COST-BENEFIT ANALYSIS IN URBAN TRANSPORT PLANNING

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CONTENTS

A C K N O W L E D G E M E N T S

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"While it is difficult to justify this assumption, it is more difficult to find a better one".
A.J. Harrison & D.A. Quarmby (1969, p.179) with reference to a typical element of cost-benefit analysis.

PREFACE.

This dissertation sets out to examine the theory, applicability and practice of cost-benefit analysis as an evaluation technique in urban transport planning. Discussion is intended to focus on the areas of contention and possible improvement, especially with a view to incorporating distributional and social issues. Although the main field of interest is in relation to urban public transport, the general nature of the transport problem demands reference to private and inter-urban transit as well.

Originally, there was to have been a second part to this dissertation, a case study to illustrate the points made in the main body of text. Unfortunately, this perhaps over-ambitious idea foundered on unavailability of information, frozen partly as a result of the 'oil crisis' and its political implications in reviving public transport schemes previously discounted as unfeasible and, therefore, ideal for student study. However, it is to be hoped that the main text will prove adequate in itself in firmly establishing the relevant issues, if in a more generalised and abstracted context.

CHAPTER 1.

INTRODUCTION TO COST BENEFIT ANALYSIS.

Cost-Benefit Analysis (CBA) is a method of appraising the value of a public investment project or indicating the most suitable choice among alternative schemes by taking into account all resultant effects, both costs and benefits, social as well as economic, on the comparative base of monetary evaluation, as far as is possible. Such an ambitious attempt to solve the problem of public expenditure decision-making is necessarily fraught with inadequacies, imperfections and, perhaps invalidities, causing CBA's once fashionable stature in the 1960's to have become tainted in many quarters with severe scepticism, notably generated by the public disillusionment over the Roskill Commission's elaborate exercise (H.M.S.O., 1969-1970), dismissed by one academic as 'nonsense on stilts' (Self, 1970). However, CBA still survives in the Government view, at least, as the most satisfactory appraisal technique for its transport investment.

The application of CBA in public investment is necessitated by the consideration of all external effects, not included in the conventional financial appraisal in the private sector concerning only direct market operations. Although the concept of optimising the 'social benefits' of investments originated in this context with Dupuit's pioneering work (1844),[x] nineteenth century

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x Perhaps the very first recorded form of CBA occured in Britain from around 1820 onwards. It involved the calculation of the change in consumer's surplus (though not identified as such) enjoyed by travellers, expressed in terms of the reduction in effort required to pull vehicles consequent upon decreasing gradients, subsequently becoming 'a principal design consideration for engineers'. It was used extensively and profitably, for example, by Macneil, one of Telford's engineers, working in 1830 on the construction of the London-Holyhead road, now the A5. (Starkie, 1973).

laissez faire ideals obscured such ideas, until the emergence of Pigou's treatise on 'welfare economics' (1920), in which he distinguished between private and social costs, recognising that the market system failed to incorporate the latter, thus producing sub-optimal allocation where such externalities existed.

The original field of practice developed in American water resource studies, implicitly as early as 1902 in the River and Harbor Act, but evolving largely from the explicit requirement of the 1936 Flood Control Act that flood control schemes would only be authorised if the benefits 'to whomsoever they may accrue' exceeded the estimated cost. Then the 1950 U.S. Green Book (U.S. Government) codified the recommended CBA principles and practices, finally validated by the major academic publications of 1958. (Eckstein, McKean, Krutilla and Eckstein). However, despite the obvious externalities in river development schemes demanding such analysis, transport, in fact, claimed perhaps the first formal CBA application in 1937 in the evaluation of Oregon's Highway Plan (McCullogh and Beakey).

In Britain, cost-benefit appraisal techniques in the planning and transport sphere were initiated by Lichfield (1956) with his 'planning balance sheet' approach to the analysis of urban development, followed three years later by Wibberly's (1959) studies of land allocation between agriculture and urban development. The first major CBA study, that of the M1, the London-Birmingham Motorway, commissioned in 1958, appeared in 1960, "undertaken as a subject of research to see whether reliable methods of assessing both the traffic that would flow upon it and

the economic value of the scheme could be devised" (Coburn et.al., 1960, preface). The basic principles defined in that study were then formulated by one of its authors, Reynolds (1961), into a generalised technique for application to inter-urban road projects. Refining the techniques further, Foster and Beesley (1963) produced a CBA of the Victoria Line, a new underground railway line in London, although as with the M1 study, primarily as a research exercise, since the decision to build was taken before the appraisal results were established. In the same year, following the same basic concepts, though applying a more qualitative weighting procedure, Buchanan's Traffic in Towns (Lichfield and Crompton,1963) also contained an outline evaluation system for his fundamental rationalisation of the transport problem.

Continuing development and refinements of cost-benefit techniques[x] prompted the Government in 1966 to stress their increasing confidence in long-term planning "through the development of better methods to measure and compare the cost-effectiveness of alternative courses of action" (H.M.S.O., 1966). CBA was adopted as standard practice in calculating the economic return for inter-urban road schemes in 1967 (M.O.T.), and many other varied studies undertaken, including urban land-use/transportation plans, consolidated both practical expertise and methodology, perhaps culminating in the technical sophistication, unfortunately tempered by public disenchantment with its political manipulation, of the Roskill Commission's inquiry into the phasing and location of London's Third Airport (H.M.S.O. 1969 and 1970).

x Particularly with reference to studies evaluating alternatives for the development of the nuclear power programme and the expansion of the South Wales iron ore ports (H.M.S.O. 1966).

CBA remains the accepted statutory method of evaluating both road and public transport schemes, being required by the D.O.E. for both its own schemes and as the basis for assessing whether financial aid will be granted to local authority proposals. In the case of inter-urban roads, a major improvement occurred in 1972 with the adoption of the COBA method (D.O.E. 1972a), replacing the former Hl/71 system (D.O.E. 1971), updated from the 1967 outline, which only weighed construction costs against the user benefits of reductions in delay, operating costs and accidents on a simple first year rate of return basis. The COBA method (D.O.E. 1973), published in detailed, analytical form in October, evaluates over the approximate period of the road's life by the discounting concept and incorporates recent research findings into a readily applied computer programme, into which the specific project details can be easily inserted. Urban roads present a considerably more intricate and politically delicate evaluation task, in which techniques must be conducted on a network-wide analysis in view of the degree of inter-relation of the city's elements and the problems of integration into the existing urban fabric.

On the passenger transport side, until very recently, the low priority assigned to investment, as a result of the dominant demands of ever-increasing car ownership for extensions and improvements to the road system, was matched by consequent lack of development of appropriate CBA techniques, after the foundation work of the Victoria Line Study in 1963 (op.cit.). In fact, apart from the London-Bournemouth rail electrification scheme and the evaluation procedures in some urban land-use/transportation

studies, CBA was prominent primarily "as an aid to the examination of railway passenger closure proposals" (M.O.T. 1969a, preface), developed by the case study of the Cambrian Coast Line.

However, a fundamental change in government policy from road, especially urban motorways, to public transport investment was announced in July 1973. The White Paper (H.M.S.O. 1973) recognised that "some cities will need new or improved capital-intensive fixed-track systems" and that road improvements should be designed with regard "to the help they can give to bus operation", with urban transportation techniques requiring to be suitably adjusted to accommodate these new objectives. At present, though, there is no standardised public transport equivalent to the COBA Manual (D.O.E. 1973), and local authorities or Passenger Transport Executives submit their own analyses, based on the updated time values from the 1969 M.O.T. figures (op.cit.) usually discounted over thirty years at 10%, to support their application for an infrastructure grant under the terms of Section 56 of the 1968 Transport Act.

With the scale of public investment increasing rapidly and the imminent expansion of passenger transport facilities, the demand for suitable appraisal techniques to aid decision-making continues. CBA remains the most widely used method, but as its many critics readily point out, it still suffers, at least, from numerous technical and practical shortcomings and, at most, major methodological uncertainties. Generally, a more satisfactory technique would emerge from a better interpretation or formulation of the basic transportation models to facilitate the

appraisal of individual links, a greater understanding of the relationships between land use and transportation, consideration of factors with less bias from institutional constraints and perhaps, most importantly, a clearer specification and incorporation of the distributive effects. It is intended that this dissertation should be directed towards the examination of such points, perhaps producing some tentative suggestions or indications for improving investment appraisal practices in public transport projects.

CHAPTER 2.

THE THEORY OF COST-BENEFIT ANALYSIS

The aim of CBA is to guide the decision-maker into channelling resources into projects which will yield the greatest gain in net benefit to society. In order to achieve this, an objective function defining the values under which social welfare is construed must be stated at the outset.

In standard CBA, following from the U.S. Flood Control Act of 1936, the decision objectives are most commonly expressed implicitly in the form of the Pigovian Social Welfare Function (SWF), as defined by Foster (1966), which holds that all costs and benefits to whomsoever they accrue are to be accounted according to the existing price schema, under the assumption that the marginal utility of money is constant. This function is basically Paretian, but incorporates the Kaldor-Hicks (1939) concepts of hypothetical compensation, thus adopting the primary goal of efficiency, as measured by a net increase in national wealth, while assuming away possibly adverse distributive effects. Such a decision function is usually justified by claims that redistributive effects are minimal anyway, that any redistribution is best effected through taxation and that the present distribution of income, as it is, is generally acceptable. A minor distributive objective may be internalised in the function where a project is to be financed, at least partially, through price discrimination, voluntary contributions or taxation subventions.

Often, the Pigovian SWF is qualified by an income distribution constraint that nobody loses more than a specific or proportional amount as a result of the possible decision. Alternatively, the objective may be to stress income redistribution by maximising net benefits to a disadvantaged sector, perhaps limited to a degree by an efficiency constraint. A more complex, though desirable, type of SWF is one which assigns varied weights to different types of benefits and costs according to which classes they affect. Such a function would necessarily have to be numerically specific in its weightings and categorisations, and would require detailed data of a highly disaggregated nature.

However, following standard practice, a Pigovian SWF is implicitly adopted, perhaps with some distributional considerations at the output, and the CBA proceeds in five basic stages :-

1) The identification and enumeration of all relevant costs and benefits.
2) Their evaluation, as far as possible, in monetary terms.
3) The choice and application of a suitable discount rate.
4) The treatment of risk and uncertainty.
5) The decision recommendation according to the appropriate formula and constraints.

2.1 Definition of Costs and Benefits.

The initial requirement is to define precisely the extent and expected life of the project under appraisal. This procedure generally identifies the direct costs, that is the value of goods and services required "to establish, maintain and operate a project" (Eckstein 1965, p.51). Such costs in public transport investment usually occur through a combination of land acquisition, engineering, construction and the provision of new vehicular or rolling stock on the capital side and maintenance, operation and energy costs on the running side.

The real (i.e. opportunity) costs of the investment are in those goods and services which have been foregone because of the diversion to the project of resources that might have produced them. However, because of monopolistic practice, imperfect knowledge, indivisibities, government intervention and so on, the relevant market prices will differ from these true opportunity costs. In standard practice though, direct costs are simply itemised at their market prices, with any differential from the real opportunity cost perhaps recorded as a positive or negative benefit, either by use of shadow or surrogate pricing, though often just left unquantified as an 'intangible'.

The direct benefits conceptually are equal to the value of "immediate products or services resulting from the measures for which the project costs were incurred" (ibid). In most public transport CBA, the term 'user benefit' collectively covers direct benefits, which consist mostly of time savings. Time, as such,

has no market price and so must be attributed a derived surrogate value in the evaluation process.

Then, according to the different systems of classification, there are the secondary benefits, such as the utilisation in the project's construction of unemployed labour which involves no social opportunity cost, indeed having a positive subjective effect in morale-boosting. This induced benefit will then be extended through the multiplier effect depending on the level of unemployment in the area in the development of 'stemming' activities.[9] However, there may be secondary costs involved in the mobilisation of factors and capital opportunities foregone and these must be set off against the benefits to give a net figure for secondary effects, which stand as prime considerations in income distribution and the promotion of regional development.

The external effects of the project are the most difficult to identify but are vital to the analysis, constituting the basic rationale behind the cost-benefit approach. Externalities are those effects caused by the project but not compensated for by the market, representing Pigou's (1920) initial concern with the deviation of market prices from social costs. Typically, the externalities arising from public transport schemes involve environmental factors, such as noise, visual intrusion, fumes,

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[9] of course, these benefits will be common to all alternative projects in the same area, except in so far as they might employ differing quantities of labour, but they are extremely relevant to the question of inter-regional investment allocation.

vibration, glare and ecological impact, relief of congestion elsewhere, comfort considerations, increased job opportunities and extensions of labour pools and the multifarious social and planning implications of increased accessibility. Externalities, while difficult to identify precisely and independently, as well as involving dangers of double counting, prove even more problematic in their evaluation, since by definition they have no direct market price. Often they are simply listed and left unquantified as 'intangibles'.

In the classification, costs, especially external, other than the direct capital involved, are sometimes included as negative benefits, in order to separate the ongoing effects from the once and for all investment outlay. This practice can present problems in the comparison of projects and the calculation of benefit/cost ratios, and even a consistent categorisation procedure throughout can produce anomalies in the sensitive ratio determination. However, with the increasing influence of absolute figures representing the net present value of a project in decision-making, this classification deficiency, which is rectified simply by more stringent definitional application, becomes relatively insignificant in current CBA.

Pecuniary spillovers, as distinct from technological externalities discussed above, will also occur in the form of changed output or utility of any third party due to changes in demand caused by the project, but they should not be included in the efficiency analysis as they are simply monetary transfers not affecting the aggregate of social welfare, but only its

distribution. In this last respect, they should be recorded for consideration by the decision-maker. The major pecuniary external effects resulting from public transport investment will usually be increases in land values and rents around the points of improved accessibility, with perhaps corresponding falls in places less well favoured. Since an increase in land values is merely the capitalisation of the value of reductions in travel costs, it is an expression of the time savings already included in the direct benefits and therefore must not be counted, so that duplication is avoided.

Together, the above categories should cover all costs and benefits, but, in addition, their variation over time must be specified in order to derive accurate discounted values. This involves highly subjective estimates based on assessments of physical length of life, technological changes, shifts in demand, emergence of competing products and a whole range of exogenous factors. Accurate predictions become more important the lower the discount rate, since future figures will register greater significance in present value terms. Kuhn (1962,p.64) suggests that "as a general rule, unless compelling reasons dictate otherwise, the life of a public project should not be assumed to exceed 40 years, for shorter periods simply introduce greater prudence into the planning process".[x] However, with discount-

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x Current British CBA practice favours evaluation over a 30 year period. (D.O.E, 1972 a, G.G.T.S./B.R, 1973).

