THE CONCEPTUAL FOUNDATIONS OF BENEFIT-COST ANALYSIS AND THE USEFULNESS OF THIS TECHNIQUE IN THE AREA OF ENERGY ECONOMICS.

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Introduction

This paper examines Benefit-Cost Analysis, or Cost-Benefit Analysis (CBA) as it is commonly known. In particular, the process of conducting a CBA, how costs and benefits are measured, the advantages and disadvantages CBA presents and the application of the tool in the energy industry are considered.

The purpose of CBA is to determine whether it is economically efficient from the public's perspective to proceed with a given project. As such, CBA is a tool primarily used by governments and other public agencies.

The history of CBA is entrenched in the water sector, dating back to 1808 when then U.S Secretary of Treasury Gallatin reported on the costs and benefits of water projects (Tyner, 2001). However, it was the 1930s that saw the emergence of CBA as a modern tool of economics, in response to Roosevelt's "New Deal" during the Great Depression (Hufschmidt).

Process for Conducting Cost Benefit Analysis

Harman (2003) describes a five-step process of conducting a CBA as:

- Listing the candidate projects to be assessed;
- Listing the social costs and benefits for each project;
- Quantifying each of these costs and benefits with supporting technical evidence;
- Calculating a money value for each cost and benefit;
- Arriving at a final evaluation.

Evaluation

Evaluation is performed by assessing the time value of money using net present value (NPV) principles. This is because economic initiatives are measured in monetary terms and are felt over long periods. A CBA is not the same as a discounted cash flow analysis (DCF), however. DCF concerns the economics of the firm, so is microeconomic in nature, whereas CBA deals with societal impact and is thus macroeconomic in its approach.

Consequently, the components of NPV calculations differ between CBA and DCF. DCF will consider a firm's financial ingoings and outgoings. CBA will instead deal with economic costs and benefits to society. Regarding discount rates, the rate applied under a DCF analysis usually reflects the Weighted Average Cost of Capital to the firm (WACC). In contrast, under CBA the discount rate is the "social rate of time preference" (SRTP), which is discussed further below.

The formulation of a CBA can be expressed as:

$$NPV = NB_0 + \frac{NB_1}{(1+r)} + \frac{NB_2}{(1+r)^2} + \ldots + \frac{NB_n}{(1+r)^n}$$

Where: NB = the sum of Net Benefits in each period (or the sum of Benefits less Costs)

r = the discount rate, or SRTP in the case of CBA.

Source: Perkins

Measuring Benefits

In measuring the benefits a project will bring, economists test the degree to which society's welfare will be improved. Welfare, in turn, is measured by the value of goods and services generated by a particular economic activity. That value is not necessarily the same as price because the price at which a good or service is offered may be less than the price consumers are willing to pay. The difference between value and price is called "consumer surplus", although it is difficult to quantify and economists tend to use price as a means of measuring value and therefore benefits (Harman, 2003).

Measuring Costs

When it comes to measuring the costs associated with a particular project for a CBA, opportunity costs are calculated rather than actual project costs. The opportunity costs reflect the expense of the next best economic activity that must be forgone if the project concerned is to be allocated land, capital and labour resources. There are, however, several factors that need to be taken into consideration when calculating opportunity costs. The first of these concerns employment, because the costs of employing people should not be taken into account under a CBA unless full employment has been achieved. Additionally, monopoly rents where these are a component of input pricing should be excluded, as is taxation which is a transfer rather than an inherent part of the cost of production (Harman, 2003). In practice, of course, it is difficult to measure and extract these items to arrive at a true assessment of the costs related to a project. Equally, whether taxes should be excluded from CBA is clouded by taxes that measure externalities, such as carbon taxes.

Social Rate of Time Preference

In theory, the SRTP is the mean discount rate expressed by each individual in the population affected by the project in question. Usually, the SRTP is determined by reference to the market rate of interest, but that rate is subject to central bank influence (Harman, 2003). Overall, establishing a SRTP is difficult, so some government agencies simply apply a given rate. Often, a range of discount rates are applied to a project as sensitivity analysis to test for robustness. Selection of the SRTP requires careful consideration, as results tend to be very sensitive to changes in the given rate.

