

**COMPETITIVE AND SUSTAINABLE GROWTH  
(GROWTH)  
PROGRAMME**



**UNification of accounts and  
marginal costs for Transport Efficiency**

**Deliverable 1:  
The Overall UNITE Methodology**

Version 2.2  
12 May 2000  
(with minor revisions, 23 August 2000)

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# UNITE

1999-AM.11157

## **UNification of accounts and marginal costs for Transport Efficiency**

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### **Deliverable 1: The Overall UNITE Methodology**

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<b>Table of Contents</b>	<b>page:</b>
<b>EXECUTIVE SUMMARY</b>	<b>i</b>
<b>1 INTRODUCTION</b>	<b>1</b>
<b>1.1 Study Context and Purpose of this Deliverable</b>	<b>1</b>
<b>1.2 The Structure of this Report</b>	<b>1</b>
<b>2 KEY POLICY ISSUES FOR UNITE</b>	<b>2</b>
<b>2.1 Recent Developments in Infrastructure Charging Policy</b>	<b>2</b>
<b>2.2 Policy Relevance of the UNITE Information</b>	<b>4</b>
<b>2.3 Priority Policy Issues for UNITE</b>	<b>6</b>
<b>3 TECHNICAL ISSUES ARISING FROM POLICY NEEDS</b>	<b>8</b>
<b>3.1 Policies and Information Needs</b>	<b>8</b>
<b>3.2 The Limitations of Existing Accounts</b>	<b>9</b>
<b>3.3 The Relevance of Cost Coverage Information</b>	<b>10</b>
<b>3.4 General Technical Issues Arising</b>	<b>12</b>
<b>3.5 General Technical Issues Closed at this Stage of UNITE</b>	<b>14</b>
<b>4 IMPLICATIONS FOR THE TRANSPORT ACCOUNTS IN UNITE</b>	<b>16</b>
<b>4.1 The Distinction between “Ideal Accounts” and “Pilot Accounts”</b>	<b>16</b>
<b>4.2 Technical Issues relating to Accounts</b>	<b>16</b>
<b>4.3 Accounts -related Technical Issues Closed at this Stage of UNITE</b>	<b>19</b>
<b>4.4 Accounts -related Technical Issues Remaining Open at this Stage of UNITE</b>	<b>20</b>
<b>5 IMPLICATIONS FOR THE MARGINAL COST ANALYSIS IN UNITE</b>	<b>21</b>
<b>5.1 The Role for Marginal Costs</b>	<b>21</b>
<b>5.2 Technical Issues relating to Marginal Costs</b>	<b>21</b>
<b>5.3 Marginal Cost-related Technical Issues Closed at this Stage of UNITE</b>	<b>24</b>
<b>5.4 Marginal Cost-related Technical Issues Remaining Open at this Stage of UNITE</b>	<b>24</b>
<b>6 THE ROLE FOR INTEGRATION</b>	<b>26</b>
<b>6.1 The Purpose of the Integration of Approaches</b>	<b>26</b>
<b>6.2 Alternative Perspectives on Integration</b>	<b>26</b>
<b>6.3 Towards a Framework for the Integrated Use of Information</b>	<b>27</b>
<b>7 OUTLINE OF THE OVERALL UNITE APPROACH</b>	<b>28</b>
<b>7.1 The Overall Focus of UNITE</b>	<b>28</b>
<b>7.2 Implications for The Main Components of UNITE</b>	<b>28</b>
<b>Glossary of Terms</b>	
<b>References</b>	
<b>Appendix I: Review of Transport Accounts</b>	
<b>Appendix II: Equity in Transport Infrastructure Charging</b>	
<b>Appendix III: Costing and Pricing in Transport – Alternative Approaches</b>	

## Executive Summary

The UNITE project is designed to support policy-makers in the setting of charges for transport infrastructure use. The purpose of this report is to advance and prioritise subsequent methodological and empirical developments in the project.

The report begins by identifying the key policy issues relevant to UNITE. These are:

1. how should the structure and level of charges for use of infrastructure be determined?
2. which financial and social cost coverage considerations are relevant in determining charges, and what are current levels of cost coverage?
3. how can fair charging be promoted between and within modes, also avoiding discrimination between users of different nationalities?

These policy issues imply the need for a highly disaggregate system of information. This may include marginal, variable and fixed costs, benefits and revenues. Both financial and social costs are relevant, but costs that are purely internal to the individual user should be excluded – such costs are not relevant in the calculation of actual charges.

At the most disaggregate level possible, the UNITE information would be used to answer questions of:

- efficiency – what are the marginal costs of making a trip on any link in the transport system, and how do these compare to marginal revenues?
- equity – how much does any individual user of a certain group (income group, for example) pay for a trip, in relation to the costs imposed?

At present, it would be extremely demanding to create a comprehensive information system – covering all modes, transport links/ terminals, for all user types - for any country – and the costs of data collection could exceed the benefits of doing so! Yet, as this report’s brief worldwide review indicates, existing accounts contain data that is so aggregate that neither efficiency nor equity questions can be successfully answered at the level of detail needed to set charges for any individual part of the transport system. All they can do is offer some broad guidance on likely levels of charges for some elements of cost, and current levels of cost coverage.

Existing accounts answer a number of interesting policy questions, but not the key policy issues identified for UNITE. Therefore, UNITE’s ambition must be to provide much more disaggregate transport accounts wherever possible, together with highly disaggregate - and transferable - marginal costs.

The “ideal accounts” provide the blueprint for the structure and methodology underlying the ambitious form of accounts. The “pilot accounts” provide empirical accounts that are a compromise between “ideal accounts” and what is feasible for the 18 countries in UNITE for which accounts will be produced.

The key features of the ideal accounts will include:

- a high level of disaggregation – reflecting factors such as location and time period at the transport link or terminal level;

- full information about the financial and social cost structure – including marginal, variable and fixed costs;
- similarly, full information on the charging/ taxation structure – including variable and fixed components;
- use of a basis of social cost accounting – as opposed to a purely financial or business accounting basis;
- dynamic - examining changes in response to new charging structures/levels through the use of transport modelling and enabling the non-linearity of cost functions such as congestion to be taken into account by means of demand and supply interactions;
- capable of aggregation to the appropriate level of decision-making – to enable examination of who incurs costs and how much they pay, for different geographic areas, modes, income groups etc.

In contrast, the compromises necessary to deliver the pilot accounts are likely to involve limitations in relation to:

- level of disaggregation – this will depend crucially on the level at which existing data is collected, and so will be highly country-specific;
- absence of transport modelling – costs will be reported at the current level of transport demand.

Two additional fundamental aspects of the accounts are that:

- there should be no arbitrary allocation of costs to user groups – the costs that are truly joint to a number of user groups should not be fully allocated to the individual user groups. This implies that at the most disaggregate level (e.g. a single trip) only a very limited allocation of costs can be made. In contrast, at an aggregate level (e.g. the road or rail sector) nearly all costs can be allocated to the sector; and,
- cost information should relate to the present and future, and not the past – future rather than historic costs are of relevance in the accounts, since costs incurred in the past are sunk costs that cannot be influenced in any way. Future costs include the costs of new infrastructure and renewals, but exclude aspects of existing infrastructure that do not generate renewal costs (e.g. land).

In parallel with the ideal and pilot accounts' development, significant methodological and empirical advances will be made in UNITE in relation to marginal costs. This report seeks to highlight key technical issues relating to both marginal costs and accounts, and to provide direction for future project developments by determining which issues should be answered at this stage of UNITE, and which should remain open at this stage.

The last element of the UNITE project, combining both transport accounts and marginal costs, is the “integration” component. In order to maintain focus, the policy issues of primary relevance in UNITE omit a wide range of issues of relevance to charging for transport infrastructure a comprehensive information system.

To address these issues, integration must consider how a wider range of policy issues can be taken into consideration. Integration may thus be interpreted as an even more ambitious system of transport information than the ideal accounts – as a “higher level concept” which will provide a comprehensive system for transport costing and pricing.

The additional policy issues that should be taken account of in the integration research may include:

- efficiency considerations – making use of marginal cost information;
- cost coverage/ equity issues – using information from the accounts;
- optimal infrastructure capacity investment rules – using social cost benefit analysis to prioritise investments;
- optimal setting of regulatory standards – again, using cost benefit analysis to determine the appropriate level of intervention;
- rules for establishing whether the introduction of new pricing instruments is justified – by comparing the full range of costs and benefits;
- modelling alternative equilibria including supply and demand interactions; and,
- determining wider impacts on the economy, and incorporating constraints such as the shadow price of public funds.

