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Mega Urban Transport Projects

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Mega Transport Projects: The Challenge of Embedding Sustainability in Financing Mega Urban Transport Projects

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There are very few Mega Urban Transport Projects that are not planned to have significant impact on the functioning of the urban and regional economies that they aim to serve. The Oresund Link sought to integrate the Malmo and Copenhagen regional economy across international boundaries, the Melbourne CityLink restructured traffic patterns in Melbourne with significant efficiency benefits, the Hong Kong Airport Express Railway facilitated the redevelopment and regeneration of economically and physically obsolete urban industrial areas in Hong Kong although the railway itself is probably loss-making. In all cases, modern planning expectations is usually that the economic impacts of such highly capital intensive, often location- and function-specific infrastructure assets should yield significant net benefits to their host societies, despite the extremely high risks that are nature to their fixed asset characteristics and inflexible primary transport-related functional objectives. A more modern requirement is also the expectation that they should embed sustainability in their planning and intended impacts.

This brings into focus the primary purpose of project appraisal, namely the identification of MUTPs that are socially desirable, economically viable and sustainable and provide net benefit to their societies over their intended lives. Given the irreversibility and inflexibility of MUTP investments, we view appraisal criteria thus to also include sustainability considerations, which we assume includes at least two concepts. First, beyond Brundlandt, we consider a workable view of *sustainability* to mean the ability to continue an activity as long as society benefits from it without requiring a fundamental change in the mix of resource inputs; and secondly, we consider *sustainable development* to imply continued improvement and evolution of all in a progressive way and with it the ability to adjust the set of inputs to reflect changing resource imperatives (Barron, 2010). With large, capital intensive and inflexible MUTPs, sustainability thus means that achieving at the time of development the correct mix of fixed and variable inputs to ensure sustainability is critical, because the expectation is that the nature of MUTPs invariably means that the mix will likely have very limited flexibility over the MUTPs life. It is ambitious to expect that we are capable of planning successfully today a resource input mix that would be sustainable over an MUTPs life, and particularly so with changing social and economic priorities, and expectations of climate change in the near future.

This paper is concerned with one of the mix of resource inputs into MUTPs, namely finance. We are concerned with embedding sustainability considerations into the appraisal of Mega Urban Transport Projects (MUTPs), but more so with particular aspects of MUTP appraisal that draw on finance theory for their underlying logic, namely the choice of project discount rates. More generally, appraisal errors in cost-benefit analyses (CBA) are frequently blamed for sunk capital in underperforming projects, but often cost-benefit analysis methodology is also blamed for poor decisions. It is well-known that CBA is incapable of incorporating effectively positive or negative environmental and social externalities that are not fully commodified, or is incapable of allowing assessment of secondary or tertiary positive or negative impacts, or is considered incapable of allowing effective consideration of unintended impacts and systems dynamics (see Barron, Perlack & Boland, 1998). Often forecasts are simply wrong or based on assumptions that were manipulated, or could not survive changes in the structure of economies or societies. However, beyond criticisms of CBA methodology, we are concerned with the intuition surrounding the incorporation of finance considerations through choice of project discount rates in CBAs, and how this may influence project appraisals. In particular, we are concerned with problems that arise in project appraisals created by the ***cost of finance***, rather than the ***raising of finance***. The two matters are directly related, of course, because the former influences in large part the latter, and more so when long time period are of the essence. Finance always matters greatly and is often contentious, because while at best MUTPs such as those mentioned above are able to benefit their host societies greatly, at worst they represent massive irreversible capital investments, possibly lost opportunities for alternative economically more attractive or socially more desirable application of the capital sunk in an underperforming MUTP.

Current political realities all over the world favour private sector participation in the provision of many goods and services formerly considered public sector goods, or outright privatization of such activities, through now widely accepted institutions such as Build-Own-Operate-Transfer (BOOT) and similar Public-Private-Partnerships (PPPs) or Private Finance Initiatives (PFIs), and other project-specific

institutions and entities that facilitate joint public-private ventures. With many urban and regional development initiatives, including MUTPs, the ambition and scale of projects often dictate the necessity for extensive private sector participation in financing and execution. Several typical forms that facilitate private sector participation are commonly used with MUTPs, such as the BOOT family of entities that typically draw on project finance-type arrangements to incorporate large proportions of private debt finance into MUTP entities (these arrangements are common phenomena particularly in new toll roads, bridges and tunnels, and often in single stand-alone rail line developments) (see Pretorius, et al, 2009). Another typical form is the rail-property development model used so successfully by the Mass Transit Railway Corporation in Hong Kong, and recently also in the development of the Channel Tunnel Rail Link in the United Kingdom (see Barron, Ng & Kwok, 2001). Typically very large amounts of finance are drawn from the private sector capital markets into such joint public-private sector entities to finance the projects, and in many cases it has assured that some projects materialize at all.

As is pointed out below, the practical effects of differences in approach to project appraisal and decision-making between the private and public sectors are often underestimated by public sector partners, and are just as often misunderstood. There are entirely valid theoretical and practical reasons for conflicts between public and private sector interests, and for these conflicts to influence sustainability considerations through discount rates. In the private sector project evaluation and decisions to invest explicitly subsumes a relatively narrow set of phenomena, thus if private sector participation is sought for publicly inspired developmental initiatives this incentive structure does not change because the venture partner happens to be a public sector agency. Much of the context surrounding private sector participation in the financing of MUTPs and other public sector developmental initiatives thus requires an appreciation of the incentive structure that governs private sector finance and investment behaviour. This incentive structure is entirely reflected in a private sector organization's choice of discount rate. The principal aim of this paper is to present insights into the challenge of embedding sustainability logic into one aspect of appraisal methodology, a challenge that emanates from the fundamentals of finance theory that surround the choice of project discount rates. The insights extend directly to those projects where private sector participation is introduced particularly in financing of stand-alone transportation projects such as toll roads, tunnels, particular types of rail projects, and more. In many respects the problems identified concern societal values, but much of what is presented in this paper is concerned with more practical problems associated with public sector investment decision-making methodologies, and choice of discount rates for evaluating MUTP and other projects that categorise as public infrastructure.