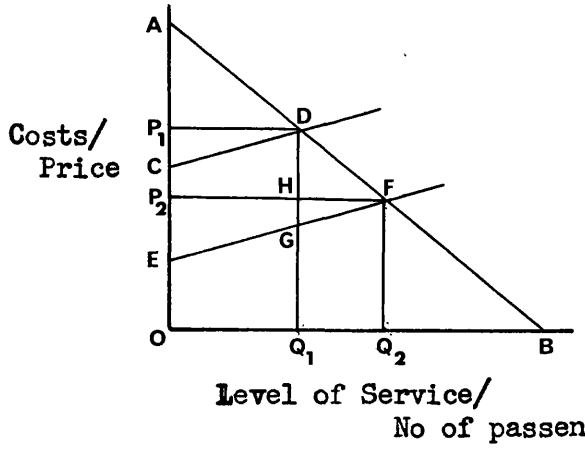
ing rates as high as 10% plus currently, the project life problem is not so severe, as short-term effects assume almost overriding significance, and the additional application of sensitivity analysis can indicate the impact of the forecasting assumptions involved for the consideration of the decision-maker.

Once all costs and benefits have been enumerated and specified over time, the CBA can proceed to the evaluation stage.

2..2 Evaluation

In order to maintain consistency with the overall CBA objective of maximising the SWF, it is necessary to ensure that the prices attached to the benefits and costs reflect accurately society's valuation of the goods, services and resources involved.

On the benefits side, their collective worth will be represented by the aggregation of individual's willingness to pay for them as indicated by their demand curves. However, since this total would require investment to the point of zero price to absorb all demand, that is the whole area under the demand curve, there has to be a supply/cost consideration to avoid over-investment and inefficient allocation of resources. Thus, in the diagram below, with AB representing the demand curve for speed, comfort, convenience, etc. and CD representing the marginal costs of providing varying standards of public transport services, then market forces would settle the service provision at level OQ_1 at user costs of OP_1. But though total revenue equivalent only equals OP_1 DQ_1 under marginal cost pricing, the aggregate



willingness-to-pay equals ADQ_1O, since there are OQ_1 people prepared to pay more than the market price OP_1 in varying degrees according to the demand curve. Thus the 'consumer's surplus' is represented by triangle AP_1D and, similarly, 'producer's surplus' is equal to the triangle CP_1D. If a new project were to produce a marginal cost curve EF, consumer's surplus would increase by P_1DFP_2 to triangle AP_2F and the producer's surplus would increase from triangle CP_1D to triangle P_2EF, giving an overall net increase in the combined surpluses of triangle DFG. Dupuit (1844) originally theorised that the net increase in the combined surpluses through a public project, as in triangle DFG, was a direct cardinal indication of the resultant improvement in social welfare. This proposition, of course, assumes that the marginal utility of income is constant, even with changing prices. Marshall (1890), the master marginalist, later refined this basic work and held that changes in consumer's surplus alone indicated social welfare changes. Mishan (1972) also concurs that producer's surplus does not merit inclusion, being merely a form of economic rent.

Although the Marshallian approach has been severely criticised by those who argue that utility cannot be measured cardinally, only ordinally, and therefore cannot be compared between individuals, consumer surplus survives as a major conceptual foundation of CBA. However, its use demands acceptance of the Kaldor-Hicks compensation criterion which states that social welfare is bettered overall if the gainers from a change can compensate the losers and still profit, necessarily

therefore involving interpersonal comparisons of utility (Kaldor, 1939; Hicks 1939). This converts the distributively neutral but excessively restrictive Pareto optimality condition that a change can only be approved if nobody loses out, and that at least one person gains, into a useful form for practical prescription. However, it refers only to potential compensation, the efficiency criterion, so that unless fiscal arrangements are self-adjusting to effect the necessary transfers, the distributive effect could well be regressive, and, indeed, Scitovsky (1942) identified the paradoxical situation where the distributive effects might result in the losers 'bribing' gainers to return the position back to the status quo, so that no clear-cut welfare gain may be discerned.

Even without considering the distributive reservations and the false assumption of the constant marginal utility of income, the derivation of consumers surplus requires the identification of the full demand curve, which is only partial in context and tends to indeterminacy at its extremities. However, despite the difficulties, consumer surplus is incorporated to a large extent in public transport CBA, since the valuation put on time savings, the major element on the benefits side, is derived from behavioural studies, although the standardisation into average values for practical purposes does destroy some of its theoretical validity.

Where benefits do have a market price, it can be used, after adjustment for the basic market imperfections, to indicate society's willingness-to-pay. Referring to the same diagram, the reasoning is as follows :-

Total willingness-to-pay (WTP) = Price (P). Quantity (Q) + Consumer's surplus (CS)

i.e. $ADQ_1O = OP_1 \cdot OQ_1 + AP_1D$

With new project,

Change in WTP (dWTP) $= AFQ_2O - ADQ_1O$

$= DFQ_2Q_1$

$= Q_1Q_2 \cdot OP_2 + DFH$

= change in quantity. new price + $\frac{1}{2}$ change in quantity. change in price

Therefore, $dWTP = dQ\ (P_2 + \frac{P_1 - P_2}{2}$

$= dQ\ (\frac{P_1 + P_2}{2})$

If the investment causes only a marginal shift in prices, then it can be assumed that P_1 and P_2 are more or less equal, and therefore the market price, once adjusted, represents the WTP per person.

$$dWTP = dQ. \ (\frac{2P}{2}) = dQ.P$$

Therefore, $\frac{dWTP}{dQ} = P$

Since neither condition that market prices equal marginal costs nor that marginal cost reflects the true social cost of resources obtains in the real world, the market does not produce the optimal set of prices. The divergence between market and social valuations exists because of monopolistic structures, indivisibilities, taxation and government intervention, externalities, multiplier effects, collective goods, imperfect knowledge and various non-equilibrating forces. The theoretical alternative to unsatisfactory market prices is the derivation and use of shadow prices.

Shadow prices can be defined as the marginal rate of substitution between the 'outputs' in question, incorporating both the willingness-to-pay and opportunity cost concepts. The actual values represented by shadow prices depend on the objective function being maximised, which, in the case of standard CBA, is of the Paretian/Pigovian type, concerned purely with 'efficiency' in allocation to the exclusion of distribution, so that the shadow pricing rule is to value at marginal social cost. However, since prices in the private sector continually fail to reflect marginal social costs, it is not theoretically possible to state that the use of shadow pricing in public projects will bring a necessarily better overall allocation in society, since the Paretian optimum will still not be attained. In essence, this is the 'second-best problem', whose nihilism is avoided by those who claim that, in the absence of any better rule, shadow pricing according to social marginal cost is the most likely to steer allocation in the right direction towards ultimate efficiency.

In practice, the difficulties of deriving marginal social cost curves to indicate shadow prices are severe, so the compromise of using market prices, where they exist, is usually adopted, with any important differentials from social valuation, through externalities or other factors, recorded separately in the list of items.

The greatest problem, though, is in evaluating the 'intangibles', such as amenity, for which there is no market indication as to their monetary values. Consumer question-

naires, behavioural studies, identification of similar goods and services in the market to give surrogate prices, the cost of provision and the shadow prices implicit in government decisions are all methods of varying validity, practicality and applicability for the derivation of monetary values for intangibles. Often, however, intangibles, especially the more abstract, are simply left unquantified, but are listed as contingencies to be considered subjectively alongside the monetised costs and benefits. If there is only one intangible factor, the decision-maker will have a straight-forward choice as to whether its contribution or detraction is greater or not than the difference between the measured costs and benefits. However, in practice, there is usually more than one intangible item, so that CBA's objectivity lapses into indeterminacy, leaving the decision-maker to compare his own subjective evaluations, weigh them up in his own mind under his political objectives, or in theory the stated SWF, and thereby come to his rational conclusion and answer.

The assumptions implicit in the derivation of collective consumer surplus, shadow and surrogate pricing and the unaccountability of some intangibles have predictably aroused the greatest controversy in the process of CBA, involving the whole question of the practicability and validity of applying the monetary measure so widely and the pursuit of the efficiency objective while distribution is ignored in the analyis proper. x

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x The evaluation methodology of the two major elements in user benefits in transport schemes, namely, the value of time savings and the value of reductions in accidents, is examined fully in the next chapter (3.3 and 3.4).

Even once values have been satisfactorily calculated, a further theoretical debate is encountered in discounting these values over the time to current worth, though without, perhaps, quite the same difficulties of practical application.

2.3 The Rate of Discount.

In order to accommodate society's preference for present as opposed to future consumption, the costs and benefits, as evaluated at current prices, must be adjusted by the application of a suitable discount rate, so that their magnitudes in the future may be given an appropriate present value, thus permitting the consideration of the cost-benefit flow over time at the common values of one point in time, the present. The positive discount rate of the consumer is an expression of his dislike of waiting and general impatience to spend, probably because of uncertainty ahead, occasioned by such possibilities as death or the future unavailability of goods and services, and his diminishing marginal utility of real income, as it is expected to rise over time and, consequently, yield progressively less satisfaction incrementally. Also, in the case of consumer durables, assuming long life equivalent to human expectancy, a consumer will rationally prefer to buy immediately to maximise his total utility over his lifetime, rather than later when total utility added over a shorter period of his life will necessarily be less.

Although the reasons for discounting may be fairly well agreed, the choice of a suitable social discount rate (SDR) for public investment generates considerable academic debate. Basically there are four possibilities or theories:- 1) The use of the social time preference rate (STPR), so that society's view as a whole is taken; 2) The social opportunity cost (SOC) rate, usually based on the return in the private sector, the alternative destination or source of the public project funds;

3) The rate on government bonds, which represents the financial cost of the capital for the project; 4) A composite SDR reflecting both the STPR and the SOC.

1) Social Time Preference

STP indicates the rate "which expresses the concensus of the electorate concerning the rate of discount they wish to be applied to future costs and benefits in evaluating government projects which provide services for future generations" (Bain, 1960). It is generally assumed that the STPR is lower than the discounting rate implied in market behaviour.

In explanation, Pigou (1920,p25) originally reasoned "that our telescopic faculty is defective, and that we, therefore, see future pleasures, as it were, on a diminished scale". This argument claims that individual's 'myopic' tendencies result in a market interest rate higher than the optimal which would derive from rational decision-making. Further, it may be thought that present society has a collective responsibility for future societies, so that altruism should supercede the avarice and supposed irrationality of current preferences. Similarly altruistic is the argument that views society as a continuous entity, so that the element in the individual's time preference for uncertainty and risk of death should be rejected in calculating the STPR. However, values both individually and collectively change over time in an unpredictable fashion making the current standards inappropriate, and since future preferences cannot be known Marglin (1963, p 97) argues that it is "axiomatic that a democratic government reflects only the

preferences of the individuals who are presently members of the body politic".

Another line of reasoning for the use of a low STPR postulates that people approve of the government providing 'collective' goods for future generations, but in self-interest will conceal such concern, since they could not be certain of all other individuals voluntarily contributing jointly towards these future public benefits. Thus, the real STPR will be lower than that indicated by personal, self-interested behaviour in the market. Marglin (1963,pp 98-99) refers to this approach as the 'schizophrenic view', in which an individual is regarded as both citizen and economic man.

Directing the STPR in the opposite way, upwards, is the hypothesis of diminishing marginal utility, stating that future generations will be richer than the present, and, therefore, will attach less value to each incremental benefit, so that there should be a positive impulse to the time preference rate. Assessing by how much this idea is accurately incorporated into actual personal considerations has proved extremely difficult and, not surprisingly, inconclusive.

In general terms, the use of a STPR can be justified on the basis of the two standard objections to the value represented by the market rate. Firstly, there are the technical imperfections of the capital market, "rife with rationing, ignorance, differential tax treatments, reluctance to finance from external funds, slow adjustment processes, etcetera, which destroy the normative significance of actual rates found in the market"

(Eckstein, 1961,p.503). And, secondly, as with other prices in the economy, market rates reflect and reinforce the current distribution of income and wealth, whereas the government may have equity objectives in addition to aiming at Paretian efficiency.

Overall, the STPR is a useful conceptual device with a strong theoretical foundation, but, with its predictable problems of derivation, has not been used in pure form as an operational SDR in CBA.

2) Social Opportunity Cost

The basic argument supporting the concept of SOC indicating the valid SDR states that, since capital funds are not unlimited, a public investment will incur the sacrifice of some other project, probably in the private sector. Therefore, it is hypothesised that the social rate of return on the foregone investment, or the lost benefit from current consumption, represents the level below which public investment should not be undertaken. This SOC is thus to be derived from the private capital market's marginal internal rate of return, emphasising the efficiency criterion in resource allocation.

The major problem of identifying the SOC rate is familiarly that market rates do not reflect social returns from private investment, failing to take into account external effects, shadow price differentials, consumer surplus elements and all

the imperfections of the capital market mentioned in the last section.[Θ] Further, since public investments are reckoned to be generally of low risk, comparably low risk private ventures must be used, adjusted for differential tax considerations, to give a realistic rate. Under these conditions, Alfred (1968) calculated the British SOCR at between 10% and 11%, six months after the Government had set a rate of 8% (H.M.S.O. 1967).

3) The Government Borrowing Rate

The financial rate of government borrowing has also been suggested as the suitable SDR, since it represents the actual accounting cost of raising funds for public investment. However, this neglects the real social costs, taxation revenue and the use of Treasury rates for monetary and fiscal policy ends. In addition, while all virtually risk-free, there are varying rates according to the nature of the government bond, and selection of the suitable one is a major problem. Although fairly convenient in the direct observation of the relevant rates, conceptually their representation of the SDR has no valid basis and is little favoured in the academic literature.

4) A Synthetic Rate

The compromise of establishing a SDR by deriving some weighted average of the STPR and SOC, an intuitively satisfactory, practical solution, has been formalised, and perhaps

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Θ They are also volatile and subject to dramatic fluctuations, so that even the more appropriate long-term rates vary considerably and, accordingly, cannot give a reliable indication as to the desirable SDR.

validated, by Marglin (1967). His model essentially allows for the opportunity costs of public investment to be split between foregone private investment and foregone consumption. Thus, he determines the appropriate 'synthetic' rate, weighted according to the marginal propensities to invest and consume between the SOC and STPR respectively.

