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The Land Transport Sector: Policy and Performance

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ABSTRACT/RESUME

The land transport sector: policy and performance

This paper provides a broad overview of policy goals and instruments and commonly used performance and policy indicators related to land transport. Two policy aspects, infrastructure investment and externalities, are explored in more depth. A review of planning and decision making in individual countries reveal significant variations between countries as regards how cost-benefit analysis affect decision making about infrastructure investment. There is scope for improvements in the use of cost-benefit analysis. Estimates of external costs for fifteen European Union countries are provided, together with estimates on the extent of pricing to internalise external costs. Fuel taxes amounted to around 2% of GDP in 2000, roughly corresponding to estimated external costs related to environmental and health effects. There is a potential to reduce congestion by introducing congestion charges. This can be done in a revenue-neutral manner by transforming existing vehicle taxes and road tolls.

JEL codes: H43; Q51; R42; R48

Key words: Transport policy and performance; infrastructure investment; cost-benefit analysis; pricing of externalities

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Transports terrestres : Politiques et performances

On trouvera dans ce document de travail un large aperçu des objectifs, des instruments d'action et des indicateurs couramment utilisés pour évaluer les performances et les politiques dans le secteur des transports terrestres. Deux aspects, les investissements en infrastructures et les externalités, sont étudiés de façon plus approfondie. Un examen de la planification et de la prise de décision dans les différents pays fait apparaître des différences très marquées quant au degré auquel l'analyse coûts-avantages influe sur les décisions concernant les investissements en infrastructures. L'utilisation de l'analyse coûts-avantages pourrait être grandement améliorée. Les coûts externes pour 15 pays de l'Union européenne sont estimés, de même que le rôle de la tarification dans l'internalisation des coûts externes. Les taxes sur les carburants représentaient environ 2 % du PIB en 2000, ce qui correspond à peu près aux coûts externes estimés pour l'environnement et la santé. Il serait possible de réduire les encombrements en les taxant. Une solution neutre du point de vue des recettes consisterait à transformer les taxes sur les automobiles et les péages routiers actuellement en vigueur.

Codes JEL : H43 ; Q51 ; R42 ; R48

Mots clés : Politique des transports et performance des transports ; investissements en infrastructures ; analyse coût-avantages ; tarification des externalités.

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THE LAND TRANSPORT SECTOR: POLICY AND PERFORMANCE[1]

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1. Introduction and main findings

1.1 This paper reviews major structural policy issues related to land transport. According to the national accounts, value added in land transport amounts to around 2% of GDP on average in OECD-countries. The national accounts only cover a fraction of transport activity as the provision of passenger transport by car by households, the dominant component, is not included. Transport policy pursues several objectives, some of which involve trade-offs. Goals related to efficiency include reducing travel time for goods and persons and improving accessibility. Moreover, transport policy often aims at supporting social goals, for instance, regional policy objectives. There are also significant health and environmental costs related to transport. For the EU15 it is estimated that health and environmental costs for road transport amount to 1.9% of GDP. A major policy concern is to reduce these costs while providing efficient transport systems. Investment in new infrastructure has been and is the main instrument for improving transport systems, though the current difficult fiscal situation puts a premium on a better use of networks. Additional policy instruments comprise user charges directed at internalising external costs, regulatory reform directed at improving competition of commercial transport services and traffic management. The OECD has developed policy indicators for regulatory reform, indicating progress along different dimensions. In other areas indicators are less well-developed or non-existent. This paper provides a broad overview of policy goals and instruments and additionally explores approaches to develop policy indicators for the planning and decision-making framework for infrastructure investment and the use of pricing to internalise external costs.

1.2 The paper is structured in the following way: Section 2 highlights the characteristics, size and structure of land transport services. Section 3 reviews policy objectives, policy instruments and policy indicators. Section 4 presents country examples on investment planning and decision-making frameworks for infrastructure investment with emphasis on the use of cost-benefit analysis. Section 5 presents estimates of external costs for fifteen European Union countries, principles for the use of pricing and estimates of the extent of use of pricing relative to external costs.

1.3 The main findings are:

- Investment in transport infrastructure differs from most other types of investment by the long life span of the capital (an expected economic life of 40-60 years is not uncommon) and by having little alternative value. Transport by car is the dominant form of passenger transport and associated time costs constitute the largest share of total transport cost. Both the characteristics of infrastructure investment and the importance of passenger transport by car have implications for the choice of performance indicators.

- Congestion costs are by far the largest external cost. Congestion costs for road traffic for the EU15 have been estimated at 1.9% of GDP for the year 2000. There are additional costs

1. Jan Persson and Daeho Song were seconded to the Economics Department of the OECD to work on this project. They would like to thank Nils-Axel Braathen, Kurt van Dender, Leif Ellingsen, Peter Hoeller, Tomasz Kozluk, Borghild Ollestad, John White, Jean-Luc Schneider and Douglas Sutherland for providing useful comments and suggestions and Susan Gascard for editorial assistance.

associated with other externalities (accidents, noise and other types of local air pollution, degradation of land and greenhouse gas emissions) also estimated at 1.9% of GDP for the EU15.

- While a number of countries had road investment of around 1% of GDP in the first part of the 1990s, the investment ratio has converged towards ½ per cent of GDP after 2005. In many countries, investment in rail infrastructure has moved in tandem with road investment. According to earlier work at the OECD, there is some evidence that investment in transport infrastructure may have impacts that go beyond those to be expected from a higher capital stock. Regarding the OECD as a whole, there appear to be episodes of both under-provision and over-provision and of both efficient and inefficient use of investment. The analysis did not, however, provide support for the view that the decrease in infrastructure investment across the OECD has impeded growth.

- The OECD regulatory indicators capture entry barriers (road and rail), price controls (road), market structure (rail), vertical integration (rail) and public ownership (rail). Through the1980s and up to the mid 1990s, the indicators reflect a significant dismantling of barriers to competition in road freight transport. By 2007, barriers in most areas had been dismantled in all countries except in Greece and Turkey. Significant gains from this deregulation of road transport have been documented. In the United States regulatory reform in railroads was pursued since the beginning of the 1980s. In most other countries reform gathered pace in the mid 1990s, but there are still significant barriers to competition in railroads. While welfare gains from deregulation of railways have been documented for the United States, the evidence is less conclusive for Europe.

- The National Accounts (NA), the most frequently used data source for efficiency studies, has lacunae in the coverage of the capital stock and investment data and differences in the institutional classification of the capital stock hinder the calculation of meaningful capital and total factor productivity estimates. And importantly, the NA-data do not permit the separate analysis of railways and road transport. A major part of the economic benefits of reforms reflect reduced travel time for households when commuting or on leisure trips, which are not recorded in the NA. The NA-framework is thus neither sufficiently detailed nor sufficiently comprehensive to assess the economic effects of infrastructure investment.

- Alternatives to overcome the shortcomings of the NA are to use data sets based on company accounts with technical data on inputs and outputs, to use household-expenditure surveys and data on time use. Data based on surveys on the quality of road and rail infrastructure conducted by the World Economic Forum is a readily available source of data for comparisons. But these reflect subjective valuations of outcomes and not efficiency.

- Performance data based on cost-benefit analysis (CBA) provide a bottom-up alternative to capture the returns on infrastructure investment. A number of countries now publish results from *ex-ante* CBAs for many large infrastructure projects. A CBA combines micro data on specific projects with forecasts of traffic developments and valuation of externalities. CBAs have the advantage of providing benefits and costs, including external costs, both for the business and the household sector.

- CBAs and *ex-post* project appraisals have become integral parts of the planning and decision-making frameworks for infrastructure investment. Methodologies for use of CBA and the share of investment covered have improved. Of the countries reviewed, Australia, the United Kingdom and France seem to have the most formalised guidelines or procedures. International collaboration has contributed to convergence on methodological issues. In Europe cooperation and EU financing of intra-European projects has been a contributing factor.

- There are significant variations between countries as regards how CBAs affect decision making. While positive net benefits generally translated into a positive investment decision, a negative net benefit outcome does not necessarily block an investment. In Korea one tenth of the implemented projects considered have negative net benefits, while in the Netherlands a third of the investment projects that go ahead have negative net benefits. In Norway even a clear majority of the *proposed* larger investment projects in the current transport plan have negative net benefits.

- Decisions to go ahead with projects with negative benefits may partly reflect distributional concerns related to regional policy. Using infrastructure investment to achieve equity goals may, however, be extremely expensive as the economic value for the beneficiaries often is a small fraction of the cost of the investment for society. Both society as a whole and the recipients may gain from using direct monetary transfers as an alternative instrument.

- There is potential for improvement in the appraisal framework and the use of CBAs in decision making. There is generally no central compilation of results from CBAs, entailing a loss of data that contain important information and making *ex-post* evaluations more costly to conduct. Extending and publishing systematic *ex-post* evaluations represent a means to improve *ex-ante* assessments, and may improve the credibility of the assessments. Transparency and consistency in decision making over space and time would be improved if decision makers were required to specify the reasoning that leads to decisions, which are contrary to appraisal results.

- The CBA results show that generally, the most important economic impact of new infrastructure accrues to households in terms of reduced time costs. These impacts are not captured within a NA-framework. Furthermore, the significant incidence of projects with negative net benefits implies that there is not necessarily a clear link between investment and economic growth.

- The policy discussion on infrastructure projects usually focuses on the quantity of investment, for example measured by the ratio of investment to GDP. It should be possible to develop indicators that also capture quality dimensions of policies by measuring the use and impact of CBA in planning and decision making. This approach would require the collection of data on the use of CBAs and outcomes from member countries.

- There is limited use of congestion pricing, but where it has been introduced, it has proved an effective instrument to reduce congestion. Opposition to the use of congestion charges is linked to distributional effects; groups with a high valuation of time profit at the expense of groups with low valuation of time. Even though flanking polices in terms of increased investment in public transport have been introduced to mitigate these distributional effects, it has proved difficult to muster political support for congestion charges. The difficulty of introducing a congestion charge warrants the assessment of other market based mechanisms based on quantity rationing (limiting the number of parking spaces or tradable driving quotas) or more reliance on combinations of price and quantity mechanisms (limiting the number of parking spaces combined with increased parking fees, which may be combined with preferential treatment of residents) to limit driving in congested areas and periods.

- Fuel taxes and toll charges both contribute to reduce driving. Fuel taxes for OECD as a whole amounted to around 1% of GDP in 2000. Fuel taxes in Europe were significantly higher, at around 2% of GDP in the EU15, roughly corresponding to the external costs related to environmental and health effects. The share of fuel taxes has declined somewhat since then. Vehicle taxes on the purchase and use of cars amount to 0.6% of GDP in the EU15. These taxes are not linked to driving distance, and thus do not provide incentives to limit driving. The vehicle taxes, however, may be converted to congestion charges, and thus represent a potential for reducing the welfare loss associated with congestion without raising total taxes.

- Tolls on road use are mainly levied as a source for financing road investment and maintenance. Total investment and maintenance amounted to a little below 1% of GDP in 2007 for the countries where data are available. In countries were tolls constitute a large financing source for investment and maintenance, a transformation of tolls to congestion charges could contribute to reducing congestion costs.

- There is a wide dispersion of externality costs reflecting the type of vehicle and fuel, age of the vehicle, location of roads and time of the day (in congested areas). Estimates from the Netherlands show that externality costs can be 10–15 times higher under unfavourable circumstances than the most favourable circumstances and are much higher than existing fuel taxes. The gap between external costs and fuel charges differ between diesel and gasoline powered vehicles. While fuel charges in both the Netherlands and in Korea are close to covering external costs for gasoline driven cars in favourable circumstances, this is not the case for diesel and LPG powered cars. Also trucks get away lightly. Taxation could thus be better geared towards internalising externalities.

2. The transport sector: size, structure and its importance for the economy

Characteristics of transportation

2.1 Due to market imperfections transport networks are not spontaneously provided by markets. Government intervention is needed to ensure financing (through taxes or granting public or private entities the right to levy user charges) and to acquire the needed land. Investment in transport infrastructure differs from most other types of investment by the long life span of the capital (an expected economic life of 40-60 years is not uncommon) and by having little alternative value. Moreover, the location of transport networks affects the economic geography, such as the location of industries and housing. Efficient investment decisions thus require a long-term planning horizon, and a planning framework which takes these issues into account.

2.2 Transport is generally not consumed for its own sake, but the benefits are derived from moving from one location to another for consumption or work purposes. People will generally want to be transported as swiftly and conveniently as possible (there are exceptions, such as taking a cruise). It follows that the costs for passenger transport, in addition to operating costs, should include time costs for passengers, which constitutes a large share of total transport cost.

2.3 Networks are subject to capacity constraints and periodic congestion, which gives rise to additional costs (congestion externalities) and a welfare loss for society. Market imperfections arise as the individual does not take into account the marginal social time costs. As discussed in Section 3, market outcomes may be improved upon by the introduction of a congestion charge or other market mechanisms which monetise congestion costs and make all participants subject to the same marginal cost. As reported in Section 5, negative congestion costs for road traffic for EU15 have been estimated at 1.9% of GDP for the year 2000.

2.4 There are additional costs associated with other externalities (accidents, noise and other types of local pollution, degradation of land and greenhouse gas emissions). These externality costs for road transport have been estimated at 1.9% of GDP for the EU15 in 2000. Households contributed roughly 60% and commercial goods transport contributed 40%. The negative externalities imply that without government interference, all participants in the market for transport services face a private cost schedule positioned below the social cost schedule. As shown in Section 5, fuel taxes cover health and environmental costs in Europe (EU15).

Commercial transport

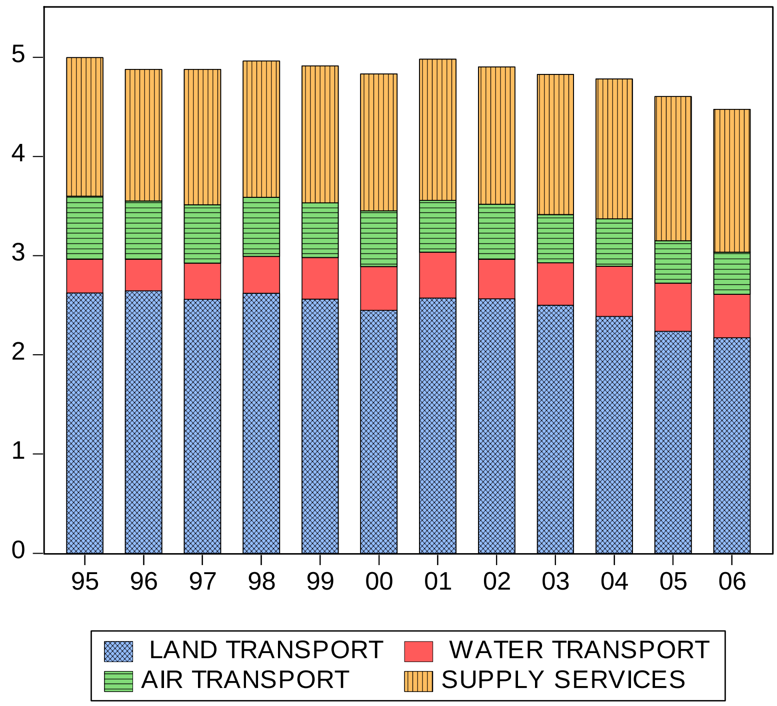
2.5 According to the national accounts, the value added of commercial transport firms accounted for 4½ per cent of GDP in OECD member countries on average in 2007, but with marked cross-country differences. At the low end is the United States with just below 3% of GDP, Switzerland at 3½ per cent and Germany at 3¾ per cent. At the high end are Finland and the Czech Republic with more than 7%. The general trend since the mid-1990s has been a small decline in value added as a share of GDP (Figure 2.1):

- *Land transport* (rail and road transport plus pipelines) is the largest subsector, accounting on average for half or more of value added.

- *Air transport* is a relatively small sector, accounting for less than ½ per cent of GDP in most countries. Iceland stand out as an exception, with a value added share of 1½ per cent of GDP.
- *Water transport* is separated into inland water transport (in Europe only of importance in France, Germany, Belgium and the Netherlands) and sea/costal transport, the latter being dominant.
- *Supporting services* constitute the second largest component in most countries. They encompass a number of activities (loading, unloading, storage of goods, logistics, travel agencies and ticket offices).

Figure 2.1. **Relative size of the different transport sectors according to the national accounts**

Per cent of GDP[1]



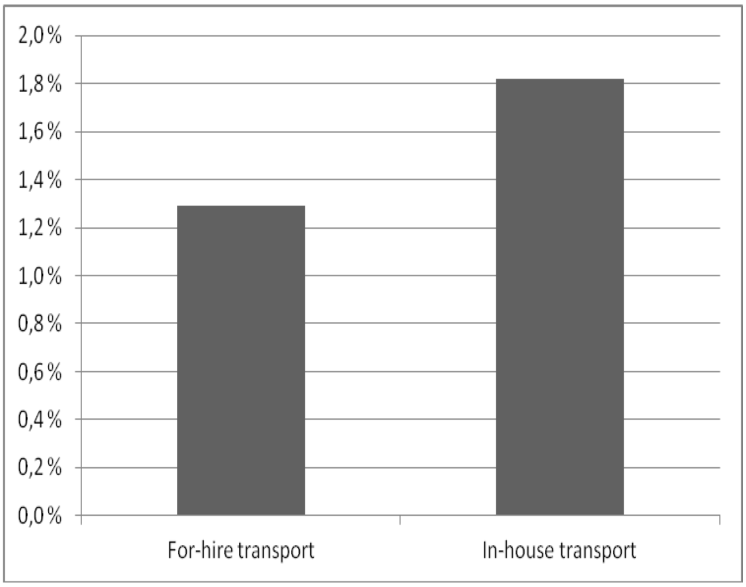
1. Unweighted average. Data for Australia, Canada, Hungary, Ireland, Japan, Korea, Mexico, Poland, Spain, Switzerland and Turkey are not available for the whole time period.

Source: OECD, STAN database.

2.6 In the following, the focus will be on land transport, specifically road and rail transport. Viewed from a national policy perspective, there are important differences between land transport and the other modes of transportation as land-based transport is dominated by national transport systems. Hence performance will mainly be influenced by national policy frameworks. Air transport on the other hand is often dominated by international travel. Thus, a single country may only affect part of the network infrastructure and the regulatory framework. The same holds for sea/costal transport, the dominant part of water transport.

2.7 Part of the road freight transport services are produced outside transport firms. According to the US transport satellite accounts, in-house transport of goods accounted for more than half of total transport within agriculture, construction, wholesale and retail and other services. All in-house transport by trucks accounted for more value added than for commercial transport in 1996 (Figure 2.2). Eurostat publishes data for the share of in-house transport in the total transport volume for member countries. These show that in-house transport on average accounted for 16% of tonne/km in 2005. Data for the contribution to GDP are not published.