We have ordered the paper into three principal sections. First, in order to demonstrate how finance theory contributes to obstacles to incorporating sustainability in MUTP and other development proposals, we revisit briefly the familiar problem of evaluating projects with benefits and/or costs that are expected to occur far into the future – discounting and intergenerational distribution of costs and benefits. The choice of discount rate is shown to be a key variable in the decision to proceed or not where projects have long expected lives, and insight into the various considerations associated with choice of discount rates is central to our narrative. Secondly, thus, we review how project discount rates are determined: first private sector discount rates to demonstrate how its logic forces adherence to a narrowly defined set of economic and social incentives that motivate private sector organizations; and then public sector discount rates to illustrate fundamental differences between the two. In all, unlike with the logic underlying public sector choice of discount rates and public sector cost-benefit analyses (CBAs), private sector discount rates and project evaluation is internally consistent, appropriate to private sector capital budgeting decisions, and this reality thus also prevails with private sector participation in joint public/private MUTPs. For these reasons initiators of MUTPs with substantial private sector participations are often disappointed with the attitudes of private sector negotiators – both incentives and costs are generally much more clear to private participants, while the objectives of corporate governance provides very well-defined objectives. Thirdly, we present insight into some theoretical developments that may indicate some practical policy potential to overcome the discount rate problem. The conclusion presents a mix of analysis and two proposals. We outline how the discount rate problem is exacerbated through cost of capital concepts where private sector participation takes place. A disappointing outcome of this analysis is the suggestion that if private sector participation is considered, it may technically function largely to eliminate the potential to utilize public sector initiatives as policy mechanisms to capture long run project benefits. Much greater care is needed in decisions about which parts of projects are considered suitable for private sector participation, in order to ensure that long-term sustainability objectives are not undermined.

Further, following the development of the field of real options analysis as an extended capital budgeting methodology in the private sector, public sector-led project initiators are urged to consider a "flexibility by design" approach to incorporate the value of flexibility options in CBAs in order to account for the undervaluation of long-term sustainability benefits. In all, we attempt to explain why the choice of discount rates for public sector-led development initiatives is possibly more complex and important than appreciated. Where once simple heuristics often sufficed to justify the choice of discount rates, this is not easily defensible when project aims incorporate sustainability considerations.

The overall context of the paper is conventional corporate and public finance, in particular capital budgeting ("investment") decisions. An important matter which influences the context of the paper is that in primarily market based economies the difference between "public finance" and "private finance" is often vague. For clarity we thus follow convention which (simplistically) views public finance as funds generated through taxation to finance public sector activities, plus government borrowing from private capital markets to finance shortfalls between its revenue and spending. Convention further has it that the public sector borrowing requirement competes with the private sector for the same pool of finance generated by the economic activities of individual economic agents in society through savings (individuals and families, businesses and governments) and allocated through the financial system to those activities and institutions where these are demanded (including governments that borrow)(following the modern view as outlined by Crane, et. al, 1995). In general therefore, the principal source of finance sourced from capital markets is private, and this means that only the application of finance defines it as public or private finance. While we set out to indicate the constraints imposed by the providers of finance on users of finance in market-based economies, including the private sector and public sector in all their borrowing activities, for the purpose of this paper we do not enter normative debates that seek to prescribe how the cost of finance *should* be determined, or how the private sector *should* behave for example with respect to matters such as environmental impact or corporate social responsibility more generally. We hope that the matters raised, and the dogma that has developed around these matters, indicates that there are fundamental problems with the institutions of capitalisms (to borrow Oliver Williamson's famous phrase) when sustainability and sustainable development enters societies' agenda.

METHODOLOGY MATTERS: SUSTAINABILITY CONCEPTS, THE DISTRIBUTION OF COSTS AND BENEFITS OVER TIME, AND DISCOUNT RATES

For many decades now, the fundamental methodology underlying both private and public sector capital budgeting methodology[1] remains based on estimating project/program impacts (costs and benefits) and reducing these to a common monetary measure for decision-making purposes, after taking into account time value preferences and cost of capital through discounting. In order to inform much of what follows in the rest of this section, we therefore present first a short comparative analysis of private and public sector capital budgeting principles, before proceeding to consider the influence of discount rates when projects are evaluated which include sustainability criteria and have costs and benefits that are distributed over terms long enough to span more than a generation. Most MUTPs could probably be placed in this category, and certainly public or private sector projects that aim to reverse environmental damage probably all do. While there are underlying similarities in the approach to capital budgeting between the public and private sectors, there are important differences. That also influences choice of discount rates. We ask for informed readers' patience while we present this brief conceptual outline of the problem, because there are subtleties that have to be appreciated and are worth emphasizing.

The basis of private sector capital budgeting decisions is the family of discounted cash flow (DCF) methods, in particular the Net Present Value rule (NPV rule), which simply determines that a project's (present) value must exceed its costs to be attractive to the corporation and to attract scarce capital.

[1] "Capital budgeting methodology" refers to methods that facilitate choice between different projects subject to a corporation, or government agency's, overall capital or budget constraint. In public sector agencies it is typically referred to simply as "project evaluation", but we prefer to use the corporate finance terminology because it encapsulates so strictly the notion of capital as a scarce resource which requires budgeting. In essence investment opportunities ("projects") compete for capital, and the assumption is that not all projects can be funded. The general distinction often drawn in the public sector between *financial* evaluation of projects (deemed to be the narrow capital budgeting decision of a funding agency), as opposed to *economic* evaluation of projects (deemed to be a comprehensive impact analysis which incorporates society-with costs and benefits), is not at issue here, for both types of analyses ultimately still depend on the same cost-benefit analysis methodology.

Private corporations have long settled on Discounted Cash Flow methods, in particular the NPV rule, as primary decision-making methodology to allocate scarce corporate capital amongst competing projects (Breally, Myers and Allen, 2006). The logic and practice of NPV simply formalizes economic accounting to a particular enterprise of a project's private costs and benefits in a proposed application of corporate capital, discounted at the appropriate risk-adjusted discount rate for the corporation and for the particular opportunity. Fundamental theoretical concerns about DCF methodology (time-value of impacts) were resolved some seventy years ago. Public sector capital budgeting decisions, on the other hand, have primarily relied on cost-benefit analysis, which determines that a project's benefits must exceed its costs, thus drawing in principle for public investment decisions on exactly the same logic that underpins private sector decision-making. What matters greatly is that in its practical application CBA in effect also relies on the same DCF methodology as applied in the private sector, the principal difference being that benefits and costs to society are being valued, and the discount rate is that which is appropriate to the nature of the (public sector) project. Information and knowledge about inputs, intended and actual learnt from past experience, are critical inputs into all capital budgeting exercises, private and public.