Of course, in the perfect market situation at equilibrium, both rates would be equal and the problem of the choice of the SDR would not arise. In the real world though, Baumol (1968) postulates that the equilibriating process will be perpetually inhibited by institutional barriers and the existence of risk. His argument basically states that since private industry must earn at least the government borrowing rate after tax to attract funds, its ruling gross marginal internal rate of return must be the gilt-edged plus tax rates and, being viable, reflects the consumer's willingness-to-pay for the private product, in other words, representing the SOC. Therefore, the STPR, indicated by society's willingness to lend to the government at gilt-edged rates, must differ from the SOC because of taxation, and, by similar reasoning, risk, and, therefore, there exists an essential indeterminacy in the choice of rates.

Despite the above proposition and some solid academic support for the pure SOC assessment, the U.S. Bureau of the Budget (1964), following the Marglin line, recommended the procedure of combining SOC and STP as a suitable basis for all CBA. In contrast, the British Government's choice of a SDR of

8% (H.M.S.O., 1967), subsequently raised to 10% suggested outright acceptance of the opportunity cost arguments and Mishan's (1967a) contention that the source of the opportunity cost as to foregone consumption or investment is irrelevant, since sacrificed consumption could have been invested privately, thus representing the SOCR (Mishan, 1967). However, in practice, especially under to-day's rapidly changing conditions, the specification of the discount rate for CBA, as with the current 10% in Britain, is essentially arbitrary and based on political expediency within the bounds of the STPR and SOCR.

In the private sector, risk and uncertainty are incorporated into the capital market rate, and indeed the extra margin they provide represents the entrepreneur's reward, or profit, for coping with them successfully. However, in public investment, with no profit orientation, risk and uncertainty must be treated differently, and this is the topic discussed in the next section.

2.4 The Treatment of Risk and Uncertainty.

Technically, risk and uncertainty are distinguished under the criterion established by Knight (1921), namely that the former exists when there is sufficient information to assign a probability distribution to the values in question, and the latter when no such knowledge obtains, but, in essence, they are very similar and the terms are used almost interchangeably. They mainly arise from sudden and unforeseen changes in consumer tastes, technological breakthroughs and alterations in the relative price structure through the effects of natural or political upsets.

It has been argued that risk in public investment is negligible, since the government invests in a great number of diverse projects and can pool risks, and that there are no 'moral hazards' of fraudulent behaviour, which constitutes a major component of risk in the private sector. Also, if it is considered that the government, as a societal entity, has an existence and interests apart from the individual preferences indicated by market behaviour, then public investment would be undertaken according to national objectives, such as a target rate of growth, with an implicit SDR, virtually indifferent to risk.

However, individual government projects do suffer uncertainty, as evidenced by several aviation industry fiascos, and leave real costs to be borne by the public.[x] The simplest and

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[x] In the context of urban passenger transport, a striking example of technological innovation nullifying recent investment occurred with the building of the Paisley suburban railway line

(cont. overleaf)

most popular method of allowing for risk is the addition of a risk premium to the discount rate, making risk a compound function of time, thereby directly implying that the further into the future, the more uncertainty involved. Despite its intuitive appeal, this risk premium device assumes that uncertainty increases monotonically with time, although empirical evidence does not support this, it applies to all items, risky or not, thereby obscuring the real nature of risk, and has difficulties, both conceptually and practically, in translating uncertainty accurately into a discount figure, and indeed is summed up by Henderson (1968) as a 'very crude expedient'.

Alternatively, items with elements of uncertainty may be revalued, if costs, or devalued, if benefits, by a specific proportion, but such ad hoc adjustments to initial cost and benefit estimates are hardly an adequate substitute for a comprehensive and systematic assessment of risk, based on past experience and expert knowledge which deals with the total implications or risk rather than just simple over-optimism.

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x (continued).

and stations in 1898 by the Caledonian Railway, albeit a private company with a risk consideration in its investment appraisal. Before the service could even commence after the completion of the construction work, the competition from the lightning spread of the electric tramcar had made the line commercially unviable. (Thomas, 1971, pp 224-5).

A similarly unsatisfactory method is to shorten the considered time-horizon of the project, in fact specifying a pay-off period, perhaps where Prest and Turvey (1965, p.699) suggest "a sudden day of reckoning when benefits disappear or costs soar" might be roughly identified. In fact, British road evaluation, up until the adoption of the COBA method (D.O.E., 1972), effectively overcame any uncertainty problems by using the simple but inadequate first year rate of return ruling. Again, this practice is objectionable since it avoids consideration of later costs and benefits, in a similar way to which the risk premium diminishes their significance.

While it is these 'rules of thumb' which are actually used in CBA, there are theoretical solutions to the problems of risk and uncertainty. Often, the elements of a project may be governed by 'states of nature', which, on the basis of past observation and experience, may have established a frequency pattern from which a probability distribution may be derived. According to each state of nature, the project will have a certain outcome whose utility may be assessed. The decision-maker then has two choices. He may either reckon that, in terms of overall social welfate, the risks of all government investment will cancel out, and therefore he should just proceed under the 'Law of Large Numbers' to maximise the expected utility of the defined projects, derived from the mean of their probability distributions. Or, on the other hand, if he decides to formally allow for risk, he can use the 'certainty equivalent' approach, where his trade-off for risk as between mean and variance values is defined on an indifference map, enabling each

project to be assessed at the common level of 'certainty equivalent', established by recording the relevant indifference curve values at zero variance.[x] Thus, rational decision-making under the circumstances can be achieved.

However, another method must be employed in situations of new states of nature about which information is inconclusive and is insufficient to determine an objective probability distribution. Instead, on the basis of professional judgement, a subjective interpretation of the possibilities may be formulated according to the 'degree of belief' attached to each prospective situation, which also will possess an estimated utility. Various axiomatic systems, developed by such authors as Ramsey (1931), von Neumann and Morgenstern (1947), Savage (1954) and Marschak (1954), provide consistency conditions, under which both degrees of belief and utility indices can be simultaneously determined, so, by simply applying the subjective probability values, solutions may be obtained. While the great significance placed on individual subjective decisions for the good of society as a whole may be criticised, any evaluation of risky projects must inevitably involve the use of personal judgements, and such methods as above merely systematise and rationalise a necessarily subjective decision procedure.

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x The shape of the indifference map will depend on the decision-maker's objectives. For instance, risk aversion may be considered vital in a depressed region, where the failure of a project might be crippling or, at least, more damaging than in a prosperous region, whose wealth and stability can comfortably absorb such consequences.

Where the likelihoods of project outcomes just cannot even be guessed at in a situation of complete uncertainty, decision rules derived from the theory of games may be applied, according to four criteria:- a) The Maximin (Wald) Criterion guarantees security by choosing the strategy with the highest minimum pay-off. b) The Maximax (Hurwicz) Criterion attaches 'the index of pessimism' of the decision-maker in the form of a probability function and then chooses the outcome with the highest net benefits index. c) The Minimax Regret (Savage) Criterion adopts the strategy which minimises the possible difference from all other outcomes. d) The Laplace or Bayes Criterion simply assumes all possible states of nature equally likely, and chooses the strategy with the highest expected pay-off (Dasguptaand Pearce, 1972, pp 187-194). The choice of criterion will depend on the character of the decision-maker, whether pessimistic, optimistic, cautious or random in nature, and perhaps on the circumstances.

Thus, the theory dealing with the rational treatment of risk and uncertainty has reached a fairly sophistocated state of development, but has yet to be incorporated into any CBA application. Simple, but conceptually unsatisfactory, devices, such as risk premium, marking down the uncertain items, and shortening the time-horizon, are still widely used, but the most recently introduced practice is the accompanying procedure of sensitivity analysis. A sensitivity analysis identifies the major assumptions as to future conditions, shadow or surrogate pricing arrangements, choice of SDR, and so on, and then defines the likely ranges of values and results obtainable by varying these assumptions within their feasible limits. Although this deals

with uncertainty in the widest sense, such a variation in evaluated outcomes is produced, that from the decision-maker's point of view, the sensitivity analysis merely puts the whole CBA into a state of indeterminacy, which only generates yet more confusion as to the optimum decision. The application of the theoretical methods for coping with risk and uncertainty will perhaps shortly mark the next progression of CBA towards the synoptic ideal of a rational decision-making technique.

2.5 Decision Criteria.

The most generally acceptable decision rule in CBA is that of maximising the net present value of benefits from a project, although this has only been formally adopted for English road schemes since late 1972, and still remains to be implemented in Scottish practice. Basically, any project whose discounted benefits exceed discounted costs is worthwhile to society. However, because of the gap between the SOCR and the STPR discussed in the last section, as well as government fiscal and monetary policy, funds will be constrained and probably fall short of covering every project showing a positive net present value (NPV), which serves only as an absolute, not a relative, measure. Therefore, a ranking rule is required to order projects in terms of their overall social profitability, and is generally represented by the benefit/cost ratio, where gross benefits at present value are divided by costs. Projects should then be selected by moving down the ranking list until the budget constraint is reached. Unfortunately, the ratio is very sensitive to the classification of items as negative benefits or costs, since this affects the magnitudes of both the vital denominator and the numerator non-proportionately.

The alternative to the NPV rule is the internal rate of return (IRR), whose value in the project's initial year was the general yardstick for nearly all British road and public transport schemes, until the recent adoption of the COBA method (H.M.S.O. 1972). Instead of incorporating a predetermined SDR to derive present worth, the IRR, or yield, is calculated as the discount

rate at which the NPV of the project is reduced to zero. Thus, projects can be ranked by yield until the budget cut-off point precludes further investment, while, without the funds constraint, all projects whose IRR is greater than the considered SDR can be deemed socially worthwhile.

However, although decision-makers tend to find consideration of a straight percentage 'yield' easier than an absolute NPV figure or benefit/cost ratio, the IRR does have its drawbacks, in addition to requiring a tedious, iterative process of computation. The well-documented disadvantages of the IRR approach (Feldstein and Flemming, 1964) lie in its discrimination against projects with long gestation periods, its inflation of the desirability of short-life projects, its supplementary modifications necessary to deal with mutually exclusive schemes, and its occasional production of more than one solution rate. These inconsistencies all derive from the IRR being a function both of time periods involved and the size of the capital outlay, as well as the solution to a polynomial equation, whereas NPV is not affected by absolute magnitudes of outlay. Therefore, the NPV rule is to be methodologically preferred for public investment decisions, although the IRR still features in many analyses, and, indeed, can incorporate an allowance for risk into a single figure, rather the more unsatisfactory range of NPV's.

Other decision criteria exist of which the 'payback' has the most frequent usage, simply accepting or rejecting projects according to whether or not the benefit flows cover the cost flows by some arbitrarily established time horizon. Less

pragmatic and more soundly founded is Mishan's (1967b) proposition that, instead of discounting to the present time base, costs and benefits should be compounded to the estimated end of the project's life to give the net terminal value. Following 'normalisation' procedures of allowing for differential compound rates for consumption (STPR) and reinvestment (SOC) and adjusting projects to equalise their present value of costs, a normalised IRR, defined as the discount rate which makes the terminal value of benefits equal to the present value of expenditures, can be accurately derived. The great attribute of this normalised IRR is that it accords with the popular conception of an internal rate, as an average rate of growth over the relevant period, and is, therefore, more comprehensible to the public and decision-makers.

The criteria discussed so far are all solutions aiming at maximising efficiency in the administrative decision as to the selection of projects, with but one constraint, the budgetary consideration, incorporated. However, there must inevitably be a complex framework of political constraints controlling any public investment decision, particularly with regard to specific policy priorities and departmental or agency allocations, all of which should ideally have been stated as the government's SWF in the CBA's objectives at the outset. Indeed, projects will normally come under governmental scrutiny before being subjected to CBA, and, if, at this crude level, are broadly considered politically inexpedient, they will be 'screened out' before reaching the analyst, who may find them embarrassingly efficient.

Perhaps because of the massive disruption and implications of the large projects typically evaluated by CBA, the pressure to recognise the distributional effects, previously just lightly assumed away, has justifiably mounted to the point that it is generally accepted that CBA should consider distribution, but it still remains to be formally incorporated into the analysis in practice. As mentioned earlier in the short discussion on the SWF's underlying CBA, some specific distributional weighting systems have been devised, though not yet applied.

Foster (1966), for example, proposes the use of a 'democratic strength of preference function', which requires that all costs and benefits are to be scaled up or down, according to their incidence, by the ratio of the income of the individual, household or group affected to the average income of the population. Thus, each gain or loss is multiplied by x, where $x = \bar{Y}/Y_i$, with $\bar{Y}$ = the national mean income of the unit concerned, and Y_i the income of the particular individual, household or group. The basic principle involved is giving everyone potential equal weight in decision-reckoning by compensating for differences in income, and therefore for differences in the marginal utility of income, and yet allowing weight to differences in strength of preference. In this way, assuming a linear marginal utility of income curve, a rational redistributive component can be internalised in the analysis, but the demanding data requirements have so far precluded its actual application.

Following another line of reasoning that democratic govern-

ment's bias in decisions is a function of its electorate's preferences, Weisbrod (1968) and others, in the American context, have derived distributional group weights based on the evidence of recent government trade-offs between efficiency and distribution. Similar belief in the government's ability to reflect consumer's and societal wants prompted Krutilla and Eckstein's (1958) use of marginal rates of taxation, adjusted for allowances, as surrogate weights for the marginal utility of income. However, it is extremely doubtful that taxation rates bear a simple direct relationship to equity and marginal utility considerations, for they must incorporate the many fiscal facets of economic policy, but, despite this, the U.S. Bureau of the Budget (1964) has given some support to this type of weighting device.

In practice, though, there seems to be little chance of an internal distribution computation being incorporated, for, unfortunately, in addition to the data and weighting difficulties, governments tend to shrink from stating specifically their total objective function, so that they can retain their power of decision from the usurping analyst-adviser. In effect, the CBA gives the 'efficiency' solution and should state explicitly the incidence of the costs and benefits. The government will then decide on the basis of maximising efficiency, subject to the distribution constraints, among others perhaps, that gains or losses to particular income groups, communities or regions do not exceed the notional level which their political objectives would find unacceptable.

Thus, CBA has emerged from a prolonged theoretical devel-

opment, in which many of the debates are far from resolved, to a point where consolidating textbooks, drawing together a profusion of papers, have perhaps granted some subject entity to it. (Kendall, 1971; Mishan, 1971; Pearce, 1971; Dasgupta and Marglin, 1972; Dasgupta and Pearce, 1972; Layard, 1972; Georgi, 1973). Criticism continues unabated, both with regard to individual, simplifying assumptions and its whole, fundamental rationale. Yet, despite its shortcomings, which are examined in the next chapter, no generally acceptable alternative has emerged and CBA remains the best recognised appraisal procedure for public investment.