Figure 2.2. **Freight transport by road in the US**[1]
1996, per cent of GDP



1. Total in-house transport by all modes of transport. According to Sloboda, in-house transport outside trucking accounts for less than 0.1% of GDP.
Source: U.S. Department of Commerce, Bureau of Economic Analysis.

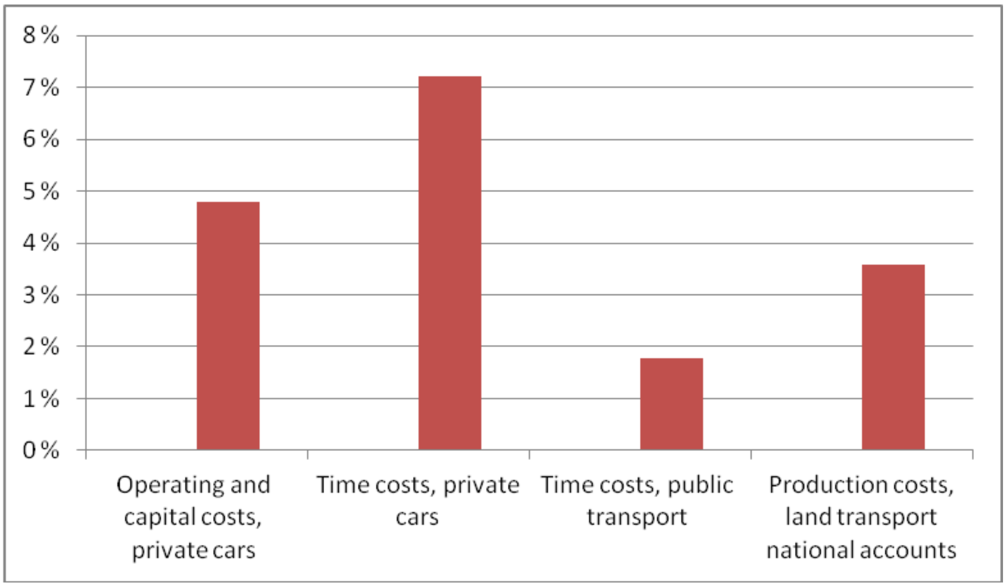
Transport services produced by households

2.8 The largest share of passenger transport is performed by private cars. In Europe, the share of private cars, measured in passenger kilometres amounted to 76% of total passenger transport in 2004, while these shares were 86% and 58% in the United States and Japan, respectively. Figure 2.3 shows household spending in the Netherlands, in terms of monetary outlays and time costs, on private cars and public transport. For reference, total production costs (value added plus inputs) for land transport according to the national accounts are included in the figure. As can be seen, the sum of operating and capital costs and the value of time is more than three times higher than the recorded production value of land transport. If one would account for the value produced in the household sector (private car capital expenses plus time costs of private car use and public transport), total value added in the production of transport services by households would have amounted to more than about a tenth of GDP. The share of value added in the household sector for other OECD countries would be of a similar order of magnitude.

2.9 The general tendency has been to shift production of services outside households (for example, child care). Against this background it may seem surprising that households dominate the production of passenger transport services. An important explanation is the time costs associated with travel and the possibility of combining the role of passenger and driver. When commuting by private car, the driver is both driver and passenger. The accrued costs are capital and operating expenses plus the value of time, the largest expenditure item (Figure 2.3). If the commuter chooses public transport, he would still use his time, but in addition to capital and technical operating costs of the vehicle pay part of the professional driver's time cost. The extra cost element entails a cost disadvantage for public transport, given that time cost per hour is the same. If public transport is to be competitive, it has to compensate this disadvantage by offering higher speed and thereby lower time costs, work facilities that reduce the valuation of time costs or large savings in operating costs by a high level of productivity. These conditions may be fulfilled for certain types of passenger transport (long distance transport by high speed train or air transport). It has, however, turned out to be more challenging to match the advantages of car transport in terms of time savings and flexibility for shorter travel distances.[2]

Figure 2.3. **Cost structure of land transport in the Netherlands**[1]

2007, per cent of GDP



1. Operating and capital cost data are based on household expenditure shares from 1995 (Bode *et al*., 2002). Time cost data are derived from survey data on mobility from 2007 provided by the Dutch Ministry of Transport and a weighted average of time costs from table 4.3 (2/3 of lower interval, 1/3 of higher interval).

Source: Bode *et al.* (2002); Dutch Ministry of Transport; and OECD STAN database.

2. In practice time cost estimates vary across modes of transport, distance and purpose of the trip. Ramjeridi (1997) found for Norway that total time costs (including delays, waiting and walking time) were higher for public transport than for cars in urban transport, but lower for cars and air travel for interurban travel. Air travel had by far the highest time costs. In French cost/benefits analysis, inter-city road travel is valued higher than second class, but lower than first class rail and air transport (Quinet, 2006).

3. Policy objectives and policy frameworks

An overview

3.1 This section presents an overview of the policy objectives and instruments and discusses how they interact. It also reviews policy and performance indicators. Box 3.1 presents four examples of high level objectives for transport policy as formulated in policy documents. At subsequent lower levels operational objectives are stated. The objectives can be split into mobility objectives (including the reduction of congestion costs), objectives related to reducing other external costs and social policy objectives.

Box 3.1. **Goals of transport policy – four country examples**

Australia[1]

- Economic – To promote the efficient movement of people and goods in order to support sustainable economic development and prosperity.
- Safety – To provide a safe transport system that meets Australia's mobility, social and economic objectives with maximum safety for its user.
- Social – To promote social inclusion by connecting remote and disadvantaged communities and increasing accessibility to the transport network for all Australians.
- Environmental – Protect our environment and improve health by building and investing in transport systems that minimise emissions and consumption of resources and energy.
- Integration – Promote effective and efficient integration and linkage of Australia's transport system with urban and regional planning at every level of government and with international transport systems.
- Transparency – Transparency in funding and charging to provide equitable access to the transport system, through clearly identified means where full cost recovery is not applied.

Norway[2]

- Travel time should be reduced to strengthen competiveness and contribute to maintaining regional settlement patterns.
- Transport policy shall be based on a vision of zero accidents resulting in serious injuries and fatalities.
- Transport policy should contribute to limiting climate gases and reduce environmental impacts of the transport sector, and help achieve national targets and Norway's international obligations in environmental protection.
- The transport system should be accessible to all users.

Sweden[3]

- The transport system will contribute to provide everyone with basic accessibility of good quality and functionality and development capacity throughout the country. The transport system will ensure gender equality, meeting the transport needs of both women and men equally.
- The design, function and use of the transport system will be adapted to eliminate fatal and serious accidents.
- It will contribute to the achievement of the environmental quality objectives and better health conditions.

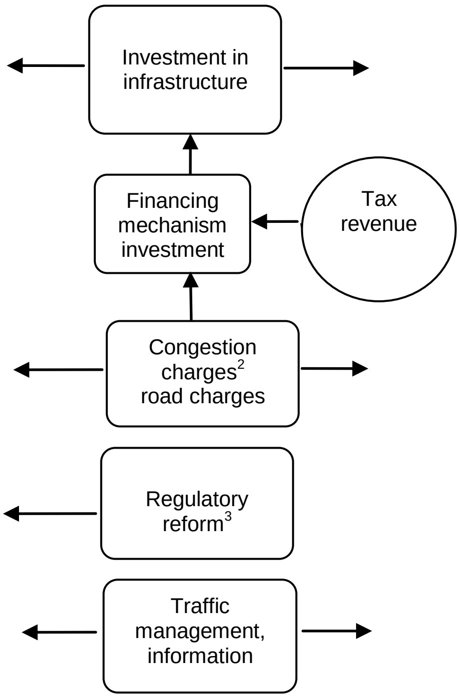
United Kingdom[4]

- To support national economic competitiveness and growth, by delivering reliable and efficient transport networks.
- To reduce transport's emissions of carbon dioxide and other greenhouse gases.
- To contribute to better safety, security and health and longer life-expectancy through reducing the risk of death, injury or illness arising from transport and promoting travel modes that are beneficial to health.
- To promote greater equality of opportunity for all citizens, with the desired outcome of achieving a fairer society.
- To improve quality of life for transport and non-transport users, and to promote a healthy natural environment.

1. National Transport Commission Australia (2009): *National Transport Policy Framework*.
2. Ministry of Transport Norway (2009), *National Transport Plan 2010 – 2019, Norway*.
3. Ministry of Enterprise, Energy and Communications Sweden, (2009), *Objectives for Transport Policy.*
4. Department of Transport United Kingdom (2007), *Departmental Strategic Objectives.*

3.2 In addition to efficiency and competitiveness, the mobility goals include social goals: accessibility for all groups, promotion of equal opportunity, a fairer society in the British case, support for regional policies in the case of Australia and Norway and to contribute to a more gender equal society in the case of Sweden. The objectives as regards health and the environment are broadly similar.

Table 3.1. **Transport policy objectives and instruments**

Mobility-congestion externality objectives[1]	**Type of policy instruments**	**II. Additional externality objectives**[1]
Improved traffic flow and reduced time of travel so as to strengthen competitiveness and contribute to maintaining the settlement pattern and a public transport system that fosters social inclusion: A. Improved services and reliability B. Reduced interregional travel cost C. Reduced rush hour delays, increased accessibility and reliability in order to strengthen competitiveness D. Improved infrastructure for pedestrians and cyclists		***Safety*** A. Number of persons killed or seriously injured in traffic accidents shall be reduced by at least one third by 2020 ***Other externality concerns*** B. Comply with national targets for climate gas reductions C. Reduce No_x emissions D. Contribute to achieving national targets for local air and noise pollution E. Avoid harming important natural territories and safeguard ecological functions F. Reduce encroachment on important national heritage sites, cultural environment, cultural landscape and farmland

1. The objectives have been taken from the latest national transport plan for Norway.
2. In Norway there is presently only one example of a road charge which is differentiated according to peak traffic density.
3. Not specified as a transport policy instrument in the Norwegian transport plan.

3.3 In Table 3.1, the policy objectives are depicted together with the available policy instruments. Arrows indicate the links between instruments and goals. Additional policy instruments that indirectly affect transport goals include regulations on land use and regulatory standards on vehicles.

3.4 In policy analysis, policies are often summarised by indicators that allow differentiation between and classification of alternative policy settings on performance across the various policy objectives. Additionally they may indicate a normative ranking of polices. For the transport sector, the best developed policy indicators concern regulatory reform.

Investment and modes of financing

3.5 Investment in new infrastructure has been and still is the central policy plank to improve outcomes within the transport sector. Increases in infrastructure capacity can improve mobility in various ways: by establishing new corridors that cut travel distances, by allowing for larger traffic flows (either by reducing bottlenecks and congestion or by making it possible to raise speed limits), by increasing accessibility by offering alternative modes of transport or facilitating intermodal transport. Infrastructure changes are also an important means to reduce external costs. For example, shifting transport from road to rail contributes to fewer accidents and also reduces environmental costs. Building highways that separate traffic flows in opposite directions can reduce traffic accidents, while moving traffic flows out of city centres improves the quality of inner city life. The quality of the planning and decision-making system will influence the returns on investment in terms of improved mobility and reduced externality costs (Section 5).

3.6 The financing options may both impact the total funds available for investment and the returns on investment. The government may either finance investment from tax revenues, by collecting road charges either to cover costs for a specific project, by earmarking road charges for infrastructure investment purposes, or by ensuring financing through Public Private Partnerships (PPP) where the private partner is given the right to levy user charges (Box 3.2). A successful PPP may lead to increased returns on investments through lower investment and operating costs in addition to easing constraints on investment, but good governance is needed in order to reap these benefits.

Box 3.2. **Public private partnerships (PPP) in financing infrastructure**

Cooperation between the public and private sector may entail private sector involvement in the development and construction of infrastructure projects, operation/maintenance and financing. The cooperation may involve significant risk sharing. If the cooperation has all these characteristics, it is generally classified as a Public Private Partnership (PPP) (OECD, 2008). With a PPP, the private entity involved issues debt that is repaid through revenues from user charges or government subsidies. According to Égert *et al*. (2009*b*) spending by public private partnerships in all network sectors in the OECD, measured in 2005 prices, increased from around $1 billion in 1994 to $33 billion in 2004. The level subsequently fell to $21 billion in 2007. The prevalence of less extensive forms of cooperation like franchises and concessions is higher in transport than in other network sectors. Issues related to financing have been discussed in a number of OECD publications (Égert *et al*., 2009*b*).

PPPs may yield advantages through numerous channels:

- Introducing competitive pressures through tendering of infrastructure projects, franchising/concession for operations.
- Designing risk sharing arrangements that exploit comparative advantage between the private and public sector in their ability to handle risks.
- Reducing budget constraints through private financing. With a tight budget constraint, projects may not go ahead, even if the social returns are high.

Private sector involvement through concessions/franchises or full PPPs raise a number of governance issues:

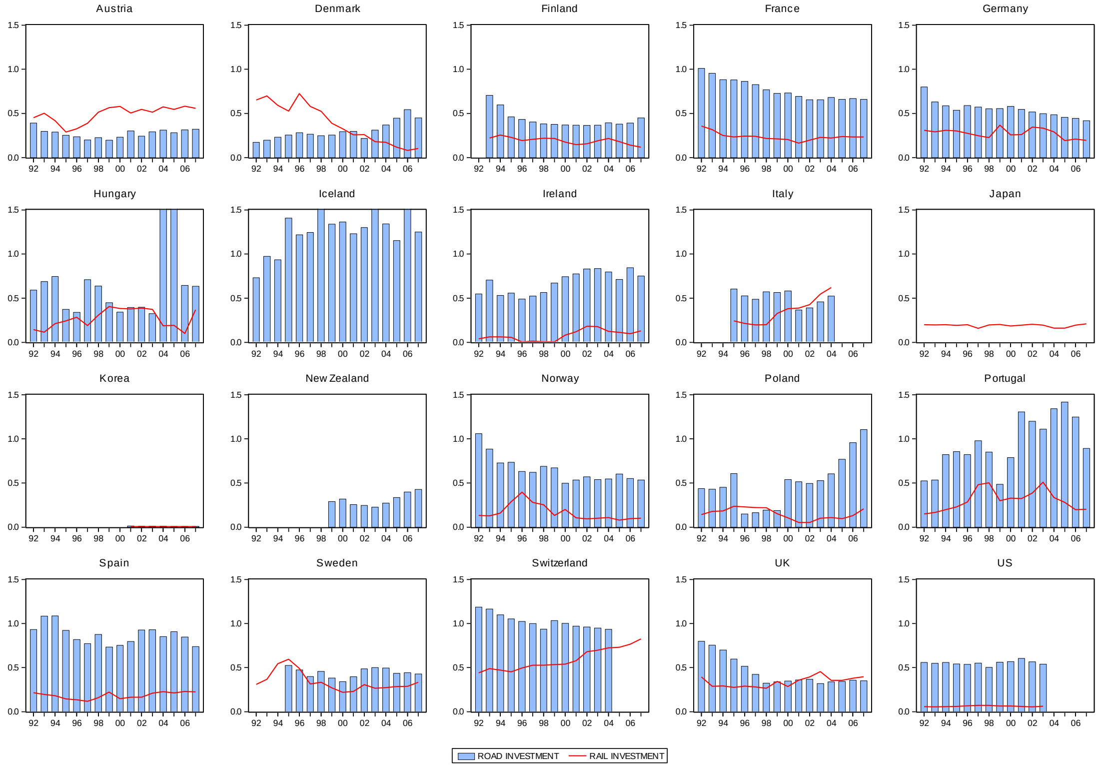
- The appropriate period for concessions/franchises needs to be set, so that the concession holders have incentives to deliver services in accordance with policy objectives.
- Prices that compensate private operators for investment costs need to be set at the right level to discourage overinvestment.
- Performance needs to be monitored to avoid underinvestment.
- PPPs can be costly to negotiate and are susceptible to delays and cost overruns. As there are scale economies due to transaction costs, PPPs are generally not suited for smaller projects.
- The advantages/risks involved in a PPP should be assessed as part of the project assessment through a cost/benefit analysis.
- Contracts should be tailored according to the specific objectives/outputs. Given the long-term character of the cooperation, contracts need to be flexible. In order to avoid disruption of services in case of re-tendering, contracts should contain clauses relating to sharing costs of risks. Contracts should contribute to a stable institutional framework and procedures for renegotiation. The contracts should be designed so as to avoid disinvestment towards the end of the contract period.

3.7 While increased network capacity adds to the productive capacity of the economy, a positive shift in investment in transport infrastructure will only translate into higher economic growth if the returns are at least as high as those being obtained in other sectors. If the policy framework does not ensure that benefits exceed or equal costs for new investment projects, potential growth will be negatively affected.

3.8 Figure 3.1 shows the evolution of investment as a ratio of GDP for road and rail infrastructure for countries where data are available. Developments have been diverse. In the United Kingdom, France and Germany, which had a fairly high investment level at the beginning of 1990s, there has been a significant decline in the investment ratio for roads. The investment ratio has also declined in Finland, Norway, Switzerland and Spain. For the other countries, the investment ratio either remained stable or increased. While a number of countries had road investment of around 1% of GDP at the in the first part of the 1990s, the investment ratio has converged towards ½ per cent of GDP after 2005. In many countries, investment in rail infrastructure has moved in tandem with road investment. Some exceptions stand out. In Switzerland, which has the highest overall investment level in land transport infrastructure with more than 1½ per cent of GDP there has been a strong increase in rail infrastructure investment. Also in Austria investment in rail infrastructure has increased, and has reached levels significantly above road investment, In Denmark, on the other hand, there has been a significant decline in rail infrastructure investment.

Figure 3.1**. Investment ratios for infrastructure investment in selected countries**

Per cent of GDP, 1992–2007



Source: International Transport Forum, OECD.

3.9 In most countries traffic volumes grow at slower pace than GDP. For instance, in the United Kingdom, the number of vehicle km grew almost 1% less than GDP per year from 1994 to 2009. Sweden, Finland and Japan show similar developments. Greece and Italy represent exceptions, as traffic volumes outpaced GDP growth. Declines in the traffic/GDP ratio should lower the investment and also the infrastructure capital to GDP ratio.

3.10 There is an ongoing discussion whether the declining rate of infrastructure investment reflects missed growth-enhancing investment opportunities, or whether the decline reflects reduced returns on investment. Égert *et al*. (2009*a*) investigated whether it is possible to establish a link between investment in transport and other network sectors and economic growth, that is whether investment in network infrastructure contributes more to economic growth than other types of investment. They concluded that while it is hard to establish the growth impact, there is some evidence that investment may have impacts that go beyond the impact to be expected from a larger capital stock. Infrastructure investment appears to have a non-linear effect with a stronger long-term effect on growth at lower levels of provision. Regarding the OECD as a whole, there appear to be episodes of both under-provision and over-provision and of both efficient and inefficient use of investment. Consequently the analysis did not provide support for the view that a general increase in infrastructure investment would enhance growth.