While this is by no means suggested as universally true, in corporate sector applications the range of variables and prices required to conduct credible NPV analyses is typically fairly narrow and reflects private interests. This is determined by the particular enterprise's nature of business, and in established industries relatively good price information is available and used at the time of capital budgeting. The fact that the scope (if not the scale) allow most corporate sector project evaluations to be typically fairly narrow further helps in constraining the range of variables in the analyses, and thus also facilitates credible risk analyses. Further, in practice private sector analyses also are typically conducted with the luxury of relatively clear legal demarcation of risks and responsibilities, with clear stakeholders/beneficiaries and relatively clear social objectives. It is the fundamental nature of private sector interests to take commercial risks within this relatively well-defined envelope. In all, it can be argued that private sector project evaluation is an internally consistent methodology, appropriate to the institutional framework of private sector capital budgeting decisions, and this reality thus also prevails with the evaluation of those components of proposed joint public/private MUTPs that are intended for private sector participation. Together with relatively good price information about variables and prices that determine corporate costs and benefits, in the private sector we thus have relatively good information to conduct entirely credible appraisals following DCF methodology for the proposed projects of any particular enterprise.

In general, public sector capital budgeting decisions are conducted several orders of complexity and ambiguity away from the rarified private sector atmosphere described above, despite drawing on a common methodology. As introduced earlier, the framework for public sector project evaluation is CBA, the public sector derivative of the NPV rule (see Rosen, 2005). Similar to private sector capital budgeting, CBA purports to formalize economic accounting of a proposed project's costs and benefits, discounted at the appropriate discount rate, for decision-making given competition with other projects for scarce public sector capital. The NPV-equivalent CBA rule specifies that projects should achieve a net increase in a society's general economic welfare to secure funding – its benefits should exceed its costs. The logic of welfare economics and CBA does provide widely used analytical frameworks for the evaluation of projects with long-lasting expected urban and/or social environmental impacts, such as MUTPs; but invariably public sector projects have wider and less tangible objectives, many benefits and costs are difficult to specify and are often not reflected in traded prices, often secondary and tertiary multipliers are not understood or appreciated (particularly in open urban systems), and often system dynamics generate wildly unexpected results and externalities. So, while private sector organizations have a narrow and clearly defined set of economic and social objectives and internally consistent methods with reasonably good data to support capital budgeting decisions, the same cannot be said of public sector capital budgeting decisions. By their very nature these decisions eventually have to deal with the whole body politic as legitimate stakeholders and recipients in the distribution of costs and benefits, even if a particular project or programme has a narrow focus.

The message presented above concerns the symmetry of project evaluation methodology between private sector investors and the public sector, while their stakeholders and motives may differ (more below). The logic of CBA is not undermined by sharing a common techniques with private sector entities, the problems associated with the technique are to be found in the logic supporting the choice of discount rates for the two different sectors. In few applications is this fundamental discontinuity more evident than when public sector projects with costs and benefits distributed over very long time

periods, exceeding at least one generation, are evaluated. Many development projects that are concerned with creating urban (and rural) societies that incorporate expectations that their activities should be socially, environmentally and economically sustainable at least, and preferably facilitate sustainable development ideals, expect net positive effects to take place only well into the future – certainly beyond one generation. Many MUTPs fall into this category – they are typically very long-lived, fixed investments expected to generate services and benefits often for more than a century.

The concerns surrounding the expectation that sustainability criteria may require projects with costs and benefits distributed across generations are twofold. Firstly, there are particular viewpoints about intergenerational equity which question the wisdom of the current generation (of taxpayers, say) to invest in activities and assets that may benefit future generations at their cost . Fortunately this view has a compelling corollary, which considers that significant current investment is necessary to ensure the sustainability of future societies. This is considered to be equitable as it generates options for future generations (see Pearce et al, 2003). The second concern is more practical, and is that under conventional capital budgeting methodology, private or public, capital will not be allocated to projects with expected productive lifetimes of more than one generation. The question surrounding the intergenerational distribution of project impacts is a fundamental challenge to public policymaking and allocation of public sector capital when sustainability or sustainable development is an objective. When we consider private sector imperatives in the next section, we also see that intergenerational distribution of impacts is not, and is unlikely to be, a formal part of the private sector framework to determine discount rates for project evaluation; and that private sector participation in public sector-initiated projects possibly systematically undermines public sector potential to incorporate concern for the distribution of intergenerational project impacts through low discount rates.

In order to provide context for the problem of equitable intergenerational distribution of project impacts, it is necessary to state very briefly the technical reasons why projects with costs and benefits that span generations may be considered an attractive use of private or public finance. In principle discounted cash flow (DCF) is the mathematical process applied to adjust expected project impacts for when they occur in time, normally but simplistically the present and near-present time for costs of a project, and the near and further future for the benefits of a project. Generally discounting observes the absolute amount of a project impact ("cashflow") when it is estimated to occur in time, and then changes the weighting attached to that cashflow according to the future time period in which it is expected. Essentially the further the cashflow occurs into the future, the lower its weighting in the summation of all cash flows to determine the net effect. Key to DCF is the choice of Discount Rate (**k**), which represents the choice of weighting applied to future flows.[2] For a private sector project the costs and benefits are assumed to be private to the organization and its owners and stakeholders. Summed present value of the proceeds of a proposed corporate project must exceed the summed present value of project costs for the project to proceed. Given this simplicity, we do not consider it necessary to develop the private sector model further.

A fundamental problem that emerges when public infrastructure projects with very long expected lives such as MUTPs are proposed is that CBA methodology does not easily accommodate benefits or costs that occur in a project's distant future. The problem is illustrated very well in urban transport projects. Typically CBA studies, for example, are not able to show in financial terms the long term social and economic benefits of urban rail development initiatives, despite that there is widespread acceptance of their desirability beyond changes in property values (which are anyway typically captured as private benefits). In the broader sustainable development debate similar problems are encountered with projects that may have the objective of repairing environmental damage, but may only pay off far into the future – in a following generation's lifetime. The problem of accounting equitably for projects that generate such intergenerational impacts is caused both by the intuition of DCF and the mathematics of discounting. The mathematics of discounting benefits and costs that occur far into the future typically would generate a decision to reject any capital investment proposal where the principal benefits occur, and accept any proposal where the principal costs occur more than one generation into the future (i.e. say where the term over which evaluation is conducted