It is recognised that this broad specification for the integration activities is extremely demanding; and the work on these issues will initially be conceptual in nature, determining how the information produced by accounts and marginal cost estimates can be used in answering these questions rather than in actually producing the answers.

In conclusion, this report has sought to clarify the overall UNITE approach, and to determine the scope and key technical issues relating to the ideal accounts, pilot accounts, marginal costs and integration.

## **1 Introduction**

### **1.1 Study Context and Purpose of this Deliverable**

The UNITE project is designed to support policy-makers in the setting of charges for transport infrastructure use – by providing appropriate methodologies and empirical evidence.

The purpose of this report is to advance and prioritise subsequent methodological and empirical developments in the project, in particular:

- by separating the policy issues of primary interest from those of secondary importance to the project; and,
- by identifying which technical issues can be closed down at this stage, and which should remain open at this stage.

### **1.2 The Structure of this Report**

The report begins by setting out recent and ongoing initiatives at the European and national levels, before a discussion of the types of uses to which transport cost and charging information may be put. Chapter 2 concludes by separating the policy issues of central relevance to UNITE from secondary issues.

Using this prioritisation to structure the subsequent analysis, Chapter 3 highlights the linkages between policy needs and the UNITE outputs. Various general technical issues arise, for example are existing transport accounts an adequate basis for UNITE, and what level of disaggregation is required in the UNITE information. As far as possible, these issues are closed down in this report, in order to maximise the potential for productive work in subsequent stages of UNITE.

Detailed discussion of the accounts and marginal cost technical issues is postponed to Chapters 4 and 5. Having clarified the role of the accounts and marginal cost components of UNITE in these chapters, Chapter 6 then identifies the role for the ‘integration’ component of the project. UNITE is structured so that these three streams of research - accounts, marginal costs and integration - can proceed in parallel, however, the integration stream has a unique role in bringing the other components together (the ‘Unification’ in the project title).

To conclude, Chapter 7 – “Outline of the Overall UNITE Methodology” – provides a brief resume of the definition of ideal accounts, pilot accounts, marginal cost and integration activities within UNITE.

## **2 Key Policy Issues for UNITE**

### **2.1 Recent Developments in Infrastructure Charging Policy**

In order to highlight the pricing issues of most relevance to policy-makers around Europe, Section 2.1 sets out recent and ongoing developments in infrastructure charging policy. These highlight the relevance of information relating to cost structures and coverage of specific cost categories by user charges. This brief summary enables the common themes emerging from recent and ongoing policy development to be drawn together in Section 2.2, and for the key policy issues that UNITE seeks to address to be prioritised in Section 2.3.

#### **Developments at the European Level**

The White Paper ‘Fair payment for infrastructure use’ (CEC, 1998) has been analysed extensively by interest groups and researchers. For this reason, it is not appropriate to duplicate these interpretations, but merely to highlight how the White Paper came into being, and briefly summarise its core features.

The White Paper, and its predecessor the Green Paper ‘Towards fair and efficient pricing in transport’ (CEC, 1995a), emerged from an environment of considerable turbulence in the transport field. A range of needs at Member State and European level were apparent, including the need to manage transport capacity more efficiently, to finance transport infrastructure, and the need to improve the efficiency of the transport sector by means of institutional reform involving deregulation and privatisation.

The framework contained in the Green and White Papers represented the Commission’s endeavours to provide a comprehensive pricing principle across modes that would ensure that that in times of change there was a scientific basis for the development of the transport market.

The core features of the White Paper focused on the need to relate charges more closely to the underlying costs associated with infrastructure use, extending these costs to include external costs, with the need to depart from prices that are purely based on the direct costs of infrastructure use when cost coverage requirements need to be met. The need to ensure transparency, and facilitate fair competition between modes, within modes, and across user types was emphasised. Furthermore, the contribution of transport services to the enhancement of industrial efficiency and European competitiveness was recognised.

To support a policy of relating charges to costs, and to check on the extent to which Member States are doing this, there has been a longstanding emphasis on the need for consistently prepared transport accounts<sup>1</sup> (e.g. High Level Group on Infrastructure Charging, referenced in CEC, 1995a).

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<sup>1</sup> It has long been a requirement, under Regulation 1108/70 (CEC, 1970), that Member States submit annual expenditure accounts. However, such information, where it continues to be collected, is not of a suitable format for direct use in examining infrastructure charging policy.



The mode-specific pricing policy developments that have either stemmed from the Green and White Papers or have emerged in parallel with them have been:

- **road, freight** - the “Eurovignette” directive, CEC (1996a), was intended to set a limit for the maximum infrastructure access charges payable, on the basis of average infrastructure costs, with non-discrimination between goods vehicle operators of different nationalities;
- **rail** – the process of seeking to facilitate open access, enabling “on the rails” competition was begun by Directive 91/440. This sought to separate accounting for infrastructure and operations in order to make basis for infrastructure charging transparent. There are currently proposals for a new directive on rail infrastructure charging;
- **ports** – the Green paper on seaports and maritime infrastructure, CEC (1997b), has sought to establish principles for port access charging based on the underlying costs of port operations and the need to ensure fair competition between ports – particularly those in adjacent countries;
- **airports** – the directive on airport charges, CEC (1997a), seeks a similar system of charging to that for ports, again based upon underlying cost structures and a desire to ensure fair competition between airports.

In parallel with these developments have been the more general policy statements, including the Common Transport Policy (CEC, 1995b) and its forthcoming revision in 2000. Another such development is the range of directives intended to promote combined or inter-modal transport.

### **Developments at the National Level**

Policies on charging and taxation have also been in a state of flux at the national level. The following list illustrates the range of country-specific policies and measures, with examples from several countries<sup>2</sup>:

- **HGV charging** – e.g. weight- and distance-related HGV charges are to be implemented in Switzerland in 2001, based on coverage of infrastructure and environmental costs, and contributing to a fund which will be used to finance railway and motorway investments;
- **inter-urban roads** – e.g. Austria introduced a motorway ‘vignette’ in 1996; ‘vignettes’ have also existed for freight vehicles on German autobahns since 1995, but Germany now has plans for full electronic motorway tolling; other countries with longer-established motorway tolls are moving towards more sophisticated charging structures, such as time-variable charges on some French toll roads;
- **urban roads** – e.g. in the UK, legislation allowing revenues from urban-road pricing to be retained by city authorities and ring-fenced for use in the transport sector has been drafted by the government and will be considered by parliament this year; Norwegian ‘toll-ring’ revenues are already directed to fund road construction;

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<sup>2</sup> A number of these examples are drawn from INFRAS (1999).

- **environmental taxes** – e.g. in line with other Scandinavian countries, Denmark introduced a ‘green tax’ on car ownership in 1997, variable with fuel efficiency rather than size or value - there is a debate about ‘green taxes’ on transport in many other countries; Switzerland has announced a CO<sub>2</sub> tax of up to 0.3 euro per litre of gasoline if reduction targets are not met by voluntary agreement by 2004.

### The Overall Pace of Change

Despite these developments, the rate of change in moving towards implementation for Europe as a whole is limited. Two major factors underlying the slow pace of change are: firstly, the lack of empirical evidence to address the implications of the Commission’s proposed approach in the real world; and, secondly, the narrow interpretation that has been placed on the proposed approach, that it disregards the issue of “who should pay for the fixed costs of transport infrastructure?”. This latter barrier to progress has not been helped by a body of academic literature that has purely focused on economic efficiency, implicitly suggesting that who pays for fixed costs is a matter of very little importance<sup>3</sup>.

## 2.2 Policy Relevance of the UNITE Information

The UNITE project is intended to support infrastructure use charging development at both European and national levels, by generating two sets of information: marginal cost information, showing how a sub-set of overall costs vary with use; and, accounts information, providing total costs and a comparison with total revenues<sup>4</sup>.

For which aspects of policy development, at the European or national level, is the UNITE information expected to be relevant? Building on the discussion in the previous section, and on the review of existing accounts in Appendix I, the possible applications are:

- **pricing and taxation** – in addition to prices based on the direct costs of infrastructure use (e.g. marginal cost pricing), one area of interest is infrastructure cost coverage by transport modes and vehicle type or - more precisely - the coverage of costs that are relevant for public budgets. A second issue, from a sustainability perspective, is total cost coverage - infrastructure costs and external costs excluding congestion - in order to compare average costs with average revenues. Some take the view that this could be used as a crude proxy for long run marginal social cost pricing.
- **strategic planning / sector budgeting** - for performance assessment and productivity comparisons between modes and over time, information on the cost structure is highly relevant (magnitude of different cost components), the structure between different modes and transport means and the change of the most important cost, revenue and coverage indicators. For sector budgeting the level of

<sup>3</sup> E.g. with common assumptions being that taxes in other parts of the economy can make up resultant deficits, or that that urban road users will support new charges that are used to finance such deficits in other sectors or geographic areas.