3.11 The policy discussion on infrastructure investment usually focuses on the quantity of investment, for example measured by the ratio of investment to GDP. It should be possible to develop indicators that also capture important dimensions of the quality of the planning and decision-making framework. The role of project appraisals is one dimension. The use of CBAs in the planning process (Section 4) could be measured by the value share of projects considered in the decision-making process that had been subject to a CBA, the prevalence of second opinion CBAs and the prevalence of *ex-post* evaluations. The role of CBAs in decision making (how close decisions adhere to CBA results) could be measured by the relative share of CBAs with negative net benefits in the total number of projects implemented or alternatively the average benefit-cost ratios for implemented projects with negative net returns. This approach would require the collection of data on the use of CBAs and of CBA data from member countries.

Externalities and user charges

3.12 Externality costs related to health and environmental effects may be addressed by user charges. Efficient pricing of externalities requires a charge corresponding to the difference between social and private marginal cost (Section 5). Countries have already directly or indirectly introduced user charges. All OECD countries levy taxes on fuel, initially predominantly motivated by fiscal, but later increasingly by environmental concerns. Fuel taxes in the EU15 exceed estimated external environmental and health costs. Additionally motorists pay vehicle taxes, which do not affect driving distances. Tolls have been introduced for financing purposes in parts of the road network in many OECD countries.

3.13 While the total external costs related to congestion in the EU15 is estimated at 1.9% of GDP (Section 5), the net welfare gain from introducing congestion charges is much less. Estimates based on alternative methodologies arrive at values between 0.05% and 0.7% of GDP for the EU (Koopmans *et al.,* 2003, INFRAS/IWW, 2004 and Kopp *et al.,* 2007).

3.14 Existing fixed charges like fuel taxes are not very effective in reducing congestion costs as they will be low relative to the marginal local and time specific cost of congestion. A congestion charge is a variable charge and an instrument to reduce time costs and improve the reliability of networks that are congested at specific locations in specific time periods (Box 3.3). Although costs related to congestion are increasing, only a few countries have so far introduced congestion charges.

3.15 The capacity utilisation of existing networks can also be influenced through a variety of non-economic measures that may be grouped under the heading “traffic management and information”. Traffic capacity at specific parts of the network may be increased at peak hours by making more lanes available for traffic in directions with congestion. Traffic can be redirected by adjusting capacity according to demand by reversing lane directions, by dissuading users from using parts of the network through restrictions or through information on the traffic situation and implicit time costs. The experience of the

Netherlands shows that there are considerable efficiency gains to be reaped from effective traffic management. It is estimated that improved traffic management reduced the number of lost vehicle hours due to congestion by 25% between 1996 and 2005 (The Ministry of Transport, Public Works and Water Management, the Netherlands, 2008).

Box 3.3. **Rationing by queue, price or quantity**

Networks with free access and sparse capacity provide public goods. When network utilisation approaches capacity limits, congestion develops. Traffic slows down and time costs increase. Without government intervention, the imbalance between demand and supply is resolved by queuing. In equilibrium everyone has equal access to the network and faces the same marginal cost measured in time units. However marginal costs measured in money varies according to the individual valuation of money. It is most costly for those with a high valuation of time, either because they are high income earners or because they travel in a professional capacity. Time costs are low for low income earner or those who use the network for leisure travel.

Rationing by price is an alternative to queuing. Rationing access by a user charge monetises time costs and ensures that everybody faces the same marginal (social) costs. User charges will increase operating costs for all participants in the network. This will contribute to lower demand. At the same time, time costs will decline as the speed of the traffic increases. For those with the highest valuation of time, the time cost effect will dominate, causing the price to go down and demand to increase. For those at the lower end of the valuation scale, the reduction in time costs will not be enough to compensate for the congestion charge, and they will drop out of the network. For society as a whole welfare will increase and the losers can in principle be compensated, provided that the government channels the revenues from the congestion charge to low income earners. It is, however, difficult to design a compensation scheme that achieves this, and in practice compensation is not paid (Weitzman, 1975).

A third alternative is quantity rationing, for example by limiting inner city parking space or by permitting cars with license plates ending with even and odd numbers on alternate days entering the city. The latter scheme has been used to reduce local emissions. Both in systems with user charges and with quantity rationing, local residents have in some instances been given preferential treatment through discounts or through allocated parking rights. Quantity rationing may, in principle, be developed further by setting a ceiling on traffic, and to distribute driving quotas compatible with this ceiling. These could be made tradable in the same way as tradable emission quotas. The system would have to be accompanied by a system of penalties for those exceeding their quota. In a world without uncertainty, this system would lead to the same efficiency outcome as a charging system. Under uncertainty, it may from an efficiency point of view be inferior to a system based on user charges (Hepburn, 2006). But it may have more appealing incentive and distributive effects. If tradable permits are handed out for free, for example to those living or working in an urban area, it would represent a redistribution of income from groups with a high valuation of time to groups that either have a low valuation of time or who do not drive themselves. The system ensures that total welfare gains are broadly distributed. Other variants could be designed, such as combinations of tradable and non tradable quotas (the latter based on the view that driving to some extent is an entitlement good).

While there have been technological obstacles to introducing a tradable quota system, new GPS/GSM technology like the one planned as part of a road pricing system in the Netherlands could provide the necessary information on quota use, and could be used for transmitting trading prices and for transactions of extra quotas. In assessing the efficiency gains from introducing market schemes, one has to take into account the operational cost, which may amount to almost 50% of gross revenue (see discussion on the London scheme in Section 5).

3.16 In Section 5 data on congestion costs and other external costs are reported together with fuel taxes affecting operating costs for road transport. Comparing the ratio of fuel taxes with the externality costs relative to environmental and health costs provides an indicator of the extent to which fuel taxes internalise externalities. A comparison for the EU15 shows that fuel taxes are roughly equal to marginal social costs related to environmental and health externalities. The tax structure across fuel types and vehicle types is however not optimal. Vehicle taxes constitute a significant share of total operating cost in many countries. As they are generally independent of distance, they do not contribute to internalising externality costs. However, the ratio of vehicle taxes to GDP is still of interest, as it shows how much vehicle taxes could contribute to correct externality pricing, if vehicle taxes were converted to road charges. Additionally road tolls levied for infrastructure financing purposes contribute to reduce externalities. Altogether, the present revenue envelope from fuel and vehicle taxes and toll charges is sufficient to internalise the major part of externalities associated with road transport, provided the externality charges are correctly designed.

Product market reform

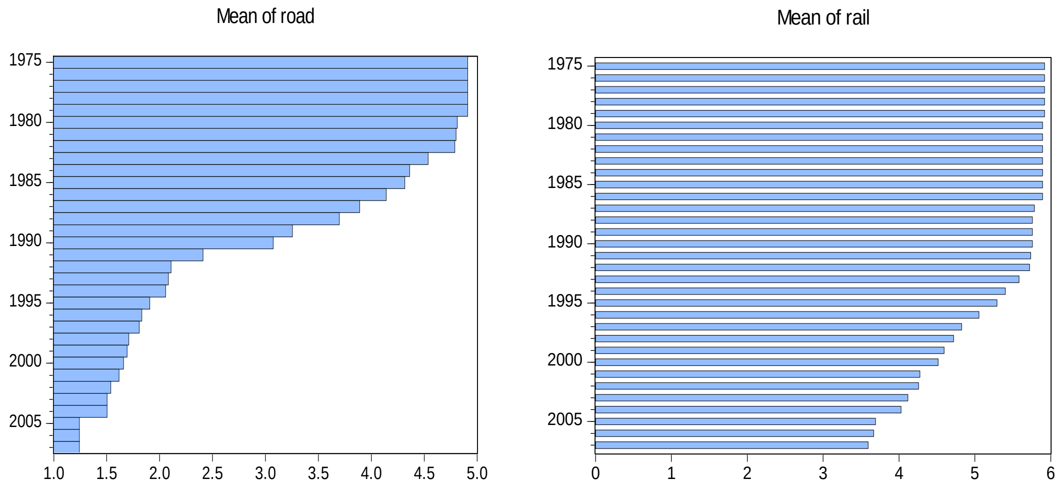
3.17 Product market reform implies reducing or eliminating entry barriers and price controls. The regulatory framework in transport encompasses regulations addressing safety, health and environmental concerns (SHE), and measures to regulate public or private monopolies. More competitive conditions are achieved partly by choosing approaches to safety, health and environmental concerns that minimise adverse effects on competition. Product market reform increases price competition and forces out the less efficient firms. The gains reaped from reform are partly lower prices and partly improved quality of services. Regulatory reform may indirectly also contribute to a better utilisation of the network across space and time to the extent that variable pricing is introduced, reflecting traffic intensity and capacity utilisation. Product market reform will only have a direct impact on framework conditions for commercial transport services. While product market reform does not have a direct impact on external costs related to health and the environment, it can spur innovations that indirectly may reduce externalities.

3.18 The OECD regulatory indicators capture entry barriers (road and rail), price controls (road), market structure (rail), vertical integration (rail) and public ownership (rail). Within each of these areas, sub-indicators are derived which take values from 0 (fully competitive conditions) to 6 (high barriers). At the highest level of aggregation, the regulatory conditions are summarized in one composite indicator. Both road transport and rail transport were heavily regulated in the 1970s (Figure 3.2). Through the1980s and up to the mid-1990s, there was a significant dismantling of barriers to competition in road freight transport. Deregulation continued up to 2005, albeit at a slower pace. By 2007, barriers in most areas had been dismantled in all countries except Greece and Turkey. In the United States regulatory reform in railroads was pursued from the beginning of the 1980s. In most other countries reform gathered pace in the mid-1990s, but there are still significant barriers to competition in railroads (Table 3.2).

3.19 Winston (1993) found welfare gains due to regulatory reform of about ¼ per cent of GDP for trucking in the United States. Significant gains for trucking, both in the United States and in other OECD countries, have been corroborated by later research. Boylaud (2000) provides a survey. It has proved harder to find effects of regulatory reforms and efficiency gains for railways. Winston (1993) found gains for railroads of 0.15% of GDP for the United States. Friebel *et al*. (2008) found positive productivity effects of sequenced reforms for railways in Europe. However, broader reform packages were found not to influence productivity or even have negative effects, depending on the country analyzed. This analysis was based on regulatory indicators collected from various sources, including the OECD's, that captured entry, vertical separation and independent regulatory entity (not included in OECD regulatory indicators) covering the 1980s and 1990s. Table 3.4 presents the efficiency data from the analysis by Friebel *et al*. together with results from two other efficiency studies. There is no clear correspondence between regulatory reform rankings according to the OECD regulatory indicators and the efficiency rankings. One possible explanation may be the quality of the performance indicators: the output variable used for deriving efficiency indicators may not fully capture elements like service and time reliability improvements. Another explanation might be the quality of the policy indicators. It is more challenging to capture the degree of competition in railway transport than road haulage through a limited number of indicators which are aggregated to a summary indicator as regulatory reform does not entail a hands-off approach by the authorities, but requires regulatory oversight and measures that ensure incentives as regards cost efficiency and to keep investment at the desired level.

Figure 3.2. **Progress in regulatory reform for road transport and rail transport**[1]

1975-2007, average score of the regulatory indicators



1. Unweighted average of the countries for which a complete historical series is available: Australia, Austria, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Italy, Japan, the Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, United Kingdom and the United States.

Source: OECD Product Market Regulation Database.

Table 3.2. **Remaining barriers to competition in road and rail transport**

2007

Barriers to competition		Road freight	Rail transport
High ↑	Indicator value >5 – 6	Turkey	Finland, Ireland, Korea, Luxembourg, Turkey
	>4 – 5		Belgium, Greece, Japan, Portugal, Spain, United States
	>3 – 4	Greece	Austria, Canada, France, Italy, Mexico, New Zealand, Norway Poland, Switzerland,
	>2 – 3	France, Korea	Czech Rep., Germany, Hungary, Netherlands, Slovak Rep., Sweden
↓	>1 – 2	Belgium, Iceland, Italy, Hungary, Mexico, Netherlands, Norway, Portugal, Slovak Rep	Australia, Denmark
Low	0 – 1	Australia, Austria, Canada, Czech Republic, Denmark, Finland, Germany, Ireland, Japan, Luxembourg, New Zealand, Poland, Spain, Sweden, Switzerland, United Kingdom, United States	United Kingdom

Source: OECD Product Market Regulation Database.

Trade-offs between objectives and interactions between policy instruments

3.20 In some cases there are trade-offs between mobility objectives and externality objectives. To the extent that upgrading of road systems leads to higher average speed and more traffic, emissions increase, unless countered by increasing user charges. Moreover, in choosing policy instruments, one should take into account that the feasibility and cost of adjusting policy instruments differ. Traffic management tools are easy to adjust and should be used to tackle short-term developments. The introduction of road charges requires investment in monitoring and payment systems. However, when the system is in place, the direct cost of changing charges will be small. Changes in these instruments may also have indirect long-term impacts on the returns on investment that should be taken into account. If an investment decision is based on an assessment of returns that is made prior to, and without consideration of the introduction of a pricing scheme, net returns will be overstated as the traffic reducing effect of prices are not being taken into account. Traffic management measures may similarly reduce the need for increased capacity which will be reflected in lower net returns on investments. Investment in new infrastructure networks often requires a gestation period of ten years or more and may have an economic life of forty to sixty years or even more, making investment an inflexible policy instrument. In order to maximize net returns, alternative options for meeting policy objectives should be considered within a comprehensive framework, for example by assessing costs and benefits of attaining objectives through alternative packages of policy instruments.

Equity issues and political economy considerations

3.21 There are equity issues related to investment and financing. Returns on infrastructure investment depend on traffic volumes. The socially profitable projects will usually be found in areas with strong concentrations of populations. If the networks are financed through taxation, and access to transport systems is seen as an entitlement good, new infrastructure projects with high returns in central areas could be matched by demands for quality upgrading of infrastructure in areas with low traffic volumes and therefore low net returns.

3.22 When considering transport infrastructure investment as a means to achieve regional objectives, one should assess the merits of these measures relative to alternative measures. As discussed in Section 4, a number of projects that either have been implemented or are under consideration in Norway have large negative net benefits. The negative net benefits reflect low user benefits, not for the single user, who may reap large individual benefits from the investment, but because there are few users. To illustrate the alternative options, assume that a project worth NOK 1 billion is under consideration, and that a CBA analysis shows total benefits of NOK 300 million that accrue to the inhabitants of a region. Then an alternative option would be to make a budgetary transfer of NOK 300 million that the local authorities could allocate to transport or for use in another way. The region would be equally well off, while the budgetary savings for the central government would amount to NOK 700 million. The example illustrates that using infrastructure investment as a means to achieve regional equity objectives may be extremely expensive.

3.23 Both investments in new infrastructure and the introduction of congestion charges reduce time costs. They have, however different distributional effects. As shown in Section 4, investment projects that reduce time costs will benefit all user groups, but primarily drivers of private cars as they constitute the dominant user group. The revenue from optimal congestion charges is significantly larger than the increase in consumer surplus (net welfare benefits). It is primarily freight transport, public transport and higher income commuters that profit directly from the introduction of congestion charges because of their high valuation of time. Car drivers in the lower end of the income scale loose and they may constitute a powerful block of voters. In practice it is hard to design compensation schemes that make everybody better off. In a number of cases the introduction of road charges has been part of a policy package, where the revenues have been used to expand local transport infrastructure and, especially, public transport. This is a form of compensation that ensures that revenues are channelled back to the transport users, but not necessarily to those who are adversely affected by the congestion charge. The distributional issues involved with the use of congestion and user charges may explain the political resistance to their introduction. Judging from the public debate, there is also resistance to charges based on expectations that they will not be matched by a reduction in other taxes, but will lead to an increase in the overall tax burden. Additionally operational and capital costs related to congestion pricing are in some instances considerable and reduce net benefits. The authorities might also be tempted to set the charge so as to maximise revenue, and not social benefits. Alternative market based instruments such as transferable driving quotas could prove more acceptable, provided implementation costs are not too high.

Performance indicators

3.24 The choice of performance indicators depends on the type of the analysis. In the analysis of comparative efficiency of rail transport across countries one can estimate production functions from historical data on outputs/outcomes and inputs of infrastructure capital, rolling stock and labour. The tricky issue is to aggregate over passenger and goods transport, as discussed below. If the task is to analyse the performance of the commercial road transport of goods and passengers, one has to take into account that part of available capacity of the road infrastructure is occupied by private cars. If the task is to analyse the contribution of growth from new investment, a different complication arises as total returns will depend on traffic volumes up to 40 or even 60 years into the future.

3.25 The National Accounts are the most frequently used data source for efficiency studies for industrial sectors. The NA express economic valuations of outcomes in the commercial transport sectors that capture some aspects of quality changes. One can either trace the effects of inputs on value added in land transport or on GDP and compute performance indicators like labour, capital and total factor productivity. However, lacunae in the coverage of the capital stock and investment data and differences in institutional classification of the capital stock hinder the calculation of meaningful capital and total factor productivity estimates. And importantly, NA-data do not permit separate analysis of railway and road transport. Table 3.3 shows labour productivity levels relative to the United States and relative country rankings in land transport and supporting services, of which a large share is associated with land transport. While the United States ranks among the countries with the highest productivity in land transport, it ranks only 17th for supporting services. The Netherlands and Luxembourg obtain top ratings in both sectors. It is difficult to see any economic explanation for the strong variations in the productivity levels in supporting services. One reason could be a high degree of statistical noise or large differences in the composition of such services across countries. Without knowing the differences in the capital/labour ratios between countries, one should be careful in drawing inferences on cost efficiency from the data.

3.26 Different strategies have been pursued to combine economic and technical data to obtain internationally comparable data for land transport. In Égert *et al.* (2009*a*), technical data on infrastructure for rail and roads are combined with GDP data in order to analyse the relationship between infrastructure investment and growth. In a number of comparative studies of railway efficiency, technical data for output and input have been used in conjunction with company accounts. Examples of such studies are presented in Table 3.4. In order to derive single outcome measure indicators for the rail network, it is necessary to transform passenger and goods transport into a single measure. This may be done by estimating the average value of a person km relative to the average value of a tonne km, or in a more sophisticated way by deriving cost functions based on joint production. Either way, the methodology involves relative valuations of tonne km and person km. The studies referred to in Table 3.4 are based on different time periods, different aggregation levels, and different methodologies. The results from Coelli *et al*. (1999) show that different methodologies have some influence on relative outcomes across countries. The results seem to be reasonably robust across methodologies and time periods for Austria, Belgium, France, Germany, Greece, the Netherlands, but on the other hand the relative outcomes are quite different for Italy, Portugal, Spain, and to some extent also for Finland and Luxembourg. It is an open question to what extent the country ranking in the individual studies reflects differences in productivity or different methodologies.