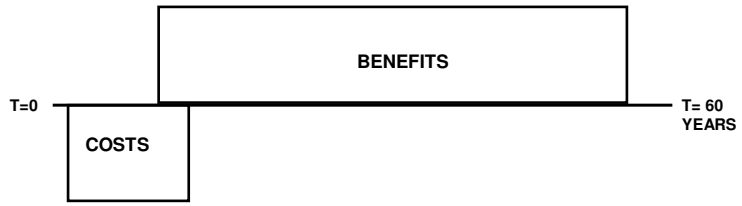
[2] Technically, for discreet time models we have

$$PV \sum_{t=1}^{n} \frac{Benefits_t}{(1+k)^t} - PV \sum_{t=1}^{n} \frac{Costs_t}{(1+k)^t} \geq 0 \text{ ,}$$

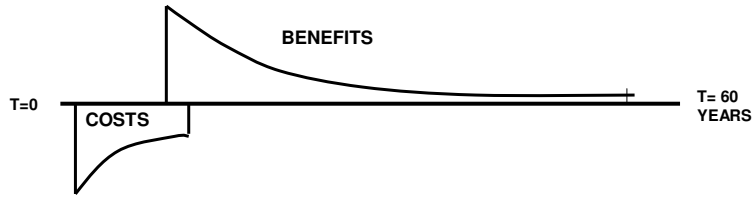
where ***t*** indicates the time of the cost or benefit's occurrence, assuming a discrete time such as the end of a period, say a year; while ***n*** indicates the impact furthest into the future (at time ***n***). ***k*** is the appropriate discount rate, around which this whole section is centred

exceeds 25-30 years). At low discount rates (say around 3%, an accepted heuristic for public sector projects), costs or benefits after 30-40 years contribute very little to net project benefit/cost, and at high discount rates (10% +, not entirely unusual in private sector projects) most impacts that occur after around 12-15 years do not have much influence on Net Present Value. Thus it turns out that discount rates, **k**, matter a great deal in the conduct of CBAs with intergenerational impacts. In short, as Pearce et al (2003) argue, discounting seems to be inconsistent with sustainable development initiatives that may require investment actions with long gestation periods for benefits, or require present actions with costs that may be borne by coming generations. Key to this phenomenon is thus the discount rate used. We illustrate this phenomenon graphically in Diagram 1. Panel 1 shows a project with a zero discount rate, which shows benefits to exceed costs, while panel 2 shows identical nominal costs and benefits, but when discounted at 4% costs exceed benefits, and the project is rejected. Costs or benefits that materialize, say, after thirty years into the future have practically little weight in summation of present value of impacts following a conventional CBA.

Diagram 1: Effects of discounting on projects with intergenerational impacts



No Cost of Capital – 0% Discount Rate: B>C



Positive Cost of Capital – Say 4% Discount Rate: C>B

In this way MUTPs and public sector capital investments that offer substantial benefits more than one generation into the future, say for example one aimed at reversing urban sprawl, but requires substantial present capital investment will be summarily rejected – only schemes with shorter term benefits will qualify for funding. Similarly, if large costs were expected, say for environmental rehabilitation, in the future and were for the account of a future generation, such costs would not likely influence negatively the decision to proceed at the present time. This logic pits the interests of future generations against the present generation tasked with making such investment decisions. It places future costs that may result from present (in)actions, including those that may have reduced or mitigated such impacts, entirely with future generations while benefits accrue to present generations, while the logic of investing in sustainable development initiatives may require the opposite pattern of impact weightings. In any event, it would seem that any methodology that is not able to embed intergenerational impacts into CBA procedures requires fundamental revision – in this case public sector discount rates appear not to stand the test that requires equitable intergenerational distribution of impacts.

We relax this somewhat simplistic outline and limited conclusion below, following an exploration of selected further insights into the nature of public sector discount rates and the intergenerational discounting problem. As may be expected, there is a substantial research literature that support use of low (but non-trivial) and also time-varying discount rates for public sector CBAs. We return to such research below, where we also draw attention to the differences between private and public sector capital budgeting decisions. However, because we argue that the institutional arrangements chosen for project execution (public, public/private, private), and thus also how the project is financed, matter

a great deal when determining discount rates for public sector projects in the context of sustainable development, we first have to present the context within which private sector discount rates are formed.

THE STORY BEHIND CHOICE OF DISCOUNT RATES: PRIVATE AND PUBLIC SECTOR PROJECTS

The world of the ***private sector*** presents an engagingly simple environment compared to the public sector when the influence of time and choice of discount rate enters the capital budgeting process. The choice of private sector discount rates was resolved some forty years ago with the widely accepted cost of capital approach.[3] This consensus determines that there is no generally observed discount rate, there are only purpose-specific discount rates appropriate to specific business activities and project proposals. This assertion implies that the company that executes the project is irrelevant, it is the nature of the activity is most important. This overall point of departure thus requires a company's success firstly to depend on successful execution of its projects (existing and proposed), in other words its investment decisions. The relevance of institutional arrangements, i.e. the company that executes the project, enters the picture only when execution is considered, and for finance purposes principally through how the company considers paying for the project. How the company pays for its projects depends on its total amount of capital, and its sources of capital (equity, debt, leases, etc. all provided by sources external to the company). Each source of capital represents a contractual liability between the supplier and the corporate entity. While the return that may be expected from a particular project the company may choose depends on its risk nature, payments to the different liabilities (equity, debt, etc.) depend on the nature of the contract and their proportions in overall company capital. Unlike debt and hybrid sources of capital, which typically have fixed contractual rates, the contractual nature of equity is more complex, and may be described as requiring the company to pay an expected rate of return rather than a fixed contractual rate. In a sense, thus, companies contract with their providers of capital to deliver to them the overall combined contracted cost of the company's capital. The NPV rule determines that chosen projects thus have to achieve at least this overall cost to satisfy the company's liabilities. This "cost of capital" is the discount rate for its proposed projects.