Selection of Candidate Projects

Having arrived at a series of NPVs for the candidate projects, all those with an NPV > 1 should be approved unless projects are mutually exclusive or budgetary limits exist (Perkins, 1994).

If two or more candidate projects are mutually exclusive, that is one project can be substituted for another, then the project with the highest NPV should be selected (Perkins, 1994). Should there be a budgetary limitation on which projects can proceed, then in descending order the projects with the highest Net Benefit Investment Ratio should be approved until the budget has been exhausted. The Net Benefit Investment Ratio is the "ratio of the present value of a project's benefits minus its operating costs, to the present value of its investment cost" (Perkins, 1994).

Commonly Perceived Shortcomings of Cost-Benefit Analysis

In the 1930s, CBA was applied to projects whose costs and benefits could be measured without undue difficulty. However, CBA is now being applied to education, transport, health and environmental projects, which have costs and benefits that are much harder to measure. This imprecision exposes CBA to criticism, particularly when project costs or benefits cannot be valued directly. Under these circumstances, alternative or "shadow" prices must be found.

Shadow prices are used especially when it comes to the valuation of "externalities". These were observed by economist Arthur Pigou as the "knock-on" effects of an activity, the full cost or benefit of which is not reflected in the cost of production (Econlib). One example of an energy related externality is the aesthetic impact of windfarming. Another is the impact of power station emissions on the environment, causing global warming, the mitigation of which causes costs to society. The development of carbon taxes under the Kyoto Protocol is an attempt to value that impact for inclusion in the costs of production.

The impact of externalities on society is so great as to be undeniable. Therefore, however imperfect measurement systems might be, an attempt must be made to quantify these externalities in monetary terms. Consequently, shadow prices are calculated using several methods, namely: (i) the Compensation Test; (ii) Travel Costs and; (iii) Hedonic Pricing. The Compensation Test involves asking members of the public what they might pay for the project concerned not going ahead and the resource(s) in question not therefore being used. This approach is flawed because people do not actually have to pay the amount they elect, so they may not provide a proper response. Travel Costs, on the other hand, consider how much people are willing to spend travelling to enjoy the resource under threat. Finally, Hedonic Pricing calculates that part of a good or service's price that can be attributed to a certain feature. As an example, at the Sellafield nuclear power station in Britain, it should be possible to compare property prices before and after construction of the facility to arrive at some conclusions on the externality of local land demand.

Economic Efficiency Vs Social Equity

CBA, therefore, it is a best fit measure for resource allocation. What CBA does not do, however, is arrive at any conclusions regarding what is feasible from a political, environmental or national security viewpoint (Harman, 2003). In particular, though, CBA ignores the question of whether a project is socially equitable.

On the issue of equity, CBA was originally done on the basis of Parito Optimality, which is when no one is made worse off by a project going ahead, but some or all are better off. However, as there are few projects where this occurs, the compensation principle was developed by Kaldor and Hicks (O'Riordan & Turner, 1983). This states that if, as a result of a reallocation of resources, the "gainers" can compensate the "losers" and still gain then the project should proceed. However compensation does not actually have to be paid because CBA has always being aimed at establishing whether a project is economically efficient rather than whether it is equitable. This limitation is criticised by detractors of CBA (O'Riordan & Turner, 1983).

Two proposed power stations in Thailand provide tangible examples of this limitation. The Union Power and Gulf Electric coal fired power stations are expected to deliver over ten per cent of Thailand's power needs when completed. However, in 1998 development on both projects was effectively suspended by the Thai Government after protests by local residents. Many were not satisfied about environmental issues, especially regarding the impact on fisheries and thus their livelihood. Yet compensation from the government or the project companies was not forthcoming. Had a compensation package been established to restore equity, then it is possible the protests would not have started and the projects would have been completed by now.

