PART 1

ECONOMIC CONCEPTS IN COBA

Contents

Chapter

1. THE COBA METHOD

1.1 Traffic flows with and without the road scheme under appraisal are obtained from a process, separate from COBA, of assigning trips to the road network with and without the scheme in question. The technique appropriate for this assignment will vary according to the particular scheme, reference should be made to the Traffic Appraisal Manual (TAM - DMRB Volume 12). The essence of COBA is that the travel cost for each component (link and junction) of the network is calculated separately according to the flows and turning movements assigned to it. These individual link and junction costs (that is, time, vehicle operating costs and accidents) are summed to yield the total user costs over the network.

1.2 Unless COBA is being run in 'Accident Only' mode to assess the changes in accident costs for a variable trip matrix appraisal, the matrix of trips is assumed to be fixed (see Part 1 Chapter 3) and a comparison is made between total costs before and after the improvement in question. The reduction in costs is taken as a measure of the scheme benefits as they arise in each year of the appraisal period. This estimate rests on the assumption that the improvement in question does not affect the number of trips made nor their origins and destinations. benefits are calculated for all traffic on the whole road network affected, including the traffic using the new road.

1.3 Historically COBA has always worked in resource costs and this has not changed in COBA11. However, additional tables have been added to show the conversion into market prices to be compatible with the New Approach To Appraisal. Also, with the New Approach any changes in accident costs are now reported under the safety criteria and not the economic criteria

1.4 Figure 1/1 sets out the procedure by which the COBA program calculates the changes in user costs over the entire road network affected by a scheme.

1.5 User costs comprise changes in travel time, vehicle operating costs (fuel and non-fuel) and the number of accidents. COBA applies monetary values to each. These user cost changes are then set alongside capital and maintenance costs.

1.6 The printed output from COBA 10 has been restructured and the standard results previously expressed in resource costs are now also presented in market prices. In addition, the appraisal results are also presented in the format of the Economic Efficiency of the Transport System (TEE) table, see GOMMMS Volume 2 Worksheet 6.1.