The expected rate of return for a private sector project depends on its nature, as stated. Assuming the company's portfolio contains similar projects, the expected rate of return for any project is composed of two factors; a risk-free rate of return, and a market risk premium associated with the nature of the activity. In well-functioning financial systems the general level of interest rates is benchmarked by "risk-free" rates of return as yielded by government debt instruments (typically denoted $\mathbf{r_f}$) with different rates for different terms to maturity (the term structure of interest rates), followed by premia above risk-free for the various interbank and corporate lending and borrowing rates, for different risk categories and for different terms to maturity (the risk structure of interest rates). Technically any private sector project is thus first required to earn at least the risk-free rate of return, and secondly, an additional premium for the specific risk of any particular proposal is expected. In practice this risk premium is observable through capital market information reflected in share prices (practically close enough), through asset pricing models such as the finance industry's basic standard – the Capital Asset Pricing Model (CAPM). Note that this observed required rate of return for the "project" is typically for a company and its portfolio of projects, but for theoretical and practical consistency and internal capital budgeting purposes the company has to reduce it to a project required rate – this is common practice in well-managed companies. The expected rate of return for any project represents the market's view of its return relative to its risk, as if it was executed entirely by a single-project company financed entirely with equity. [4]

A company's financial structure, however, also influences the riskiness and expected return of the company's equity to prospective investors, and thus influences the company's cost of capital. Technically a company's financial structure identifies narrowly the contracted financial stakeholders, the owners of company equity, debt, and other financing instruments such as leases, and the

[3] One should not underestimate the intellectual achievement that this represents – altogether it involved at least five Nobel laureates in economics directly, if we include the Capital Asset Pricing Model: Markowitz, Tobin, Sharpe, Modigliani and Miller. Tellingly, there is not yet a public sector finance name in this company.

[4] CAPM has it that the required rate of return for a "project" executed by a single-purpose equity-financed company is given by $r_{equity} = r_f + \beta(r_m - r_f)$. β represents the specific risk of the investment (project) under consideration, and $(r_m - r_f)$ represents the general market risk premium – the premium over the risk-free rate for engaging in *any* commercial activity (see Copeland, Weston and Shastri, 2006) for a technical treatment of these principles). There are several formulations of CAPM, for example the intertemporal formulation, but for present purposes the classic form suffices.

proportion of their stake relative to overall capital invested in the company. The required rate of return for equity, which also reflects an ownership right, is typically not contracted but determined in the equity markets through price movements for the company's shares following investor expectations and CAPM logic. A company's perceived behaviour towards regulatory and corporate governance matters, and to stakeholders with no contractual claims, such as may be broadly represented by its corporate social responsibility activities (and pronouncements), reflect directly in the required rate of return demanded by shareholders and reflected in share price changes. Together these factors contribute to determine a company's cost of capital for each project, $\mathbf{r_{project}}$, weighted according to source and required rate of return and represented by a "Weighted Average Cost of Capital" (WACC).[5] Because most companies' share prices reflect the influence of debt and other financing instruments, some reverse engineering is required to establish a generic project-type expected rate of return that is institution-free.

This brief theoretical outline serves an important purpose: it indicates the clarity, relative simplicity and internal coherence of the logic of required rates of return demanded for private sector applications of capital, plus that in effect it represents contracted liabilities to the company. We explained that private sector organizations typically function in narrow business environments with relatively good price information and relatively good knowledge of competitors, and concerns for its own sustainability through its project choices, based on its cost of capital. The NPV rule and private sector discount rates are appropriate to this environment, with few stakeholders (shareholders, creditors, and other agencies that are contracted liabilities), and then those with interests (customers, suppliers, labour, society - in an abstract sense, as operating against society's norms and best interests is expected not to be sustainable). Private sector decisions thus have the luxury of limited stakeholders and consequently less potential for ambiguity in focus. Private sector discount rates reflect this narrow focus, and technically cannot reflect more, because in modern economies this framework reflects strictly the organisation's contractual liabilities to the sources of capital – and this is society's providers of capital, the savers identified in the introduction.

The appropriate discount rate in private sector capital budgeting decisions is of fundamental importance for at least two critical reasons – it reflects time-scale imperatives that companies have to address in its self-renewing processes to maintain its own sustainability, and, importantly for reasons raised below, it is critical in the enterprise's wealth-generating activities on behalf of its investors – recall we have here capitalism in action, and wealth destruction will be punished. In this regard it is instructive to note that managing a company to achieve sustainability as an objective is a well-developed technical financial management construct, developed some fifty years ago (see for example Copeland and Murrin, 2000). [6] Observed capital market prices reflect the investing public's verdict of management's approach to this. The discipline imposed by capital market investors is often misunderstood. Private sector discount rates reflect the price that the suppliers of capital (the stakeholders) place on providing the capital. This is their price, below which they have an alternative use of the capital, the company does not set this price. It may be argued that the institutions of shareholder capitalism demands with little ambiguity that companies be first concerned with their own sustainability. All this clearly suggest that private sector activity may thus be expected to occur at discount rates significantly above risk-free rates, which places concern for intergenerational project impacts practically beyond its project decision-making horizon, and technically perhaps several orders below its range of contractual liabilities. [7]

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[5] Technically, the Weighted Average Cost of Capital (WACC), or discount rate used by the company in project evaluation, is represented by.. $r_{project} = WACC = \frac{E}{V} r_{equity} + (1-t)\frac{D}{V} r_{debt} + (1-t)\frac{L}{V} r_{leases}$,

for a company with equity (E), debt (D) and leases (L), where ***r*** represents the respective costs of the financing instruments and V represents the company's total value. ***t*** represents the liability to pay corporate tax (which in effect constitutes a benefit if the company has debt). In this way an appropriate discount rate for any private sector project can be determined, through analyzing the project parent organisation's sources, weights and costs of capital.

[6] Furthermore, there is also the discipline imposed by the market for corporate control – incompetents or managers that do not act in the interest of owners are subject to being replaced. What stock markets cannot do, however, is predict if and when corporate leaders and managers are thieves and gangsters – but then these types are encountered in all walks of life, even in academe, amongst those of the cloth, and public servants.

[7] Again, we present positivistically current facts without questioning the institution of shareholder capitalism and corporate governance – we simply aim to identify that the corporate sector is regimented into a more clearly demarcated economic environment than the public sector is, and possibly more so than career public officials, planners and academics appreciate.

There is a fundamental difference between the ***public sector*** and the private sector approach to determination of an organisation's cost of capital. We outlined above the comparative clarity in logic with which private sector enterprises are able to approach their cost of capital in developed capital markets, and we outlined in section one the comparatively clear objectives of private sector capital budgeting processes. However, with CBAs in the public sector there is no luxury of clear theory, nor intuition, or even observable common sense to guide the search for an opportunity cost against which to compare various project options, indeed, over the last decade matters have become decidedly more problematic.