<sup>4</sup> as outlined in Chapter 3, the vision is that the accounts will in fact be highly sophisticated - they will provide highly disaggregated information, distinguishing fixed and variable costs and defining the structure, not just the overall level, of costs and revenues.

coverage of financial expenses is an important performance indicator (regardless of whether or not there is a requirement for 100% cost coverage);

- **institutional reform** - here, among the most important financial performance measures are the levels of cost recovery (or profitability) obtained by the infrastructure operators. For example, how do new institutions such as privatised railways, airports, privatised motorways perform from a financial point of view, and how does their performance change when viewed from a social perspective, including external costs? Comparisons of performance over time on a social accounting basis could have a role in monitoring the success of institutional reform;
- **transport regulation** - this aim overlaps somewhat with sector planning. Most important is the change of external costs (especially accidents, congestion, environmental costs) over time in order to have a periodic monetary indicator for the effectiveness of transport policy; and,
- **social policies on equity and distribution** - there is an ongoing debate in many countries about the fairness of road tax regimes, including 'green taxes', on disadvantaged groups within society and the relationships between transport policy and wider social policy. Information comparing taxes raised from different groups of motorists (including international traffic) with the costs they impose, and information identifying the different fixed and variable cost components of these costs, can inform this debate.

It is anticipated that in practice both the marginal costs and transport accounts<sup>5</sup> will be useful in relation to most or all the above areas of policy formulation. However in order to effectively guide the development of the UNITE methodology, a single, clear area of policy application is needed as a focus. For this purpose, pricing and taxation has been chosen because:

- a) it is the one most central to the European policy context set out in Section 2.1; and,
- b) it is a highly demanding application in terms of the detailed information needed - outputs satisfying this need will also be highly relevant for other policy uses.

Section 2.3 elaborates on the key policy issues to which UNITE will contribute within the particular area of pricing and taxation.

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<sup>5</sup> recognising that the full definition of "transport accounts" will follow later, within UNITE Workpackage 3.

### Information on cost and charging structures

UNITE is focused on the needs of European transport policy-makers, operators and users in the real world. Infrastructure charging policy is implemented through pricing instruments, so UNITE focuses on the price structure - both current and potential - with the aim of relating this more closely to the cost structure. On one hand this means that the distinctions between, for example, annual access charges (such as registration taxes), fuel taxes (per litre consumed) and road tolls (charged on various bases), will be made clear within the revenue analysis. On the other hand, the cost structure, including fixed costs and costs which vary with levels of use, will also be a major focus of both the accounts and marginal cost methodology.

In the past, the costs and charges have been related in a number of different ways. For example, private toll road operators have focused on the relationship between infrastructure costs borne by the operator, in comparison with toll revenues received by the operator. Meanwhile, untolled roads have yielded no revenue stream to the operator, whilst vehicle and fuel taxes have been used to generate revenues for the public authorities (the tax levels have in general not been related to infrastructure investment needs at all). A key challenge identified in EU infrastructure charging policy is to harmonise charging principles on the basis of ‘fair and efficient pricing’ whereby the variable charges faced by users at (or near to) the point of use, reflect the social costs of that use, whilst other costs may be recovered in other ways. The overall UNITE approach places the relationship between the cost structure and the charging basis at the heart of the discussion (Figure 2.1).

**Figure 2.1: Cost structure and charging basis - an example**

<b>Cost structure:</b>	<b>Fixed cost</b> (infrastructure cost)	<b>Variable cost</b> (infrastructure operating cost)	<b>Marginal cost</b> (wear and tear)
<b>Charge structure:</b>	<b>Annual fee</b> (vehicle registration)	<b>Variable charge</b> (fuel tax)	<b>Differentiated charge</b> (urban road pricing)

Thus in the pricing and taxation field, UNITE relates to how the underlying cost structure of marginal and fixed costs is reflected in the charging structure. The charging structure can be considered as a form of multi-part tariff; a better understanding of the way the components relate to one another on the cost and revenue sides will facilitate a clearer approach to the policy issue of infrastructure use charging.

### 2.3 Priority Policy Issues for UNITE

The focus of this section is on prioritising the policy issues that are of most relevance to the UNITE project, within the general area of **pricing, charging and taxation**. In

order to prioritise, it is also helpful to identify those policy issues that are of limited relevance, or no relevance at all.

The priority policy issues that arise from our interpretation of recent and ongoing policy developments are:

- **how should the structure and level of charges for use of infrastructure be determined?** – how should minimum and maximum charges be determined, bearing in mind efficiency and equity issues, i.e. the costs directly associated with infrastructure use (marginal costs), the costs associated with infrastructure provision (fixed costs), and distributional issues (reasons for levying charges lower or higher than actual cost levels - according to user income, region etc.) and when infrastructure provision and regulation of vehicle standards are likely to be sub-optimal;
- **which cost coverage considerations are relevant in determining infrastructure use charges, and what are the current levels of cost coverage?** – by means of national-level pricing instruments such as annual vehicle registration fees, fuel taxes etc.; for which categories of costs - total social costs, variable social costs, total infrastructure costs or variable infrastructure costs?; and, how can cost coverage targets be used to promote productive efficiency; and,
- **how can fair charging be promoted?** – fair competition between different modes, different vehicle classes or operators within the same mode; avoidance of discriminatory charging between infrastructure users of different nationalities.

The policy issues that are of less importance, but remain relevant are: the specific instruments to use in the implementation of pricing initiatives, whether the current level of infrastructure provision or proposed investment is either too high or too low; and, how project finance should be raised in the transport sector.

Lastly, policy issues of little or no relevance to UNITE are the techniques for social cost benefit analysis of projects, of specific regulatory standards, or of specific pricing reform initiatives<sup>6</sup>.

The priority policy issues identified in this section are used to guide subsequent analysis in the proceeding chapters. Throughout this report, the focus will remain on the information necessary for infrastructure use charging.

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<sup>6</sup> Note, however, that the external cost estimates developed in UNITE will progress the input parameters needed in social cost benefit analysis. This is not the issue of *how to do* cost benefit analysis, however.

### 3 Technical Issues arising from Policy Needs

#### 3.1 Policies and Information Needs

The previous chapter identified the three priority policy questions:

- “how can charges for use of infrastructure be determined?”;
- “what level of cost coverage is necessary?”; and
- “how can fair charging be promoted?”

Table 3.1 links specific examples of policies to the types of marginal cost and account information needed for the implementation of the policy.

**Table 3.1: Policy Needs and Information Requirements**

Policy Example	Primary focus of UNITE (✓✓) or not (X)	Information Requirement	
		Efficiency issues	Equity Issues
<b>Setting charges for use of specific infrastructure</b>			
HGV charging: electronic km charges	✓✓	MC by link, time period etc.	Accounts information across vehicle classes
Inter-urban road tolling: time of day variation	✓✓	MC in new equilibrium; by motorway link; peak/off-peak; comparison with marginal revenue	Distribution of net revenues in new equilibrium
Urban road pricing	✓✓	MC in new equilibrium; by location; peak/off-peak; comparison with marginal revenue;	Distribution of net revenues in new equilibrium
<b>Determining level of cost coverage</b>			
HGV charging: based on total costs	✓✓	MC	Total social costs; allocation to vehicle classes
Strategic planning/ sector budgeting: social rail account	X	(only as input to accounts)	Total social costs; comparison with total costs, allocated by train type
Institutional reform: business rail account	X	(only as input to accounts)	Financial costs and revenues
Long term sustainability monitoring: social road account	X	(only as input to accounts)	Total social costs by vehicle type; comparison with total revenues
<b>Promoting fair charging</b>			
Port use charges: inter-country comparisons	✓✓	MSC for the use each port	Accounts information for ports
Rail track access charges for international freight	✓✓	MSC for freight trains' use of the infrastructure	Accounts information for freight, passenger trains

Supposing that a national decision-maker had overall responsibility for determining strategies for all the policy examples in Table 3.1 that are identified as priorities for UNITE. What type of information system would this policy-maker require?

To answer all of these specific policy questions, a highly disaggregate system of information would be required. In UNITE, this form of information system has been termed the “comprehensive information system”.

The “comprehensive information system” could potentially incorporate a vast array of data. It could include marginal, variable and fixed costs, benefits and revenues – both those associated with infrastructure use and with existing and future infrastructure provision. Both financial and social costs could be included.