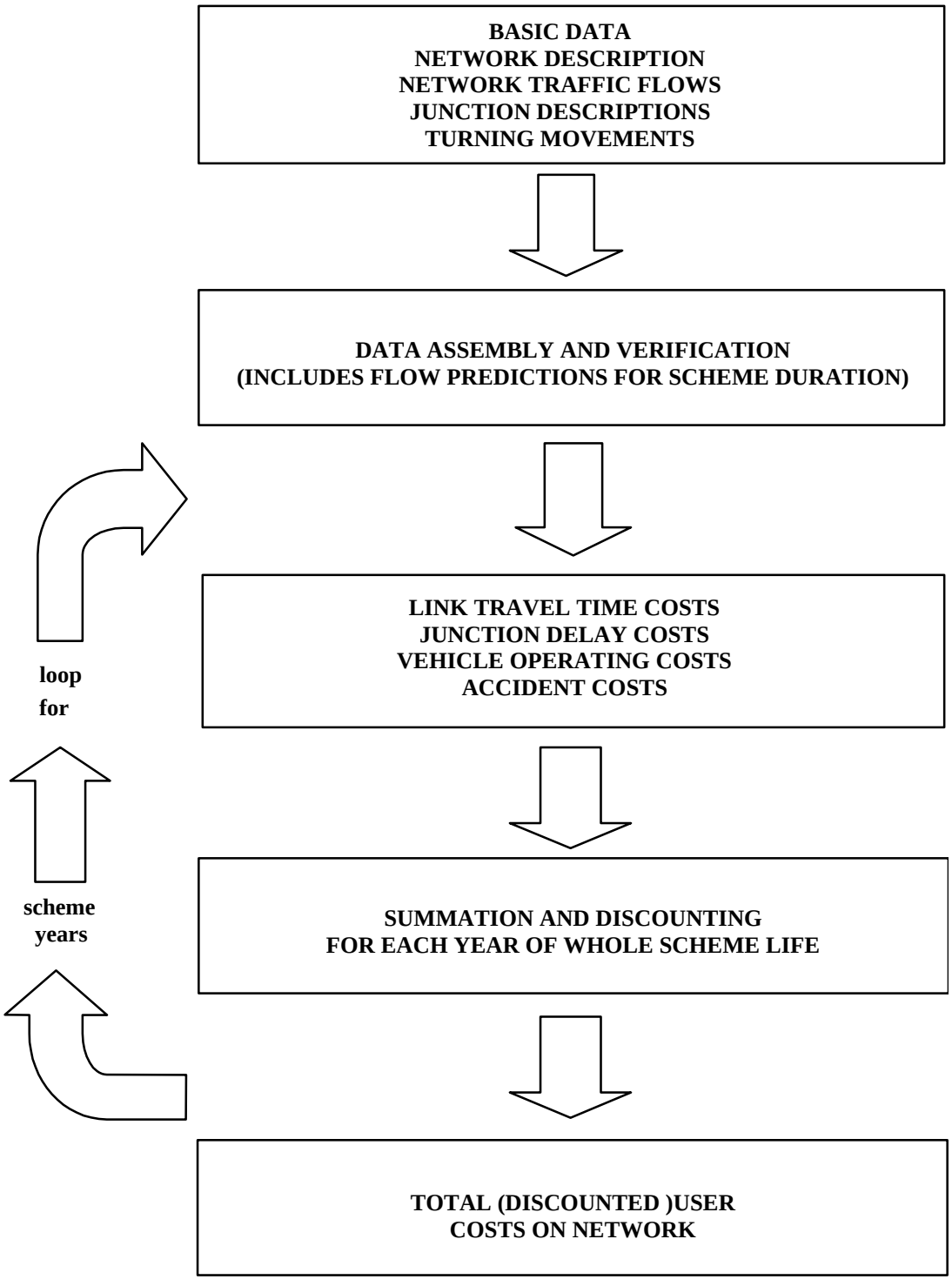

Figure 1/1: Process for Calculating User Network Costs

2. THE 'DO-MINIMUM' AND 'DO-SOMETHING' OPTIONS

2.1 The first stage in a COBA appraisal is to define the alternative options which are to be appraised. The minimum number of options is two, namely, a 'Do-Minimum' and a 'Do-Something' option. In most cases, however, there will be several 'Do-Something' options under consideration. While these terms may appear self explanatory, in fact they raise some issues of fundamental importance.

2.2 The 'Do-Minimum' scheme (or 'option') is the base road and traffic network against which alternative improvements can be assessed. In many cases, the definition of the 'Do-Minimum' is straightforward; it is simply the existing network without modification, that is, a 'Do-Nothing' scenario. This corresponds to the general principle that all expenditure which is not 'sunk' or past requires an economic justification. However, one or more of the following four cases may arise, in which the 'Do-Minimum' differs from the 'Do-Nothing':

i) **the case where works will be carried out regardless of whether or not the 'Do-Something' scheme is built.** An example is where there is a firm commitment to improving a junction in the existing network, regardless of the road proposal. In this case, the improved (not the existing) junction should be coded in the COBA network in both the 'Do-Minimum' and 'Do-Something' schemes in the year it will be improved. The cost of the junction improvement may be regarded as committed and is irrelevant for the COBA appraisal of the road proposal; it should not therefore be included in the scheme costs;

ii) **the case where the existing network may be improved to form a 'Do-Minimum scheme which can be tested as an alternative to carrying out major Do-Something improvements.** An example is where an existing junction or link is forecast to become heavily overcapacity in the near future and where relatively minor improvements can be undertaken to increase capacity, for example, by adding a lane at a traffic signal. This class of Do-Minimum improvement is particularly important where the existing network is congested and where a literal Do-Nothing scheme would represent an unrealistically poor baseline for comparison. The COBA printout identifies junctions and links which exceed their capacity in the Do-Minimum; one useful rule of thumb is that Do-Minimum network improvements should always be considered where junctions or links are forecast to go overcapacity outside peak hours (that is, outside flow groups 4/5). When such improvements are included, the Do-Minimum should include both the cost of the improvement and the changes in the network compared to the Do-Nothing. One would generally expect that the benefits (or difference in user costs) comparing the Do-Minimum and Do-Nothing would greatly outweigh the construction costs involved in the Do-Minimum. It is recommended that where this type of Do-Minimum expenditure is significant, that is, 20% or more of the cost of the cheapest Do-Something scheme, the 'Do-Minimum' itself should be appraised against a literal 'Do-Minimum'; provided the expenditure is justifiable in this way the minor improvements should be included in the 'Do-Minimum' for comparison with the major 'Do-Something' improvements;