Standard micro-economic theory offers a concept known as the Social Discount Rate as a measure of public sector cost of capital, which technically reflects two measures: the marginal efficiency of capital investment (**r**) in productive applications which are seen to generate more benefits than costs to society (but note this assumes aggregate economy-wide investment and includes private sector capital investment); and secondly, society's rate of time preference (**s**), the rate at which it is prepared to trade present consumption for investment in future consumption (and which underlies DCF logic) (Pearce, 1983). Important further assumptions are that individuals are able to exercise their preferences in investment decisions, and that the given distribution of endowments in society is somehow optimal and acceptable. The marginal efficiency of capital (**r**) reflects the supply side in a conventional theoretical market ("we offer this return for use of your savings"), while society requires a rate of return for supplying its savings equal to the social rate of time preference, **s** ("we will invest in [i.e. 'buy'] your project with our savings if offered this rate of return"). In equilibrium **s** equals **r**, and this is the social discount rate (for simplicity and without debating equilibrium concepts or if **s** and **r** converge or not, we simply denote this as **k**). Technically **k** can be conceived of as the social discount rate for a particular project executed by the public sector, with **k** determined by a private sector comparator project (to borrow PFI vernacular), a practically possible scenario where a government enterprise may compete in the same market with private enterprise.

Whilst the theory supporting the social discount rate is not in dispute, in practice it is: it becomes very complex to conceive of sectoral, or even economy-wide, social discount rate measures than can be operationalised effectively similar to CAPM. What is key to this analysis, however, is that under normal capital market circumstances the theory will always yield positive discount rates for project, sectoral or aggregate economic activities, and thus comparable discount rates for public sector investments that are in nature similar to private sector investments (possibly adjusted positively for expected additional private sector efficiency gains). This is because in principle the analytical framework used to derive the social discount rate assumes applications of capital for economic purposes in competitive markets, and which compete for financing in private capital markets.

Heuristics have nevertheless developed to suggest appropriate discount rates for public sector CBAs - Baron, et al (1998) for example suggest that around 3% is a generally acceptable discount rate for public sector CBAs with an environmental purpose, while Wong, Chau,Yiu and Yu (2008) have estimated social discount rates for land use in Hong Kong of around 4%. As argued before, discount rates at these levels do not change prospects for intergenerational distribution of impacts in a material sense, projects with intergenerational distribution of costs and benefits are still likely to be rejected. It may be argued that the social discount rate, as a concept, may simply be too narrowly conceived to reflect sustainability concerns because it proceeds from similar intuition as that which determines private sector cost of capital. Not only does it assume positive time preference and the ability to exercise personal choice in investment activities, it further assumes that personal choice is also enhanced by competition for capital (higher returns is better) (Graves, 2007). Not only does this pit individual members of the present generation against each other and as a group against future generations – it does so without the supporting and coherent logic encountered in the private sector model described above.

Is There Relief from The Tyranny of Discount Rates? Possibly

Fortunately there has been important theorizing about discount rates which relax this bleak view of the (un)desirability of intergenerational projects somewhat We commence by restating the point of departure for estimating a private sector discount rate, namely the required rate of return for a particular publicly funded project such as a mass urban transit railway line. More recent insights into the nature of factors that influence the discount rate suggest that it does not necessarily exclude zero or positive but trivial discount rates. This suggests that both investments with sustainable

development and intergenerational objectives may not be summarily disqualified following the tyranny of intergenerational discounting. In our presentation we generally follow Pearce, et al's (2003) framework with additions. Pearce proceeds from by stating that here seems to exist observed evidence that discount rates vary with time – **k** is not static over time – and what's more, it seems to reduce as the discounting term increases. It is widely assumed that chosen discount rates are at least static over the discounting period, but probably positively sloped (increasing with time) following conventional theories of the term structure of interest rates and actual observed interest rates (see Luenberger, 1998). Studies of actual behaviour however seems to support impacts in the distant future to be discounted at lower rates than previously assumed (see Frederick, et al, 2002). In essence this apparently anomalous empirical discovery suggests discount rates than are hyperbolic over time – over time they increase first and then decrease.

Recall that under private sector assumptions but also following the assumptions of the social discount rate, all discount rates are taken to be benchmarked by risk free rates of interest, ultimately the interest rates for lending to governments. Somewhat weak empirical evidence for the intuition of time-varying discount rates mentioned above nevertheless has found theoretical support from Weizman (1998) and Gollier (1997). For example, Weitzman's argument proceeds from the assumption that time varying interest rates occur where uncertainty about future weightings to be attached to cashflows originates, and shows that averaging probabilistic discount factors cross-sectionally, rather than discount rates themselves over time results in time-declining discount rates. Certainty equivalent discount rates decline over time with the rate of decline most rapid early. The simulations are over very long periods, though, up to 500 years (summarized from Pearce, et al 2003, and with some supporting empirical research by Newell and Pizer 2000, 2001). Weitzman factors thus offer some theoretical support for time-declining discount rates. There is not yet an accepted theory to support hyperbolic (or time-declining) discount rates, but it may have important consequences. It allows impacts further in the future to be discounted at lower rates than those occurring closer in time, thus allowing later impacts to exert a larger than previously expected influence on outcomes and may allow projects with long expected operational lives to show net positive benefits. This seems somewhat self-serving to those who see lower discount rates as desirable because it conveniently may support more projects with sustainability objectives, but Pearce et al (2003) point out that if there is empirical evidence that currently expressed preferences are for time-declining discount rates, these may become legitimate instruments of current policymaking.

THEREFORE WHAT? PROPOSALS AND CONCLUSION

Much of what is presented above is an attempt to provide some insights into the motivation behind private sector and public sector behaviour, and to indicate how DCF methodology and the logic underlying discount rates combine to discriminate against projects that might expect net positive benefits beyond one generation into the future - as might be expected if projects have sustainable development objectives. One conclusion from the analyses presented is that in general, it is very difficult to expect discount rates, private or public, to be zero or positive but trivial. There is also not sufficient theoretical justification for hyperbolic discount rates, nor sufficient empirical evidence to support a "hyperbolic term structure of discount rates" theory, similar to conventional term structure theories. In this conclusion we thus consider two possible approaches that may be considered by public sector initiators of MUTPs and other developmental projects to overcome problems that emanate from the discount rate problem, but without attempts to revisit conventional discount rate theory. Much of what is presented considers arguments to proceed with long-term projects with sustainability objectives despite a high probability that they would not qualify for capital in the conventional way.

Institutions matter: The "privatization at all costs" trap

The analyses presented above suggest reasoning which could result in lower discount rates than conventionally assumed once sustainability and other fairly conventional economic processes are also considered. If we imagine that a government could plan, finance and develop a flexible urban transportation system in the abstract, and incorporate all the factors considered above in the discount rate, it would indeed seem possible to embed sustainable development initiatives and consider the

intergenerational distribution of project impacts in social discount rates. However, as stated, the analyses surrounding the social discount rate ignore the institutions which inevitably will be required to execute any public sector project, irrespective of modifications to incorporate time-declining discount rates. It turns out that this is not a matter of minor importance, it is central to much of how public finance has developed over the last three decades in most market economies.