Private Sector Participation in the Energy Sector

To an extent, CBA is having to redefine itself in the face of an increasing number of energy projects being implemented on a private basis, especially in the electricity and gas sectors. While CBA might demonstrate the merits of a project from the macroeconomic perspective, it is quite conceivable that a project company is unable to demonstrate reasonable returns under a DCF analysis. This is due in part to mismatches between the macroeconomic benefits of a project and those that are captured by the firm at a microeconomic level. Consequently, unless the State provides some degree of transfer of those benefits to the Project Company, the private sector will not be motivated to implement the project. Philosophically, however, governments have difficulty in providing any form of subsidisation to private sector projects. This mismatch should be considered alongside CBA, something the Public Sector Comparator developed by the PFI in the UK attempts to do.

An Imperfect but Unrivalled Tool?

While CBA has its shortcomings, it is an appropriate means of measuring the rationale of economic activities in the absence of a better approach.

It has become particularly useful in determining the value of reforms in the energy sector. Recently, a report to the Western Australian Electricity Reform Task Force on *The Benefits and Costs of Reform of the Electricity Industry* was concluded. The study measured the economic impacts to emerge from reforming Western Australia's electricity sector by separating the four sub-sectors. The analysis found that the efficiencies brought about by increased competition should lead to savings of up to AUD 90 million a year, increasing Gross State Product, employment and private sector consumption. The report noted that the increased level in private consumption was the closest measure of the expected change in welfare. A financial impact study was also made to examine the financial viability of the disaggregated electricity businesses (Allen Consulting Group, 2002). The combination of the cost benefit analysis and the financial impact study supported the state government's decision to proceed with the reform process.

Conclusion

CBA deals with subjective ingredients and so is prone to criticism. However, it is one of the best tools available to measure the impact of proposed economic initiatives on public welfare. The question of equity requires consideration, however, so the incorporation of equity measurements into CBA is merit worthy, as is the actual payment of compensation by those materially and adversely affected by projects. Shadow pricing of externalities will continue to be a major challenge for CBA, as will the consequences of projects being undertaken increasingly by the private sector.

References

Allen Consulting Group (2002). The Benefits and Costs of Reform of the Electricity Industry in Western Australia. A report to the Electricity Reform Task Force of Western Australia. 8 May 2002. <http://www.ertf.energy.wa.gov.au/publications.htm>

"Biography of Arthur Cecil Pigou", The Concise Encyclopedia of Economics. Liberty Fund, Inc. Ed. David R. Henderson. Library of Economics and Liberty. 7 May 2003. <http://www.econlib.org/library/Enc/bios/Pigou.html>.

Harman, F (2003). *Cost Benefit Analysis M393/ 493 audio lecture notes*. Murdoch University. 1 May 2003. http://wwwphys.murdoch.edu.au/teaching/acre/m393-m493real/topic7/m393-m493topic7part1.mp3, part2.mp3

Hufschmidt, M.M. *Benefit-Cost Analysis: 1933-1985*. Report to the Universities Council on Water Resources at the Southern Illinois University in Carbondale. 7 May 2003. http://www.uwin.siu.edu/ucowr/updates/pdf/V116_A11.pdf

Krupnick, A.J & Burtraw, D (1996). *The Social Cost of Electricity: Do the Numbers Add Up?*. Paper developed for Resources for the Future, Washington D.C. 8 May 2003 http://www.rff.org/CFDOCS/disc_papers/PDF_files/9630.pdf

O'Riordan T & Turner K.R eds (1983). Traditional Cost-Benefit Analysis and its Critique, Section 3 of *An Annotated Reader in Environmental Planning and Management*, Pergamon Press: Oxford

Perkins, F. (1994), Practical Cost Benefit Analysis, Macmillan

Tyner, W (2001). The History of Cost Benefit Analysis. *Purdue University ACEG 608 Course Notes*. 7 May 2003. <http://www.agecon.purdue.edu/academic/agec608/ppt_files/1>