Table 3.3. **Value added per hour worked in transport**[1]
2004

	Land transport		Supporting services	
	Index US = 100	Ranking OECD	Index US = 100	Ranking OECD
Australia	74	9	196	4
Austria	40	22	115	13
Belgium	79	12	89	19
Canada	108	4	105	16
Czech Republic	38	17	145	9
Denmark	69	14	155	7
Finland	78	5	180	5
France	88	8	89	19
Germany	62	16	61	23
Greece	21	20	74	22
Hungary	29	25	99	18
Ireland	37	23	35	25
Italy	91	15	38	24
Japan	37	18	133	10
Korea	21	24	151	8
Luxembourg	106	2	503	1
Netherlands	152	1	199	3
Norway	96	10	172	6
Poland	66	19	115	13
Portugal	72	6	270	2
Slovak Republic	52	21	81	21
Spain	57	13	128	11
Sweden	71	7	109	15
United Kingdom	55	10	120	12
United States	100	3	100	17

1. The estimates for the Czech Republic, Hungary and Slovakia indicate that some of the sub sector estimates are subject to wide margins of measurement errors.

Source: Ypma (2007).

3.27 Subjective data based on yearly surveys conducted by the World Economic Forum are an alternative readily available source of data for comparisons. Table 3.5 is based on responses from industry to a questionnaire on the quality of rail and road infrastructure. These reflect valuations of outcomes and not efficiency. Comparing the outcome for rail, one finds that a number of the high-scoring countries in terms of technical efficiency (Table 3.4), especially France, Germany, the Netherlands and Switzerland, also obtain a high score in Table 3.5. For some countries however, there are large differences. The United Kingdom only achieves an average score in the survey and also Spain ranks significantly lower in Table 3.5 than in Table 3.4.

Table 3.4. **Railroads in OECD Europe: relative technical efficiency**

Country ranking in different studies, and with alternative methodologies

	Friebel *et al*., 2008	Coelli and Perelman, 1999			Savolainen, 2007		
	Average	Average 1988-1993			Level 2002		
	1980-2003 I	Output or. II	Input or. III	CSR IV	Passenger V	Freight VI	Combined VII
Austria	10	9	10	7	13	4	11
Belgium	9	9	8	8	14	5	10
Czech Republic					16	10	16
Denmark	4	16	15	15	1		
Finland	11	13	13	13	12	3	8
France	2	3	2	5	6	12	3
Germany	6	5	5	4	8	6	4
Greece		17	16	17	13	17	12
Hungary					16	13	14
Ireland		4	3	11	9	16	9
Italy	3	12	14	16	7	14	5
Luxembourg		6	6	9	10	1	15
Netherlands	1	1	1	3	1	1	1
Norway		14	12	14			
Poland					15	9	13
Portugal	8	15	17	12	1	8	6
Slovak Republic					17	7	15
Spain	5	11	8	6	1	11	1
Sweden	7	8	11	2	1		
Switzerland		7	7	1			
Turkey					11	15	7
United Kingdom		1	4	10			

I. Estimates based on Cobb Douglas production functions and derived by OLS.

II-IV. Results are based on alternative assumptions on production possibilities (II outward oriented distance function, III inward oriented distance function and IV constant returns to scale). Each column reports the geometric average of three different estimation techniques (corrected least square, DEA and construction of a parametric frontier with the use of linear programming).

V–VII. Results are based on constant returns to scale and DEA analysis.

3.28 The data sources discussed so far only cover transport conducted by transport service firms. However, if the focus is the full economic impact of transport, one will have to take into account in-house transport, and more importantly passenger transport by households. In a broader welfare analysis one additionally would have to take account of external costs. The financial costs of production of transport services by households, such as car insurance, can be derived from household expenditure surveys. Time costs can be derived from time studies and time valuations used in cost-benefit analysis as discussed in Section 4.

3.29 CBA is increasingly used in planning and decision making in the transport sector, primarily as regards infrastructure, but also related to other policy instruments. A number of countries now publish CBA results for a large part of central government projects. It is therefore of interest to investigate whether data from CBA could be used as performance indicators. If the purpose is to be forward looking and assess expected returns on additional infrastructure capital CBA can yield this type of information. A CBA combines micro engineering data on individual projects, data on potential demand shifts and demand increases due to cost changes and forecasts of traffic developments. Valuation methods make it possible to include a range of effects not measured by market data. In Section 4 samples from *ex-ante* assessments and *ex-post* evaluations of infrastructure projects from a handful of countries are presented. These data indicate that a major part of the economic benefits from infrastructure investment reflect reduced travel time for households. These benefits would not be captured if one had chosen to filter effects through a NA-framework.

Table 3.5. **Quality of road and railroad infrastructure**

Ranking among OECD countries[1]

	Road	Rail
Australia	19	20
Austria	4	9
Belgium	10	8
Canada	13	12
Czech Republic	29	19
Denmark	5	11
Finland	8	5
France	1	3
Germany	3	4
Greece	22	27
Hungary	27	24
Iceland	18	-
Ireland	25	25
Italy	23	23
Japan	13	2
Korea	9	6
Luxembourg	11	13
Mexico	24	29
Netherlands	15	7
New Zealand	20	22
Norway	26	21
Poland	30	26
Portugal	6	18
Slovak Republic	28	17
Spain	16	15
Sweden	12	10
Switzerland	4	1
Turkey	21	28
United Kingdom	17	16
United States	7	14

1. Relative ranking based on the following question: How would you assess the quality of the rail and road infrastructure in your country?

Source: World Economic Forum 2009 – 2010 global competiveness index.

3.30 A production function approach represents an alternative top down approach to capture the mobility effects of infrastructure investment. In order to be forward looking, this methodology must also rely on forecasts of traffic developments. A Swedish study (Forslund *et al.*, 1995) used CBA data on net returns on infrastructure investment in 284 municipalities, aggregated over 53 regions, and compared them with estimated returns in the manufacturing industry from the implementation of the investment programmes. The estimated returns were used for testing the hypothesis that improved infrastructure would lower transportation costs and manifest itself as an outward shift in the production function. The purpose of the analysis was to investigate the correlation between a CBA approach and a traditional production function approach to the returns on infrastructure investments. The results show a clear and strongly significant relationship between the estimated returns based on the two approaches. In most cases the CBA yields higher returns than the production function approach. This is to be expected, as CBA provides a wider welfare measure (taking into account impacts on time costs for households) than captured by the value added concept in the National Accounts.

4. Planning of infrastructure and the role of cost-benefit analysis

4.1 This section reviews project appraisal systems (*ex-ante* assessment and *ex-post* evaluation), based on cost-benefit analysis (CBA) and their role in planning and decision making at the central government level. The main emphasis will be on ex-ante appraisals and the term CBA will generally refer to an ex-ante CBA. When ex-post CBAs are involved they will either be referred to as ex-post CBAs or ex-post evaluations (EPE). As an introduction to these issues, background information on the planning system in seven OECD countries is presented.[3] As will be seen, devolution of decision making and financing to lower levels of government is a cross-cutting issue in the countries reviewed. Devolution raises a number of issues related to the use of CBAs and the decision-making process, but it is outside the scope of this paper to pursue them.

Elements of planning, decision making and implementation: some country examples

4.2 ***Australia*** is far advanced in formalising the planning process. Planning guidelines from 2006 specify eight stages (Australian Transport Council, 2006). *The first phase* consists of setting broad objectives for transport policy at the national level. In *the second phase*, these objectives are made operational by being transformed into policy choices as regards the general thrust of transport system management. These include considerations, such as the relative importance of economic efficiency, safety, regional development, environmental implications, emphasis put on infrastructure solutions versus non infrastructure solutions, equity issues, and funding and allocation of funds. *The third phase* consists of a top down approach focusing on transport corridors and area strategies. System planning entails stakeholder involvement in addition to data collection concerning land use and economic trends. The planning horizon is typically 15 to 20 years. In *the fourth phase*, the information is moulded into concrete initiatives, which are subject to inputs from the relevant government agencies, the private sector and the political process. In *the fifth phase*, initiatives are filtered through successive screening mechanisms, by testing how well they contribute to the objectives, an appraisal through a preliminary CBA and lastly a detailed appraisal, including detailed CBA and environmental impact analysis as well as social, regional and equity impacts. The filtering is intended to use scarce appraisal resources in an efficient way. *Phase 6* involves prioritisation based on the results of the appraisals. Following prioritisation, a programme is developed from the list of prioritised initiatives and a timeframe and sequence is specified. *Phase 7* is the delivery phase of the programme. *Phase 8* consists of performance reviews; assessments of the *ex-post* efficiency and effectiveness of the decision, planning and implementation process and transport-system efficiency. Performance reviews can by carried out with varying degrees of intensity and may include a full range of assessments covered by the *ex-ante* CBA and additionally assessments of environmental, social and regional impacts.

4.3 While Australia's decision-making process has been, as in many other countries, shaped by devolution of financing and decision making since the 1980s, the federal level has found ways of promoting national goals and asserting influence in a decentralised environment (Twomey *et al*., 2007). The independent Productivity Commission has played an important role in assessing Australia's economic challenges, including a wide range of issues within the transport sector. The Council of Australian

3. The information is mainly based on OECD (2005) and national planning documents.

Governments, founded in 1992, has been instrumental in reaching an intergovernmental agreement on road transport, as well as in other policy areas.

4.4 Despite a well formalised planning system, critical remarks have been raised. Ergas *et al*. (2009) question the quality of the assessments that have been conducted. They point out that insufficient attention has been paid to alternative project options, that low quality of *ex-ante* assessments is a cause for concern and that an additional weakness of the appraisal system is that the CBAs are not updated when financing decisions are taken, making auditing difficult. They conclude that there is considerable scope for methodological improvements by increased cooperation between those involved in CBAs.

4.5 In ***France***, the 2002 plan shifted the focus from separate plans for each mode of transport to a multimodal approach. The 2002 plan has a planning horizon up to 2020. All larger investment projects have to conform to the objectives of the plan, though the plan has to be updated if a new major project is implemented. The plan includes targets for service provision covering: efficiency, quality (for instance, comfort and frequency of passenger trains) and external costs (safety and environmental costs), traffic management, regulations and intermodal distribution.

4.6 There has been significant devolution of responsibilities to departments and regions. The overall plan includes planning contracts between the central government and the regions, defining mutual obligations of the levels of government and providing for implementation of programmes given priority by the contracting parties. The contracts have entailed co-financing by the regions, usually half of total financing. This approach has entailed complex financial relations and for the state some loss of control over the prioritisation of projects.

4.7 Public debate over projects has to be organised at an early stage, which has implied that administrative procedures are increasingly time consuming and costly. In 2004 it took 14 to 15 years from the beginning of the planning stage to the completion of a 50 km stretch of a highway, three times the time it took in the 1970s. The government has sought to tackle this problem by moving the debate from the national level down to the regional and local level by devolving responsibilities to prefects and by shortening and simplifying procedures governing discussions. At the same time, the requirements for assessments have become increasingly comprehensive: sustainable development aspects should be taken into account, a uniform methodology should be used, and the need for each project should be rigorously examined while concerns related to the use of public funds should be addressed through both a socioeconomic analysis and a CBA.

4.8 *Ex-ante* evaluations of infrastructure projects in monetary terms were introduced in the 1950s (Chapulut *et al.*, 2005). The use of CBAs for major infrastructure projects became mandatory in 1982, while *ex-post* assessments became mandatory for larger projects in 1984. Significant changes in methodology have been introduced by successive commissions appointed by the Commissariat general du plan (an intergovernmental administrative body). In order to ensure consistency in evaluations over time and space, two government bodies, the Inspection Générale des Finances and the Conseil Général des Ponts et Chaussées has been given responsibilities for auditing construction projects. According to Quinet (2006) a number of factors have contributed to limit the impact of CBAs in decision making. Firstly, politicians have difficulties understanding them and the results have often been considered as uncertain and susceptible to manipulation. Secondly, the CBAs have not provided the politicians with the information they want, especially effects on income distribution and economic growth.

4.9 In ***Korea*** the national transport infrastructure network plans are formulated for a 20 year period by the Ministry of Land, Transport and Maritime Affairs. The planning process covers forecasts for transport demand, defining objectives for national transport infrastructure and an implementation strategy, identification of new projects and enlargement and maintenance of existing projects, funding strategies and the setting of investment priorities.

4.10 The mid-term infrastructure investment plan is set for five year periods. The relevant government entity responsible for evaluation of mid-term planning performance can be a local government or a government agency. These evaluations serve as a basis for the National Transport Committee in their assessment of the government's transport policy. The Minister of Land, Transport and Maritime Affairs issues guidelines regarding investment evaluation to government agencies to enhance the coherence of investment evaluations.

4.11 The Preliminary Feasibility Study, which includes a CBA, was introduced in 1999 to encourage a prudent approach towards making decisions on new large projects. The CBA is conducted by the Ministry of Strategy and Finance. Projects over KRW 30 billion (EUR 18 million) are scrutinised by the government throughout the whole process to enhance the efficiency of government spending. The board of audit and inspection monitors the projects that are undertaken or supervised by the government agencies. The National Assembly also has the authority to audit government-run projects.

4.12 Transport planning in **the Netherlands** consists of three stages. First a long-term plan with a time horizon of 20 years is adopted by the parliament. The plan defines potential projects that are in line with policy objectives and the necessary requisition of land. The plan will to the extent deemed necessary be updated and altered during the planning period. The next stage includes a Mid-term Programme on Infrastructure, also adopted by parliament, which develops projects in the long-term plan, making them ready for implementation and allocates funding. To take into account the inter-linkages between transportation, land use and environmental protection, the plans for the three policy areas are treated jointly by parliament. Responsibilities and financial resources have been devolved from the state to the regions. The regions may now initiate larger projects of regional importance, up to EUR 225 million.

4.13 All larger projects are subject to an Environmental Impact Analysis (EIA) and a CBA that may cover a wide range of societal concerns. The EIAs and CBAs are typically contracted out to consultancy firms or to research institutions. The contractor of the individual projects is responsible for providing both. The appraisal procedure is also strongly recommended, and more and more frequently used, for smaller projects. Guidelines for CBAs were introduced in 2000. A second opinion CBA is often carried out for larger projects, in many cases by the Central Planning Bureau. However, universities and government agencies may be also be used.

4.14 According to OECD (2005), the planning process has had shortcomings. Asymmetric information between the initiators and stakeholders has resulted in the views of the stakeholders being considered too late in the process, which has sometimes resulted in law suits delaying the project. Another problem has been that projects have been studied in isolation, and not as part of a larger integrated planning initiative. The initial cost estimates have only been based on a limited number of legally recognised aspects, not covering the full range of cost factors. Moreover, the government may choose a different project design from that originally planned and assessed by the stakeholders. Recently measures have been taken to speed up decision making by introducing a simplified fast track CBA procedure for categories of projects that are not of national importance or of a high degree of complexity.

4.15 In **Norway** a national transport plan covering ten years is presented to the Storting every four years. The present plan, presented in 2009, covers all transport modes. The plan is the outcome of the close cooperation between the ministries concerned with the agencies responsible for roads, rail and maritime transport services in the lead. The agencies work out plans for national and international transport corridors for each transport mode, based on preliminary budgetary guidelines from the Ministry of Transport and Communications. The counties and large cities are invited to present their views on the proposals. A governance reform was implemented in January 2010, which will transfer the responsibility of a significant part of the road network from the central government to the counties and strengthen their role in decision making.

4.16 The final outcome, the presentation of a selection of projects consistent with the budgetary framework and political priorities is presented in a white paper. The white paper presents CBA results for projects above NOK 200 million (roughly EUR 25 million). In addition to the CBAs, which are carried out by the agencies involved in planning, a special procedure for quality control for projects in excess of NOK 500 million is gradually being phased in. The procedure which is administered by the Ministry of Finance entails evaluation by external consultants, not only of the specific project, but also of alternatives. Decisions on budget allocations for investment projects are presented in the yearly budget. The present national transport plan follows plans of other countries by introducing explicitly quantified policy objectives concerning the reduction in the number of fatalities, reduced time costs for road travel distances, increased reliability of trains (percentage on time), etc. The outcomes relative to these objectives are monitored in the yearly budget proposals by the Transport Ministry.

4.17 The **Swedish** national transport plan has a ten year horizon. The government transport agencies presented their proposals to the government in August 2009. The proposals contained a prioritised list of projects that conform to the main transport priorities of the government. Local governments and the business sector are involved in coordination and reference groups throughout the process. In March 2010, the government presented its plan for the period 2010–21.

4.18 There is ongoing work to improve the assessment of infrastructure investment. Specifically, emphasis is given to improve methodologies for forecasting costs and addressing uncertainty. The use of CBAs has been extended to smaller projects. Assessments by the relevant government agencies are supplemented by work of external consultants and the authorities are cooperating with universities to ensure quality and coherence of the CBAs.

4.19 A comparison between the Swedish and the Norwegian planning system (Lauridsen *et al.*, 2001) revealed that the planning process was more centralised in Sweden, where the strategic planning was led by a research institution under the Ministry of Transport. In Norway, the State Road Agency was in the lead of the planning process. There were differences in the setting of targets. Sweden operated with a hierarchy of goals, the responsible agencies focusing on quantified targets, while the Norwegian system operated with high level goals (robust regional economies, more environmental friendly and safer transport systems) which did not give the agencies operational guidance as how to prioritize. Furthermore, while the Swedish guidelines underlined the importance of CBA to achieve economic efficiency, the Norwegian guidelines underlined the uncertainties and inherent weaknesses of CBA methodologies.

4.20 In **the United Kingdom** transport plans cover a 10 year period, the most recent being presented in July 2000. The plan set targets and indicates the available resources. Full information on CBA results was available for high-priority schemes. The targets relative to 2000 were set in terms of congestion on trunk roads (unchanged level, despite an expected 26% increase in traffic) and an increased volume of public transport (10% plus for bus and 50% plus for rail). The plan, including the targets, has been periodically revised in view of new information, and was later rolled forward to take into account forecasted income and population changes up till 2015. The Highway Agency is responsible for developing infrastructure projects on the basis of studies made by transport consultants under the guidance of regional planning bodies. The agency furthermore is responsible for procurement. The Strategic Rail Authority is responsible for developing proposals for the rail network.

4.21 Both *ex-ante* assessments and *ex-post* evaluations are integral parts of the planning process. In 1998 the so called New Approach To Appraisal (NATA) methodology was introduced. It is a mixture of a

CBA analysis for some core elements that may be expressed in monetary terms and covers the remaining elements by a multi-criteria analysis (MCA) (see below). The appraisal methodology has evolved. With the publishing of new guidelines for project appraisal in 2003, more of the elements considered were given a price tag, and included in the CBA.