Although its influence has receded somewhat, it may be argued that public finance in the 1980s and 1990s was dominated by "privatization at all costs" dogma. Whilst much of the rhetoric centred on efficiency gains and other economic factors, in many instances privatization initiatives relied upon large private capital participation in developmental projects in all sectors, and notably so in transport infrastructure (urban and inter-urban). Whilst in many instances caused by budgetary constraints, private sector participation in many MUTPs such as toll roads, bridges and tunnels, became commonplace through now widely accepted institutions such as Public-Private-Partnerships (PPPs) of the Build-Own-Operate-Transfer (BOOT) family, or the more complex Private Finance Initiatives (PFIs). As stated, typically very large amounts of finance are drawn from the private sector capital markets into such joint public-private sector entities to finance the projects. If we take a careful look at some forms of private sector participation in MUTPs, the realities of private sector cost of capital concepts brings into question the ability of PPP arrangements to embed sustainability objectives into MUTPs financed in this way.

Any institutional analysis of PPPs would commence with the entity chosen to deliver and operate a project. Suppose a government agency proposes to develop a particular flexible transportation corridor project, and that it is determined that an appropriate social discount rate for the project is a low 1%, after all factors and the cost of recoverable publicly owned capital resources (such as land) had been considered. It is further proposed that the government will finance the project with public sources of capital –from tax revenue, or also by borrowing. If the government in question has no debt and runs surpluses, it may finance the project solely from current tax revenue or accumulated reserves.[8] In this case the social discount rate of 1% may show a net positive benefit over 30-40 years, and some sustainability objectives may be achieved. The problem within the scenario emerges when the government considers borrowing to supplement financing, for illustration, say, such borrowing is project specific and takes the form of an infrastructure revenue bond (this is a commonplace scenario with local authority infrastructure finance in the USA). If funds are borrowed from capital markets to finance the project there is a clear minimum cost – the rate of interest demanded by capital market participants for borrowing of this particular kind by the particular level of government. This will be at least the risk-free rate, and probably more, given that this is project specific lending and not general obligation debt, and it may be assumed the cost of such borrowing is around 4% for low risk projects from long-run observation. It may be clear to observant readers that it means the government agency faces a problem that mirrors directly the private sector cost of capital concept – borrowing to develop the project will increase the discount rate to reflect the influence of the debt liability, because it is contractual. To what extent it will do so will depend on how much is borrowed compared to how much capital the government contributes from tax revenue, but in any event the introduction of debt (project-specific or general obligation) will function to decrease the ability of the project to achieve long term sustainability objectives even if the social discount rate was assumed to be zero, directly as a result of capital market borrowing.

Suppose that political preferences and budgetary constraints determine that the project should be delivered and operated using a typical BOOT arrangement, as an alternative arrangement. What does this institutional form mean for sustainable development and concern for intergenerational transfers? Firstly, BOOTs are typically set up as highly regulated single-purpose private sector project companies, financed by proportionately less equity (30-40%) and more debt (60-70).[9] The project company's discount rate would simply be the weighted costs of capital contributed by both its equity investors and its providers of debt. Whereas it may raise project-specific debt at a comparable cost to the hypothetical government discussed above (say 4%), private equity will demand the appropriate rate of return commensurate with the risk of the project – a low social discount rate of 1% is entirely out of the question. There is little chance that a project company will have a weighted cost

[8] This is a heroic scenario. There are however governments that are in this fortunate position – the Hong Kong Government is one.
[9] As a particular financing mechanism it is one of the objectives of project finance to attempt to maximize a project's debt. There are very good reasons for this (Pretorius, et al, 2009).

of capital less than 5%, which effectively rules out private sector participation for projects with objectives other than short term.

The comparative analysis presented confirms the intuition that private sector participation in the private project company form is expected to dominate project objectives through the discipline demanded by its cost of capital constraints. Any relaxation of this widely used institutional form, say by governments investing "patient" equity alongside the private sector, may influence its ability only at the margin to achieve long-term sustainability objectives, because the project discount rate remains dominated by the cost of debt. Under such circumstances discount rates cannot be low because the institutional form dictates that private sector imperatives must outweigh public sector interests, and intergenerational distribution of costs and benefits and sustainable development initiatives are sacrificed to the budgetary requirements of the public sector.

A disappointing outcome of this analysis is the suggestion that if private sector participation is considered, it may technically function largely to eliminate the potential to utilize public sector initiatives as policy mechanisms to capture long run project benefits. It was further shown that even with very low social discount rates and public sector control of projects, the requirements of the debt capital markets are likely also to undermine sustainability objectives of public sector-led projects because it introduces contractual cost of capital imperatives into project criteria. Nevertheless, our conclusion is that "privatization at all costs" ideology severely reduces policymakers' options to make long-term investment decisions with sustainability or sustainable development objectives, because institutional designs to facilitate private sector participation must inevitably function to increase the project's cost of capital and so increase project discount rates.

A policy proposal that recognizes the limitations of private participation is slowly emerging from the last two-three decades' experience with privatization experiences worldwide, and can only be strengthened with experience. It calls for a fundamental re-evaluation of the nature, scale and share of private sector participation in MUTPs (and infrastructure investment generally, including social infrastructure). This confirms emerging opinions amongst governments in many parts of the world, namely that more thoughtful selection of the parts of projects that may be appropriate for private participation is required.[10] It is not only that the private sector by its nature is compelled to target those parts of larger systems that are potentially viable, it thus also follows that the parts targeted by the private sector cannot be expected to be critical parts of a plan to foster sustainability or sustainable development initiatives that require actions with intended long-term benefits. Public sector projects possibly should be differentiated very carefully for which objectives policymakers wish to achieve – if sustainable development and intergenerational equity in distribution of project impacts are considered desirable objectives, private sector participation may simply have to be ruled out in favour of outright social objectives. Reconciling the impact of such policy initiatives is likely to be a real political and institutional challenge – a reversal of the modern assumption that private sector participation in public sector projects is the default preference. This calls for much smarter planning and decision-making about private sector participation than has possibly been the case over the last three decades. Further, it goes without saying that significant accumulated public sector debt reduces severely any potential ability to apply low or zero discount rates to any projects. Perhaps it is timely that the problems of public indebtedness has been so dramatically thrust onto the world stage in 2009-10.