At the most disaggregate level possible, the comprehensive information system could be used to answer questions of:

- **efficiency** – what are the marginal costs associated with an individual trip on a link of the transport network, and how do these compare to marginal revenues?
- **equity** – how much does an individual user of a certain income group pay for a trip, in relation to the overall social costs associated with such a trip<sup>7</sup>?

To produce such a comprehensive information system **within UNITE** for all the links and nodes and all the transport modes for a country would be extremely demanding, at an empirical level, for most countries. Furthermore, it is questionable whether the costs of data collection and analysis could exceed the benefits of having such a detailed information system, for any given country. Nevertheless, the need for such disaggregate information, in order to address specific pricing and taxation questions, is very clear<sup>8</sup>.

### 3.2 The Limitations of Existing Accounts

The previous section identified the need for highly disaggregate information, for the purpose of determining infrastructure use charges. The question then arises: how well is this requirement met by existing accounts?

To answer this question, a brief worldwide review of existing transport accounts has been conducted (the full review is included at Appendix I). Amongst the findings is that:

- cost and revenue information in existing accounts is extremely aggregate, typically at the national level, disaggregated by mode (road, rail, etc), and sometimes by vehicle type - thus existing accounts do not provide all the information required to implement differentiated charging policies;
- questions of who pays / who imposes costs are not explicitly addressed - so it is not straightforward to see whether particular groups of users (e.g. high/low

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<sup>7</sup> Several distinct concepts of equity were found in the transport accounts and pricing policy literature. The alternatives are highlighted and a preferred interpretation set out in Appendix II.

<sup>8</sup> Of course, the information need not be more disaggregate than the charging tools that are likely to be available in the future can incorporate (e.g. electronic road pricing may vary by road link and by half hour time period).

income, urban/rural dwellers, domestic/international traffic) are under- or over-paying in relation to the social costs they impose;

- one of the common themes of the accounts reviewed has been the desire to determine the current level of cost coverage - this raises a further question: how (if at all) does cost-coverage information relate to UNITE's priority policy issue of pricing and taxation of infrastructure use? This question is addressed in Section 3.4.

Two further limitations are apparent:

- arbitrary allocation of costs to vehicle types or user groups – costs that are truly joint, and for which there is no theoretical basis for allocation to individual user groups, are often arbitrarily allocated to individual user groups. This is misleading to policy-makers as it implicitly suggests some form of causality between transport users' behaviour and costs. It is preferable to present policy-makers with information on the level of disaggregation at which costs may be sensibly allocated; and,
- cost information that relates to past, sunk costs – commonly, existing accounts relate to costs that have been incurred in the past (e.g. the full costs of a road network). Neither policy-makers nor transport users have any influence whatsoever over these costs – even if the transport system in question were completely shut down. Current infrastructure costs and the costs of future infrastructure provision are clearly relevant to policy-makers. This implies that information should be forward-looking, rather than backward-looking<sup>9</sup>.

Thus it appears that existing accounts contain data that is so aggregate that neither efficiency nor equity questions can be successfully answered at the level of detail needed to set charges for an individual link or node in the transport system, that existing accounts often have an arbitrary cost allocation basis and are backward-looking.

Without an appropriately disaggregated template from past experience, it must be UNITE's ambition to provide more disaggregate transport accounts wherever possible, looking into the future and avoiding arbitrary allocation.

### 3.3 The Relevance of Cost Coverage Information

The meaning of *cost coverage*, as used in the literature, is generally 'the extent to which revenues match, exceed or fall short of costs'. Furthermore, cost coverage usually compares total (or average) costs with total (or average) revenues<sup>10</sup>.

In UNITE, the intention is to provide the cost and revenue information separately, and in a highly disaggregated form wherever possible. Nevertheless, given the focus of

<sup>9</sup> It is recognised, however, that many parts of historic costs will be useful in estimating the future renewals requirements and expenditures for transport infrastructure. Furthermore, where there are remaining project finance requirements, outstanding debt may remain relevant.

<sup>10</sup> a significant exception is the Finnish social accounts study (Metsaranta, 1999), which also estimates and compares variable costs with variable revenues.



much pricing theory on *marginal* costs, it is worth stating why total, *and* average, costs and revenues are relevant to the priority policy area of pricing and taxation.

### 3.3.1 Equity

Equity may be of interest between income classes, between transport modes, between passengers and freight, between vehicle classes, or between trips originating in different countries. There is no convenient, unique definition of equity in the literature<sup>11</sup>, however equity clearly depends on the relationship between costs and charges. Where excess revenues are generated in relation to costs (e.g. by charges set at a high level to restrain demand) who pays and who stands to benefit from the recycled revenues are key questions. On the other hand, given the income characteristics of users of each mode, there are potential equity reasons for subsidising particular modes whilst requiring others to recover (or over-recover) costs.

In order to assess the equity characteristics of a particular charging structure, cost and revenue information may be needed by income class of user, or by nationality of user, or by other disaggregations. In the extreme, equity analysis could theoretically require information at the level of the individual user, but it is intended in UNITE to compromise with aggregated data for social groups.

### 3.3.2 Efficiency

Economic efficiency concerns, from a public finance perspective, are another potential source of cost recovery constraints on charging, and hence another demand for cost recovery information. Raising government funds is costly because most taxes require market distortions on labour and product markets. Second best pricing rules require information on the costs that are to be covered. On the other hand, when transport industries are characterised by increasing returns to scale, there may be an efficiency rationale for the public to subsidise part of the fixed costs out of tax revenue, whilst leaving the operator free to charge for marginal costs (which equates, *de facto*, to establishing cost recovery for the operator and again requires total cost and total revenue information).

### 3.3.3 Financial viability

Finally, private infrastructure owners – e.g. German or UK rail track owners; French autoroutes - are driven by profit maximisation or similar objectives. Total cost coverage is a requirement for financial viability in the long run and variable cost coverage is a requirement for financial viability in the short run. There is therefore a private sector requirement for cost recovery at the level of the enterprise, which is a relevant constraint in some cases on governments' charge-setting policies.

Hence although the total cost and revenue information in the existing accounts has been found to be unsatisfactory for our purposes (i.e. setting differentiated charges), detailed information on total costs and revenues, at a detailed sub-national level, is

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<sup>11</sup> a more in-depth discussion of equity, and its role in UNITE, is given in Appendix II.

relevant to the pricing and taxation policies at the heart of UNITE. This is what the UNITE accounts will seek to provide.

In Section 3.4, a range of further technical issues are raised and discussed.

### **3.4 General Technical Issues Arising**

#### **3.4.1 Scope of the Information to be Collected in UNITE**

Section 3.1 has set out the potential scope of cost, revenue and benefit categories of potential relevance to UNITE. Which of these are relevant to the charging of transport infrastructure use?

Costs that are purely internal to the transport user are both incurred by the transport user and “paid” by the transport user. For this reason, they are of no relevance whatsoever to infrastructure charging. Such costs may be immediately ruled out of scope for the purposes of UNITE. They may provide interesting secondary information (e.g. about the magnitude of new charges in relation to user costs), but will only be presented in UNITE if they are needed in the calculation of external costs.

To answer efficiency questions, the costs, benefits and revenues of infrastructure use provide essential information.

For equity questions of who pays/ who incurs costs, the same information is also relevant. In addition, the costs of infrastructure provision – both past and future – are also of interest. Such costs may be financial, i.e. the capital costs associated with creating the infrastructure, but they also include the environmental costs associated with providing the infrastructure (e.g. community separation/severance, landscape destruction etc.).

A remaining question is over the inclusion or exclusion of the benefits of infrastructure provision. These are not relevant to efficiency considerations but could be relevant to some views of equity. However, it is very difficult to measure benefits from transport systems in aggregate, as opposed to benefits from changes in the system. The preliminary conclusion in this report is that accounts are not the right mechanism through which to explore the measurement of transport benefits.

#### **3.4.2 The Appropriate Basis – Social or Business?**

It is possible for transport information to be prepared on a social basis, taking into consideration the wider costs and benefits to society, or to be prepared on a business or financial basis.

UNITE will inevitably draw on information sources that are sources from business accounts and from financial flows. So, much of the data to be used will be on a business basis, and it is important to highlight the linkages with this data when the results are presented.

Having said this, since the project is concerned with the wider impacts of transport provision and use on society at large, the primary basis for answering both efficiency and equity questions will naturally be a social basis.

Preparing information on a social basis enables like-for-like comparisons across modes, even when the different modes face different institutional settings – e.g. publicly owned or privately owned. Clearly use of a social basis raises technical issues relating to conversion of information on a business basis to a social basis. For example, the principles of asset valuation in business accounts are affected by taxation and accountancy laws that may be unrelated to a social resource accounting basis.