CHAPTER 3

THE LIMITATIONS OF COST-BENEFIT ANALYSIS IN TRANSPORTATION PLANNING.

A major, fundamental limitation of CBA as an evaluation technique lies in the narrow context of its use. In a full strategic evaluation procedure, as described by S.Z. Walters (1972, pp 5-10), the process must begin with an examination of the problem in hand, for which the eventual project choice will be the most satisfactory answer, under the criteria of people's needs and the decision-maker's objectives. Such a basic consideration should then generate a broad range of responses which will be selectively refined through the levels of policy and wide action alternatives until the favoured type of solution is determined. Following this decision, specific project options may be proposed, and, after probably undergoing a feasibility/filtering process, only then will CBA be applied to a small, manageable set of projects, in order to indicate which option should finally be chosen for implementation. Therefore, CBA contributes only at the lowest and least important level of decision-making by choosing between a limited set of similar means to satisfy pre-determined ends which emerge from an obscure, but fundamentally vital, elimination and supposed rationalisation procedure beforehand. Indeed, such an imperfect, but typical, approach will conceal possible misjudgements at the earlier stages, where the goals and objectives formulated in response to the real problems are usually neglected, and further lack of consideration of funding constraints leaves CBA perhaps evaluating unlikely and irrelevant schemes of doubtful

value to the community.

Therefore, the concept of comprehensive rationality underlying the superficial appeal of CBA is illusory, since CBA constitutes only a partial method whose operational ends and means are predetermined by the political process and may be couched in inconsistencies. Of course, CBA cannot attain the synoptic ideal in the real world of imperfect economic, social and political systems. Even working within 'bounded rationality', it can never honestly achieve optimisation unless the practical impossibility of comprehensively defining a genuine, operational objective function is somehow fulfilled. Therefore, the most that CBA can effectively achieve is the indication of the most appropriate decision under the circumstances, perhaps partly self-imposed, in a second - or third - best situation.

However, even allowing for the aforementioned methodological inconsistencies, still "it is always easy to criticise any CBA since in the last resort the technique is merely a listing of the advantages and disadvantages of the project(s) where these are identified, quantified and monetised, where possible, brought down to a common base for comparison and presented as an aid to decision-making. Inevitably, bias will enter the analysis and for this reason alone decisions based on unqialified acceptance of CBA are not satisfactory" (Barrell, 1974).

The first element subject to implicit criticism regards the identification of all the effects resultant from the project, intuitively, perhaps, seeming a relatively simple task. Yet, even the ambitious Roskill Commission apparently missed two

signifcant items, according to Mishan (1970, p.232).

Firstly, he argues that the proposed airport, by promoting international air travel, especially with charter flights, will contribute to the global destruction of natural beauty and tradition by tourist blight and western standardisation, yet this cost is never mentioned. Of course, such an effect was outside the terms of reference of the exercise and its costing would depend on the objectives set. However, it could be argued, under Roskill's apparent objective function, that the increased air travel generated by the new airport would have a negative impact elsewhere in the vicinity of receiving destinations, but this would extend the analysis to unmanageable proportions and begs the question as to whether international welfare should be considered.

Secondly, in ignoring the effects of accidents and loss of life, the increasing value attributed to airport sites generating more traffic is sadly overestimated by Roskill's CBA. This point is later discussed in the context of urban transport evaluation (3.2). Since most cost-benefit exercises are considerably less elaborate and sophistocated than Roskill, it is fairly likely that there is in general some failure in identifying all the project's effects, although, in many cases, some may be erased through political screening or discarded as of neutral net impact.

However, much more contentious than mere identification is the quantification and monetisation of costs and benefits, not just at the technical level, but concerning the basic

methodology and validity of the whole procedure. For instance, Self (1970, pp.249-60) argues that, since the common value of the £ or any other monetary unit derives from exchange situations, it is inconsistent to represent items not subject to direct exchange by monetary ratings. Also, Hill (1968, p.20) contends that costs and benefits can only be summed in the context of a single objective, and that the aggregate totalling of CBA under various objectives is conceptually invalid. Hence, nearly all factors by these criteria are incomparable on a monetary base and can only be considered within some kind of general planning framework.

A more widely held view concerns the incompatability of intangibles with 'costed' items. Again, for example, the Roskill Commission, although reiterating at the outset the CBA principle that all effects be accounted, had to leave certain items unquantified. These were the long-term values of the conservation of landscape, wild life and historic buildings and the regional planning implications, ultimately left simply for individual assessment by the political decision-makers, who, in fact, decided that they outweighed the carefully costed differences of the quantified elements. It is rare, however, for the significance of the intangibles to register so heavily. For, it is widely recognised that decision-makers, and people in general, when comparing monetised items and intangibles, attach greater importance to the former, since a precise numerate definition is much more easily comprehended than a seemingly abstract quality, adequate appreciation of which requires exceptional understanding and mental effort. This is known as the 'fallacy

of misplaced concreteness' (Mishan, 1967), whose effect nearly always underestimates the cost side, since most intangibles occur through the deterioration of the environment. Such a consistently assymetrical treatment of cost factors, partially left unquantified, on the one hand, and benefits, expressed as a money total, on the other, seriously jeopardises the ability of CBA to indicate the true net social worth of any project. Naturally, the intensity of the urban fabric magnifies environmental disruption and, thus, this consideration has additional significance in city transport projects.

While misplaced concerteness and assymetry undoubtedly erode the very foundation of CBA's methodology and myth of objectivity, controversy is fiercer over the validity of transport benefits valuation, consisting mainly of savings in time, accidents and running costs. Running costs can be fairly directly and accurately determined (M.O.T.1968), but both time and health require tenuous surrogate valuations, which are examined in 3.3 and 3.4.

The final and vital element in Barrell's basis for criticism concerns bias. Wherever subjective judgement is required, and it occurs inevitably in CBA, as epitomised by Roskill, bias must be involved, unless there is an explicit and comprehensive objective function strictly applied, virtually a practical impossibility. Unfortunately, urban public transport projects suffer from an additional and more serious element of a systematic disequity bias, resulting from the underlying assumptions and techniques of the transportation studies and models through which any schemes are formulated and assessed.

3.1 Inherent Bias in Transportation Studies

As with CBA itself, transportation studies generally fail to establish explicit economic, social and political objectives at the outset, and, consequently, the standard methodology and techniques applied are often largely divorced from immediate, real needs. Unfortunately, this situation pertains particularly in Britain, whose intricate urban forms and way of life are far removed from the car-oriented cities and society of North America, where transportation studies originated and were developed. Yet, with apparent disregard for the difference in context, the highway-oriented American techniques have been widely applied in Britain. As a result, transport planning has given a systematic preference to the car-owning population, with relatively high incomes, at the expense of the public transport users, cyclists and pedestrians, the relatively poor, who still represent much the greatest proportion of the urban trip-makers.

The basic land-use/transportation planning process starts with a survey of existing land-use, population, socio-economic and traffic characteristics by zone, from which the calibration factors for the model are derived to be applied to the forecasts of these parameters at the planning target date(s). The future generated trips, thus derived, are then distributed, split by mode and assigned to routes, according to the model based on present system performance, thereby indicating where transport investment will be required.

The disequity bias in such transportation studies is

fundamental, for, even at the survey stage, no data for pedestrians and cyclists is generally recorded, and, thus, these two very important movement groups, consisting largely of the relatively disadvantaged, are excluded from the basic modelling process, with the result that no ultimate provision is recommended for them in the plan output. Further underestimating their vital role in actual movement patterns is the simplifying, but distorting, modal split assumption, because of the household base for data collection, that all personal trips by members of car-owning households have the option of car use. In fact, only the husband in a one-car family generally has unrestricted access to the vehicle, while opportunities for his licence-holding wife and older children are severely constrained, and non-driving members are totally dependent for personal trips on both car and 'chauffeur' availability, so that the household, as a whole, may have a heavy net demand for public transport[x] (Hillman,1972).

Aggregation of household data to the zonal level, in order to make the necessary computations manageable, also tends to obscure the movement problems of the disadvantaged, for their needs will be obscured in the averaging process. This situation can be rectified by the careful definition of traffic zone boundaries to contain strictly homogeneous socio-economic groupings, but this ultimately requires an extremely fine zoning network whose proportions would be virtually impossible to work with,

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x Willmott's London survey (1973) suggests that not having a car available crucially affects the quality of people's life and leisure.

except at fantastic cost in computer time and capacity. Thus, aggregation continues to conceal the large intra-zonal differences, which are probably much more significant than the inter-zonal variations incorporated into the actual model, so that, once again, the transport deprived are likely to be neglected.

In addition to being simply passed over, the same disadvantaged groups suffer from the apparent doctrine of transportation planning that takes demand as an exogenous factor, a function of independently determined socio-economic parameters (Plowden, 1967). In fact, demand, as in a typical economic model, is a function of taste, the availability of substitutes and complements, the pricing system and so on. However, by projecting forward the socio-economic parameters, car-ownership is assumed to increase greatly, and, therefore, in order to preserve consumer sovereignty at all times including the peak hours, transport planners inevitably have always proposed, until recently, a massive expensive and disruptive highway investment programme, so that, short-sightedly, the capacity is provided for the supposed demand. There is no consideration of the present standard of transport provision influencing actual usage, which is directly equated with demand as a socio-economic dependant and, accordingly, little attention is paid to the possibilities of directing future usage to a more desirable pattern. This stems from the lack of any objective function, which might well approve such measures as traffic management, capacity restraint, improved public transport, provision of

footpaths and cycleways and differemtial pricing policies in order to produce the required 'balance' in the urban transport system [xx].

While all these inherent disequity biases in transportation planning are particularly disturbing, there are also great limitations in the scope and technical validity of the basic transport model, necessarily distorting a true appraisal, but not in any consistently divergent manner that can be identified.

At the fundamental level, by ignoring the processes of a full strategic examination, as advocated by Walters (op.cit.), the model is tightly and wrongly constrained by the refusal to recognise the interdependence of land-use and transportation and its implications. However, American modelling in the early 1960's tried to incorporate a two-way, continuous feedback interaction process, culminating in the Lowry techniques (1964), but, in practice, the complex and time-consuming iterative computations hardly produced significant enough results to make the operation worthwhile. Though alternative activity or land-use/transportation patterns have been postulated in Britain (Jamieson et. al., 1967; Solesbury and Townsend, 1970), no study, except perhaps for the Strategic Plan for the South-east (1970), has attempted to apply the concepts. If land-use variations are to be considered

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xx Some studies do of course employ such methods, but generally only after an absolute capacity constraint on the proposed highway network has been reached, although more attention is being given to them now.

and they are intuitively pleasing, although maybe unrewarding in practice, the methodology and design of transportation studies require a fundamental re-structuring (Smith, 1970).

As regards technical sophistocation, the gravity model usually employed to distribute generated trips according to the attractiveness of competing destinations, modified by a measure of travel resistance, such as distance, time and cost, still lacks formal verification, although Wilson's (1970) entropy approach does grant it some theoretical justification and respectability. Its practical shortcomings have been well expounded by Heggie (1969, p.93-110), who identifies its overestimations of travel in densely populated areas and when a node increased in size or attractiveness, and its logical inconsistencies in application to the real travel situation, which relates more closely to an economic model of supply and demand than to Newtonian mechanics. After his empirical investigations, Heggie (ibid., p.108) concludes that "in general, the gravity model gives a very poor explanation of observed traffic flows. The margins of error are so wide that it cannot consequently be accepted as a valid means of explaining present traffic behaviour or of predicting future traffic patterns".

In addition, the broad modal split assumptions, neglecting the aforementioned problems of car availability, latent public transport demand and the actual quality of public transport provision, all imparting a direct disequity bias, have only been refined slowly and in a limited number of studies. Likewise, at the assignment stage, vast oversimplifications in single route

considerations within the context of complex urban networks have undermined the validity of the model, but now multiple route assignment, using diversion curve procedures, produces a more realistic pattern, though encountering some computational difficulties.

Much of the improvement in the constituent parts of the overall transportation model, or paradigm, has been due to their examination in terms of sub-systems within the whole system, which demands their overall logic, their internal consistency and the congruity of their connections. In particular, the development of a closely integrated distribution and modal split approach has brought the fundamental "structure of the model into closer accord with its philosophical base and .... allows a choice to be made in a systematic manner between alternative policies which incorporate real options within public transport" (Starkie, 1973, p.373). However, despite two decades of development, the typical transportation model still possesses serious imperfections, which on balance impart a definite, systematic disequity bias, which is then further aggravated by standard practices in transport evaluation techniques.

3.2 Faults in typical evaluation procedures of transport projects

In addition to the methodological inadequacies, the conduct of the recommended techniques (e.g. COBA, H1/71) is often marred by minor errors, inconsistencies and invalidities. Almost inevitably, these tend to favour car users by overstating the desirability of urban road construction, thus partially diverting funds from possible investment in public transport facilities. Generally, the capital costs of urban road schemes tend to be underestimated, and benefits over-valued, while the alternatives of public transport solutions apparently rarely merit any evaluation at all, are not considered seriously and are simply passed over in most cases.

In assessing the capital costs of an urban highway proposal, the major item often, that of land and property acquisition, is recorded on the basis of "historic costs without attempting to adjust them to reflect social opportunity costs where necessary" (Pearce and Nash, 1973, p.133). Since it appears to be standard local authority practice to gradually assemble land to add to its existing holdings within the likely lines of projected road schemes, that same public body, when valuing the projects' land requirements, will register a zero or nominal historic cost against much of the area. Where the land acquisition involves displacing residents, as is likely in the urban context, the real opportunity costs will be represented by the total rehousing costs, which should also include the necessary infrastructure and services, loss of amenity and, perhaps, locational disadvantages if the new houses have to be built on a green-

field site on the perimeter of the city, due to pressure and space shortage within. There is also likely to be an element of householder's surplus, composed of his sense of security, satisfaction and established personal activity patterns, which form the difference between the occupant's subjective valuation of his house, and the 'objective', open market price which the acquiring authority records[x].

All in all, by the use of standard practices, the real costs of land occupation by any new transport scheme are usually greatly underestimated. Since highway projects are by far the most voracious in land consumption, the evaluation procedure will favour them in relation to public transport alternatives, which, even with fixed track, often easily put in tunnel, or other types of segregated systems, are comparatively low land-users, having a high density of person movement per unit area.

