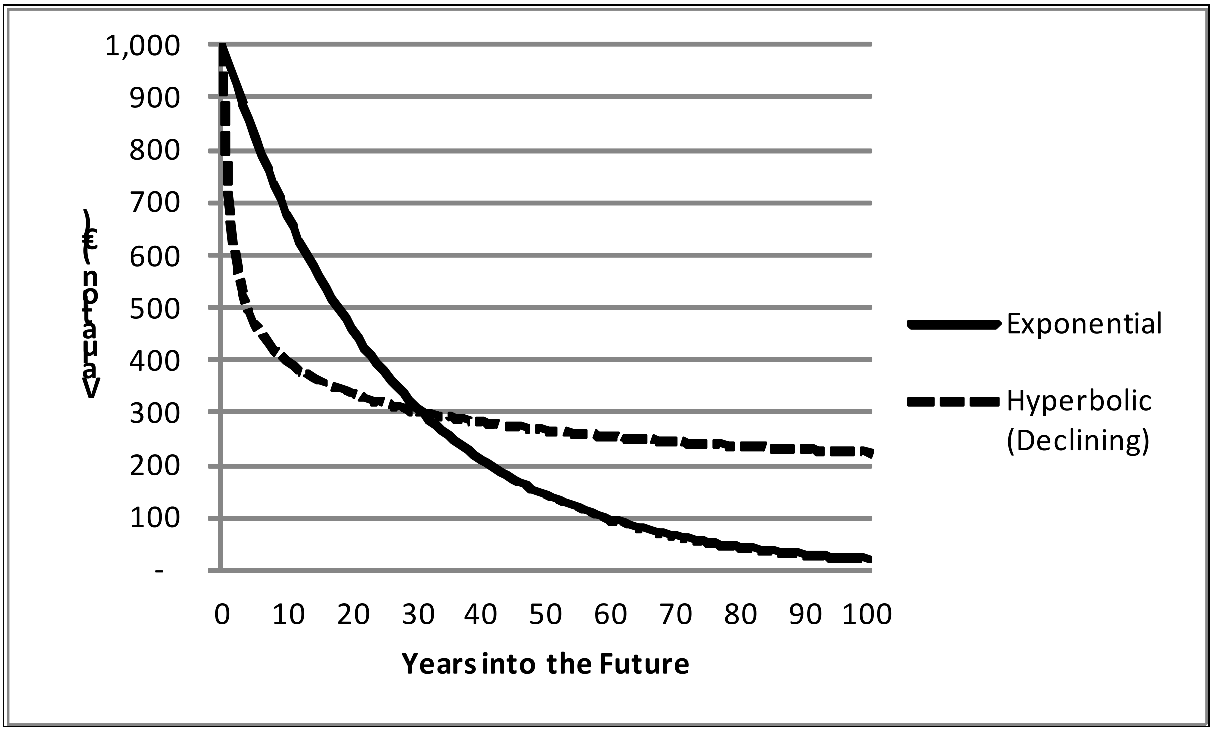
according to a probability distribution. Weitzmann (1998) assumes that the probability of predicting the discounted value follows a gamma distribution, which results in decreasing discount rates[14].

To understand the implications of the alternative discounting approaches it is again useful to consider the example of €1000 received at different times in the future using the two approaches, which is shown in Figure 1. The figure clearly shows the more rapid initial decline in valuations and the less rapid decline in valuation in the more distant future using the hyperbolic (declining) discounting compared to exponential discounting. A €1000 received (lost) in 100 years is valued just over €200 using the hyperbolic (declining) approach, while it is only worth €20 using the exponential discounting approach.

While there is significant evidence in favour of some kind of hyperbolic discounting, the debate is ongoing (e.g. Bugess and Zerbe, 2011). Nevertheless, the response in a number of countries has been to use hyperbolic (declining) discounting for costs and benefits that accrue more than 50 years into the future (e.g. HM Treasury 2011). This approach is appealing since it does not bias the analysis against projects with benefits that arise in the near future by applying exponential discounting to these, while allowing for costs and benefits that arise in the distant future to by applying hyperbolic (declining) discounting. A practical approach would be to apply the higher discount factor (lower discount rate) of the two i.e. the exponential discounting up to the point where the two lines in Figure 1 cross and the hyperbolic (declining) thereafter. In Figure 1 the two lines cross at 31 years, where the crossing point is determined by the parameterisation and discount rates chosen. For use in actual evaluation these would need to be chosen carefully.

[14] Processes for which the time between events is relevant are often found to follow a gamma distribution. Given that there is a time span between the point at which a valuation is made and the point in time when the outcome is realised, the gamma distribution is a natural choice.

Figure 1. Comparison of the Value Today of €1000 received in the Future using Exponential (4%) and Hyperbolic (Declining) Discounting



Note: The parameters for the hyperbolic discounting are taken from Angeletos et al. (2001) page 51.