### **3.4.3 Use of National or European Datasets**

The emphasis within Section 3.1 was on a highly disaggregate system of transport information. This raises the issue of whether national transport information, or European information (e.g. summarised in Eurostat publications) is of more relevance to UNITE.

Although European datasets seek to provide data on a common basis across countries, there are two disadvantages of such data. The first, and most important, is that to develop a common standard for collating many countries' data generally implies the need to collect highly aggregate information. This conflicts with the need for highly disaggregate data, and means that valuable disaggregate data from individual countries is likely to be omitted from European-wide datasets.

A second disadvantage is that each country uses different conventions for the definition of statistics. While European datasets may seek to document each set off national definitions, inevitably many important definitional aspects are lost when national datasets are not used directly.

The preference in UNITE is for the use of the most disaggregate datasets possible, implying that national datasets will play the dominant role in the project.

### **3.4.4 Technical Issues Common to Any Study**

Lastly, there is a range of technical issues that need to be determined for any study of this nature. The issues that are discussed in turn here are:

- treatment of uncertainty;
- valuation basis;
- issues of transferring values between contexts;
- price base, year for which values are presented, year to which costs etc. are discounted back to.

In relation to uncertainty, in order for policymakers to understand the nature of the information decisions are to be based upon, they need to understand the level of confidence that can be placed in cost estimates. The level of uncertainty should thus

be made explicit, and may be represented by providing low and high range estimates, along with a description of the level of certainty attached to the estimates.

For aspects such as the value of time, accidents and environmental damages a range of valuation bases exist. In general, a preference for use of a willingness to pay basis exists. For effects which are indirect and not readily perceived, such as the health effects of air pollution, this should be combined with the impact pathway approach, to trace through and value the ultimate effects of the pollution, rather than valuing the pollution itself. Use of such a basis, although not the specific values, will be common across the different countries and case studies contained in UNITE.

In the case of both the transport accounts and marginal costs, there will typically be a need to transfer values between contexts. The two most obvious examples are transferring economic values between countries and between years. The approaches proposed for value transfer when values relate to willingness to pay estimates are:

- transferring between countries – use of real GDP per capita, on a purchasing power parity basis<sup>12</sup>; and,
- transferring between years – as a first approximation, factoring by growth in real GDP per capita.

Where existing valuation studies support the use of more advanced value transfer approaches, such information will be exploited.

The main year for accounts and marginal cost estimates in UNITE is now proposed as 1998. This would naturally form the common year for the price base, year for which values are presented<sup>13</sup>, and year for which values are discounted back to.

### 3.5 General Technical Issues Closed at this Stage of UNITE

This chapter concludes by setting out the issues that should be closed at this stage of the UNITE project, and those that should remain open at this stage. The intention here is to maximise the potential for productive work in the future stages of UNITE, by providing a focus for subsequent activities.

The general technical issues that should be closed at this stage of UNITE are:

- G1. **Scope should be restricted** – efficiency and equity objectives are of primary importance in setting infrastructure charges. Consequently, the information collected in UNITE should be restricted to: the costs, benefits and revenues of infrastructure use; and, the future costs associated with existing and planned infrastructure provision;
- G2. **Avoidance of arbitrary allocation** – no cost category that is a joint cost for a number of user groups should be allocated to any individual user group;

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<sup>12</sup> Use of purchasing power parity exchange rates, as opposed to use of market exchange rates.

<sup>13</sup> Except for future and past year accounts, where the value would be for the year in question.

- G3. **Exclusion of purely internal costs** – elements of user time, vehicle operating cost etc. that are purely internal to the transport user are not relevant to the setting of infrastructure charges, and in general will not be collected;
- G4. **Exclusion of benefits of infrastructure provision** – such benefits are not appropriately dealt with through the mechanism of transport accounts.
- G5. **Social as opposed to business/financial basis** – although UNITE will inevitably provide much information on a business/financial basis, the primary basis for analysis will be social;
- G6. **Preference for use of national datasets** – to fully exploit data at its most disaggregate level, national rather than Europe-wider datasets will be the primary source;
- G7. **Explicit treatment of uncertainty** – low and high estimates will be provided, along with the approximate levels of confidence;
- G8. **Use of common valuation approaches** – such bases will be established, in preference to the use of national conventions for values (e.g. the willingness to pay approach will be proposed for accidents, and this approach may conflict with national evaluation approaches);
- G9. **Use of common value transfer procedures** – procedures for adapting values to suit the application context will be common across the project; and,
- G10. **Use of a common price base, value, discount years** – the base years will also be common across the UNITE project.

## 4 Implications for the Transport Accounts in UNITE

### 4.1 The Distinction between “Ideal Accounts” and “Pilot Accounts”

In Chapter 3 the need for transport accounts to meet policymakers’ requirements has emphasised the need for provision of a comprehensive database of highly disaggregate information.

In setting the future direction of UNITE activities for the transport accounts, an important distinction must immediately be made between the:

- **“ideal accounts”** – these provide the basis for the structure and methodology for a very ambitious, highly disaggregate form of accounts – able to answer efficiency and equity issues at a very detailed level; and,
- **“pilot accounts”** – these form the empirical accounts, representing a compromise between the ideal accounts, and what is feasible for the 18 countries in UNITE for which accounts will be produced.

The major constraint that distinguishes the ideal accounts from the pilot accounts is clearly the level of disaggregate data availability for each individual country.

### 4.2 Technical Issues relating to Accounts

#### 4.2.1 Scope of the transport accounts

The selection criteria for transport account activities should reflect the scope set out for the project as a whole (i.e. as indicated in points G1-G4 in Chapter 3). These include all categories of cost and revenue associated with infrastructure use, and the fixed costs of infrastructure provision.

In the case of the fixed costs of infrastructure provision, there is a distinction between the capital costs of infrastructure, and the environmental costs associated with infrastructure provision; the distinction being that the procedures for estimating the environmental costs of infrastructure provision are at an early stage of development. For this reason, methodologies for estimating such costs should be examined in UNITE, but actual values are unlikely to result from the empirical analysis within the project.

#### 4.2.2 Level of disaggregation of the accounts

The key issue here is the highest level of disaggregation at which efficiency and equity analysis needs to be made by policymakers. The discussion of needs from the efficiency perspective is postponed to Chapter 5.

In the case of equity, disaggregation may be geographical (national, regional, urban etc.), modal, by vehicle type, journey purpose, time at which trip is made, user type and income group of user.

Of these potential disaggregations, analysis by income group of user would appear to be the most relevant analysis perspective, since marginal utility varies with income and intervention in the transport market is often made on “social welfare” grounds.

The role of congestion costs in existing accounts has been the subject of much controversy. In part this has been because such accounts have been highly aggregate, and often only designed to answer equity issues at the level of an overall mode. For “modal equity”, the role of intra-modal externalities such as congestion is ambiguous. This issue also applies to intra-modal accident costs. These categories should appear in the accounts, but should not be included in total social costs at an aggregate level.

However, the important role of congestion and certain parts of accident costs is more readily apparent in relation to a highly disaggregate information system.

#### **4.2.3 Methodological issues relating to cost estimation**

Cost estimation issues relating to marginal costs are covered in Chapter 5, so this section focuses on estimation of fixed costs. As indicated in Chapter 3, these relevant costs will be forward-looking, taking into consideration the future avoidable costs associated with infrastructure provision. This necessarily excludes any elements of historic costs that will not require renewal in the future. Thus, land costs are excluded, as are many categories of embankments and cuttings that will never need renewal.

In relation to these future costs, three key issues identified here are:

- which asset valuation convention should be adopted to value transport infrastructure networks? - options include historic cost and modern equivalent assets valuations;
- how should consumption of fixed costs (depreciation) be calculated?
- what approach should be taken to the opportunity cost of capital (interest)?

These issues remain to be resolved in the subsequent work within UNITE. The main issue raised in Chapter 3 (point G4), is the need to provide information on a social resource accounting basis, as opposed to a business or financial accounting basis.

#### **4.2.4 Methodological issues relating to cost allocation**

What principles should be used in allocating fixed costs, for example between modes (e.g. inter-modal terminals), between passengers and freight, between vehicle classes and between services used by different income groups?

Various cost allocation methods have been proposed in the theoretical literature or adopted in practice. Because by definition there is no direct link between fixed costs and infrastructure use, criteria for cost allocation tend to be on a more or less arbitrary basis. Criteria used in the past have included allocation of fixed costs:

- in proportion to variable costs (i.e. implying that the average cost is associated with the user);

- in inverse proportion to demand elasticities in market segments (e.g. Ramsey-Boiteux approaches to mark-ups over marginal costs); questions of equity may be raised if inelastic demand does not correspond to higher ability to pay);
- according to which group of users is classified as the main user (the 'prime user' concept); and,
- allocation of fixed costs to peak period traffic.