In addition, other capital costs incurred by pursuing a motorisation policy in a city tend to miss inclusion in the basic highway appraisal. The two main items concerned are the provision of parking capacity (i.e. multi-storey car parks) for the increased flow of terminal traffic into the city centre, and the additional roadworks involved outside the strict limits of the project under appraisal, but necessary to enable the predicted usage to be generated from outside. So once again, there is a serious element of under-estimation on the capital cost account.

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x "The Roskill Commission Research Team concluded that an average surplus figure of 52% over and above removal costs, for tenants and owners alike, was applicable to house price data" (Pearce and Nash, 1973, p.136).

Even without considering the seldom appreciated social and environmental costs involved in highway construction, there is consistent, and perhaps deliberate, optimism on the engineering side as to their final bill, often through failing to take uncertainty into account adequantely. Consequently, road schemes almost always turn out to be more expensive than estimated, though this also applies to some public transport projects, and, in general, most public works. A Road Research Laboratory survey confirmed this, finding that the average excess of actual over estimated cost was 20% (Thomson, 1971).

Highway schemes tend to cause much greater disturbance and distress than their public transport equivalents, because of their greater extent and resultant severance, continuous noise and visual intrusion, vibration and pollution by fumes and dirt, so that the general underestimation of social and environmental costs is much more serious in the former case. The situation, however, has been considerably improved under the recent legislation (H.M.S.O., 1973), which extends compensation rights to those affected by public works. Now those injuriously affected, though not actually displaced or to be displaced, join an enlarged classification of those suffering from planning blight, in being eligible for increased claims for insulation against noise, home loss payments, disturbance payments, rehousing costs, and severance of land (ibid.). The extra compensation involved is regarded as part of the cost of providing the road, or other facility, and ranks for a central government grant (after D.O.E., 1972b), thus being recorded in the capital cost account.

Although apparently fairly comprehensive, the Land Compensation Acts (op. cit.) legally invalidate many justifiable claims by setting very restrictive application conditions, especially concerning disturbance and uncertainty during construction. They give the "impression that the politicians tried to do the right thing, but that the civil servants have done their best to make sure that as little public money as possible is spent regardless of what is called for by justice" (Justice, 1973). In addition, little research in terms of economic evaluation appears to be forthcoming in the difficult, but important, fields of vibration, dirt and dust and visual intrusion[x] (D.O.E., 1972b; Bor and Roberts, 1972). In brief, here is yet another instance, through short-counting, of favour towards road schemes, with its consequent disequity bias, although some consideration may be alloted to these unquantified costs to uncompensated sufferers under their nebulous itemisation as intangibles.

On the benefits side of the evaluation equation, standard values of time and accident savings, whose arbitrariness is discussed in 3.3. and 3.4, are applied to the traffic forecasts for the first year of operation, derived from the doubtful procedures mentioned in 3.1. Yet there is a basic inconsistency in the whole approach, although this may be partially relieved when a 30-year appraisal period is generally adopted for urban roads. For, presuming the almost certain existence of

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x Noise, however, has been extensively studied (H.M.S.O., 1969, Foster and Mackie, 1970; D.O.E. 1972b), and now quantified, it stands in the legislation and regulations as being directly compensatable when abusing these statutory standards (H.M.S.O. 1973a, Sections 20,21; 1973b, Sections 18,19).

latent demand, "there is no allowance for any feedback from the construction of an urban motorway on to trip generation rates, trip distribution, modal split, land-use or population location" (Pearce and Nash, 1973, pp.138-139), so that the inevitable generated traffic is ignored. As such, a road will have been designed to the capacity forecast, the extra traffic will create significant congestion costs, which will then eliminate the marginal trips, leaving an equilibrium pattern with travel costs at their original pre-road level (ibid.). Conversely without the road, traffic would be much less than forecast, and travel costs at the same level. The frustrated demand for mobility could then be absorbed by high-capacity public transport improvements, with ultimately lower travel costs overall, as Lichfield and Chapman demonstrate (1971). Thus, "any scheme which will relieve the network of an equivalent amount of traffic will have the same network benefits" (Pearce and Nash, 1973, p.140), whether for private or public transport, but with the latter achieved at much lower social cost. However, the car-blinkers of transportation planning, now fortunately being discarded, have largely prevented such far-sighted conclusions being reached, although the Stevenage study and its success in practice should have stimulated re-thinking as long as five years ago (Lichfield, 1969a).

Similar reasoning to the above also causes the over-valuation of accident savings in the appraisal of high-grade road schemes. For, once again, the traffic is assumed to be fixed regardless for the target year, so that no account is taken of the considerably smaller volumes, with a lower absolute accident total, occurring in the situation without the proposed

road and its traffic generating properties. Even though the high-grade road proposed might well have a lower proportional accident rate, the absolute accident costs overall will be higher due to the greater volumes being generated and carried. On the other hand, public transport, possessing virtually infinite safety, could absorb almost any degree of increased movement without raising its accident costs from more or less zero.

Indeed, standard CBA as practised in urban transport evaluation appears to possess a heavily regressive effect, exacerbated by a general refusal or relectance to consider or appraise the public transport alternatives. In addition, motorway and expressway construction tends to be encouraged at present by the structure of central government grants (Foster, 1972), and, despite the fuel crisis and a fundamental re-examination of transport policies, a high-capacity highway system rather than its public transport equivalent apparently possesses a prestige value in the eyes of city councillors as a symbol of modernity and affluence.

3.3 The Value of Time Savings

The largest element, by far, on the benefits side of the cost-benefit equation in transport investment evaluation is invariably time savings, yet the validity of its values and their principles and methods of derivation arouse perhaps the greatest doubts in the applicability of the analysis. Although Sharp (1973, p.55) claims that "time savings alone may be expected to make up about 90% of the value of the benefits resulting from a typical transport investment", the percentage in urban public transport schemes tends to be a little lower, as low as 72% in the case of the Victoria Line (Foster and Beesley, 1963), since savings in vehicle and accident costs become more significant where considerable private road traffic is being diverted. Still, however, with such a high proportion of the final calculation dependent on one factor, it is vital that its valuation should be valid and as accurate as possible.

The extreme difficulty of assigning monetary values to time savings arises because a primal value for time does not exist, for time, in itself, has no direct market and as such has no direct exchange price. In order, therefore, to value time, a surrogate measure must be identified and qualified, or determined by some logical, deductive process.

The valuation of time savings involves two basic concepts, the time opportunity cost of and the positive disutility of travel. In the first respect, travel occupies time in which additional, or less rushed, participation in both work and

leisure could be undertaken, and, thus may be represented by the value of these foregone activities. Secondly, it is assumed that people do not enjoy travelling, and therefore, the time involved in transit is of direct disutility to them. On the basis of these two fundamental considerations, the valuation placed on time will vary according to the particular circumstances, such as the purpose of the journey, the conditions of travel, the characteristics of the traveller, and so on. The Department of the Environment currently recommend the initial division of time savings into two main categories, those involving working time and those in non-working or leisure time (M.O.T., 1969b), occurring normally in the proportions of approximately 5:95 (Tipping, 1968), with the differential slightly reduced for urban public transport schemes specifically.

The evaluation of working time generally utilises the measure of the wage rate, which, by the marginal productivity theory of factor rewards, is held to represent directly the value placed on the individual's marginal product per unit of time. Therefore, with production lost through time spent in travelling involving an opportunity cost to society, any in-work time savings through transport improvements may be valued at the traveller's wage rate, in view of the corresponding, potential increase in production. Since it is the net labour cost that an employer must equate with marginal productivity, all associated costs, such as insurance payments, employment taxes, pension contributions, overheads and so on, must also be included.

However, as may be expected, like most ruling proposit-

ions of classical economics, the marginal productivity theory of wages has only a very tenuous basis in the real world. Typically, the imperfections of the market involved, the labour market, effectively invalidate the straightforward application of the theory, particularly in this case, where controls and non-market agreements are manifest. For instance, it may be argued that wage rate determination is at least a partial function of trade union power or militancy, and, certainly, nationwide collective bargaining has distorted regional wage structures. Neither factor directly concerns any labour market consideration of differential productivity, nor do the constraints of restrictive agreements, imperfect knowledge, general monopolistic and monopsonistic behaviour, mobility limitations and so on.

Another major limitation in directly applying the marginal productivity theory to all working time savings is the inherent assumption that the period involved is then fully devoted to further productive activity. However, working schedules are notoriously rigid and often split into indivisible half-hour units, so that unless the time saving is of this magnitude, it is doubtful whether any increase in production will actually occur. Small time savings, particularly relevant to the urban transport context, will probably result in the same amount of work being completed more leisurely (following Parkinson's Law), with no material benefit to the employer, although it may mean a happier and less harassed workforce. Perhaps, in the long-term, there will be a tightening of work patterns as actual time availability gradually influences habits, but, even then, increased production will still depend on the buoyancy of

demand. In the case of the businessman, as opposed to the worker, there is liable to be more flexibility enabling time savings to be more effectively utilised, but, even here, there will be an element of simply 'nipping off home early'.

An additional problem of applying marginal productivity theory occurs when dealing with the self-employed or some kinds of piece-worker, where it is difficult to distinguish between working and non-working time (Harrison and Quarmby, 1969). In practice, as in other aspects, this discrepancy in theory application is obscured in the massive aggregation process, which may allocate proportionately to both categories, according to sample data.

Finally, a third major assumption, that of the absolute disutility of travelling, casts doubts on the direct application of wage rates in valuing in-work time, through two major objections. Firstly, not all time spent in transit is necessarily wasted. For example, businessmen may read documents, draft letters, generally deal with paperwork, and may even hold travelling conferences, all activities which represent at least some contribution to his employer's output. Therefore, it is inappropriate to regard travelling time as totally non-productive and measure it as though completely lost by the employee's full wage or salary rate. Secondly, the wage rate theory disregards the welfare of the traveller himself, by valuing travelling time only from the employer's viewpoint. It is likely that most individuals, except for the uncommonly conscientious or ambitious or in extremely unpleasant travel conditions, prefer travelling to

working, that is they experience less disutility in travel than disutility in work, for which they are compensated, supposedly exactly, by their wage rate. Therefore, in terms of total net utility, combining both employer's and employee's utility functions, to value in-work travel time by full wage rate will involve varying degrees of over-estimation.

The theory fails in its application basically because it is marginalistic, yet dealing in terms of average wage rates, and because it operates under the single goal of efficiency, with no concern as to the distribution of the utility involved. In the first case, therefore, it misrepresents the average wage/work load relationship obtaining in practice, thus failing to recognise the relative triviality of small time savings. Secondly, with its sole objective of maximising output, a vital component of net social welfare, namely the employee's utility function, is completely omitted and the theory records and pursues only the employer's position towards profit-maximisation.

However, despite the limitations, the D.O.E. relies on the basis of the marginal productivity theory of wage determination as the best guide to the valuation of working time. In practice, for ease of data collection and calculation, the individual employment costs of travellers are aggregated by their form of transport and type of vehicle, and given standard figures for the whole country, thereby, in terms of classical economics, favouring the poorer areas in the national distribution of transport investment. Current figures (G.G.T.S. March 1974) are up-

dated by 17% for inflation from the 1972 values of the former Ministry of Transport Economic Directorate Note 3 (1969, p.4), which were based as follows:-

	pence per hr. (1969 values)		pence per hr.
All workers	110.4	London Underground users	115.8
Car drivers	122.4	Light Goods Vehicle Drivers	52.8
Car occupants	106.2	Heavy Goods Vehicle Drivers	52.5
Rail users	132	Rural and Inter-Urban Bus Drivers	55.2
Bus users	63.6	Rural and Inter-Urban Bus Conductors	49.8

These values are assumed to rise at 3.25% p.a. in real terms, supposedly in line with the national growth rate, but this optimistic figure bears little resemblance to the average rates experienced over the past fifteen years.

The valuation of non-working time, hereafter referred to as leisure lime, presents considerably more problems, for economic theory has provided neither a workable nor acceptable base on which guidelines may be fashioned. Classical theory assumes that the marginal value of leisure is equal to what is foregone by way of extra earnings, but, as working hours are set largely by employers rather than employees, with only occasional specific overtime options offering opportunities of variation, there is generally no marginal situation in which trades-off might occur to provide the necessary information.

However, without producing any direct results, research along the lines of classical economics continues (Oort, 1969). So far, its major conclusion is that both the marginal value of leisure time and the marginal net benefit of labour underestimate

the value of an exogenous reduction of travelling time. The derivation of this conclusion is explained in Appendix 1.

Since no theory is applicable, the valuation of leisure time has been based on the behavioural or revealed preference approach. This method requires observational studies of how people in practice trade off travel time savings against cost, although other considerations are inevitably involved in what is effectively a composite decision. Most studies have identified a positive relationship between personal valuation of time savings and income, but the startlingly large variation in the coefficients, between 14% and 98% in the L.G.O.R.U. (1968 and 1970) findings alone, has left a confused situation as to the most appropriate value or range of values. The D.O.E. issue standard figures based on the updating of the M.O.T. recommendations (op. cit.), but their general applicability must be fairly arbitrary (Appendix 2).

Five basic areas of travel choice exist from which studies should be able to impute an individual's valuation of travelling time. These are as follows:- 1) In the choice of destination, or the frequency of journeys to a particular destination; 2) In the choice of travel mode; 3) In the choice of route; 4) In the choice of speed (at which to drive); 5) In decisions on relative locations of work and residence (Harrison and Quarmby, 1969). Obviously, the fourth situation is not relevant to the urban public transport context, although some individuals, if they are so inclined, may go out of their way in order to experience possible exhilaration from the higher speeds of trains, as

opposed to buses for example. Other related considerations, such as comfort, convenience, safety and numerous circumstantial factors will undoubtedly impinge on the traveller's decision, which is also likely to be made without perfect knowledge. These extraneous variables are responsible for much of the variation in leisure time valuation among studies, whose situational characteristics, unless strictly controlled, are bound to be different. With a view to isolating these external elements, Beesley (1973, pp.166-177) sets out the conditions for successful measurement of the factor in question, namely the value people assign to leisure time spent in travelling.

Since the results are to be extracted from actual consumer behaviour, much the best evidence will be obtained "when choice is confined to just two options", out of those listed, "since consumers tend to think in terms of, and more accurately report, single alternatives" (ibid. p.167). So, althouth multiple choice situations offer more scope in observations, the simple binary trade-off tends to be more reliable, and, therefore, a successful study should establish that such a situation genuinely exists.

Thereafter, in order to attach meaning to and enable further application of the results, it is necessary to assemble the individual observations into groupings, which must "clearly justify their homogeneity assumptions and their relevance, when selected, to decisions" (ibid. p.168). Income differentials have almost universally been accepted as the primary explanatory variable, but more for its computational convenience than any

proven behavioural or policy significance in the transport sphere. Thus, categorisation according to income bracketing is adopted as standard practice, usually validated by a fairly high degree of correlation.