4.22 The Eddington Study (2006) focused on the relationship between transport networks and economic success, and presented recommendations for improving planning. It provides insights into the challenges for and shortcomings of the present planning system. The study recommended a three level planning framework: starting with a 30 year horizon in order to set out long-term objectives, a 10-20 year horizon for delivering medium-term objectives and lastly a 5–10 year statement of commitments identifying the most effective polices to deliver objectives. The long-term perspective should coordinate transport policy with other policy areas like housing, environment, social inclusion and productivity. While available data on the performance on strategic rail and road links were judged to be good, there are insufficient data on inter-modal journeys, on the users and on total environmental, social and economic impacts. Among stakeholders there is also the view that the present planning system can be very costly, inefficient and can create unnecessary uncertainty for private sector participants. The study presented recommendations aiming at strengthening the planning framework through legal and institutional reform. In the United Kingdom, as in many other countries, there is a trend towards devolution of responsibilities. The benefits to be derived include better knowledge of local conditions and preferences which facilitate the choice and design of investment projects. At the same time decentralisation poses challenges as local governments may not overlap with local economic agglomerations or labour markets. In order to reach efficient decisions, coordination between decision makers is needed.

Cost-benefit analysis: the methodology

4.23 Table 4.1 summarizes analytical tools and procedures used in project appraisal in OECD countries. CBA constitutes a central element in planning across the OECD and there is widespread use of CBA for larger projects. Many countries have introduced national guidelines for CBA to improve consistency over time and space. A number of countries have also put in place systems for quality assurance for CBAs. Typically a rudimentary CBA is made early in the planning cycle for a project as a filter to assess whether the project should be selected for closer consideration. An environmental impact analysis (EIA) usually assesses whether the project is environmentally acceptable. Later in the planning process, closer to decision making, a more detailed CBA is conducted, where also alternative designs are considered. In some countries additional CBAs are conducted by independent bodies as a quality check.

Table 4.1 **Analytical tools and procedures used in infrastructure project appraisal**

	Long run forecast transport demand	CBA (or MCA)	Environmental impact analysis (EIA)	*Ex-post* project evaluation (EPE)	Monitoring system that allows for estimation of overall changes in benefits	Procedure defining relationship between CBA outcome and decisions
Role in planning process	Input in CBA (or MCA)	– Early selection of projects/basis for design/ranking of projects – In final decision making	Screening of projects	– Evaluation of historic return on projects – Input quality check of CBAs	Assessing outcomes of transport systems relative to policy targets (Crude EPE)	Decision making rule

4.24 A CBA consists essentially of computing the present value of future estimated benefits, and subtracting estimated operating and investments costs to arrive at net benefits. As the net benefits of a particular infrastructure investment normally will depend on traffic volumes over 30 years or more, long-term traffic forecasts constitute an integral part of infrastructure planning. Additionally, returns depend on the valuation of time costs and reduced accidents, pollution and other externalities. Multi-criteria analysis (MCA) represents an alternative methodology that is used to some extent. MCA may include the same elements as a CBA, but fewer elements are monetised. Thus MCA does not summarise all the results in one aggregate indicator. The MCA output consists of one core monetised value and a number of additional indicators measured in different types of units. In order to arrive at a ranking of projects, subjective weights have to be assigned to each element.

4.25 Table 4.2 presents the elements taken into account in the CBA guidelines in the countries discussed in this section, though the list is not exhaustive. As can be seen, Norway, Sweden and France take the cost of tax financing into account. It is assumed that due to tax distortions, financing investment via taxes adds an extra 20–40% to costs. The Netherlands, Sweden and the United Kingdom include further socio-economic effects as side benefits, which encompass distributional effects or up or downstream indirect effects (including agglomeration effects). The United Kingdom presents environmental impacts in physical measures but not in monetised terms. The national guidelines allow for some flexibility as regards the type of elements to be taken into account. CBAs are conducted with various degrees of detail (number of elements taken into account, types of data used). There is general agreement that the CBA methodology does not capture total benefits. In particular, there may be positive externalities in terms of extra indirect productivity effects that usually are not captured by the "core" analysis. There is, however, disagreement on the size of such effects, and the impact on CBA outcomes. According to the Eddington Study, the "missing GDP impacts", that is growth enhancing impacts not captured by the UK CBA methodology, could raise benefits by 70% in congested urban areas, 40% for international gateways and 10% in inter-urban corridors. According to a research report on Dutch public transport (Bakker *et al*., 2009), the traditional CBA captures the main benefits.

Table 4.2. **Monetised elements taken into account in cost-benefit analysis for a selection of countries**[1]

Element	Norway	Netherlands	Korea	Sweden	United Kingdom	France
Cost of tax financing	X			X		X
Construction cost	X	X	X	X	X	X
Costs for maintenance, operation and administration	X	X	X	X	X	X
Passenger transport time saving	X	X	X	X	X	X
User charges and revenues	X	X	X	X	X	X
Vehicle operating costs	X	X	X	X	X	X
Benefits for goods transport	X	X	X	X	X	X
Safety	X	X	X	X	X	X
Noise	X	X	X	X		X
Local air pollution	X	X	X	X		X
Climate change	X	X	X	X		
Indirect socioeconomic effects		X		X	X	X
Adjustment for optimism bias					X	

Source: Odgaard *et al.* (2005). Additional information, including the inclusion of cost of tax financing and adjustment for optimism bias, is taken from national sources.

4.26 A number of the CBA elements do not have observable market prices and have to be estimated. The quantitatively most important non-observable variable is time costs (value of travel time), which is a central element of transport costs (Gressier, 2005). There is a voluminous literature addressing the cost of time and cost estimates exist for business travel, commuting and leisure travel. Another important element, the value of safety improvements, requires estimates for the value of life. Table 4.3 displays estimates for time costs (lower intervals for leisure travel, higher for professional travel) and value of life. As can be seen, the value of life and time costs is correlated with income levels.

4.27 While project costs accrue over a short time span, the benefits accrue over a long time period. As a consequence of this asymmetry, the expected lifespan and the discount rate have a significant impact on the net returns of a project. In Table 4.3 recommended discount rates, assumptions about the life span are presented together with other parameters. The actual discount rate used may deviate from those reported in Table 4.3 due to different practices in incorporating specific risk premiums for individual projects. The choice of discount rate has a significant impact on CBA results. A high discount rate translates into a lower net present value, especially for distant income streams. Changing the discount rate from 3% to 10% implies that the present value of an income 10 years into the future is reduced by 48% while the present value of an income 50 years into the future is reduced by 96%. The United Kingdom and France have, out of concern for sustainable developments, chosen to reduce the discount rate for periods beyond 30 years, implying higher net benefits from investment projects with a long life span compared with the methodology used in other countries. Lack of adjustment for tax distortions tends to contribute to higher net returns for the United Kingdom compared with France, Norway and Sweden. On the other hand the British guidelines include an explicit downward adjustment for optimism bias in benefit estimates.

4.28 Variations in methodology may have significant effects on the outcome of a CBA. Økland (2008) analysed how substituting Norwegian parameter values with Swedish and British parameter values would affect the CBA outcome for a large Norwegian rail project. The Norwegian CBA showed large negative net benefits. The CBA based on the Swedish methodology as used by the Swedish Rail Administration gave an even more negative outcome than the Norwegian CBA. In contrast, the CBA based on parameter values recommended by the UK Department of Transport gave large positive net benefits. Factors contributing to a better outcome for the British CBA are: a longer time horizon, a lower discount rate, a higher valuation of time and lack of adjustment of dead-weight losses due to tax financing.

Table 4.3. **Parameter values in cost-benefit analysis across countries**

Based on information from 2003–04

	GDP per capita (EUR 2003/habitant)	Valuation intervals[1] for time 2003 (EUR 2003)	Value of human life (EUR 2003)	Real discount rate (per cent)	Time horizon years[2]
Norway	43 309	6.7–22.3	2 850 000	4½*	25
Switzerland	38 529	4.5-23			
Denmark	34 009	6.6–31.5	1 124 000	6-7	30
United States	32 715	20.8	3 641 000	3-7	varies
Sweden	30 058	9.3	1 900 000	4	15-60
Japan	29 964	31.8	284 000	4	40
The Netherlands	28 138	4.6–23	–	5½*	30
United Kingdom	26 895	11.6–32.8	1 775 000	3½*	60*
France	25 891	10–35	1 061 000	4	30
Germany	25 815	6.5–30.9	1 250 000	3	varies
Canada	24 008	8.6	1 660 000	5-10	20-50
Australia	23 501	5.2–16.5	728 000	6-7	20-30
New Zealand	17 144	3.5–12	1 320 000	8*	25
Slovenia	12 254	3.8–14.6	590 000		
Korea	10 722	8–10	242 493	6.5	30
Czech Republic	7 827	2.8–8.2	231 000	7	20-30
Hungary	7 428	4.0–5.2	136 000	6	30
Mexico	5 627	1.2–2.0		12	30
South Africa	3 146	2.5–6.7	46 500	8	20-40

1. For most countries the time cost interval refers to leisure travel (lower estimate) and professional travel (upper estimate). For some countries commuter travel and professional travel are reported, or simply averages for all types of travel.

2. Differences in the time horizon used in a CBA do not necessarily reflect a different assumption on the economic life span. In Norway for example, the technical life span is usually assumed to be 40 years. A residual value, derived by linear depreciation over the remaining 15 years is added to the estimated benefits in the last year within the time period for the analysis.

Source: Gressier (2005) and national sources. (*) Indicate updated discount rates and appraisal periods relative to those reported by Gressier.

Cost-benefit analysis – results and implications for decision making

CBA results for five countries

4.29 Tables 4.4–4.9 display results from samples of CBAs in five countries. The samples are drawn from different stages of the planning and decision-making process, and convey to some extent different information:

- The *Korean* sample includes all infrastructure projects (of which almost ¾ are transport projects) subject to a CBA.
- For the other countries the samples are limited to road and rail projects.
- The *Norwegian* sample encompasses projects that are given priority in the government's national plan up till 2020. Decisions on implementation have yet to be made by the Storting.
- The first *Swedish* sample is a mixture of approved ongoing projects, projects at the planning stage which have been earmarked for implementation in the near future (the first sample). The second Swedish sample covers projects given priority by the government transport agencies within the specified budget envelope. The third sample covers additional projects that would be given priority, if the budget envelope should be increased by 15%.
- The *Dutch* and the *Korean* samples encompass projects that have been subject to decisions.
- The *British* sample consists of a list of high return projects assembled as part of the Eddington Study. The projects had either been implemented or proposed prior to the finalisation of the study in 2006. The total cost of the projects amounted to GBP 100 billion (around 7½ per cent of GDP in 2006). This sample was assembled with the purpose of showing the potential for supporting growth through increased investment in transport infrastructure, and not to reflect the total sample of projects under consideration.

4.30 In the Korean case (Table 4.4) the information is limited to whether net benefits were estimated to be positive or negative. In the Dutch, Norwegian and Swedish case (Tables 4.5–4.8) net benefits are presented (the difference between benefits and costs). In the British case (Table 4.9) the ratio of benefits to costs[4] (BCR) is presented. A project with a net benefit will display a BCR greater than 1. The results are classified in four categories according to the benefit ratio. A ratio below 1 is considered poor, a ratio between 1 and 1½ low, a ratio between 1½ and 2 medium and a ratio above 2 high.

Table 4.4. **Korea: Cost-benefit results for 378 large infrastructure projects**[1]

Year Decision	Total cost and no. of projects		Net positive benefits			Net negative benefits		
	Cost (trillion KRW)[2]	Number of projects	Percentage of total cost	Number of projects	Stopped	Percentage of total cost	Number of project	Go ahead
1999	27.2	19	27	12	0	73	7	1
2000	14.0	30	44	15	2	56	15	5
2001	19.8	41	33	14	0	67	27	6
2002	16.2	30	38	13	1	62	17	5
2003	21.5	33	81	20	1	19	13	3
2004	18.6	55	72	41	3	28	14	4
2005	12.4	30	68	19	3	32	11	1
2006	21.5	52	43	28		57	24	6
2007	16.8	45	63	26		37	19	1
2008	11.9	43	45	28		55	15	5

1. Of these, 277 are transport projects.
2. 1 KRW = EUR 0.00059 (average December 2009).

Source: National Assembly Budget Office of Korea, Ministry of Strategy and Finance of Korea.

4. BCR = benefits/costs = (net benefits + costs)/costs.

Table 4.5. **The Netherlands: A sample of CBAs for rail and road projects**

	Year CBA	Cost, EUR million	Net benefit, EUR million	Classified as	Decision to go ahead
Rail 1	2000	1 400 – 2 600	-1 400 to -3 100	NEG	NO
Rail 2	2001	600	-59	0	YES
Rail 3	2001	4 300 – 8 200	-5 500 to -600	NEG	NO
Rail 4	2001	120 – 3 72 l	-546 to 157	NEG	YES
Rail 5	2001	54 – 1 100	-700 to 92	0	YES
Rail 6	2002	0.9 - 1.0	-0.5 to 0.2	0	NO
Rail 7	2006	3 500 – 7 900	-8 500 to -3 200	NEG	NO
Rail 8	2008	295	-72	NEG	YES
Rail 9	2008	141 – 481	-388 to -81	NEG	YES
Road 1	2005	45		POS	YES
Road 2	2005	260 – 939	-2 200 to -600	NEG	NO
Road 3	2006	304 – 421	123 to 211	POS	YES
Road 4	2006	120 – 620	40 to 605	POS	YES
Road 5	2006	297 – 330	50 to 87	POS	YES
Road 6	2006	6 – 15	-3 to -12	NEG	YES
Road 7	2007	1 300 – 3 100	-2 100 to 900	0	YES

Source: Rienstra (2008).

Table 4.6.**The Netherlands: Net benefits of approved rail and road projects**[1]

EUR million

	Number of projects	Costs	Total net benefits
Rail projects	5	1 465	-1 209
Road projects	6	3.24	-0.05

1. Based on average of upper and lower bound net benefit and cost estimates in Table 4.5.

Table 4.7. **Sweden: Infrastructure projects covering both rail and road**

SEK million[1], projects for which a CBA is available

	No. projects	Aggregate costs	Aggregate net. benefits	No. projects Pos. net ben.
Ongoing projects or projects expected to be started in near future	47	110 261	-358	23
Of these:				
Rail	23	44 345	-3 962	11
Road	24	65 916	3 605	12
Additional prioritised projects over period up until 2020	58	24 313	24 279	53
Additional prioritised projects over period up until 2020 if budget ceiling increased by 15%	42	19 140	3 621	25

1. 1 SEK = 0.096 EUR (average December 2009).

Source: Proposals for the Swedish national transport plan for the period 2010-21 from national transport agencies (Appendix 2c).

Table 4.8. **Norway: Larger central government road and rail projects proposed**
Projects proposed in the national transport plan 2010-19, projects > NOK 200 million[1]

	Cost 2010-19	Reduction in transport cost business sector	Reduction in transport cost rest of society	Net benefit	Positive benefits
Sum 6 rail projects	28 815	3 314	7 434	-12 571	1
Sum 32 road projects	43 340	7 616	16 260	-13 140	6

1. 1 NOK = 0.119 EUR (average December 2009).

Source: National Transport Plan 2010–2019.

Table 4.9. **United Kingdom: Summary of results from the Eddington Study**[1]

Sector	Total	BCR < 1	1< BCR< 1½	1½ BCR < 2	2 < BCR	Average BCR
Highway agency schemes	93	1	3	9	80	4.66
Local road schemes	48	1	2	1	44	4.23
Local public transport schemes	25	3	1	6	15	1.71
Rail schemes	11	0	2	4	5	2.83
Light rail schemes	5	0	1	2	2	2.14
Walking and cycling	2	0	0	0	2	13.55
Total	184					

1. Covers 184 projects amounting to more than GBP 100 billion (7% of GDP).

Source: Dodgson (2009).

CBA results and decision making

4.31 The Korean and Dutch samples may be divided into two: the total number of projects that have been considered, and the sub-sample for which a positive decision was taken. By comparing the results for the projects that are given a go ahead with the total sample, one can implicitly derive a decision rule. The Dutch sample suggests that a positive CBA outcome always resulted in a positive decision. An analysis of a wider sample, including infrastructure for other modes of transport than rail and road, yields the same result. However, positive decisions were also taken in 50% of the cases with a negative CBA outcome. In the Korean case, 7.5 % of the projects with a positive CBA where stopped, while 23% of the projects with a negative CBA have been given the go ahead since 1999. These results indicate asymmetries as regards the impact of a CBA on decisions. Positive returns lead almost always to a go ahead, but a negative outcome is overruled in quite a number of cases.

4.32 The second Swedish sample that comprises prioritised projects consists almost solely of projects with positive net benefits, with an average BCR of around 2, suggesting that CBA plays a significant role in the prioritisation. Of the projects in the third sample, comprising projects to be proposed, if the budget envelope were increased by 15%, 40% have negative net benefits. The average benefit cost ratio is 1.2, corresponding to the lower category in the British classification system.

4.33 According to the CBAs for the Norwegian projects only 7 out of a total of 38 rail and road projects yield positive net benefits. The aggregate net benefits amount to NOK -25½ billion, implying a benefit cost ratio of 0.65. Thus if the Storting decides to follow the government's recommendations, the present value of welfare will be reduced by NOK 25.5 billion. There are several studies of the relationship between CBA results and decisions for Norway. In a study of road projects (Friedström *et al.*, 1997), it was found that economic costs and benefits have an impact on the ranking of projects. However the impact is rather weak. A large change in perceived benefits was not found to affect the ranking very much. Sørensen (2008) found that decisions on road projects could be explained by two political mechanisms: the low ratio of taxes to public spending in regions with low population density leads to increased demand for local public spending. Additionally, high spending in these regions may be explained by relatively few voters per elected representative and intensified competition for swing votes.

4.34 If the selection of projects is increasingly influenced by political considerations as one approaches the point of decision, one would expect that projects assessed early in the planning cycle would on average show higher net returns than projects assessed late in the planning cycle. The Swedish CBA samples presented in Table 4.7 fit this pattern. The first sample comprising ongoing projects or projects about to be implemented has gone through the political assessment process, and that may explain rather low net benefits. If this hypothesis is correct, samples reflecting early planning phases may convey better information on the potential efficiency gains to be derived from infrastructure investment than the samples of decided projects.

Cost-benefit analysis – an assessment of their quality

4.35 The effectiveness of CBAs as a planning tool depends on the ability to forecast investment, future benefit streams and operating costs. An *ex-post* evaluation (EPE) provides information for improving CBAs, for deciding how much resources should be invested in CBAs, and for deciding which weight they should have in decision making. If CBAs are generally a poor predictor of net returns, it does not make sense to let CBAs carry much weight in decision making, and it does not make sense to allocate significant resources to this type of analysis. An EPE of a project entails conducting a CBA in reverse. The actual costs can be observed. The value of benefits can be derived from actual traffic flows and the parameters used in the *ex-ante* analysis. Additionally, the reference scenario from the *ex-ante* analysis, showing transport volumes and associated benefits without the new infrastructure, needs to be reconstructed. In order to do so, one needs a good documentation of the assumptions made in the *ex-ante* CBA. As good documentation is often missing, replicating the reference scenario can be challenging. Having computed how outcomes in terms of transport costs and externalities would have evolved in the reference scenario, one can address two questions: first, the difference between actual outcomes and the estimated outcomes in the reference scenario will indicate the actual returns on the investment. Secondly, by comparing the *ex-post* difference with the results from the *ex-ante* CBA, one can assess the quality of the *ex-ante* CBA. As examples in the following will show, one may have projects which give a high return, but where the *ex-ante* assessment turned out to be over-optimistic. Conversely one may have projects that yield a high positive return in the *ex-ante* CBA, but turn out negatively.