As with the previous sub-section, cost allocation procedures remain to be identified within UNITE. Such procedures should be consistent with the desire to answer equity issues by income group of user. One approach to doing this is to adopt no single allocation method, but rather simply to examine the contribution made to fixed costs by the various groups at the present time.

#### **4.2.5 Avoiding arbitrary allocation – the use of tiered accounts**

The preceding sections have emphasised the need to avoid the arbitrary allocation of joint costs. What design implications follow for the accounts from this?

At the most disaggregate level – an individual trip at a given location and time – only a very restricted proportion of total costs will be attributable; marginal social costs are clearly directly attributable to an individual trip.

In contrast, at an aggregate level – for the whole of any of the road, rail, air, inland waterway or short-sea shipping sectors – approaching 100% of total costs may be attributed to the sector.

Thus, different blocks or costs may be attributed at different levels of aggregation. As an example of this, the rail sector in a given country may be split up into:

1. passenger and freight;
2. short-distance (urban) and long-distance (inter-urban);
3. services in different regions; and,
4. individual rail services at specific times of day.

For each level of disaggregation, the costs become more difficult to allocate, and it is proposed that costs should only be associated with specific disaggregations where there is a clear basis for doing so.

This approach to avoiding arbitrary cost allocation – the use of different blocks or tiers of accounts – would enable the identification of different groups of accounts at the most appropriate level of disaggregation.

#### **4.2.6 Features of the ideal accounts**

This sub-section and the following one are intended to define the boundaries of the ideal accounts and the pilot accounts.



Building on the previous discussion in this section, the key features of the ideal accounts will include:

- a high level of disaggregation – reflecting factors such as income group, location, time period at the transport link/ terminal level;
- full information about the financial and social cost structure – including marginal, variable and fixed costs;
- similarly, full information on the charging/ taxation structure – including variable and fixed components;
- use of a basis of social cost accounting – as opposed to purely financial or business accounting;
- dynamic - examining changes in response to new charging structures/levels through the use of transport modelling and enabling the non-linearity of cost functions such as congestion to be taken into account by means of demand and supply interactions;
- capable of aggregation to the appropriate level of decision-making – to enable examination of who incurs costs and how much they pay, for different geographic areas, modes, income groups etc.

The distinction between what is included within the ideal accounts work and the integration component of UNITE is taken up in Chapter 6.

#### **4.2.7 Features of the Pilot Accounts**

Section 4.1 has highlighted the need to make compromises in relation to the ideal account requirements, particularly taking into account data constraints for each country in UNITE.

The compromises necessary to deliver the pilot accounts are likely to involve limitations in relation to:

- level of disaggregation – this will be depend crucially on the level at which existing data is collected, and so will be highly country-specific;
- absence of transport modelling – costs will be reported at the current level of transport demand; and,
- lack of scenario analysis – for the base year of the accounts the situation as it was will be recorded (not a “what if” scenario); for the future year, the most likely situation will be recorded (an extrapolation of existing trends taking into account known policy developments, not a scenario approach).

#### **4.3 Accounts-related Technical Issues Closed at this Stage of UNITE**

The issues that have been determined at this stage of UNITE are:

- A1. **Selection criteria for items to be included in the accounts are defined by points G1-G4 (Chapter 3);**

- A2. **Environmental costs associated with infrastructure provision should be included at a methodological level** – but not at an empirical level;
- A3. **Social basis as opposed to a business or financial basis** – as stated in G5 (again, with clear linkages back to the source of financial data, where this is used);
- A4. **Income group is the most appropriate level of disaggregation** - for consideration of equity issues;
- A5. **Congestion is relevant for equity issues** – at a disaggregate level such costs may be included in the analysis with certainty; and,
- A6. **The major distinction between the way in which ideal accounts and pilot accounts are defined** – in particular, pilot accounts are likely to be more aggregate, exclude transport modelling, and will not be based on scenario analysis.

Since the accounts in UNITE have been defined to include marginal cost information, the conclusions of Chapter 5 will also be relevant here.

#### **4.4 Accounts-related Technical Issues Remaining Open at this Stage of UNITE**

The main issues that remain open at this stage of UNITE include:

- B1. **The exact definition of disaggregation** – in particular, what this should be from an equity perspective;
- B2. **What is the appropriate counterpart to income group for freight transport?** - is it commodity classification, on the basis that this is the key information needed to trace through who receives the benefits or bears the costs?;
- B3. **Does congestion have a role in aggregated accounts?** – if so, what is this role, and is the same issue relevant for the intra-modal part of accident costs?; and,
- B4. **What are the appropriate approaches to fixed cost estimation, cost allocation and the opportunity cost of capital?** – particularly in relation to the equity issues discussed above.

## 5 Implications for the Marginal Cost Analysis in UNITE

### 5.1 The Role for Marginal Costs

In the previous chapters, particularly Chapter 3, the emphasis placed on the transport accounts has defined them in a way that at the most disaggregate level could include marginal cost information.

Thus, this chapter complements the previous ones, at the same time as providing some direction for the marginal cost case studies – which do not directly relate to the transport accounts.

### 5.2 Technical Issues relating to Marginal Costs

#### 5.2.1 Which categories should be included?

According to theory charges for infrastructure use that seek to maximise economic efficiency should be based on marginal social costs. This is the case in the absence of constraints such as scarce public funds or equity considerations (constraints discussed in Chapter 4).

The components of marginal social cost can be summarised in the following equation:

$$MSC = MINFR + MOPC + MECC + MEACC + MEEC$$

Where: MINFR - marginal infrastructure charge; MOPC - marginal operating cost; MECC - marginal external congestion cost; MEACC – marginal accident cost; MEEC – marginal environmental cost.

In comparing marginal social costs with existing charges, the following components of the current price are relevant:

$$\text{Price} = \text{MOPC} + \text{Taxes} - \text{Subsidies} + \text{Charges}$$

Comparison between MSC and the current Price then identifies the additional charge to be made specific to a given mode, location and time. Thus, the categories for inclusion relate to cost, benefit and revenue categories that vary with infrastructure use, i.e. with a small increase in vehicle kilometres.

Since the marginal operating cost that is internal to users cancels out, only cost categories external to the individual user are relevant to the setting of taxes and charges. These include the external component of congestion. For the benefits of infrastructure use, there is a general consensus (e.g. Laskshmanan et al., 1997) that with the exception of the Mohring effect such benefits do not exist; no empirical evidence exists that an additional trip made by a transport user leads to wider benefits to society.

Costs, benefits and revenues that do not vary with infrastructure use are thus not relevant in the above calculus. These include the fixed costs of infrastructure

provision, and the corresponding external costs (landscape, barrier effects etc.), and certain categories of charge including vehicle sales taxes. These categories are discussed further in Section 4.2.

There is a need to carefully define the revenue categories that vary with infrastructure use and should be considered. This includes the issue of whether parking should be considered as an unpaid resource cost, and whether taxes such as value added tax, fixed registration taxes, social security contributions for labour employed in the freight transport sector etc. should be included.

### **5.2.2 Level of disaggregation of the marginal costs**

Since marginal costs may be highly location and time period specific, there is a need for highly disaggregate information. This is particularly the case for congestion and environmental costs – infrastructure wear and tear costs are likely to be much more uniform across locations, and certainly over different time periods.

At the most detailed level of geographic disaggregation, a need for disaggregation at the level of the individual transport link or transport terminal would be the ideal starting point for the analysis of marginal costs.

### **5.2.3 Methodological issues relating to cost estimation of individual categories**

Although the instruments for implementation of charging regimes are not the focus of UNITE, it should be noted that appropriately disaggregate instruments for charging for all collective forms of transport are available (rail, air, inland waterway, short-sea shipping), and that in the road sector there is rapid progress in developing instruments that enable highly differentiated charges to be levied (e.g. Singapore road pricing, Californian Inter-State congestion charging).

The implementation of more differentiated charging systems is an issue outside of UNITE's remit separate issue, but suffice it to say here that the issue of available instruments should not affect the level of disaggregation at which the UNITE analysis is conducted. Clearly, highly disaggregate information may be aggregated to whatever level is needed when practical issues such as road pricing technologies are considered.

Thus, for each individual category of cost, benefit or revenue considered in the marginal cost analysis, the starting point should be the lowest possible level of disaggregation.

The key methodological issues are highlighted in Table 5.1. These are not exhaustive, but are intended to highlight the more fundamental issues to be addressed.