iii) **the case where traffic conditions can be improved without significant capital expenditure.** An example is where traffic management measures can be undertaken to reduce existing traffic delays in which case the assignments input to COBA will differ in the 'Do-Minimum' compared to the 'Do-Nothing'. It may be appropriate to use models such as CONTRAM to optimise traffic operations in the 'Do-Minimum'. Public transport/private traffic restraint options may be relevant, for example, in some urban areas. In such cases changes in modal split will violate the fixed trip matrix assumption, and COBA will not be applicable;

iv) **the case where the area covered by the COBA network includes road proposals other than the one under immediate consideration.** The COBA 'Do-Minimum' and 'Do-Something' networks should be coded to include planned improvements elsewhere in the network in the year they will be open, for example, as set out in the trunk road programme or in local authority transport plans. However it will often be desirable to carry out sensitivity tests by excluding improvements which are scheduled for completion after the scheme being appraised and which therefore may be subject to some uncertainty. Related to this is the question of how to appraise a number of inter-related road schemes, which may be either complementary or competing. This is discussed in Part 3 Chapter 4.

2.3 It should be noted that even a literal 'Do-Nothing' base case is not a 'no change' one. With traffic growth in the future, 'Do-Minimum' user costs will increase over time reflecting increased congestion.

2.4 The 'Do-Something' scheme is the road proposal under consideration. Usually there will be more than one feasible 'Do-Something' option. The number and nature of the 'Do-Something' options will change as the planning of the road scheme proceeds. At early stages in scheme planning, a wide range of different options may be considered. At later stages, the range will be narrower but 'Do-Something' options may be refined to highlight more detailed differences such as junction design or link standards.

3. THE FIXED TRIP MATRIX

3.1 When a road improvement takes place, several changes in trip patterns are possible in principle:

Reassignment: traffic travelling from A to B may transfer to an alternative route between A and B;

Time of day: trips may be made at a different time of day;

Redistribution: traffic may change its origin or destination;

Modal split: trips to the same destination may be made by a different mode of transport;

Generation: trips may be made when previously travel did not take place (including the release of suppressed demand).

3.2 COBA operates on the assumption that only the first reaction, reassignment, takes place. When it is considered that a scheme, or combination of schemes, is likely to cause a significant response other than reassignment the fixed trip matrix assumption may be considered inappropriate. This might be the case, for example, for schemes in congested conditions or in the appraisal of long inter urban routes or major estuarial crossings. When the fixed trip matrix assumption is not valid, variable trip matrix appraisal methods must be used. The TUBA program is recommended for use in these circumstances. **COBA should not be used for variable trip matrix economic appraisals but it can be used for the appraisal of accident cost changes for projects where variable trip matrices apply.**

3.3 The computation of user cost savings in the context of a fixed trip matrix is the central principle of the COBA program. Taking a fixed trip matrix and given assignments for the 'Do-Minimum' and 'Do-Something' it can estimate the effects of daily and seasonal flow variations on total user costs through the application of speed/flow, junction delay, accident and vehicle operating cost flow related formulae. Using the traffic forecasts it can repeat these calculations for each year in the appraisal period. This allows ready estimation of a stream of benefits which can be discounted to give a base year Net Present Value which is one of the measures used in the overall appraisal of projects/schemes.

3.4 The COBA program assumes that traffic growth in each vehicle category will be similar on all links of the network. However, if non-uniform growth is expected to have a significant effect on traffic flows it can be modelled in COBA by a facility called 'Reassignment' (see Part 4 Chapter 4). Reasons for expecting non-uniform growth include other schemes opening in the network, town centre pedestrianisation and major developments.