4.36 Flyvbjerg (2007) conducted *ex-post* evaluations of 258 very large transport projects with a total investment cost of USD 90 billion (1995 prices). The projects were located in 20 different countries across 5 continents and were completed between 1927 and 1998. Comparisons of budgeted and actual costs and comparisons of forecasted and actual traffic volumes showed that 90% of the projects had cost overruns (on average 20% for road and 45% for rail projects). While traffic volumes for roads were underestimated by 10%, traffic volumes for rail were overestimated by 51%. The analysis also showed that there was no tendency for forecasting accuracy to improve over time. Overall, the analysis shows that CBAs for many of these projects were based on unrealistic expectations, or that stakeholders have been able to influence the CBA results. Given the poor historical record of *ex-ante* CBAs documented by Flyvbjerg, one would expect EPE to be an integral part of the planning process, with a view both to learn from mistakes and steadily improve methodology, and as a means to strengthen the credibility of CBAs.

4.37 However, only a few countries have introduced extensive *ex-post* analysis as part of the planning machinery. In *the United Kingdom* EPEs are conducted regularly for road projects in the first and the fifth year after completion. According to the Highway Agency's reports (Highway Agency, 2007), the BCR for 14 programmes where data were available, four were consistent with projected values, six were higher than predicted and four were lower than predicted. Overall, the average of the predicted BCRs for the 14 schemes was 2.7, which was identical to the average of the *ex-post* BCRs for these schemes. Forecasts for particular components of benefits have been less accurate. Only 38% of schemes have predicted time benefits within 15% of the outturn. In the first year there has been a poor correlation between predicted and actual accident savings, though the correlation improves after five years. A sample of ten rail projects for which EPEs are available, two generated lower benefits than expected, four had a much better performance, and four were exceeding expectations by a modest margin.

4.38 In *France*, EPEs became mandatory in 1984 for projects exceeding FF 500 million (EUR 82 million). The authority in charge of the financing and construction is responsible both for the CBA and the EPE. The deadline for producing an EPE is 3 to 5 years after completion. As the law only applied to projects initiated after 1985 and given the long gestation period of a new project, the availability of results is limited. *Ex-post* analysis is not cost free. In 2005 it was estimated that an EPE of a high speed train line in France cost between EUR 100 000 and 500 000. As traffic flows are the principal driver of benefits, a rough indication of the accuracy of the CBAs can be derived from comparing actual traffic growth with estimated growth, and final investment cost with forecasts. *Ex-post* evaluations of high speed trains presented in 2005 show that actual net returns were significantly below *ex-ante* estimated net benefits. This reflects an understatement of costs ranging from 0–25% for different lines (Chapulut *et al*., 2005). For one line, the Atlantique line, actual and the forecast number of passengers show an overestimation of passenger numbers of more than 30%, mainly due to more unfavourable developments in the relative price of rail to that of other modes of transport than forecast in the *ex-ante* CBAs. For motorways comparisons of *ex-post* and *ex-ante* estimates of costs show a more balanced picture.

4.39 Despite exaggerated net benefit predictions, French high speed trains have so far produced significant net benefits. In Table 4.10, an EPE (comparison of a baseline scenario without high-speed trains and one with) of most of the high speed train lines built since the early 1980s is presented. The table decomposes the present value of cost effects in two main parts: The first part (Section A in the table), comprises cost changes that would have occurred with the same number of passengers in high speed as in the classical trains and cost changes as passengers switch from road and air transport to high speed trains. The second part (Section B) comprises the benefits of induced traffic due to lower travel costs. Section C gives the investment costs and Section D sums up the net benefits. The benefit/cost ratio is 5.6.

Table 4.10. **Ex-post evaluation of benefits and costs of the high speed train system in France (TGV – LGV)**
EUR billion, 2005

			Reference scenario costs	Project costs	Benefits due to the projects
A. Impact of lower cost per passenger					
	Train passengers	Operating costs	66.5	51.4	15.1
		Time costs	162.7	125.3	37.4
	Air passengers	Operating costs	30.5	10.9	19.6
		Time costs	53.1	54.3	-1.2
	Passengers on road	Operating costs	13.3	9.6	3.7
		Time costs	29.2	20.7	8.5
	Total		355.3	272.2	83.1
B. Impact of increase in passengers					
	Net beneftis				17.2
C.	Construction costs			17.9	
D.	Total net benefits[1]				82.4

1. Of which EUR 2.5 billion is due to lower external costs.
Source: *Les Comptes des Transport* (2009).

4.40 *The Norwegian Road Agency* has started to conduct *ex-post* evaluations of a sample of 5 road projects each year. So far the results from eight projects are available. Net benefits were within 5% of the estimates for three of the eight cases, exceeding forecasts by more than 5% in four cases, and significantly below forecast in one case. Costs were generally lower than forecast, while actual traffic volumes were higher than forecast (Welde, 2009).

4.41 *The European Union* coordinates, and partly finances large trans-European transport networks (TEN) with the view of eliminating bottlenecks and improving European transport systems. The estimated costs of priority projects within the TEN-programme are EUR 415 billion by 2020. Almost 40% of the investment had been completed by the end of 2008. Commission funding has a strong leverage effect, due to co-funding through loans from the EIB and national funding. The building of these networks is complex because the planning, prioritisation and decision-making needs to be co-ordinated across national systems. Differences in CBA methodologies are one of the challenges. The EU Commission supports methodological work directed at clarifying and comparing differences in national methodologies. Furthermore, it has published general guidance for the methodology underlying CBAs (European Commission, 2006). However, this guidance stops short of providing parameters that would make it an operational tool. *Ex-post* evaluations of TEN projects show significant cost overruns (Table 4.11). In addition demand has been overestimated in 5 out of 7 cases with available *ex-ante* demand forecasts.

Table 4.11. **Forecasts and actual cost for EVA-TREN projects**

EUR million

Project	Total construction costs		Cost overrun	Overestimation of demand
	Forecast	Actual	Actual in per cent of forecast	
ICE Frankfurt – Cologne	2 784	6 015	116	n.a
Eurotunnel	2 702	4 568	69	Yes
Oeresund Fixed Link	1 795	2 924	63	Yes
Paris – Lille TGV 25%	2 666	3 334	25	Yes
Madrid – Seville AVE	3 263	4 029	23	n.a.
Magdeburg Waterway Crossing	2 064	2 435	18	Yes
Lyon – Marseilles TGV	4 015	4 338	8	No
Malpensa 2000[1]	990	945	-5	No
Baltic Sea Motorway[1]	2 200	1 830	-17	Yes

1. In the cases of Malpensa 2000 and Baltic Sea Motorway the comparison between forecast and actual costs is uncertain.

Source: EVA-TREN (2008).

5. Transport sector externalities

Externalities and externality costs

5.1 This section discusses externality costs, presents cost estimates for specific externalities and discusses the principles for internalising them. The discussion is confined to the road transport sector. There are costs associated with congestion and externalities. Without government intervention, these costs are not taken into account in transport decisions. While private costs comprise transport user costs, such as the energy costs of vehicle use, own time costs, transport fares and transport taxes and charges, social costs include both private costs and additional social costs related to the use of transport facilities, such as congestion, accident and environmental costs. As long as there is a gap between social and private costs, there is a potential for efficiency improvement through the internalisation of external costs, through regulatory measures, taxation and pricing schemes.

5.2 There are additional maintenance costs related to the use of road infrastructure. This cost element is not discussed in this paper. Existing road infrastructure represents sunk costs, and has little or no alternative value. Thus there are little or no efficiency gains to be achieved by charging users for investment costs. From an efficiency point of view, charges related to the utilisation of infrastructure should be confined to maintenance cost.

5.3 In this section, the definition and calculation of the marginal external costs of transport are mainly based on the *CE Delft Handbook* (2008). The *Handbook* was commissioned by the European Commission to summarise the existing scientific work, via meta-analysis of previous studies. The central aim of the *Handbook* is to provide a comprehensive overview of the approaches for the estimation and internalisation of external costs in the transport sector. The *Handbook* focuses on marginal external costs of transport activity as a basis for the design of internalisation policies such as an efficient pricing scheme.

Traffic congestion

5.4 Congestion can be loosely described as a condition that arises when there is too much traffic. Congestion is a phenomenon relating to the manner in which vehicles impede each others' progression as demand for limited road space approaches full capacity. It is a relative phenomenon relating to user expectations and road system performance. According to ECMT (2007), it is not easy to arrive at an operational definition of congestion.

5.5 Traffic congestion costs are composed of additional time costs due to delay, more fuel consumption, accident risks in congested areas and air pollution. Following (INFRAS/IWW, 2004), one can define social marginal costs as equal to the change in the total costs for all transport users when an additional user enters the road system. Social marginal costs can be determined by deriving total user costs or experimentally by field observations or macro model simulations (CE Delft, 2008). There are three commonly used indicators of traffic congestion costs. First, "dead weight loss" gives an indication of the savings in social costs which can be achieved by internalising externalities. Second, revenues related to a congestion charge, which establishes an optimal level and is the measure used in this study. Third, "delay time costs" represent total costs of lost time.

5.6 Time is an important factor to consider when congestion occurs since road networks do not operate at capacity all of the time. It has a relation to the timing of urban activities which is linked to decisions made by individuals and firms relating to the purpose of their trips. Estimates of congestion costs require the valuation of travel time which translates time losses and/or reduced reliability and comfort into monetary units. Table 5.1 presents the average values for the EU25 countries recommended by HEATCO[5] (CE Delft, 2008). Examples of estimates for individual countries are presented in Table 4.3.

Table 5.1. **Recommended values of time in passenger and freight transport**

EU25 average

Sector/purpose	Unit	Car	Bus
Passenger transport			
– Work (business)	EUR 2002/passenger hour	23.82	19.11
– Commuting, short distance		8.48	6.10
– Commuting, long distance		10.89	7.83
– Other short distance		7.11	5.11
– Other, long distance		9.13	6.56
Freight transport	EUR 2002/tonne hour	2.98	–

Source: Bickel *et al.* (2006) and CE Delft (2008).

5.7 Speed depends on infrastructure characteristics, weather conditions, and travel alternatives. Thus local evidence should be used in estimating time costs of congestion. The price elasticity of demand is also affected by local conditions. Table 5.2 shows the central benchmark values for marginal social cost of morning peak road traffic in different areas and road types for cars recommended by CE Delft (2008). They are clearly much higher in urban centres than in rural areas and higher for trucks than passenger cars.

Table 5.2. **Recommended marginal social cost of morning peak congestion by road types and areas**

EUR, 2000 prices, per vehicle-kilometre

Area and road type	Passenger cars	Trucks
	Large urban areas (> 2 000 000 inhabitants)	
Urban motorways	0.50	1.75
Urban collector roads	0.50	1.25
Local streets centre	2.0	4.0
Local streets cordon	0.75	1.50
	Small and medium urban areas (< 2 000 000 inhabitants)	
Urban motorways	0.25	0.88
Urban collector roads	0.30	0.75
Local streets cordon	0.3	0.6
	Rural areas	
Motorways	0.10	0.35
Trunk roads	0.05	0.13

Source: CE Delft (2008).

5.8 The optimal congestion charge depends on the demand elasticity and marginal social cost curve. The size of the elasticity depends on the user's options to react to road pricing changes, such as taking another route, travel another time and public transport options. UNITE (2002) recommends a price elasticity of demand between -0.25 and -0.5 in between urban centres, urban roads and careful application of these values for each spatial situation.

5. HEATCO stands for Developing Harmonised European Approaches for Transport Costing and Project Assessment. Its objective is to develop and to propose guide lines for project assessment and transport costing in Europe.

5.9 A congestion charging system was introduced in central London in February 2003. In July 2005, the basic charge was raised from GBP 5 to GBP 8 per day. The original central London congestion charging zone was extended westwards, creating an enlarged congestion charging zone in February 2007.[6] According to the annual reports (2007, 2008) by Transport for London, the road pricing scheme after the first two years of operation reduced congestion within the charging zone by 30%. By 2005, the reduction of congestion was less at 21% and in 2006, congestion was only 8% below conditions in 2002. However, the 2006 number was affected by a large number of street works in the latter half of 2006.

5.10 As a part of the policy package, it was decided that net revenue should be allocated to local network improvements (bus network improvements, road safety, walking and cycling). Given that the London congestion charging system has relatively high implementation costs (Table 5.3) and that the charge is not based on how many miles vehicles travel and on the time of travel but is based on daily use on weekdays, the design of the system is not considered optimal (Litman, 2006).

Table 5.3. **Revenues and costs of the London Congestion Charging Scheme**

Revenues	2006/07 fiscal year (GBP million)	2007/08 fiscal year (GBP million)
Standard daily vehicle charges (GBP 8)	125	146
Fleet vehicle daily charges (GBP 7)	27	37
Resident vehicles (GBP 4 per week)	6	12
Enforcement income	55	73
Total revenues	213	268
Total operation and administration costs	-90	-131
Net revenue	123	137

Source: Central London Congestion Charging Impacts Monitoring 5th and 6th Report (2007, 2008).

5.11 Singapore introduced road pricing in 1975. The road pricing scheme began as a manual system called the Area Licensing Scheme (ALS) based on permits, which developed into the Electronic Road Pricing System (ERP) with advanced information technology in 1998. Starting at SGD 3[7] per day for an ALS licence for cars in 1975, the fees were SGD 2 and SGD 3 respectively for use during peak time and a whole day from 1994, respectively. From 1998 onwards, the charges vary from SGD 0.50 to SGD 3.00 per passage through ERP gantries. Road pricing (ALS) reduced traffic entering into the restricted zone by 44% at the beginning, and by 31% by 1988. After introducing the ERP system, traffic volume into the central business district had fallen by about 10-15% compared to the ALS system during ERP operation hours (Chin, 2010).

5.12 Following a referendum, Stockholm introduced charges to reduce congestion and to improve the environment in August 2007 in the inner city. SEK 20 (approximately EUR 2) per passing is charged during rush hours in the morning and in the afternoon. SEK 10 is charged during non-rush hours and no charges during nights and weekends (Hamilton, 2010).

5.13 In the Netherlands, a proposal for a comprehensive system of road charges was submitted to parliament in November 2009. The scheme would entail the introduction of a kilometre price for motor vehicles, while abolishing the present vehicle purchase and road tax. A Global Position System (GPS) device, to record the distance travelled as well as the time spent travelling and the journey made, was to be installed in every vehicle. The GPS device would send the information to a collection facility for

6. The London Mayor’s Transport Strategy has a proposal that congestion charging on the Western Extension of the central London area will be removed in December 2010. According to the consultation and survey responses in 2008, removing the Western Extension of the central area option was most preferred.

7. 1 SGD = 0.490 Euro (Average December 2009).

monitoring and invoicing. It is envisaged that a rush hour surcharge could be introduced on busy routes. The rate of the surcharge will be the same for all road users, but it could be different for different roads. The scheme will be introduced in steps, starting in 2012 for freight and gradually extended until full implementation by 2017. The Dutch government expects that the kilometre charge system will reduce the number of kilometres travelled by approximately 15% and the time loss due to traffic congestion by 40 to 60%.[8]

5.14 Although congestion charges may be collected electronically by in-vehicle devices and global position systems, practical and political obstacles regarding privacy still exist in implementing congestion pricing (Parry *et al*., 2007). And political concerns about distributional effects of congestion charges have not been overcome (Willett, 2005). Congestion pricing raises similar concerns as access control policies about the loss of “rights” to use the road system without charge (ECMT, 2007).

5.15 Fuel taxes and vehicle registration fees are not directly linked to congestion because traffic congestion occurs at specific times in urban areas roads and highways. According to Parry (2002), a gasoline tax policy to reduce freeway congestion only harvests a small fraction of the maximum efficiency gains – between 25 and 38%. A subsidy for public transport can change passenger miles when fares are adjusted to their optimum levels. It reduced 9.8% in passenger miles for Los Angeles peak bus services and increased passenger miles by 149% for London off-peak bus services (Parry *et al*., 2009).

Traffic accidents

5.16 Transport accidents lead to external accident costs, which are the social costs of traffic accidents that are not covered by insurance premiums. The level of external costs depends on the level of accidents, the insurance system and value of human life. Table 4.3 presents country examples of valuations of human life. Insurances covering physical and property damages partly internalise the accident costs of transport and the coverage of national insurance systems affects calculations of the external part of accidents.

5.17 The theory of marginal external accident costs has been developed during the last few years. Therefore the empirical knowledge on marginal accident costs is quite poor (INFRAS/IWW, 2004). According to the *CE Delft Handbook*, the internalised portion of the accident costs amounts to between 59 and 76% for road transport. On the other hand, Baum *et al.* (2008) argue that accident costs are mostly internalised by insurance. Table 5.4 presents estimates of marginal external accident costs for passenger cars and heavy duty vehicle (HDV) for different countries differentiated by network type.

Table 5.4. **Unit values for external accident costs for different network types and vehicles**
2000

	Passenger cars			HDV		
	Urban roads EUR ct/vkm	Motorways EUR ct/vkm	Other ways EUR ct/vkm	Urban roads EUR ct/vkm	Motorways EUR ct/vkm	Other ways EUR ct/vkm
Austria	5.7	0.41	2.17	14.51	0.41	3.66
Germany	4.12	0.29	1.57	10.49	0.29	2.65
Spain	5.24	0.37	2	13.35	0.37	3.37
France	6.69	0.48	2.25	17.05	0.48	4.3
Netherland	3.2	0.23	1.22	8.16	0.23	2.06
Sweden	2.67	0.19	1.02	6.83	0.19	1.72
United Kingdom	2.61	0.19	0.99	6.64	0.19	1.68

Note: HDV: Heavy Duty Vehicle; ct/vkm: Euro cent per vehicle kilometre.
Source: CE Delft (2008).

8. Following the recent elections, the scheme is unlikely to go ahead.

5.18 Parry *et al.* (2007) suggest taxes based on vehicle miles travelled are more cost effective in reducing accidents than fuel taxes because accident occurrence is directly related with vehicle miles travelled, not with fuel consumption. But to measure these variables across drivers, vehicles and regions requires monitoring systems in each vehicle, which is costly to install and raise privacy problems. Fuel charges would also be more effective than vehicle taxes or other fixed taxes. If a vehicle-kilometre tax or road charging is not feasible due to political obstacles or high implementation costs, fuel charges could be a second-best alternative for reducing accident externalities.