Another consideration of the study must be concern as to the purpose of the journey, in that the particular goods or services for which the consumer is travelling will possess certain demand characteristics, which should be specified and incorporated since they affect the decision to travel. Fortunately, since it can be reasonably "assumed that the elasticity of demand for getting to work at all is zero" (ibid. p.169), the journey-to-work situation offers probably the best study opportunity, unconstrained by complications of demand derivation.

For a consistent valuation of time, the 'cost' variable should be as unambiguous as possible, so that the perceived costs are in fact the actual costs. This poses particular problems when using car data, for, in general, drivers greatly underestimate the real travelling costs in a car, where the main expense is perceived as a fixed amount, comprising its capital cost, taxation and average, periodic maintenance. Notions of the actual car running costs tend to be clouded by the dominance of the immediate convenience benefits experienced in using the vehicle. Studies typically find that about 6% of their samples make an 'illogical' choice, and that between 27% and 52% act as genuine 'traders' (Beesley, 1965; Lee and Dalvi, 1969 and 1971). The remainder permit some inference to be attached to the time/cost relationship, but their views appear to be 'distorted' in

varying degrees by the dominant perception of the attributes of their chosen mode.

The findings of the major empirical studies in the urban context are outlined in Appendix 2. The basic document (M.O.T., op.cit., p.8) asserts that "these studies have produced a range of values which are sufficiently close for a central or average value to have some validity". The figures for non-working time were assessed at 25% of the hourly income of the head of the household, and are given as follows (ibid. p.4) :-

	pence per hr. (1969 values)
Travelling time	
All adults	16.25
Children	5.42
Walking and waiting	
All adults	32.5
Children	10.83

Although empirical and theoretical values vary directly with income, these values are averaged over all socio-economic groups and all regions because of the "simple equity consideration" (ibid, p.10). When aggregated to the household level, the standard base for data collection, the value of adult time is averaged out at 19% of the household income (D.O.E. 1970, p.25). The values are expected to increase in real terms by 3% p.a. (M.O.T. op.cit., p.5), although the reasons for the arbitrariness of this figure and its ¼% differential from the real growth rate of working time remain obscure.

The M.O.T. (ibid., p.5) paper concludes by stressing "that both the statements of values made in this paper and of the reasons

which have led to their adoption for general use are of an interim nature. Decisions cannot wait indefinitely for the development of refined methods of appraisal and analysis, so it is necessary to make some judgement, in the light of admittedly imperfect knowledge, as to what values should be used. .... Such judgements must of their nature be expected to be revised as more and better research is carried out".

Only one subsequent revision has been made, in 1972, after the acceptance, on the basis of growing empirical support, substantiated by Veal (1971), of the greater value personally attached to savings in waiting time, due to the frustration and uncertainty involved increasing its subjective disutility. Walking time has also been shown to be more highly valued than in-vehicle time, probably because of the physical effort required and susceptibility to the often adverse weather conditions, but Veal's study (op.cit.) found insufficiently strong evidence to warrant a larger standard value being allotted to it. Now, it is standard practice (D.O.E., 1972c) to value waiting time at twice the in-vehicle time, with considerable implications for schemes involving interchanges or low frequency services.

There is also an a priori case for assigning an additional value to service reliability, which is likely to be enjoyed in train and segregated or priority bus trips. Although, as yet, insufficient empirical data has been collected and analysed to indicate confidently how the variance in trip times affects modal choice and the time/cost trade-off, this may soon emerge as a further revision and refinement of the arbitrary values

currently employed.

However, five years later, virtually the same values obtain in practice, even though their validity has been "clouded" (Beesley, 1973, p.180), especially as a result of such studies as Dawson and Everall's (T.R.R.L., 1972, Appendix 2). Meanwhile, though, considerable conceptual advances are being made by theorising in terms of a comprehensive time allocation and valuation model, expanding Becker's (1965) original ideas on utility-maximisation in consumer choice between alternative forms of consumption, subject to a budget constraint. In this model, transport time savings depend on the relative values put upon different uses of a fixed supply of time, constrained by the size of the time saving in its ability to be transferred to some other preferred activity (De Serpa 1971, Evans 1972). This constraint incorporates into a formal framework Tipping's (1968) arguments against including time savings however small, and, therefore, probably worthless. However, the D.O.E. (after M.O.T. 1969) still maintains that small savings should be recorded and valued, since they can add up over individual schemes within a comprehensive programme to provide significant time savings, and that the cases where the small time saving makes possible a whole new or additional activity, previously just below the margin of time availability, will counterbalance those where the saving cannot be acceptably utilised.

Nevertheless, despite the possibilities of the time/activity - cost/budget approach, little usable data has emerged, so that the beneficial effects of transport projects continue

to be assessed largely under the openly-admitted arbitrariness of average value of time figures. Unfortunately, until alternative methods become viable in practice, the updated results from empirical studies of the 1960's will remain in command of this vital position in the transport evaluation process.

3.4 The Value of Accident Savings

Unfortunately, since solutions to a general transport deficiency usually appear to be conceived only in terms of a single, pre-selected mode, the relative inter-modal differences in terms of accident costs/savings are rarely, if ever, applied in a comprehensive manner in appraising the full range of alternatives for an individual link or a whole network. Consequently, the stark fact that projects for private road transport are nine times more dangerous than an equivalent scheme utilising public service vehicles, and no less than seventy times as accident prone as a comparable rail investment is ignored (ratios on the basis of fatal and serious casualties per miles travelled derived from figures in C.S.O., 1973). The fixing of the modal split relationships is set in the pre-analysis 'screening' stage without consideration of this vital element of relative accident costs. However, the accurate valuation of accident savings is still important in calculating the NPV or benefit-cost ratio, the measure of supposed justification, of different transport projects, since the allocation from limited funds is made on this basis.

For evaluation purposes, accidents can be divided into three categories; those involving just damage to vehicles or property, those which incur personal injury, and those which prove fatal. Since physical damage can be easily measured by direct monetary costs, derived from the repairs or replacement charges as documented in insurance claims, it is the second and third types of accidents, where subjective costs are inevitably

involved, that pose problems of evaluation.

The most frequently used method for measuring the value of life and good health simply calculates the potential, discounted output which society would gain had the accident not occurred. From this figure may be deducted the consumption which the individual would have incurred during the relevant period over which his life or freedom from injury is being assessed. In addition, allowance must be made for the costs of medical treatment and funerals, as well as the inevitable administrative and damage costs, since it is the whole cost of the accident which is being valued.

Dawson's calculations (R.R.L., 1967), incorporated into the T5/67 method of appraisal (M.O.T., 1967), were based on these concepts, weighted according to the age distribution of accident victums. However, since this 'strictly material point of view' valued a female baby's life at ~~£~~£4560, it was reckoned, fairly arbitrarily, that, as all life was generally held to have a positive value, that the subjective factor was worth £5,000.

Four years later, Dawson's thinking changed (R.R.L. 1971, p.2), considering now that "the accidents that need to be costed are those which do not occur but which, without the introduction of some safety measure, would have occurred. The fact that on this basis the individual concerned is, indeed, alive means that the individual's consumption should not be deducted when assessing the benefits of preventing accidents, as he is alive and able to enjoy that consumption." Consequently, with the retention of the arbitrary £5,000 to represent the subjective value of life,

maybe involving some double counting as Dawson himself suggests, the following values for urban area-accidents were derived, and have been adopted as standard figures (op.cit.).

Class of accident	Urban Areas (cost) £
Fatal	18,000
Serious Injury	1,200
Slight Injury	210
Damage	100
Total cost of all accidents divided by the number of injury accidents.	1,400

However, inevitably, these figures and their derivation are open to criticism, for they are based purely on the maximisation of gross national product, i.e. optimum economic efficiency, as being the sole objective of decision-maker's policy, with only a token factor arbitrarily attached for other considerations. The logical conclusion underlying its reasoning would advocate that nearly all women and retired or older men be killed off as a positive net benefit to the community, clearly an unacceptable rationale.

Two other practical methods of deriving the value of accident savings exist and have been demonstrated. One relies on the effectiveness of the democratic political process to reveal the true premiums placed on health and life, through the implicit values from such investment and current expenditure as on medical equipment and service, road safety, and so on (Weisbrod, 1961; Schnelling, 1968). Although Mishan (1971a) has severely criticised this method on the grounds that it has no economic rationale and its determining political process can be purely circular, its results could prove promising once democratic

decision-making becomes more genuinely participatory.

The other concept is based on the insurance principle, calculated on the premium a man is willing to pay and the probability of his being killed or injured as a result of engaging in some specific activity, thereby indicating the value he sets on his life. However, on top of the implied assumptions of linearity in the accident probability/premium/value relationship, there is the problem that, in the case of death, the insurance policy will compensate only dependents or next of kin, thereby reflecting the victim's concern for these persons rather than the subjective valuation of his own life. Where insurance is placed only for injury, it might well give an accurate indication of the sum reckoned to offset the prospective distress, pain and inconvenience, especially where no loss of earnings is involved.

Mishan (op. cit.) rejects the validity of using any of these measures in CBA, because they are inconsistent with the basic rationale of valuation in terms of the Pigovian SWF, to identify a potential Paretian improvement. Mishan's alternative involves the aggregation of what each member of the community is willing to pay or receive for an estimated change of risk to life or health. Although the theory is convincing, postulating that the trade--off between increased benefits at slightly greater risks, or vice versa, be identified in the context of a potential Paretian improvement, its quantification into usable statistics remains dormant, since the problems of data collection and computation have so far proved crippling.

Therefore, CBA is left with the rather unsatisfactory

measures produced by Dawson (R.R.L., 1971), and, as they are almost certainly erroneous, there is a bias imparted to different transport schemes. Due to the inter-modal accident differentials, if the standard values are under-estimated, rail schemes will be slightly favoured, in comparison to bus schemes, with private road transport projects relatively worst off, and vice versa in the case of over-estimation. However, as was discussed in 3.2, the whole concept of benefits from accident savings resulting from new transport schemes is fatuous, for only traffic proportional rates not absolute figures are considered, thereby ignoring the generative properties of the new facility. In fact, rail and bus accident rates are seldom incorporated into any CBA and are simply assumed to be zero, but since few inter-modal exercises are conducted, their only significance rests in the claims of individual schemes competing for the allocation of funds from an overall transportation budget.

CHAPTER 4.

THE ALTERNATIVES TO COST-BENEFIT ANALYSIS.

The number of alternative evaluation methodologies for transport planning is fairly restricted because of the complex mix of elements necessarily involved in developing a satisfactory technique. The requirements are most successfully covered, though, of course, far from perfectly, by CBA, but three other methods merit a full examination in view of their different conceptual approaches. These are the planning balance sheet, the goals-achievement matrix and the ordinal method of evaluation dealt with in the succeeding sections. However, there are several other methodologies or variants on the CBA theme, which will be briefly discussed first.

The simplest approach is to set the advantages and disadvantages of project alternatives against a checklist of criteria, and by an iterative process, modify the preferred schemes until a design emerges which performs best against the conditions set. This basic method has been employed extensively for years in standard engineering, design and planning practice, reaching relatively sophistocated heights in Kitching's (1969) evidence to the Roskill Commission. However, its inherent simplicity renders it inadequate in coping with any degree of complexity, thus severely limiting its applicability.

Then, there are several techniques which operate from the relatively sure basis of costs, that is the capital and direct running costs, which can be assessed with a fairly confident

degree of accuracy, against which are weighted the more nebulous benefits of the various alternatives. On the one hand, the cost may be assumed constant, and the effectiveness of its utilisation by different schemes maybe compared to give the most satisfactory solution. Of course, this involves familiar problems of measuring outputs when they consist of public goods and intangibles, but with the adoption of the comprehensive Programme-Planning-Budgeting System, ideally suited to this cost effectiveness approach, objectives can be explicitly formulated and applied to guide evaluation.

On the other hand, the 'ends' or benefits of a proposal may be held constant, while alternative 'means' or costs to achieve them are compared. In practice, this technique involves holding the scale of benefits within a small range and then assessing them against the cost differentials. A similar concept is employed in threshold theory, where designs are investigated to find that level of investment in which the combination of overhead and operating costs are at a minimum, thereby optimising the narrowly-defined objective of economic efficiency by achieving a least cost per unit situation.

Another technique, that of linear programming, is quickly developing from its origins as a computational aid to CBA to being considered by some (Blunden, 1971) as an evaluation methodology in its own right. Basically it is just "an operational research technique permitting the optimisation of an objective function which is subject to a number of well-defined linear inequality constraints" (Duckworth, 1965). Those costs and

benefits which can be monetised are expressed directly in the objective function, with intangibles and non-specific goal considerations represented as constraints. The computer can then comprehensively evaluate the details of alternative projects according to the overall SWF inserted, and indicate the optimal solution on the data given.

The advantages of this method clearly lie in the large range of alternatives which can be fully examined and the generation of genuine shadow prices, according to the given SWF, which can be re-used in standard evaluation. However, the familiar limitations of quantification effectively invalidate much of its potential application, for objective functions are always difficult to specify and the real world relationships represented by the objective function and constraints are just simply not linear, nor generally susceptible to any mathematical formulation. Blunden (1971), though, has managed to produce a book in which the land-use/transportation system is expressed as a series of components and relationships, tailored to the requirements of the computer. Although, the traffic models emerge moderately convincingly, typically, the evaluation procedure is most unsatisfactory, in terms of its operation under social, rather than physical, functions and its incorporation of intangibles, as opposed to specific quantities. Non-linear techniques, such as quadratic programming, are being developed to extend the range of the methods applicability, but the status of linear programming as a concept, will probably remain as a computational aid and expression of the theory of CBA.

Before embarking on a discussion of three socially orientated alternatives to CBA, it perhaps should be mentioned that conventional financial appraisal may be appropriate in the transport context under particular circumstances. For example, if commercial viability and profit maximisation are the accepted goals of transport investment, with road-pricing being implemented, then business investment analysis would be the correct technique to use. However, such circumstances are unlikely to arise, especially in Britain, where public ownership is increasing and the influence of the private market dwindling.