**Table 5.1: Selected Methodological Issues**

<b>Cost category</b>	<b>Quantification issues</b>	<b>Valuation issues</b>
Marginal infrastructure cost	<ul style="list-style-type: none"> <li>• Determination of marginal maintenance proportion</li> <li>• variation by vehicle type</li> </ul>	
Marginal operating cost	<ul style="list-style-type: none"> <li>• relationship between passenger demand changes and vehicle km changes</li> </ul>	
Congestion	<ul style="list-style-type: none"> <li>• level of disaggregation</li> <li>• equilibrium computation</li> </ul>	<ul style="list-style-type: none"> <li>• value of time in congested conditions;</li> </ul>
Scarcity	<ul style="list-style-type: none"> <li>• schedule delay costs;</li> </ul>	
Mohring effect	<ul style="list-style-type: none"> <li>• passenger demand/ vehicle km relationship</li> </ul>	<ul style="list-style-type: none"> <li>• value of schedule delay or waiting time</li> </ul>
Accidents	<ul style="list-style-type: none"> <li>• risk rate variation with speed, additional vehicle kms</li> </ul>	<ul style="list-style-type: none"> <li>• value of statistical life</li> <li>• inclusion of friends &amp; family valuation</li> <li>• proportion internalised by insurance premia</li> </ul>
Local/ regional air pollution	<ul style="list-style-type: none"> <li>• level of disaggregation</li> </ul>	<ul style="list-style-type: none"> <li>• value of years of life lost</li> <li>• consistency with accident values</li> </ul>
Global warming	<ul style="list-style-type: none"> <li>• variation in emissions by vehicle type, traffic speed</li> </ul>	<ul style="list-style-type: none"> <li>• valuation of marginal cost</li> </ul>
Noise		<ul style="list-style-type: none"> <li>• valuation of marginal cost</li> </ul>
Taxes, subsidies and charges	<ul style="list-style-type: none"> <li>• which taxes should count as transport charges?</li> </ul>	

For each of the individual categories, a core output of the UNITE project will be the basic methodology and empirical results. Another fundamental need is the ability to transfer empirical results between contexts. Transferability is required in respect of transfers between:

- **locations** – e.g. the ability to transfer air pollution cost estimates from one motorway to another in the same country, or a different country; and,
- **base year and future year** – e.g. transferring accident cost estimates from 1998 to 2010, taking account of factors such as growth in the values of statistical life and trend decreases in road fatality rates.

#### **5.2.4 Methodological issues relating to the overall analysis framework**

Pricing based on marginal costs requires that the equilibrium marginal social cost be charged, namely that the demand reaction to changes in prices and consequent changes in external costs needs to be considered. A typical example is the marginal external congestion cost: whenever this cost is charged to the users, demand drops and so does the marginal congestion cost. This is not an unimportant curiozum: computations have shown that the marginal external congestion cost in the present

urban peak may be 3 to 6 times as high as the equilibrium marginal congestion cost (Proost and Van Dender, 1999).

This implies the need for cost functions to be specified, in circumstances where marginal and average costs are not equal, rather than solely estimates at the current level of demand.

In addition to the marginal cost information, the implications of the efficiency aspects of UNITE also relate to the transport accounts. The accounts that have been reviewed at this stage of the UNITE project (Appendix I) were not designed with the purpose of charging for specific infrastructure links or terminals. For this reason, constructing such accounts would not result in information that directly or indirectly addressed the efficiency requirements discussed in this section.

The information requirements for the analysis of link-specific transport infrastructure use charges are extensive, particularly if a comprehensive information system were to be created for the transport networks of each country. Highly disaggregated data – by mode/vehicle type, location, time period etc. – would be required. Thus, an important technical question is whether such information requirements can be met, particularly given the constraints of availability of data in a suitable format, and whether it would be worth the costs of meeting them. It may be noted that few public transport systems actually differentiate price down to this level, even though both the technology and the information to do so are available within the organisation. The optimal degree of disaggregation at which to measure marginal social cost is a key issue here.

### **5.3 Marginal Cost-related Technical Issues Closed at this Stage of UNITE**

The marginal cost related issues that may be closed at this stage of UNITE are:

- C1. Selection criteria for items to be included relate to all categories of cost/benefit/ revenue that vary with infrastructure use ;**
- C2. Transport link or terminal is the most appropriate level of disaggregation** – for consideration of efficiency issues;
- C3. All underlying factors that affect the value per additional vehicle km must be identified** – in the methodology for each individual cost category;
- C4. Consistency between accident and environmental valuation approaches must be achieved** – since such approaches typically share a common basis; and,
- C5. Value transfer methodologies must be specified** – for the empirical results to be adapted to other locations, time periods, years etc.

Since the accounts in UNITE have been defined to include marginal cost information, the conclusions of Chapter 4 will also be relevant here.

### **5.4 Marginal Cost-related Technical Issues Remaining Open at this Stage of UNITE**

The main issues that remain open at this stage of UNITE include:

- D1. **The exact definition of disaggregation remains to be defined** – depending on the underlying factors for each of the individual cost categories;
- D2. **How should the relationship between changes in passenger demand and vehicle kms be determined?** – this is relevant to supplier operating costs, and to all other costs associated with vehicle movements.
- D3. **Which fixed charges, revenues etc. are relevant to the efficiency analysis?** – should any of these be included, and if so, which?; and,
- D4. **What role do unpaid parking costs have in the efficiency analysis?** – , should unpaid parking costs be treated as a term in the analysis, or considered as an unpaid but fixed resource cost? In the latter case, should there ideally be an alternative valuation based on the scarcity value of parking spaces?

## **6 The Role for Integration**

### **6.1 The Purpose of the Integration of Approaches**

The last of the three core components of the UNITE project, combining both transport accounts and marginal costs, is the “integration” component. The focus here is on how to produce the best possible information, based on accounts and marginal costs, for the purposes of policy making, and in particular, for the purposes of deciding on the key pricing and taxation issues identified.

At present there is a gulf between the use of information relating to efficiency (marginal costs) and the use of information relating to cost recovery/equity (accounts). Thus, some governments just rely on marginal cost information to set infrastructure charges, whereas others rely solely on accounts information in price setting.

The basic purpose of the integration element in UNITE is to show how the combined accounts and marginal cost information offer potential for a more broadly based infrastructure charging policy, that will meet with greater acceptance due to a more holistic approach.

Since the empirical work on accounts and marginal costs prior to the integration research yielding results, integration proceeds as a parallel research stream within UNITE. The main point of convergence will occur when the first tranche of accounts are produced, at the same time as the first integration report becomes available.

### **6.2 Alternative Perspectives on Integration**

There are a number of alternative perspectives on integration. In particular, two which will both be pursued within UNITE are:

1. theoretical integration – the theories underlying marginal costs and accounts are brought together in an overall theoretical framework, providing a theoretical foundation for their combined use;
2. integrated use of information – a combined information system created using both marginal cost and accounts information, and focusing on the practical considerations of scope and consistency within the UNITE information, from the viewpoint of policy-makers needs.

Perspective 1 is demanding in that it relies on the success of the project in reconciling, or at least placing in very clear perspective, theories that have developed from very different traditions – marginal cost theories of pricing based on welfare economics, accounting theories based on some form of resource accounting or business principles. This line of enquiry is therefore particularly challenging but necessary to attempt.



Perspective 2 offers much more predictable outputs, given that it focuses on the practical combination of empirical data sources (accounts, marginal costs). This is discussed in the following section.

### **6.3 Towards a Framework for the Integrated Use of Information**

To satisfy the theoretical perspective, the integration research will develop a more holistic theoretical context for the marginal costs and accounts, which will show how the UNITE information can be used to address:

- efficiency considerations - including efficiency in the wider economy (outside transport, including public finance, and public transport subsidy).
- equity considerations - ‘equity’ will be defined rigorously within this work and will represent not simply modal cost coverage, but the more fundamental issues relating to income distribution. Consumers will be distinguished by income group and by transport characteristics - e.g. car ownership.
- general equilibrium considerations, including future equilibria under new charging policy scenarios - the results will be both theoretical and empirical.

From a practical ‘integrated use’ perspective, the research will:

- highlight the processes through which data/information will actually be processed and used by the final user;
- examine ways in which the data may be manipulated to produce new information of wider relevance (e.g. by means of modelling) - for example this may include data for future scenarios, or for contexts which differ from those in which the original data was estimated;
- address practical aspects of data storage and access.

It is recognised that this broad specification for the integration activities is extremely demanding, and the work on these issues will initially be conceptual in nature, determining how the information produced by accounts and marginal cost estimates can be used in answering these questions rather than in actually producing the answers.