5. Conclusions and Recommendations

In order to prioritise investment it is important to evaluate. This paper has considered just two issues that have a crucial impact on the usefulness of evaluations using a cost benefit analysis.

The evidence on the expected costs and benefits of projects highlights that projects often do not go according to plan and that these estimates are subject to systematic optimism bias, which while not universal appears to be widespread. In particular it appears to be a significant problem in rail projects.

There is no systematic evidence on optimism bias in Ireland, which of course does not imply that optimism bias is absent. However, the Comptroller and Auditor General has identified some projects as having cost significantly more than had been expected (e.g. refurbishment of Cork Courthouse). Therefore, as a first step to protecting the tax payer, it is important to establish whether projects in Ireland have been subject to optimism bias. This requires thorough ex-post evaluation of a comprehensive set of all types of infrastructure projects. This analysis should not be restricted to transport infrastructure but should also consider other types of infrastructure. If optimism bias is found, then the UK approach would be a useful first step to protect the tax payer against cost escalation and underperformance of infrastructure.

Of course, a finding that optimism bias has not been an issue does not imply that projects have been good value; it only means that the projections were correct. If a project comes in on budget this does not mean that the costs of the project were minimised or indeed that it was the cheapest option to provide the desired outcome. An ex-post analysis of projects can also be used to compare prices across projects, identify their determinants and allows for an international comparison.

As was highlighted above, projects face a variety of risks. While the implications of risk to the value of a cost benefit analysis are well known and guidelines usually require these to be priced, in practice risks are often not taken into account (Van Ewijk and Tang, 2003). Therefore, the use of a riskless rate of discount is inappropriate in most cases and thus the discount rates currently used for the assessment of public projects are lower than the estimates of the discount rate provided above, and are almost certainly too low. This implies a lower threshold for projects and biases the results of a cost benefit analysis in favour of projects with substantial medium term benefits.

The risk free rate should not be used unless a project is indeed risk free, that is all risk has been spread to the market[15], the risks are not covered by either the beneficiaries of the project and tax payers or if the costs and benefits have been converted to 'certainty equivalents' (see Harrison 2010) [16]. Instead, sensitivity analysis should be carried out using a range of discount rates that should be centred on a plausible risky rate of return. This reflects the fact that a 'one size fits all' approach is not consistent with the heterogeneity of the projects that are being assessed. For Australia, Harrison (2010) recommends a base rate of 8% and sensitivity analysis over a range of 3 to 10%, where the base is derived from the return to capital. Given the evidence on discount rates presented, a similar approach in Ireland would imply a range with a slightly higher upper value. Where the results are found to be sensitive to the choice of discount rate, further analysis on the appropriate rate should be carried out.

Another important implication from the recent literature is that exponential discounting may be inappropriate, particularly when it comes to valuing costs and

[15] This could be achieved through the purchase of insurance, which has a cost that should then enter the calculations.

[16] In many PPP projects the risks of a project are not completely transferred to the market and indeed it can be argued that it is impossible to completely transfer risk to the market, when the projects concern strategic infrastructures.

benefits that accrue in the very long run. For costs and benefits that accrue in the distant future hyperbolic discounting should be applied. A pragmatic approach is to apply a hybrid between the exponential and the hyperbolic (declining) discounting using the lower rate of the two. This avoids biasing the analysis against projects with benefits in the near future by applying exponential discounting, while it allows for costs and benefits that arise in the distant future by applying the hyperbolic (declining) discounting.

The apparently narrow focus of this paper should not be taken to imply that only the two issues considered here are important in getting quality cost benefit evaluations, although they are among the most important. A range of other factors also should be reviewed periodically to ensure that the project appraisal guidelines guarantee the best possible analysis. For example, choosing an appropriate comparator is important in choosing the right project. If a project is only compared to a 'do nothing' comparator, then if that project is in any way effective it will dominate the 'do nothing' comparator. Consequently, such a comparison yields no insights for project prioritisation. Therefore, projects should be compared to alternative projects, and variations of the same project should also be considered in order to identify the most effective option.

The implicit assumption in this paper is that some preliminary analysis was used to establish the need for a project, which should be done on the basis of a full assessment of the existing infrastructure and the likely future needs. A fundamental prerequisite for this analysis should be a central asset register, proper condition surveys and asset management plans. These appear to be lacking in some cases in Ireland[17]. Such knowledge should also be used to decide between the building of new infrastructure, maintenance or incremental improvement of existing infrastructure. Likewise it should not be assumed that investment in new infrastructure is necessarily the most effective solution. In many cases proper maintenance of existing infrastructures would be a more efficient substitute to future investment in new structures. Furthermore, measures other than investment, such as appropriate fiscal incentives, may also lead to the desired outcome. Finally, it is difficult to have confidence in any analysis that is not made public or of which only selected aspects are made public. As such, it is imperative that all evaluations should be published in full in order to allow public scrutiny.

17 This is common practice in the private sector and in many other countries e.g. the UK.

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The ESRI acknowledges the
financial support of FBD Trust
for the *Renewal Series*