4. DISCOUNTING AND THE PRICE BASIS

4.1 Carrying out a road improvement scheme usually results in a stream of costs followed by a stream of benefits, some of which have monetary values applied to them. These monetised costs and benefits need to be presented in a consistent way and cannot simply be added together as if they all occurred simultaneously. We generally place different values on the same cost or benefit according to when it occurs. Individually and collectively we tend to prefer costs to be incurred later and benefits to accrue sooner both as consumers, preferring consumption today rather than tomorrow, and in the corporate sector, which requires a positive real rate of return on capital. Costs and benefits arising in different years, therefore, are expressed in terms of their value from the standpoint of a given year, known as the 'present value year'. In principle any year can be taken as 'present value year' but in COBA the year 2002, which is also the 'price base year', is used. Summing the present values of costs and subtracting these from the present value of benefits gives the 'net present value' of the scheme in 2002 prices discounted to 2002.

4.2 Costs and benefits arising in different years are transformed to their present values by the process of discounting. This can be understood by considering the principle of compound interest. If £1 is invested at an interest rate of r, at the end of one year it would be worth £(1 + r) and in two years £$(1 + r)^2$ and so on. Conversely £1 received in n years is worth £$1/(1 + r)^n$ now. Note that this illustration ignores the effect of inflation and assumes that £1 has the same real value in each year.

4.3 Because discounting involves the notion of charging interest against a project, rather than paying interest to an investor, 'r' is known as the discount rate. Formally any sum may be reduced to its present value (PV) by means of this formula:

$$PV = S/(1+r)^n,$$

where
- PV is the present value,
- S is the sum,
- r is the discount rate, expressed as a fraction,
- n is the year in which the sum is received,
- n=0 is the 'present value year'.

Note that the discounting factor $1/(1+r)^n$ for each scheme year is listed in the traffic growth table in the COBA printout. For example, £100 to be received in one year from now is worth £96.62 in today's money using a discount rate of 0.035 or 3.5% to derive a discount factor of 0.9662.

4.4 The default present value year in COBA is 2002 and the Present Value of a stream of Benefits is calculated according to this formula:

$$PVB = B_{(02)} + \frac{B_{(03)}}{(1+r)} + \ldots\ldots + \frac{B_{(n)}}{(1+r)^{n-02}}$$

where $B_{(n)}$ is the benefit occurring in year n.

In 2003 the Treasury introduced discount rates that reduce 30 years into the future. For later years the above formula is therefore adjusted in COBA to allow for the changed rate.

The present value of the stream of costs (PVC) is calculated by a similar formula, allowing the Net Present Value (NPV) of the scheme to be calculated:

$$NPV = PVB - PVC.$$

4.5 Note that a scheme having an NPV of zero using a discount rate of x% has an x% real rate of return. COBA calculates future benefits for 'High' and 'Low' growth forecasts (see Part 4 Chapter 10) and calculates the NPV for each using the current discount rate.

4.6 The 2002 based NPV calculated by COBA can be converted manually to a 'current year' basis relatively simply by using the appropriate price indices. Expressing the NPV in current prices and discount year may make the significance of the sums involved more readily understood. In particular, Ministerial or Treasury submissions should be expressed at the price level of the month of the latest available Retail Price Index, and at the same present value year. The Retail Price Index is prepared by National Statistics (formerly Central Statistical Office) and is published in a number of their statistical periodicals, including the 'Monthly Digest of Statistics'. For example, if the submission was made in April 2006, the COBA NPV should have been updated to Q1 2006 as follows:

i) COBA NPV = £1m in average 2002 prices discounted to 2002;

ii) at Q1 2006 prices,

$$£1m \times \frac{\text{Retail Price Index at Q1 2006 (194.2)}}{\text{Average Retail Price Index for 2002 (176.2)}} = £1.102m$$

iii) at Q1 2006 prices discounted to 2006 at a 3.5% discount rate:

$$£1.102m \times 1.035^4 = £1.265m$$

4.7 Similarly scheme construction costs should be expressed in up to date prices in Ministerial or Treasury submissions. It is important that the estimated scheme costs are those used in COBA to produce the NPV so that decisions can be made on a consistent basis (the preparation of cost data for use in COBA is dealt with in Part 2 Chapter 6) and should be converted to up to date prices by using the latest Retail Price Index. The same RPI value should be used for converting both NPV and total scheme cost to up to date prices. For example, if the submission was made in April 2005, the COBA total scheme cost should have been updated to Q1 2005 prices as follows:

i) COBA total scheme cost equals, say, £15m in 2002 prices, undiscounted;

ii) at Q1 2006 prices:

$$£15m \times \frac{\text{Retail Price Index at Q1 2006 (194.2)}}{\text{Average Retail Price Index for 2002 (176.2)}} = £16.53m.$$