Air pollution

5.19 Air pollution arises from vehicle emissions such as carbon monoxide (CO), nitrogen oxides (NOx), hydrocarbons (HC), sulphur dioxide (SO_2) and particulate matters ($PM_{10,}$ $PM_{2.5}$). Air pollution costs depend on the age and size of a vehicle, vehicle speed, fuel type and the related combustion technology with its specific end-of-pipe exhaust gas cleaning technology. Air pollution causes health problems, material damages, crop losses and damage to ecosystems. There are large uncertainties in estimating the external costs of air pollution, such as data uncertainty (emission factors for different vehicle categories and traffic situations), model uncertainty (assumptions about causal links between pollutant and health impacts, about the form of a dose-response function, choice of models for atmospheric dispersion and chemistry and underlying model parameters).

5.20 Table 5.5 presents air pollution cost values per vkm based on estimates for Germany for different types of vehicles. The emission data represent fleet average emission values, based on the TREMOVE model.[9]

Table 5.5. **Air pollution costs for passenger cars and heavy duty vehicles**[1]

Vehicle	Size	Euro class[2] (EUR ct/vkm)	Metropolitan (EUR ct/vkm)	Urban (EUR ct/vkm)	Interurban (EUR ct/vkm)	Motorways (EUR ct/vkm)	Average (EUR ct/vkm)
Passenger car Petrol	1.4-2L	Euro-2	0.9	0.6	0.3	0.4	0.4
Passenger car Diesel	1.4-2L	Euro-2	4.0	1.8	0.8	0.9	1.1
Trucks	7.5-16t	Euro-2	12.4	8.5	7.2	6.9	7.1
	16-32t	Euro-2	12.9	9.1	7.5	7.1	7.2

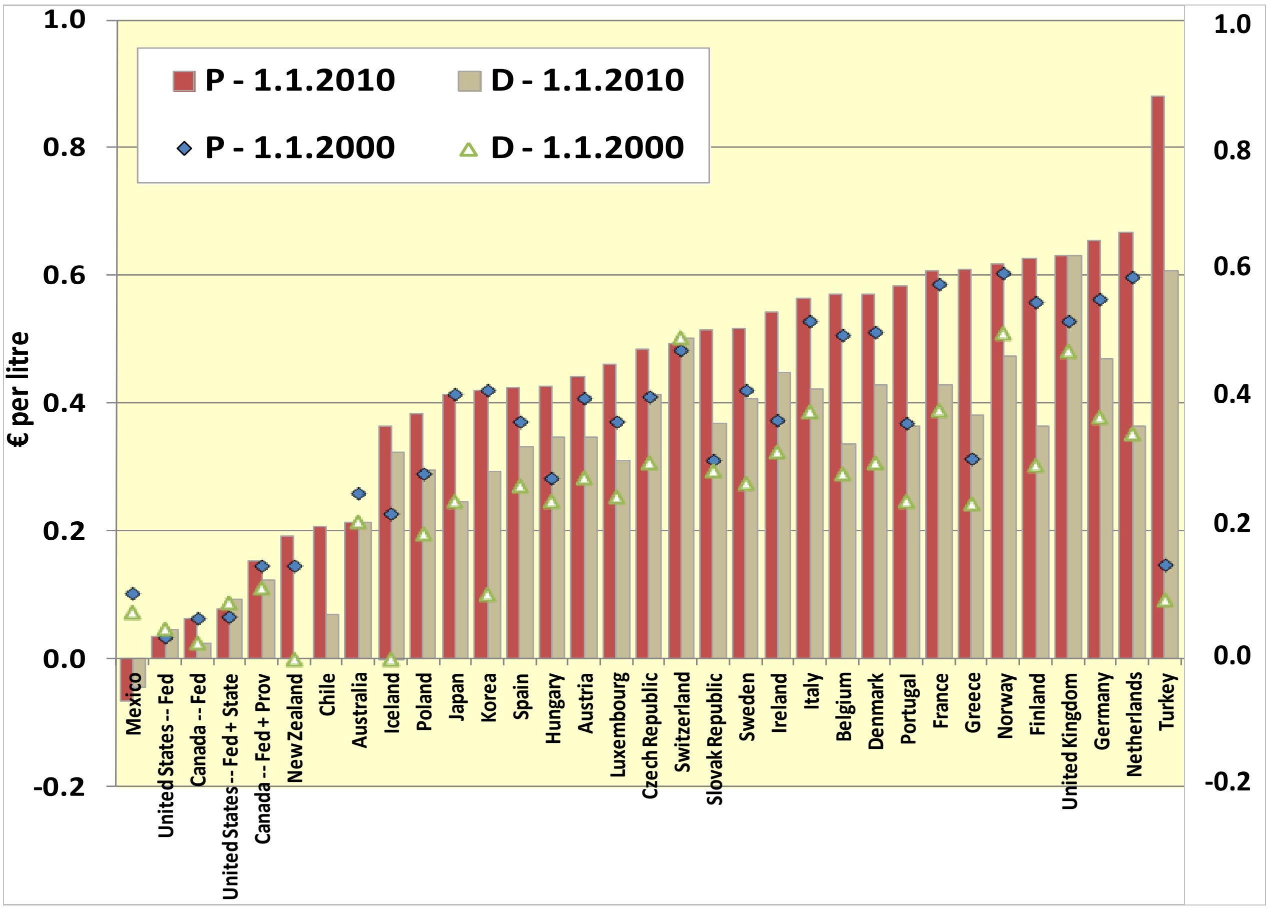
1. Emissions from TREMOVE model, HEATCO and Clean Air for Europe Programme Cost Benefit Analysis (CAFE CBA) cost factors for Germany used, price base 2000.
2. Euro class is European emission category from euro-0 to euro-5 for cars.
Source: Summary based on CE Delft (2008).

5.21 Air pollution can be decreased by improving fuel economy standards, changes in combustion technologies, less car driving, the use of end-of-pipe abatement measures (*e.g.* catalysers) and by substituting the fuel a vehicle is using. A gasoline tax alone would not be a good instrument to reduce emissions, if it does not have a strong impact on user's behavioural responses. A study by Graham and Glaister (2002) indicates that long-run elasticises of fuel consumption with respect to price are in the –0.6 to –0.8 range, and short-run price elasticises are around –0.3. Therefore a gasoline tax would reduce fuel consumption considerably in the long run. Raising fuel prices will therefore be more effective in reducing

9. TREMOVE is a policy assessment model, designed to study the effects of different transport and environment policies on the emissions of the transport sector. The model estimates the effects of policies such as road pricing, public transport pricing, emission standards, subsidies for cleaner cars etc. on transport demand, modal shifts, vehicle stock renewal and scrappage decisions as well as the emissions of air pollutants and the welfare level (*http://tremove.org*).

fuel consumption than in reducing the volume of traffic. Moreover, from the local air pollution perspective, higher taxes on diesel driven cars and trucks than on petrol driven cars would be required.[10] But Figure 5.1 shows that current fuel taxes are not in line with the air pollution costs of the different fuel types, giving consumers an incentive to buy diesel-driven vehicles. Most countries levy fuel taxes and vehicle taxes on vehicle operators. Taxes on vehicle purchase (VAT), registration and operation are not a good instrument for internalising externality costs because these taxes are levied on vehicles regardless of the amount of vehicle use which produces the externality costs.

Figure 5.1. **Tax rate for unleaded petrol and diesel**



Source: OECD/EEA database on instruments used for environmental policy and natural resource management (2010).

Traffic noise

5.22 Noise can cause physiological or psychological harm to humans. In general, the negative impact of transport noise is composed of annoyance and health costs. Noise depends on the speed of the vehicle, the vehicle type and age, its state of maintenance and the quality of the road. In some studies, above 50 dB (A)[11] is seen as harmful, while other studies choose 55 dB (A) or 60 dB (A). In line with recent

10. There are, however exceptions. Cropper *et al*. (2010) indicate that petrol-driven cars produce more volatile organic compounds (VOCs) emissions than diesel-driven cars given the particular conditions in the Washington, DC, area.

11. dB (A) stands for A-weighted decibels. It has been widely adopted for environmental noise measurement.

studies, traffic noise levels above 55 dB (A) are regarded as harmful (CE Delft, 2008, INFRA/IWW, 2004, ECMT, 1998).

5.23 The valuation of costs related to noise can be based on different methodologies. The so-called hedonic pricing method uses the Noise Depreciation Sensitivity Index which relates traffic noise and house prices. An alternative is the contingent valuation method (*e.g.* willingness-to-pay studies) which derives valuations by asking people about their willingness to pay for reductions in noise.[12] Table 5.6 presents the recommended unit values for road noise for different networks and different types of vehicles.

Table 5.6. **Unit values of marginal noise costs for different network types**
EUR ct/vkm[1]

	Time of day	Urban	Suburban	Rural
Car	Day	0.76	0.12	0.01
	Night	1.39	0.22	0.03
Motor Cycle	Day	1.53	0.24	0.03
	Night	2.78	0.44	0.05
Bus	Day	3.81	0.59	0.07
	Night	6.95	1.10	0.13
LGV	Day	3.81	6.95	0.07
	Night	6.95	1.10	0.13
HGV	Day	7.01	1.10	0.13
	night	12.78	2.00	0.23

1. Values are central values based on the predominant traffic situation in the respective regional cluster: urban: dense; suburban/rural: thin.
Source: CE Delft (2008).

5.24 Fuel charges are very weakly correlated with noise externalities, as they depend on diverse factors such as road conditions, the time of the day the noise occurs, vehicle speed or vehicle type. Although road pricing based on GPS could be used to differentiate these factors, even in this case, it must be very difficult to take all these factors into account.

Climate change

5.25 Climate change costs are difficult to pin down, because of the long term and global nature of climate change and risk patterns are very difficult to anticipate (CE Delft, 2008). The accumulation of greenhouse gases and the climate effects are independent of the location of the emissions. The transport sector contributes about one fourth to the greenhouse gases emitted by the EU countries. Road transport contributed 84% of the transport sector's CO_2 emission and 21% of the world energy-related CO_2 emission (OECD, 2009). Because almost all motor vehicles are powered by fossil fuel, greenhouse gas emissions are an inevitable by-product of vehicle use. An ECMT study (2007) shows that CO_2 emissions from the transport sector increased by 1 412 million tonnes (31%) worldwide from 1990 to 2003, and grew 820 million tonnes (26%) in the OECD countries.

5.26 There are two general approaches (damage cost and avoidance cost) for calculating the total costs due to climate change in the transport sector. The damage cost approach uses models to assess the physical impacts of climate change and combines these with estimates of the economic impacts resulting from these physical impacts (Watkiss *et al.*, 2005, CE Delft, 2008). The avoidance cost approach is a way to assess the costs of avoiding CO_2 emissions. The method is based on a cost-effectiveness analysis that determines the least-cost option to achieve a given level of greenhouse gas emission reduction related to a policy target.

12. The externality costs of noise can be difficult to pin down as residents near a street suffer from noise, but profit from reduced rents. It is the owner of the real estate and not the tenant who suffers the disadvantage of the noise exposure (Baum *et al.*, 2008).

There are large uncertainties surrounding the studies based on damage costs and the accuracy of avoidance cost estimates (CE Delft, 2008).

5.27 External costs of CO_2 based on avoidance costs are to be preferred when a (long-term) reduction target has been agreed. The spread of results from different studies assessing external costs based on avoidance costs is smaller than for studies using the damage cost approach (CE Delft, 2008).

5.28 The CO_2 emissions of road transport are increasing as the number of vehicles is growing. There is no sign yet that this trend is changing. To reign in emissions, there are several alternatives like increased motor fuel taxes, regulation and standard setting, such as stricter fuel efficiency standards for vehicles, and encouraging R&D in clean technologies. A CO_2–differntiated motor fuel tax or a cap and trade scheme are economic instruments to lower CO_2 emissions. The tax internalises the negative externality of the CO_2 emissions. Such a tax would also provide an incentive for emitters to adopt cheap abatement options and provides incentives for R&D and technology diffusion to reduce CO_2 emissions (OECD, 2009).

5.29 OECD (2009) presented scenarios for stabilising GHG concentration in the atmosphere at different levels and over different time frames (Table 5.7). The study shows that if GHG cuts can be achieved in a cost-effective way through a global carbon pricing scheme, the economic cost could be relatively modest. Marginal abatement costs of Scenario A (550 ppm-base, implying a 36% emission cut) is estimated to be USD 282 per tonne of CO_2 in 2050. In Scenario B, the marginal abatement costs are USD 145 per tonne of CO_2 in 2050 with a 6% emission cut. In Scenario C, abatement costs are USD 531 with a 52% emission cut, while and in Scenario D, abatement costs are USD 40 with a 22% emission increase in 2050 compared to 2005.

Table 5.7. **Economic costs and environmental impacts of alternative cost-effective policy scenarios**[1]

Scenario	Change in total emissions in 2050 relative to 2005		Economic costs		Maximum CO_2 concentration over 2012-2150	
	All greenhouse gases (%)	CO_2 (%)	Marginal abatement costs in 2050 (2005 USD per ton of CO_2	GDP loss in 2050 (%)	Year	Level (ppm)
A: 550 ppm-base	-34	-36	282	-3.9	2065	461
B: 550 ppm-high	-9	-6	145	-1.7	2060	495
C: 50 rel. to 2005	-50	-52	531	-6.9	2050	447
D: 650 ppm	17	22	40	-0.6	2130	548

1. Scenario A) 550ppm-base: stabilisation of CO_2 concentration at 450ppm, and of overall GHG concentration at about 550 ppm CO_2 eq, with modest initial overshooting. Scenario B) 550 ppm-high: stabilisation of CO_2 concentration at 450 ppm, and of overall GHG concentration at about 550 ppm CO_2 eq, with high overshooting. Scenario C) 50 rel. to 2005: less 50% in 2050 relative to 2005. Scenario D) 650 ppm: stabilisation of CO_2 concentration at 550 ppm, and of overall GHG concentration at about 650 ppm CO_2 eq, without initial overshooting.

Source: OECD (2009).

5.30 The *CE Delft Handbook* presents costs per vkm based on examples for different types and sizes of vehicles (Table 5.8). Emissions of road vehicles are based on TREMOVE model outputs. The underlying emission data represent fleet average 2005 emission values for Germany for different vehicle categories. Within each vehicle category values are representative for European average emissions.

5.31 A carbon tax is an instrument for achieving cost-effective climate mitigation by setting a price on the negative side effects of economic activities on the climate. A global carbon tax, once agreed upon, has also an attractive political feature since it can be implemented through national legal systems and institutions without establishing new international institutions. Though a carbon tax has attractive features, developing countries have been reluctant to adopt a global approach, as the tax affects developing countries more than developed countries.

Table 5.8. **Climate change costs for passenger cars and trucks**
Value is based on cost factors (EUR/t CO_2) for 2010

Vehicle	Size	Euro-class	Metropolitan (EUR ct/vkm)	Urban (EUR ct/vkm)	Interurban (EUR ct/vkm)	Motorways (EUR ct/vkm)	Average (EUR ct/vkm)
Passenger car petrol	1.4-2L	EURO-3	0.7	0.7	0.4	0.4	0.5
Passenger car diesel	1.4-2L	EURO-3	0.5	0.5	0.4	0.4	0.4
Trucks	16-32t	EURO-3	1.8	1.8	1.6	1.5	1.5

Source: CE Delft (2008).

5.32 An emissions trading scheme is as effective as a tax when it comes to providing incentives for R&D and technology diffusion. They provide emitters an incentive to develop new emission-reducing technologies. Innovation is likely to be a major factor that could facilitate attaining environmental goals at a low cost (OECD, 2009).

5.33 Command and control (CAC) approaches are regulatory instruments that directly set technology and performance standards.[13] There is a good reason to use CAC, if, for instance, trading leads to high transactions costs. To make CAC instruments as cost-effective as a market-based incentive, polluter's marginal abatement costs would need to be equal, or the regulator would need to have full information about individual cost structures, but these conditions are usually not met. And CAC instruments do not provide a "double dividend" since they do not raise fiscal revenues in a non-distorting manner (OECD, 2009).

5.34 The EU levies high fuel taxes and has recently introduced a fuel-economy standard. The US levies lower fuel taxes but the CAFE standard has become considerably stricter since 1978. Fuel taxes in the EU imply considerably higher carbon prices. These carbon prices are higher than what is expected in cap-and-trade regimes, and consequently there are efficiency gains from including road transport in a cap-and-trade scheme (OECD, 2010). This would make the price of abatement the same across the sectors.

Total external costs of transport

5.35 The *CE Delft Handbook* defines external costs as those costs which are induced by transport users but not borne by them. But the *Handbook* does not provide the total unit values of the respective externality costs (Baum *et al.*, 2008). As part of a critical review of the values of the *CE Delft Handbook*, the Institute for Transport Economics at the University of Cologne (Baum *et al.*, 2008) summarised the result of the externality costs of the transport sector. Table 5.9 provides an overview of the aggregate estimates for the different categories of external costs.

13. Technology standards require emitters to use specific abatement technologies and performance standards set specific environmental targets that must be met, but without requiring particular technologies.

Table 5.9. **External cost components of the *CE Delft Handbook***

Cost component		Passenger car (EUR ct/vehicle-km)				Goods vehicle (EUR ct/vehicle-km)			
		Urban roads	Motor ways	Rural roads	Weighted average[1]	Urban roads	Motor Ways	Rural roads	Weighted average[1]
Congestion	Peak	30.0	10.0	5.0	11.1	75.0	35.0	13.0	31.0
	Off-peak	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Weighted average	12.0	4.0	2.0	4.4	30.0	14.0	5.2	12.4
Accidents		4.2	0.3	1.6	1.7	10.7	0.3	2.7	3.4
Noise		0.8	0	0	0.2	7.6	0	0.1	1.4
Air pollution		0.5	0.3	0.3	0.3	7.0	5.3	5.8	5.9
Climate change		0.7	0.4	0.4	0.4	1.8	1.5	1.6	1.6
Up and downstream		0.9	0.6	0.6	0.7	2.1	1.7	1.9	1.9
Nature and landscape		0.0	0.4	0.4	0.3	0.0	1.2	1.2	0.9
Soil and water pollution		0.1	0.1	0.1	0.1	1.0	1.0	1.0	1.0
Total	Peak	37.2	12.1	8.4	14.8	105.2	46.0	27.3	47.1
	Off-peak	7.2	2.1	3.4	3.7	30.2	11.0	14.3	16.1
	Weighted average	19.2	6.1	5.4	8.1	60.2	25.0	19.5	28.5

1. Weighted average values reflect share of vehicle-kilometre for road categories and share of peak time.

Source: Baum *et al.* (2008).