This would seem to suggest a further policy objective:

Don't just consider the options, create them

We find inspiration for the next proposal to overcome the numbing influence of discount rates on long-term projects from the unlikely field of options pricing theory. We consider real options analysis to hold great promise in public sector project decision-making, but first some background. It is beyond ironic that the ability to be flexible under uncertainty is viewed by some economists as problematic. This counterintuitive concept is known as time-inconsistency and refers to the case where one government implements a policy which is considered optimal in an intergenerational setting, and the policy is then changed by a subsequent generation faced with changed circumstances. The

[10] Even in Hong Kong questions have been raised about the appropriateness of some PPP projects, following the transportation policy challenges raised by the toll fare structure embedded in the Western Harbour Crossing concession agreement (see OMEGA project profile at www.omegacentre.bartlett.ucl.ac.uk).

argument is put forward that if changed, the policy was not optimal because later behaviour was not consistent with it and it may thus have been wasteful and cost-inefficient. Fortunately it may similarly be argued, and shown, that not to change is often even more foolish, as we are presently observing with environmental actions. More enlightened behavioural economics logic, supported by research, shows that people practically revise and re-evaluate plans, thus people do behave with time-inconsistency. If people behave with time inconsistency, it may also to be expected of societies (following Henderson and Bateman, 1995). Pearce et al (2003) presents this as context to support a call for change in discounting practice – there exists presently sufficient theoretical support for societies to revise present practice of discounting social projects towards using negatively time-varying discount rates.

We consider time-inconsistency as an inevitable human behavioural characteristic, along with bounded rationality, and use the notion simply to introduce the (new-ish) field of real options analysis as a proposal to overcome the tyranny of discount rates. It may be argued that concerns about time-inconsistency could be considered in the context of neo-classical economics, the ideological framework which is also the context for technical aspects of DCF and CBA discussed throughout this paper. This context includes the assumptions that capital budgeting decisions in general, and any particular project under consideration is discreet, indivisible and presents itself as a "now or never" opportunity (see Dixit and Pindyck, 1994). This context within which NPV and CBA as capital budgeting methodologies is practiced has not changed, even if its scope may have changed with general improvements in tractability in DCF analyses offered by simulation software and analyses of any number of separate and interdependent scenarios and risks.

In the corporate sector, however, NPV methodology has recently been deepened and improved to include the pricing of strategic choices ("flexibility options") at the time of corporate investment decisions through development of the field of Real Options Analysis (ROA). This methodological elaboration has become known as "Expanded NPV" (see Copeland and Murrin, 2000). The ROA revolution is so named because over the last 30 years it has spawned theory and a set of practical techniques which allows the value of many generic flexibility options to be estimated and included in capital budgeting decisions (see Dixit and Pindyck, 1994; Trigeorgis, 2000; Copeland and Antikarov, 2001).[11] While in practice complexities introduced into project evaluation has limited ROA to progressive companies, it has fundamentally changed thinking about private sector capital budgeting as static decisions based on standard neo-classical economic principles. Most importantly, it implies that negative NPV projects should ***not*** be summarily dismissed, for example if the project design embeds the flexibility to change a project's mix of resource inputs based on future states of the economy, resource constraints, or society (changed "states of nature", in technical terms). Drawing on options pricing theory and decision analysis, ROA allows strategic choices to be valued, such as managerial discretion to delay investment decisions, incrementally scale investments, invest in multiple technologies as hedging mechanisms, mothball facilities until economic circumstances improve, and so on. In short, even if a project shows a negative NPV and should be rejected using conventional rules, flexibility, i.e. having options, has value, and more of it is better.

The ROA revolution has not reached public sector capital budgeting methodology in a systematic way, but a parallel application of the logic to public sector financial decisions is clear and surely imminent. Transport planners have for long intuitively been incorporating flexibility into planning, for example by incorporating rail and road alignments in single MUTP corridors, such as the road/rail corridor to Athens International Airport. The real value of flexibility in planning urban transport, however, might be reflected in planning decisions to reduce the scale and scope of future urban transport projects away from MUTPs in favour of a larger number of smaller scale projects with diverse technologies, which collectively may function to increase flexibility as states of nature unfold – "design for flexibility" seems an immensely sensible approach to urban transport planning, given the uncertainty surrounding current environmental concerns and the currently unstable nature of transport technology. Tentative steps have been made towards recognizing that options matter in public sector investment, with notions such as bequest value, existence value, and so on (see Pearce, 1983), but in essence practical frameworks that value systematically public sector flexibility options in CBAs remains fallow land. In sum, along with ROA theorists, we argue that flexibility benefits have been systematically underestimated in past public sector project design and CBA practice. ROA could

[11] To be sure, much of the creativity surrounding ROA rests on the ability to identify flexibility options, while there remains also the problem that incomplete commodification does constrain its use.

further function to support public sector-led MUTP initiatives where appraisals show that costs exceed benefits as a consequence of their intergenerational distribution and inflexible discount rates. This may also provide the framework for the choice of strategic projects, namely for the flexibility they may offer future generations.

A policy proposal that explicitly requires public sector-led transport projects to be designed for flexibility (and so incorporate the additional value of future flexibility), is expected to require a somewhat different approach to current politics and public sector capital budgeting practice. Heuristics has it that designing for and constructing flexibility is expected to cost more initially, and so strain public finances even further. Creating the required political attitude and public sector institutions to facilitate the creation and valuation of flexibility in public sector investments may prove complex and challenging, but it may be argued that flexibility by design forms an integral part of an overall technology policy initiative (see Geerlings, 1999). In any event, if CBA remains the public sector's only decision-making methodology, the costs of irreversibility will be completely experienced by future generations.

The Importance of Leadership

It may be argued that the public sector has become such an important presence in the day-to-day functioning of many economies that the importance of governments' vision and long-term planning and strategic initiatives is no longer appreciated. Budget constraints and the influence of privatization ideology has certainly also reduced governments' appetites for ambitious projects that may have long term structural implications, even if objectives may indeed be to create flexible structures with options, as advocated above. Also, it is a fact that there have been so many planning disasters that risk-aversion certainly is understandable. The challenge of embedding sustainable development and concern for equitable intergenerational distribution of proposed project impacts is an inherently complex problem, but it does not seem entirely intractable. More generally, though, when it comes to consideration of the sustainability and sustainable development challenges faced by all societies, it is becoming clear that the real challenge to establishing mechanisms to incorporate sustainable development criteria in MUTP and other public sector-led development projects is not in techniques used to evaluate project proposals, it is with political will and leadership at all levels.

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