5. APPRAISAL PERIOD

5.1 A significant feature of COBA is that it calculates net scheme benefits for each year of operation of the improvement over an appraisal period of 60 years from the scheme opening year. This 60 year analysis is achieved by applying forecast rates of economic and traffic growth to the original assignments input to COBA. Historically the program contained default low (DEFL) and high (DEFH) factors for traffic, economic and fuel growth. In the latest versions of COBA the low and high defaults are the same and the economic parameters, namely the values of time, vehicle operating costs and accident costs (see Part 2, Chapters 1 and 2) are common to both files and the traffic growths are consistent with the central National Road Traffic Forecasts (NRTF).

5.2 The value of each item of benefit and cost is expressed in terms of prices in the COBA present value year; these are adjusted to this year and expressed in "constant prices" or "real terms". This means that the change in money value of a particular cost or benefit from one year to the next is ignored to the extent that the change is attributable solely to the effects of general inflation. Because COBA uses constant prices, construction costs must be adjusted to the price level of the base year. The procedure for doing this is described in Part 2 Chapter 6.

5.3 The COBA facility for estimating a stream of benefits arising over the 'life' of a road scheme allows a sounder basis for evaluation than is afforded by single year measures. Such measures can be particularly deceptive since two scheme options may yield similar returns for a given year but perform differently as traffic flows change over time.

6. THE TREATMENT OF TAXATION

6. 1 The method of accounting used in the appraisal of transport schemes has changed. In order to appraise projects across the modes, it has been necessary to move from a calculus based on social costs to one based on willingness to pay. In addition, the unit of account has been changed from factor cost prices to market prices. These changes merely affect the presentation of results and not the fundamental principles of appraisal. In particular, the results using a willingness to pay calculus show clearly how different groups are affected by the project, whilst previously resource costs and benefits were aggregated and consequently masked transfer payments. A fuller discussion of the conversion between the factor cost and market price units of account is given in WebTAG Unit 3.5.6.

6.2 To ensure compatibility, an adjustment must be made for indirect taxes in the economy. These are transfers between members of society (for example, consumers to Government), rather than costs to the society as a whole. Although the accounting approach has changed, COBA continues to work in the factor cost unit of account (for time and VOC). COBA gives outputs (for time and VOC) in factor costs and also presents them in market prices**.**

6.3 The largest proportional adjustment to be made from market to factor costs is in the valuation of the change in fuel consumption in making a trip. For each litre of diesel, the non-business user pays 66.7 pence (the average pump price in 1998), of which 45.0 pence (67.5%) is excise duty, and 9.9 pence (14.8%) is VAT. The factor cost price is net of these tax transfers. In this case the factor cost price is 11.8 pence per litre (that is, 17.7% of the pump price). Business users who can reclaim VAT pays 56.8 pence but the factor cost price remains the same. A similar adjustment is made in respect of indirect taxation on other items of vehicle operating cost namely oil, tyres, depreciation and maintenance. (These items of course bear only VAT and not excise duty).

6.4 An adjustment is also made to the valuation of non-working time. This valuation is based on observations of behaviour which provide an average value per hour of time saved. This means that people can be considered as prepared to sacrifice that amount of expenditure on other goods and services in order to save one hour of non-working time. But these alternative goods and services bear prices that include the indirect tax element (mainly VAT). They are, therefore, in the market price unit of account. The factor costs of these other goods and services is less by the average rate of indirect taxation (net of subsidies) in consumers' expenditure. The average rate of indirect taxation in consumers' expenditure is calculated as:

$$\frac{\text{(indirect taxes - subsidies) on consumers' expenditure}}{\text{consumers expenditure at factor cost}}$$

6.5 The factor cost value of non-working time may be regarded as the value to the economy (in terms of factor inputs) of the alternative goods and services that would yield the individual the same benefit.

6.6 In calculating the value of work time, gross wage rates including National Insurance and pension contributions, are used rather than rates net of taxation. This is because, in competitive equilibrium, it is the employee's gross remuneration that represent how much he is costing his employer and thus reflects his worth to his employer, and by analogy, the value to the economy of his output. These values are already in the factor cost unit of account and thus do not need any further adjustment.