## 7 Outline of the Overall UNITE Approach

### 7.1 The Overall Focus of UNITE

This report has sought to separate out the issues of most policy relevance to the charging of infrastructure use from those issues that are of secondary importance. This has had two important implications:

- **Definition of the scope of UNITE** – in focusing on charging for infrastructure use, taking into account efficiency and equity criteria, the following categories have been identified as within the scope of UNITE: firstly, all costs, benefits and revenues that vary with changes in the use of infrastructure; secondly, the prospective costs, both capital and environmental, of infrastructure provision. Costs that are purely internal to the user have been ruled out of scope, as have the benefits of infrastructure provision; and,
- **Identification of the need for a comprehensive information system** - a highly disaggregate set of information is needed, encompassing marginal, variable and fixed costs (along with the other categories mentioned above).

In order to successfully address questions in relation to the efficiency and equity dimensions of infrastructure charging, strong emphasis has been placed on the need for highly disaggregate transport information – taking into consideration such factors specific to the costs relating to individual transport links/terminals and users by income group.

### 7.2 Implications for The Main Components of UNITE

The need for a highly disaggregated information system has the following implications for the main components of UNITE:

- **Ideal Transport Accounts** – this methodological approach should produce a structure for accounts that enables both efficiency and equity issues to be answered at a fine level of detail. Furthermore, the use of transport modelling is to be included in order to assess demand/supply responses to more differentiated charging systems;
- **Pilot Transport Accounts** – producing empirical accounts for each of the 18 countries in UNITE will inevitably result in many compromises, based on data availability by country.
- **Marginal Costs** – by defining the need for a comprehensive information system, the support role provided by the marginal cost component is further emphasised – as is the need to supply methodologies and results that are readily transferable between contexts; and,
- **Integration** – this focuses on the theoretical framework for combining accounts and marginal cost information, and on the combined use of such information.

## Glossary of Terms

Based on INFRAS (1998) and intended for subsequent extension and refinement in UNITE.

<b>Accident insurance</b>	Voluntary or mandated insurance against the risks of accidents (property and health). The premia serve to (partly) internalise external costs.
<b>Accounts</b>	In general, accounts compare costs and revenues/benefits of the transport system at an aggregate level. <i>Business accounts</i> focus on financial costs and revenues which are borne by one infrastructure provider. <i>Social accounts</i> embrace a wider set of costs (typically including environmental and safety externalities). <i>National accounts</i> (for transport) are specifically at a country level, across all organisations, and may follow the conventions of national accounting.
<b>Average costs</b>	Total costs in a period, divided by the quantity (output) produced/consumed in that period. Long term average costs include a share of fixed costs (e.g. costs associated with expansion of existing infrastructure).
<b>Club good</b>	A good that is non-rival but congestible and excludable. I.e. when it is provided it can be used by extra people at little or no extra cost, until it becomes congested. Access to it can be limited to members of the club.
<b>Consumer surplus</b>	Measures the net benefits from consuming a certain quantity of a good/service. It measures how much a consumer would be willing at maximum to pay for the consumption of a good over and above the market price.
<b>Contingent valuation Method</b>	Valuation technique which asks people directly method how much they are willing to pay/to accept for improving/deteriorating environmental quality. Method is based on the → stated preference approach; it is the only method that allows the estimation of existence value.
<b>Cost-effectiveness</b>	Seeks to minimise the costs of achieving a given (e.g. environmental) objective/target. This principle is a → “second-best” efficiency criterion, often used when a full cost-benefit analysis is not feasible.
<b>Differentiation</b>	Differentiation of charges according environmental performance (e.g. fuel consumption, EURO-norms), etc.
<b>Earmarking</b>	Tying revenues received to a specific use (e.g. to finance road network expansion).
<b>ECMT</b>	European Conference of Ministers of Transport
<b>Efficiency</b>	Undertaking all measures for which the gainers would be prepared to fully compensate the losers.

<b>Elasticity</b>	Percentage change in demand in response to a one percent price increase or decrease (price elasticity); or increase/decrease in income (income elasticity), or other variable.
<b>Environmental effectiveness</b>	Effect on the environment that a given policy response generates. This criterion ignores the economic costs that may result from implementing the policy.
<b>Equity</b>	Criterion that may modify the political decision in order to achieve a particular distribution of incomes in the economy (e.g. subsidies for public transport: for low-income groups; or for regional development objectives).
<b>EURO-(Norms)</b>	EU-Norms for maximal exhaustion-level of air pollutants for road vehicles.
<b>Externality (external cost)</b>	Economic cost not normally taken into account in markets and in the decisions made by market players.
<b>(Full) fuel cycle</b>	Complete fuel cycle; comprising discovery, depletion (mining), processing, transport and use of an energy resource.
<b>Hedonic Pricing</b>	Valuation technique which infers a value for environmental quality from the implicit market for it. E.g. rent or property price differentials when exposed to varying levels of noise.
<b>HGV</b>	Heavy goods vehicle.
<b>Internalisation</b>	Incorporation of an externality into the market decision making process through pricing or regulatory intervention. In the narrow sense internalisation is implemented by charging the polluters with the damage costs of the pollution generated by them, the corresponding damage costs resp. according to the polluter pays principle.
<b>IPCC</b>	International Panel on Climate Change (scientific group within UN Framework on climate change).
<b>Marginal costs (short and long term)</b>	Costs related to a small increment in demand (e.g. an extra vehicle-kilometre driven). The distinction between short and long term marginal costs is important with respect to infrastructure costs: Whereas short term marginal costs do not consider capacity increases and are related to the costs of additional traffic using the existing infrastructure, long-term marginal costs include the capacity expansion needed to service increased traffic demands.
<b>“No regrets” level</b>	Level of internalisation at which individuals or companies achieve a net personal/private benefit (e.g. savings on the fuel bill), which exceeds the loss in welfare due to a given policy. The existence of “no regrets” options will tend to increase the political acceptability of internalisation policies.

<b>Polluter -pays- principle</b>	Political/economic principle which stipulates that the user should pay the full social cost (including environmental costs) of his/her activity.
<b>Prevention approach</b>	Technique for estimating externalities whereby the costs of preventing damage are used as a proxy for the cost of the damage itself for society.
<b>Revealed preference</b>	Valuation technique wherein consumers' choices are revealed in the marketplace (e.g. by the purchase of a good).
<b>Risk approach</b>	Technique for estimating externalities whereby external costs inferred from premia for risk factors (e.g. the cost of insurance, or of risk diversification).
<b>Road Pricing</b>	System of user charges for road transport. Different options are possible. A simple solution might be a flat charge for road use, such as the Eurovignet, a sophisticated solution is based on an electronic charging system, which charges road use according different criteria (e.g. congestion, air pollution etc.).
<b>“Second-best” policy</b>	A policy that does not correspond to the theoretically optimum solution, but one which moves at least part-way towards that optimum and is the best of the available non-optimal policies or measures.
<b>Shadow Prices</b>	Shadow price is the marginal opportunity cost of the use of a resource (i.e. the loss of benefits caused if this resource cannot be used for the next best purpose).
<b>Social costs</b>	The sum total of internal and external costs.
<b>Social cost benefit analysis</b>	Systematic estimation of all costs and benefits of a project that are relevant to society.
<b>Social marginal cost pricing</b>	A pricing scheme, which charges marginal costs (e.g. infrastructure use, congestion, environmental externalities). This scheme is proposed in the EU White Paper on 'Fair Payment of Infrastructure Use' (1998). It is based on a differentiated Road Pricing
<b>SRMC</b>	<u>Short run marginal cost pricing</u> : Social marginal cost pricing, which just considers the costs of use of existing infrastructure.
<b>Stated preference</b>	Valuation technique wherein monetary estimates are derived from hypothetical statements by individuals about their preferences. The typical method used is a questionnaire approach (e.g. contingent valuation method).
<b>Surcharge</b>	Additional local charge on a base charge (e.g. Road Pricing), differentiated according specific characteristics (local environment, congestion).
<b>Tax</b>	A levy imposed by government whose size may or may not be related to the pre-tax price of a good/service.

<b>Toll</b>	Special charge levied at a particular point where vehicles pass (e.g. tunnel, motorway, etc.).
<b>Traffic mode</b>	Category of means of transport (road, rail, aviation, shipping, etc.).
<b>Unit costs</b>	Costs per unit of service or goods provided (e.g. traffic volume).
<b>User charge</b>	Charge imposed on the user of a good (e.g. road infrastructure), often linked to the costs generated by his or her use.
<b>Variable costs</b>	Costs that change with small or large changes in traffic volumes.
<b>Variabilisation</b>	Change of fixed charges (not depending on vehicle kilometre driven) into variable charges.

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