4.1 The Planning Balance Sheet (after Lichfield).

To Lichfield can perhaps be attributed the title of 'the British father of socio-economic evaluation in planning', for his initial ideas were the first published on the subject in the United Kingdom (Lichfield, 1956), and have subsequently developed on a parallel course with CBA, but always maintaining some vital differences which justify his 'planning balance sheet' approach being accorded separate treatment. The planning balance sheet approach basically represents the set of "social accounts" (Lichfield, 1968, p.18) expected to result from the plans or projects in question, so designed as to identify explicitly the value judgements involved and, if not already stated, the goals and objectives followed in the decision process. In addition to this open, comprehensive and objective-controlled approach, Lichfield, in his planning balance sheet, stresses the incidence, as well as the magnitude, of the costs and benefits, and provides an evaluation framework in which intangibles can be accommodated on an equal footing with measured items. These two specific features largely combat the major technical weaknesses of CBA, as Lichfield sees them, in its almost total concern with the goal of efficiency, to the virtual exclusion of distributional considerations, and its tendency to disregard or undervalue unquantifiables, through their secondary position in the analysis and the effects of 'misplaced concreteness'. Although Lichfield designed and has largely applied his planning balance sheet in the context of town development, where the very wide range of considerations are suited to its comprehensive

approach, the technique is easily adapted for use in transport evaluation. It was employed with a qualitative emphasis in the appraisal section of the Buchanan Report (Lichfield & Compton, 1963), and, more recently, was applied to the questions of transport policy in Stevenage, its results advocating the committment to the now extremely successful 'Super-bus' system (Lichfield, 1969a).

In terms of transport evaluation, the method, in its matured form, may be summarised as follows. "The essence of the balance sheet technique is to consider the alternative schemes from the point of view of the" (Lichfield and Chapman, 1971, p.257) "various homogeneous" (Lichfield, 1969b, p.126)" sectors of the community who would be affected by the choice of scheme. These are divided into producers/operators and consumers - individuals or groups who play a part in creating and running the services to be realised from the project, paired as far as possible with the appropriate consumers" (Lichfield and Chapman, p.257).

"The objectives, called instrumental objectives, are then enumerated for each sector .... and the costs and benefits flowing from these objectives are then computed over the assumed life of the project .... and .... discounted back to a common base date. .... Costs related to the travellers' objectives of mode and trip quality and landowners' and occupiers' objectives of amenity and so on cannot be measured in money terms. They are valued by means of a subjective points system which attaches a .... score .... for each objective in each scheme. Objectives

measured in this way are ranked in an assumed order of relative importance; so are the sectors. The results of alternative sets of weights .... in order to test for sensitivity .... show .... the implications of alternatives" (Lichfield and Chapman, 1971, p.267-8).

The final presentation then "consists of two closely interlinked but separate accounts", one indicating the financial consequences according to the institutional, legal, fiscal and commercial conventions in practice or proposed, and the other, "reduced by eliminating double counting, transfer payments, common items, etc., and by grouping related parties .... for .... the assessment of the net impact on the community as a whole" (Lichfield, 1964, p.166).

Thus, the balance sheet, so constructed,"cannot, and does not, aim to provide a conclusion in terms of rate of return or net profit measured by money values as is the case in some typical cost-benefit studies. Its value lies in exposing the implications of each set of proposals to the whole community and also in indicating how the alternatives might be improved or amalgamated to produce a better result. The purpose of the approach is the selection of a plan, which, on the information available, is likely to best serve the total interests of the community" (Lichfield, 1969b, p.130).

However, almost inevitably, there are familiar difficulties associated with this technique. The initial operationalis-

ation of objectives at the outset, although an admirable and intuitively correct approach, presents formidable, maybe insurmountable, problems. Even just the conceptual formulation of a comprehensive goals function, far less its numerical expression, has eluded the efforts of many planners.

Then, at the output stage, the decision-maker is confronted by the demanding task of sheer comprehension of the balance sheet before him, a vast mass of interrelated statistics, yet presented in discrete form under a myriad of headings and groupings. Although such an open approach allows an explicit application of various value judgements, the lack of a common base produces a very complex decision environment. Lichfield optimistically asserts that "good decisions can be reached from these viewpoints" (i.e. individuals' sets of objectives and value judgements), "or simply from flair or experience" (Lichfield, 1968, p.18), but exceptional expertise would appear to be necessary in order to establish a reasonable outcome from the multifarious analysis. However, to its advantage, the planning balance sheet does lay open many issues for debate, where public scrutiny may question the decision-makers' explicit biases, and thereby focus attention on the contentious elements.

Instead of aiming at the optimization that CBA claims with its attempts at ultimate rationalisation in the decision process, the planning balance sheet is essentially just a satisficing technique. Rather than pursue the 'synoptic ideal', Lichfield purports only "to identify the alternative which would appear on the evidence to be the best, or at least good enough"

(Lichfield, 1968, p.19), under the decision methodology of 'disjointed incrementalism' (Braybrooke and Lindblom, 1963). In fact, the two methods are gradually converging in this respect, for CBA results now often give a range of possible 'best' options, while the planning balance sheet increasingly employs the more sophistocated quantification techniques, the products of CBA research, moving implicitly towards a more precise indication of the optimum.

Overall, as has been inferred, the planning balance sheet and CBA are basically very similar, and becoming increasingly so. Although Lichfield does not apparently gain credit in the general literature, the recent improvements in CBA are concerned mostly with the problems of distribution and intangibles, the factors that he originally identified as being inadequately treated in CBA, and consequently stressed in his own technique. Perhaps, if the two approaches continue to coalesce , the emergent synthesis could produce a most satisfactory evaluation methodology.

4.2 A Goals Achievement Matrix (after Hill).

In introducing his new approach to evaluation methodology, Hill specifies his views of the inadequacies of traditional methods, intending to rectify them in his goals-achievement matrix. CBA, he claims is excessively dominated by the goal of economic efficiency, with distribution having little impact in being assumed away within the supposed synonymity in maximisation of national income and welfare. Any original non-economic objectives, especially when involving intangible items, tend to be obscured, as reduction to monetary terms stresses the economic and financial consequences, by the fallacy of 'misplaced concreteness', and can confuse the original social purpose of the analysis. His major criticism of the planning balance sheet method, while appreciating its broader perspectives, is that it fails, in his terms, as does CBA, to recognise that costs and benefits have only an instrumental value, permitting their meaningful assessment only in relation to a single, well-defined objective, although Lichfield has subsequently adjusted to this position (Lichfield and Chapman, 1971).

As an improvement to these traditional methods with their shortcomings, Hill proposes evaluation by his goals-achievement matrix. His approach demands the initial setting of goals, which must be operationally definied, as far as possible, by objectives. Then, on one of four scales of measurement as to specificity, the relevant costs and benefits are recorded as, respectively, retrogression from and progress towards each objective, to which weights are assigned for both importance and

incidence. The matrix thus formed may allow some aggregation of inter-objective results on a common basis, but will generally require the application of a goals-achievement transformation function, theoretically promising but operationally difficult, in order to relate outcomes measured in differemt units. Hill (1968, p.27) concludes that "while this method calls for an extremely complex, time-consuming and expensive task, the conceptual framework is recommended as a basis for rational decision-making."

The key to decision-making by means of the goals-achivement matrix lies in the setting and weighting of the objectives, and the significance of their incidence. Although, conceptually, all these relative valuations might be determined by a theory of government, in practice, they will emerge from an iterative process of interaction among elected representatives, officials, various groups, both formal and informal, and individuals as the community's consensus as to the appropriate goals, and the various action alternatives that their fulfilment might require.

The advantages of the goals-achievement matrix, as its title implies, are in its clear specification of objectives, their relative importance, the effects of their incidence and their primary role as the ruling yardstick of assessment throughout the analysis. This admirably comprehensive approach also incorporates intangibles and differing measurement scales, as appropriate, as well as lending itself to programming techniques and the testing of alternatives against certain, specified standards. However, it has several drawbacks too, which have so far precluded its practical application, limiting it to the hypothet-

ical evaluation of a transport project (Hill, 1968), and a similar exercise in recreation (Hill and Shechter, 1970). The major practical difficulties lie in the sheer complexity of the multiple-objective considerations, and, with the great problem of applying any valid goals-achievement transformation function, the matrix, involving not directly comparable items, leaves an indeterminate or open-ended situation, which, for a reasonable judgement, requires considerable expertise on the part of the decision-maker. Almost inevitably, largely condoning CBA, Hill (1968, p.26) admits that, "for the transformation of all the outcomes to a single scale, a monetary scale is probably the most useful", bringing the basic evaluation problem back to square one.

An extension of Hill's basic evaluation method is given by Schlager's (1968) objective fulfilment analysis, which uses a lexiographic ordering process according to the 'categories of importance' of the objectives, similar to Holmes's method (4.3). Then, for each alternative, Schlager incorporates a weighting by a 'probability of implementation', subjectively reflecting the difficulty of implementing the alternatives, and the highest score according to this rank-based expected value identifies the preferred plan. Unfortunately, like Hill's, this evaluation technique has never been used in practice, and seems unlikely to become a substitute for CBA in actual project appraisal.

4.3 The Ordinal Method of Evaluation (after Holmes).

The ordinal method of evaluation was conceived out of a concern that quantitative techniques, such as CBA were inappropriately combining exact with imprecise data in their evaluations, which were involving reduction to common measures "by assertion rather than demonstration" (Holmes 1972, p.179). Once itemised in monetary terms, a false impression is given that objective standards of value exist, when, in fact, the actual process is highly arbitrary and often entails analysts 'dressing up their own prejudices' (Beesley and Kain, 1964). In the belief that 'some important aspects of life' affected by planning decisions "just cannot be numbered with any certainty or sometimes, indeed, with any meaning, the alternative method of ordinal comparison was devised to set out a comprehensive framework in which subjective judgements could be explicitly made and logically related" (Holmes 1972, p.179), in order to produce rationally an individual's final decision.

The first step of the method, as in all evaluation techniques, involves the identification of all effects resulting from the projects in question and their ranking in importance according to their assessor's view of their relative significance or triviality. Where clear differences of importance are evident between two consecutive items on the ranking list, a division may be made and, thus, a series of 'classes of importance' may be established. Then, in respect of each criterion listed, the assessor must rank the performance of the alternative projects under consideration simply in terms of 'best', 'second best', 'third best', and so on.

Finally, the decision procedure of 'lexiographic ordering' (Kettle and Whitbread, 1973) requires the construction of a matrix as follows. The performance of the projects under examination for each criterion is recorded, with 'best' at the second level of importance being treated as equivalent to 'second best' at the first class of importance, and so on, as below. The recommended project, therefore, is the one with most 1st's, and if there is a 'tie', then 2nd's decide, and so on.

Criteria		Performance Corresponding Positions 1st	2nd	3rd	4th	5th	6th
Class of Importance.I	1)	A	C	D	B		
	2)	B	D	A	C		
	3)	B	A	C	D		
	4)	A	D	C	B		
II	5)		B	D	A	C	
	6)		C	D	A	B	
	7)		A	B	C	D	
III	8)			C	D	B	A
	9)			D	A	B	C
	A	2	2	1	3	-	1
	B	2	1	1	2	3	-
	C	-	2	3	2	-	1
	D	-	2	4	2	1	-
Overall Ranking		A	B	D	C		

Projects under consideration:- A,B,C,D.

However, Holmes does not intend these rules to be absolutely binding, a simple substitute "for the arduous process of making sensitive judgements" (Holmes, 1972. p.184). For example, should a project have an overwhelming total of second places, especially at the first level of importance, a decision-maker can opt in favour of this consistency rather than for

alternative projects, which might have just one or two firsts against particular criteria.

Cost considerations, though, do not enter his ordinal evaluation matrix, for he distinguishes between the unquantifiable sets of criteria satisfied by different projects and the measureable resource costs involved. Therefore, the decision-maker is left to judge whether the increasing achievement of more goals by dearer, and presumably better, projects is worth the extra expense - an essentially cardinal process.

Holmes supports his method on its advantages of making explicit the emphases that a decision-maker may want to apply to certain criteria and its timesaving as a shorthand technique of recording and collating this data. The rulings ensure that only the really significant criteria influence the decision, and that they are not arbitrarily or carelessly relegated. When divergent views are clearly displayed this way, the opportunities are greater for agreement and conciliation through the immediate highlighting of the contentious issues, facilitating feedback and actual modification or redesign of the alternatives.

In practice, this method was employed by the Jack Holmes Planning Group to determine the best line for the new A9 road north of Inverness (Holmes 1972). In this context, it was perhaps an adequate evaluation technique, since the location offered no problems of complex city traffic networks nor the intricate urban fabric and the small planning team, by using broad subjective judgements in place of detailed data collection, quantification and analysis, was able to bring the task within their staff

resources and available budget. However, its value elsewhere is doubtful.

The basis simplism of the ordinal approach and the numerous inconsistencies it can produce render it open to severe criticism (Kettle and Whitbread, 1973). In the first respect, by reducing all information to a simple presentation in rankings, the value of the planning data, much of which is subject to valid and direct quantification, is greatly diminished, with the vital expressions of differential strengths of preference by society ignored. No evaluation process can afford to neglect such valuable information, especially when advising a separate, cardinal treatment of cost considerations and, thus, breaking the consistency of ranking application anyway. Either capital cost is included as one of the ordinal criteria, almost necessarily of first importance, or as an individual goal of 'saving scarce resources', or else the validity of cardinal evaluation is admitted, since Holmes's hybrid version, based on a tenuous distinction between unquantifiable planning criteria and measurable resource costs, is internally inconsistent.

Secondly, by the nature of procedural rulings, the decision will depend greatly on the division into 'classes of importance', which can only be established with some cardinal conception of by how much one criteria is more significant than another. Furthermore, there is the question of aggregation in the criteria, for, perhaps, several related lower order criteria could be combined to form one of first importance, and similarly, disaggregation could relegate the significance of a wide, but

vital, criterion to lower order consideration. Finally, by recognising the implications of regular second positions maybe indicating a better overall solution than an isolated first, Holmes effectively admits the severe limitations of his evaluation procedure, which must provide for the assessment of differences between items on a common basis in order to allow the necessary trades-off to be made.

While this ordinal method easily identifies the contentious issues and requires little effort to apply, its adequacy as an evaluation technique must be regarded as extremely limited, and certainly inappropriate in the context of urban public transport, which is the main concern of this dissertation. "Sound decisions are only possible with formal evidence as to the wider consequences of proposals", necessitating that "we should undertake difficult enquiries and delve deeply into community preferences" and implications of plans "in order to obtain the requisite evidence for intelligent decision-making" (Kettle and Whitbread, 1973, p.99). Even decision-makers, themselves, though the framework is specifically designed for them, are not likely to favour this method, since their judgements are increasingly subjected to intense public scrutiny, yet there is no provision for objective justification to support their decision.

CHAPTER 5.

CONCLUSIONS.

CBA has established itself firmly as the accepted method of economic evaluation in urban transport planning, indeed, with its impressive-sounding nomenclature being held in reverent awe by the public for whom it acts. Born out of the private market's profit-maximising theory, it applies the equivalent goal of efficiency to the public sector. It, therefore, recommends a solution divorced from distributional considerations and other constraints, physical, legal, administrative and budgetary. It is also a partial technique based on marginalist concepts, and is incapable of evaluating situations involving large fundamental changes, which should be analysed within a general equilibrium framework. Thus, CBA is limited to assessing only the net efficiency of small projects, necessarily only one out of many possible objectives, so that it can be no more than "an aid to decision-making, not a substitute for it" (H.M.S.O. 1970).

Despite some progress towards a structure destined for the 'synoptic ideal' (as formulated by Simon (1957) and Rothblatt (1971), the pursuit of a completely rational model of decision-making must founder in practice on the difficulties or impossibilities of specifying both the ruling objective function and many of the quantities possessing strong subjective valuations and uncertainty doubts. Though quantification techniques may be developed to reach peaks of sophistocation, coping adequately with elements formerly left as imponderables, the process can never achieve ultimate, perfect measurement of all components,

nor complete specification of the decision-maker's goal. In this direction, CBA has been additionally hindered by its continued adherence to and association with its economic, rather than social science, origins.

Unfortunately, its role in the transport planning process is minor, being brought in as a residual at the last stage, to justify the strategy, network or project already chosen by the transport model, or, at most, to nominate its preferred alternative out of a narrow range of essentially similar, pre-selected proposals. Since the transport modelling procedures incorporate an in-built disequity bias, CBA, lacking any effective internal mechanism for distribution appraisal, merely reinforces the disequitable output and conclusions of the transport model, affording them a supposed justification of economic efficiency.

Thankfully, as cities begin to seize up and oil begins to dry up, the implications of the accepted transport planning practice have had to be reviewed (H.M.S.O., 1972), so that, in order to restore the balance in urban transport according to gemuine short-term needs, and long-term expediency, a policy orientation towards public transport has been officially adopted (H.M.S.O. 1973). CBA has recently been subject to occassional adaption for some token distributional input, but its underlying structure, designed under the omnipotent efficiency objective, will need a fundamental reconstruction to achieve adequate sensitivity to the distributional implications of its decision recommendations. Though, the policy promises and intentions in both the transport model and its economic evaluation are towards

a realisation that, after genuine needs have first been identified, the procedures should set appropriate ends and then establish the most satisfactory means towards achieving them, practice is slow to follow. So entrenched are the traditional doctrines of both transport and economic theory, and so fundamentally innovatary are the policy concepts proposed, that it will be years before the planning profession fully accommodates them into the framework of standard practice, and even longer before the problem of transport deprivation is relieved.

Although beset by these fundamental limitations, CBA is, however, currently, and is likely to continue as, the most satisfactory evaluation method available for transport investment. It is the best way of utilising given information for public investment appraisal, and preferable to acting merely on uninformed or arbitary hunches, or being subject to other abstract, and probably more unsuitable methods. Therefore, while holding the aforementioned deficiencies in mind and recognising the long-term nature of their improvement, it is perhaps better to concentrate on areas where marginal short-term advances are foreseeable and relatively easily facilitated.

In the first place, it is essential that both CBA and land use options are integrated into the transport model, instead of being tagged on as mere appendages to the whole process. In this way, a much wider range of alternatives will be tested, and it may require the rapid development of linear programming techniques to cope with the sheer volume of computation involved. But, only by considering a full range of feasible solutions, can

the preferred proposal be recommended with confidence.

Also at the outset, the decision-maker's objectives[x] should be stated explicitly, even though, as yet, techniques cannot, and might never, internalise them into the analysis because of specification difficulties. Still these objectives should explain and justify the omission of certain possibilities from the final CBA evaluation stage, previously a frequently mysterious, arbitrary or devious practice. Interaction between the decision-maker and the analyst should be maximised with the elected representative choosing the basis for data collection, the assumptions to form the transport model and its input, and the magnitude of the values to be attached to the vital variables. Public participation should also be invited, not only to satisfy democratic ideals, but to contribute to locally relevant, realistic estimates of behavioural elements. He, therefore, should determine the whole process rather than accept bemusedly the precise, and thus apparently accurate, result which the analyst has derived merely from inserting perhaps arbitrary measures into a model whose continually simplifying assumptions produce only spurious accuracy.

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x In particular, the objectives concerning regional policy should be clearly stated, for the apparent presumption that transport investment is a strong stimulant to regional development weighs heavily in many decisions, yet is unsupported by empirical evidence (Georgi, pp.52-60). Also, preferences for flexibility in the decision output should be indicated, so that the incorporation of the appropriate techniques for incorporating the possibilities of the uncertain future can be applied in the analysis.

In this way, a transport evaluation procedure may be democratically structured, and councillors or politicians may establish, with people as the fundamental consideration, improving universal personal mobility to certain levels as their prime objective, rather than maximising vehicle movement or accessibility to points, the material view that largely obtains in transport practice at the moment. A personalised data collection, trip generation and distribution procedure, as in the behavioural/activity base of Kutter's (1973) individual-factor model, may be preferred, as well as criteria measured according to indices of personal opportunity through the transport medium for jobs, shopping, education, recreation and other important socio-economic/physical elements of life. This type of approach might involve considerably more effort than its abstracted equivalent, but its potential comprehension to both politician and public would provide an infinitely clearer appreciation of the transport alternatives, and set a firm acceptable basis on which communal decisions could be taken.

A welcome innovation recently introduced into the CBA framework, and with further potential for development, is sensitivity analysis, where a realistic range of values for uncertain parameters is applied to indicate the influence of the more doubtful assumptions on the recommended decision. Although this may result in several alternatives being suggested for implementation, the implications of the operative postulates are exposed for consideration, and, thus, rather than in a state of confusion, a proposal may be chosen with a greater degree of confidence.

An imminent requirement of CBA in Britain will be its

inter-sectoral applicability, for corporate planning will soon take over funding allocations according to progress towards comprehensive objectives, instead of the present system of division according to arbitrary departmental claims or records. In this respect, common values or ranges of values will have to be operationalised in terms of the set objectives, so that CBA can determine, as far as is possible, all public sector investment decisions, including, of course, transport, on an equivalent basis.

Thus, considerable scope remains for improvement and refinement to CBA techniques in transport planning, dependent on both marginal and fundamental progress towards an operationally-comprehensive decision process within a genuinely representative transport model. In order to achieve this, the transport planning profession must adopt a greater flexibility in attitude, be blessed with considerable powers of insight, and devote considerable effort to the necessary research.

APPENDIX 1.

The Evaluation of Travelling Time:

Efects of Rigidities of Working Time and the (dis)utility of Travelling (after Oort, 1969).

Since people often cannot work less hours than they want to, because of the standard working week, although they have flexibility in the choice of working longer if they wish through overtime, individuals can adjust their working time upwards from the standard working week more easily than downwards. Assuming that the standard working week is a compromise between those who would prefer it to be longer, and those who would prefer it to be shorter, there will be few individuals who work less than they would like to, but some who work more. Therefore, the latter group will value leisure more highly, at the margin, than the net benefit of labour, and consequently, for this group and hence for society on average, the value of leisure time will be somewhat higher than the marginal utility of the money earned by spending the time in work, plus the marginal (dis)utility of labour, to which it is usually equated.

This can be expressed as follows :-

Let the individual's welfare function be represented by

$$U = U(t_w, t_v, Y)$$

where U = the individual's utility

t_w = amount of working time

t_v = amount of leisure time

Y = money income

and let P = the individual's rate of pay.

Therefore, following the reasoning above,

$$\left(\frac{\delta U}{\delta t}\right)_v \quad P. \frac{\delta U}{\delta Y} + \left(\frac{\delta U}{\delta t}\right)_w \quad \ldots\ldots (1)$$

Assuming that any reduction of travelling time, such as the speeding-up of a commuter train or bus, for example, is an exogenous event, inevitable and costless to the individual, and has an inherently neutral utility effect, in itself, it may be construed as an increase in the total time available to the individual. Therefore;-

With T = total time available to the individual for work and leisure.

t_r = travelling time (fixed exogenously for the individual)

$$-\left(\frac{dU}{dt}\right)_r = \frac{dU}{dT} = \left(\frac{\delta U}{\delta t}\right)_v \quad P. \frac{\delta U}{\delta Y} + \left(\frac{\delta U}{\delta t}\right)_w \quad \ldots\ldots (2)$$

In other words, the money value of a reduction of travelling time is still equal to the marginal value of leisure time, but the marginal net benefit of labour now yields only a lower limit for the value of an exogenous reduction of travelling time.

If travelling time is now generally recognised to have a disutility value, since people, for example, do not, as a rule, enjoy commuting, the straight increase in utility derived from an increase in total time, as a result of an exogenous reduction in travelling time, will represent only the lower limit, and usually underestimate, the value which individuals actually attach to that reduction in travelling time.

Therefore,

$$-\left(\frac{dU}{dt}\right)_r \quad \left(\frac{\delta U}{\delta t}\right)_v \quad P. \frac{\delta U}{\delta Y} + \left(\frac{\delta U}{\delta t}\right)_w \quad \ldots\ldots (3)$$

Now, the difference between the value of a marginal increase in the total time available to the individual (dU/dT) and the marginal utility of an exogenous reduction of travelling time ($-dU/dt_r$) is obviously equal to the specific utility of travelling, which will generally be negative.

Therefore,

$$-\frac{dU}{dt}_r = \frac{dU}{dT} - \frac{\delta U}{\delta t}_r$$

$$= \frac{\delta U}{\delta t}_v - \frac{\delta U}{\delta t}_r$$

$$= P. \frac{\delta U}{\delta Y} + \frac{\delta U}{\delta t}_w - \frac{\delta U}{\delta t}_r \quad \ldots\ (4)$$

Thus, taking together the effects of both the rigidities in working time and the disutility of travelling by combining equations (2) and (4), the conclusion may be reached that both the marginal value of leisure time, by the two effects, and the marginal net benefit of labour underestimate the value of an exogenous reduction of travelling time. Empirical testing of this result has as yet proved inconclusive, but, intuitively it seems quite acceptable.

Extracted and modified from Oort (1969,pp.280-285).

APPENDIX 2.

EMPIRICAL STUDIES OF NON-WORKING TIME.

Those studies examined as the basis of the M.O.T. (1969) recommendations :-

Modal choice studies for the journey-to-work

1) Beesley (1965) - Sample of 1109 civil servants faced with train/bus trade-off in London. Results;- time valued at between 30% and 50% of income, according to the rank and salary - clerical officers=31%, executive officers =37%, highest grades=42-50%.

2) I.A.U.R.P.(1963) - Large sample of commuter choice between bus and metro for final part of journey-to-work, after arriving at main-line stations of the S.N.C.F. from the suburbs. Results; time valued at about 75% of income.

3) Lisco (1965) - Analysis of time/cost trades-off in choice between public and private transport for 159 commuters from Skokie and Merton Grove suburbs into central Chicago. Results:- time valued at 40-50% of hourly pay for middle income groups.

4) Barnett and Saalmans (1967) - Analysis similar to Beesley with small sample for journey-to-work to County Hall, London. Results:- time valued at 30% of income for those earning under £1000 p.a., down to 15% for those earning £2000 p.a.

and above - figures may be unreliable because of the small sample size.

5) Quarmby (1967) - Sample of 639 journeys-to-work in Leeds with trade-off between private and public transport. Results:- a general range of 21-25% of income, but when two significant factors are omitted to match Beesley's study, the values approximate to around the same, i.e. $\frac{1}{3}$. Walking and waiting are found to be valued at two to three times the in-vehicle time.

6) Stopher (1968) - Dual sample of University College and County Hall commuters based on modal choice between public and private transport. Results:- time valued at 20-25% of income.

Route Choice Studies

7) Claffey et. al. (1961) - Based on the characteristics of passenger car travel on toll roads and comparable free roads. Results:- 42-50p. per hour was put on the value of time, but this range is not felt to be reliable.

8) Dawson and Smith (1959) - Analysis based on trade-offs between using Queensferry route or upstream Kincardine Bridge. Results;- time valued at 36-47p. per hour, but not reliable.

9) Thomas (1967) - Analysis of time/cost trade-off in choice

of tolled or untolled roads. Results:- vary from 40% to 83% of income under different assumptions.

Other Studies

10) Mohring (1960) - Analysis of the trade-off between commuting costs and housing costs in residential location decision. Results:- time valued at 22-43% of income.

11) Mohring (1965) - Analysis of time/car running costs with speed as the variant. Results:- time valued at £1 per hour.

On the basis of these studies, the Ministry of Transport (1969) choose to recommend values at 25% of income.

Later Studies of Significance

a) L.G.O.R.U. (1968 and 1970) - Observations on modal choice in the journey-to-work were made in four cities; Leeds, Leicester, Manchester and Liverpool. Because of the differences in the range of choice of modal opportunities in the four cities, a startling variation from 14% in Leeds to 98% in Leicester was found in the valuation of in-vehicle time as a proportion of hourly wage rates, but, by adjusting for the different situations, an average value of 24% of income was derived.

b) Lee and Dalvi (1969- and 1970) 1966 sample of 1000 journeys-to-work in Central Manchester. The results give a

broad variation between 15% and 45%, reduced to just 25-30% of income in the major, central range.

c) Veal (1971) - Survey of short urban leisure trips. Results:- in-vehicle time valued at only 9-12p. per hour, with walking time at a slightly higher level, but waiting time twice as much.

d) D.O.E.(1971a) - Analysis of time/cost trade off in modal choice between Solent hovercraft and ferries. Results:- very wide range with time valued at between 15p. and 858p. per hour, probably due to the unusual nature of the inter-modal differences.

e) Dawson and Everall (1972) - Italian study of choice between tolled autostrada and equivalent free road using multiple logit analysis rather than the usual discriminant technique. Results;- time valued at between 90p. and £1.25 per hour. Authors stress importance of the comfort factor of travelling on the autostrada and qualify the applicability of the results to Britain, because of exchange problems, and differences in habits, customs and attitudes.

These studies (a-e) have cast considerable doubt on the M.O.T. (1969) figures and their derivation, as suggested by Beesley (1973, p.180).

(The information in this appendix has been taken from Harrison and Quarmby (1969), M.O.T. (1969), Beesley (1973) and the individual Studies themselves, where available).

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