5.36 Total external costs amounted to EUR 321.84 billion in 2000 for the EU15 (3.8% of the GDP of the EU15). Total external costs of the passenger car sector amounted to EUR 186.46 billion, while the total costs caused by goods vehicles amounted to EUR 135.38 billion. The total costs were calculated using road traffic volumes (2 302 billion vkm for passenger cars and 475 billion vkm for goods vehicles, *OECD Environment Data*, 2007) in 2000 for the EU15. Total congestion costs in Table 5.10 are measured by using congestion costs at the optimal level. This implies that congestion costs in the current situation of road usage are greater. Table 5.10 shows that congestion costs account for roughly half of total external costs. Consequently policies directed at lowering congestion costs should yield high social returns.

5.37 Internalisation approaches are effective in reducing transport externalities as long as transport users pay the full social costs associated with travel decisions and transport choices are price sensitive (European Commission, 1995). GPS based road pricing systems, such as the Dutch road pricing scheme will be able to differentiate externality costs and levy appropriate charges on vehicle users.

5.38 Figure 5.2 shows that fuel taxes on average in the EU15 amounted to around 2% of GDP in 2000, covering the external costs, excluding congestion, which amounted to 1.9% of GDP. There are large variations between countries. In Denmark, Italy, Luxembourg, Sweden and the United Kingdom fuel taxes amounted to 2½ % of GDP. In the United States total fuel taxes amounted to 0.6% of GDP.

5.39 Various taxes on vehicles amount to 0.6% of GDP on average in the EU15. As vehicle taxes do not depend on distance driven, they do not contribute to internalising externality costs. However, they are of interest, as a potential source for introducing road charges by converting existing taxes, without raising total taxes. Fuel taxes and vehicle taxes as a per cent of GDP have declined somewhat on average since the mid-1990s, reflecting the lower transport intensity in GDP (Section 2).

Table 5.10. **Total external costs of passenger and goods vehicles for the EU15**

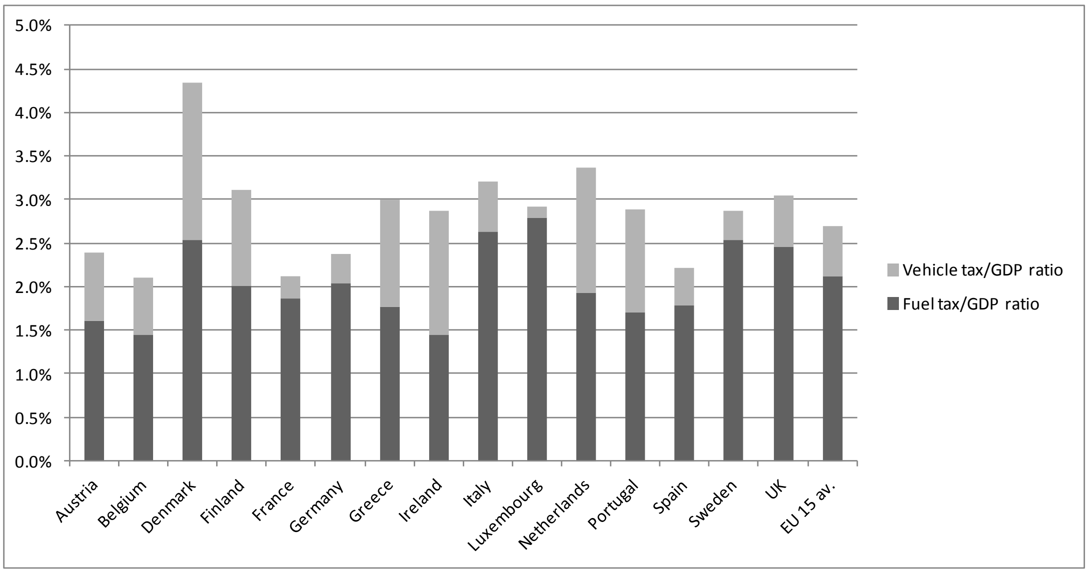
Cost component	Total externality cost of passenger cars (EUR billion)	Total externality cost of goods vehicles (EUR billion)	Total externality cost of passengers and goods vehicles (EUR billion)	Per cent
Congestion	101.29	58.90	160.19	49.78
Accident	39.23	16.15	55.29	17.18
Noise	4.60	6.65	11.25	3.50
Air pollution	6.91	28.03	34.93	10.85
Climate change	9.21	7.60	16.81	5.22
Up-and downstream[1]	16.11	9.03	25.14	7.81
Nature and landscape	6.91	4.28	11.18	3.47
Soil and water pollution	2.30	4.75	7.05	2.19
Total cost of externality in EU15 (EUR billion)[2]	186.46 (58%)	135.38 (42%)	321.84	

1. Up- and downstream: indirect effects due to the production of energy, vehicles and transport infrastructure that cause additional costs which occur outside the transport sector.
2. Total external costs are approximated by multiplying marginal unit costs (Table 5.9) and total vehicle km for passenger cars and goods vehicles.

Source: Own calculation based on the study by Baum *et al. (2008),* the Institute for Transport Economics at Cologne University, *CE Delft Handbook* (2008) and OECD Environmental Data, Transport (Compendium 2006/2007).

5.40 Tolls on road use are mainly levied as a source for financing road investment and maintenance. Total investment and maintenance amounted to just below 1% of GDP in 2007 for the countries where data are available. There are large differences across the OECD. In Norway toll charges covered 40% of the state road budget in 2008, amounting to 0.25% of GDP (Ministry of Transport, 2008). In the United States, tolls only accounted for 5% of the financing of highway construction in 2003 (Perez and Lockwood, 2006). In countries where tolls constitute a large financing source for investment and maintenance, a transformation of tolls to congestion or other externality charges could make a contribution to the pricing of externalities.

Figure 5.2. **Fuel and vehicle taxes for the EU15**
2000, per cent of GDP[1]



1. The tax/GDP ratios cover all energy products and overestimate tax ratios somewhat, as some of the fuel is used for stationary purposes (estimated at about 4% on average in the OECD) and because fuel for domestic water based and air based transport in some countries are subject to limited taxation.

Source: OECD EEA Database.

Externality costs and fuel taxes – the case of Korea

5.41 A recent study (Lee *et al*., 2008) for Korea highlights the correspondence between external costs and taxes, calculated by the difference between automobile fuel taxes and external costs, taking into account air pollution, climate change and congestion costs in 2006 (Table 5.11). The results indicate that the total external costs surpass the amount of the fuel tax in all fuel categories and that the tax rates are not proportional to the external costs of different fuels. In order to equalise fuel taxes with the external costs, the fuel tax needs to be increased unless other instruments are used to reduce externality costs.

Table 5.11. **External costs[1] of road transport and fuel taxes in Korea**
2006, KRW/vkm

	Gasoline KRW/vkm(EUR ct/vkm)	Diesel KRW/vkm(EUR ct/vkm)	LPG KRW/vkm(EUR ct/vkm)
Air pollution	8.14(0.65)	91.36(7.28)	18.54(1.48)
Climate change			
high level	1.55(0.12)	1.53(0.12)	1.35(0.11)
low level	0.77(0.06)	0.76(0.06)	0.68(0.05)
Congestion(time cost)	75.31(6.00)	55.84(4.45)	19.48(1.55)
Low level external cost	84.23(6.71)	147.96(11.79)	38.7(3.08)
High level external cost	109.32(8.71)	172.82(13.77)	60.68(4.83)
Fuel tax	81.49(6.49)	73.16(5.83)	35.62(2.84)

1. External costs are composed of air pollution, greenhouse gas and congestion cost.
Lower level used USD 3.71 ton CO_2, high level used USD 7.43 ton CO_2. This cost is significantly lower than that of CE Delft value (EUR 25 t CO_2) and EU standard (EUR 20 t CO_2 for short-term EU average, based on Kyoto target).
Based on the exchange rate (KRW/EUR was 1 255 in 2006).

Source: Lee *et al*. (2008).

5.42 Since transport fuel taxes are lower than external costs, the fuel tax does not induce motorists to use vehicles at an optimal level. And differences in tax rates on different types of fuel induce people to buy the vehicles that are less heavily taxed. Therefore, higher taxes on fuels such as gasoline provide incentives to buy more diesel vehicles which incur higher externality costs.

5.43 The Korean study excluded costs related to traffic accidents which contribute significantly to external costs in the CE Delft study. Furthermore a relatively low value for the climate change externality cost was applied in the Korean study compared with the value used in other studies. Table 5.12 shows the different values among various studies. EUR 5.78 per ton of CO_2 is used in the Korean study while EUR 20 per ton of CO_2 is the EU standard, EUR 25 per ton of CO_2 in the *CE Delft Handbook* and EUR 56 per ton of CO_2 in the study on the Netherlands.

Table 5.12. **Marginal cost level of climate change in different studies**

	Korea (2008) High level	EU based on Kyoto target	CE Delft (2008) central value	Netherlands (2002) Car (petrol), worst case
Marginal cost of CO_2 (EUR/t CO_2)	5.78	20	25	56
Marginal cost of CO_2 (EUR ct /vkm)	0.12	0.54	0.7	1.69

Note: Exchange rate (KRW/EUR in 2006) was 1 255.
Source: Lee *et al.* (2008), CE Delft (2008), CE Delft (2004), INFRA/IWW (2004).

Externality costs and charges – the case of the Netherlands

5.44 The CE Delft study for the Netherlands aimed at providing insights into the social costs of the various modes of transport including the magnitude of costs and the share of the costs borne by the transport sector itself, via taxes and charges. This study used the pricing policy approach, by charging all variable costs to users. A best and a worst case which depends on the production year of a vehicle (2002/1993), urban/rural area and peak/off-peak are used in this study to reflect the diversity of situations in the transport sector.

5.45 According to the CE Delft study (2004), in the case of passenger cars, besides congestion costs the main variable costs are associated with accidents and air pollution. The charges for petrol-driven cars in the best case surpass the external costs. However, if the congestion costs are included in the case of petrol passenger car, charges cover only about 12% of the costs. Ignoring congestion, even in the worst case charges cover just over half the external cost. In the best case of diesel passenger cars and diesel LGVs (light goods vehicles), charges cover 50% and 40% of external costs. In the worst case of LPG passenger cars just cover 1% of external costs. For the worst case of HGVs (heavy goods vehicles) the charges covers between 4% and 9% of the external costs (Tables 5.13 and 5.14).

Table 5.13. **Externality costs of transport per vehicle km in the Netherlands**
2002

		Costs (EUR ct per vkm)						
Modes of transport	Fuel	Variable costs of infrastructure maintenance and operation	Accidents	Noise	Air pollution	Climate emissions	Congestion	Total
				Worst case				
Passenger transport								
Car	Petrol	0.24	5.01	0.88	6.05	1.69	46.00	59.87
	Diesel	0.24	5.01	1.05	9.04	1.37	46.00	62.71
	LPG	0.24	5.01	0.88	2.69	1.32	46.00	56.14
Freight transport								
LGV	Diesel	1.05	1.91	1.31	18.98	1.77	46.00	71.02
HGV<12t	Diesel	10.12	11.61	8.58	23.96	2.65	91.00	147.91
HGV>12t	Diesel	5.21	11.61	11.55	59.01	7.96	91.00	186.34
				Best case				
Passenger transport								
Car	Petrol	0.24	1.97	0.13	0.13	1.13		3.60
	Diesel	0.24	1.97	0.13	0.86	0.97		4.17
	LPG	0.24	1.97	0.13	0.27	0.88		3.49
Freight transport								
LGV	Diesel	1.05	2.78	0.16	1.73	1.33		7.05
HGV<12t	Diesel	10.12	4.92	0.39	3.44	1.77		20.64
HGV>12t	Diesel	5.12	4.92	0.55	7.34	4.42		22.35

Source: CE Delft (2004).

5.46 This implies that for all transport modes considered, with the exception of "best case" petrol-driven passenger cars, current marginal charges are lower than the external costs, and cars powered by diesel and LPG do not cover their variable social costs. The deficit amounts to some 50-90% in the case of diesel cars and 85-90% for LPG vehicles. The tax benefit to owners of LPG cars (who pay over 90% less duty compared with owners of petrol vehicles) in view of lower emissions would therefore seem unjustified.

Table 5.14. **Charges per vehicle km in the Netherlands**

2002

Mode of transport	Fuel	Fuel duty +regulatory energy charge (EUR ct per vkm)
		Worse case
Passenger transport		
Car	Petrol	7.17
	Diesel	2.95
	LPG	0.68
Freight transport		
LGV	Diesel	3.80
HGV<12t	Diesel	5.70
HGV>12t	Diesel	16.41
		Best case
Passenger transport		
Car	Petrol	4.78
	Diesel	2.09
	LPG	0.45
Freight transport		
LGV	Diesel	2.85
HGV<12t	Diesel	3.80
HGV>12t	Diesel	9.12

Source: CE Delft (2004).

5.47 There is a wide dispersion of externality costs reflecting the type of vehicle, type of fuel, age of vehicle, location of roads and time of the day (in congested areas). Estimates for the Netherlands show that externality costs can be 10–15 times higher under unfavourable circumstances than the most favourable circumstances and much higher than fuel taxes. Time costs related to congestions is a major explanatory factor. However, indirect congestion costs related to noise and emissions are also important. The cost structure should be reflected in externality charges.

5.48 The studies for Korea and the Netherlands show that the fuel charges imposed on vehicle use tend to be lower than total externality costs. Congestion costs are the dominant cost component in both countries. The charges should be imposed at a level of marginal external costs which reflect diverse situations. The transformation of vehicle taxes into road charges would make it possible to introduce congestion charges, to some extent, without raising total costs for motorists. Advanced technology should provide the necessary information to charge according to the time and place where congestion takes place. This raises the possibility to impose optimal charges on vehicle users. Road pricing via GPS (Global Position System) and electronic sensors should also be feasible.

References

Albalate, D. and G. Bel (2009), “What Local Policy Makers Should Know about Urban Road Charging: Lessons from Worldwide Experience”, *Public Administration Review*, Vol. 69, No. 5.

Australian Transport Council (2006), National Guidelines for Transport Management in Australia.

Baanders, A., R. Piers and J. Robinson (2005), “National Transport Policies and their Impact on the Community Transport Objectives”, Association for European Transport and Contributors.

Baker, G.P. and T.N. Hubbard (2003), “Make Versus Buy in Trucking: Asset Ownership, Job Design and Information”, *American Economic Review,* Vol. 93, No. 5.

Bakker, P. and P. Zwanenveld (2009), “Het belang van openboar verfoer”, CPB Netherlands Bureau for Economic Policy Analysis and Knowledge Institute for Policy on Mobility.

Baum, H., T. Geissler, J. Schneider and J-A. Bühne (2008), “External Costs in the Transport Sector. A Critical Review of the EC Internalisation Policy”, ITF (Institute for Transport Economics at the University of Cologne).

Bickel, P. *et al.* (2006), “Developing Harmonised European Approaches for Transport Costing and Project Assessment”, Final Technical Report.

Bode, B. and J. Dalen (2002), “The Cost of Private Transportation in the Netherlands”, 1992–1999, *ECB Working Papers*, No. 124.

Boylaud, O. (2000), “Regulatory Reform in Road Freight and Retail Distribution”, *OECD Economics Department Working Papers*, No. 253, OECD, Paris.

CBO (1997), “Toll Roads: A Review of Recent Experience”, *CBO Memorandum,* U.S. Congressional Budget Office, Washington, D.C.

CE Delft (2004), *The Price of Transport. Overview of the Social Costs of Transport*.

CE Delft (2008), *Handbook on Estimation of External Costs in the Transport Sector*.

Chapulut, J.N., J.P. Taroux and E. Mange (2005), “The New Ex-post Evaluation Methods for Large Projects in France”, Association for European Transport and Contributors.

Chin, K. (2010), “The Singapore Experience: The Evolution of Technologies, Costs and Benefits, and Lessons Learnt”, *ITF/OECD Round Table Discussion Paper* No. 2010-1.

Coelli, T. and S. Perelman (1999), “A Comparison of Parametric and Non-parametric Distance Functions: With Application to European Railways”, *European Journal of Operational Research*, Vol. 117, No. 2.

Commission of the European Communities (2001), "White Paper – European Transport Policy for 2010: Time to Decide", COM(2001)370 final.

Commission of the European Communities (2007), "Impact Assessment of the Communication on the Extension of the Major Trans-European Transport Axes to the Neighbouring Countries", *Commission Staff Working Document*, COM(2007)32 final.

Conway, P. and G. Nicoletti (2006), "Product Market Regulation in the Non-manufacturing Sectors of OECD Countries: Measurement and Highlights", *OECD Economics Department Working Papers*, No. 530, OECD, Paris.

Crafts, N. (2009), "Transport Infrastructure Investment: Implications for Growth and Productivity", *Oxford Review of Economic Policy*, Vol. 25, No. 3.

Dender, K. van, P. Crist, J. Corbett and J. Winebrake (2010), "Policy Instrument to Limit Negative Environmental Impacts: An Economic Perspective" in: *Globalisation, Transport and the Environment*, Chapter 9, OECD, Paris.

Dodgson, J. (2009), "Rates of Return on Public Spending on Transport", *Royal Automotive Club Foundation for Motoring Report*, No. 09/13.

Downs, A. (2004), "Traffic: Why It's Getting Worse, What Government Can Do", *Brookings Institution Policy Brief*, No. 128.

ECMT (1998), *Efficient Transport in Europe. Policies for Internalisation of External Costs*, OECD, Paris.

ECMT (2000), *Efficient Transport Taxes and Charges*, OECD, Paris.

ECMT (2003), *Reforming Transport Taxes*, OECD, Paris.

ECMT (2007), *Managing Urban Traffic Congestion*, OECD, Paris.

ECMT (2008), *Transport Infrastructure Investment: Options for Efficiency*, OECD, Paris.

Eddington, R.(2006), "The Case for Action", H.M. Treasury, United Kingdom.

Égert, B. (2009), "Infrastructure Investment in Network Industries: the Role of Incentive Regulations and Regulatory Independence", *OECD Economic Department Working Papers*, No. 688, OECD, Paris.

Égert, B., T. Kozluk and. D. Sutherland (2009*a*), "Infrastructure and Growth: Empirical Evidence", *OECD Economic Department Working Papers*, No. 685, OECD, Paris.

Égert, B.,T. Kozluk and. D. Sutherland (2009*b*), "Infrastructure Investment: Links to Growth and the Role of Public Policies", *OECD Economic Department Working Papers*, No. 686, OECD, Paris.

Eijgenraam, C.J.J., C.C. Koopmans, P.J.G. Tang and A.C.P. Verster (2000), "Evaluation of Infrastructural Projects: Guide for Cost-Benefit Analysis", *Section 1: Main Report, Research Programme on the Economic Effects of Infrastructure*, NEI, the Netherlands.

Ergas, H. and A. Robson (2009), "The Social Losses from Inefficient Infrastructure Projects: Recent Australian Experience", *Productivity Commission Round Table, Strengthening Evidence-Based Policy in the Australian Federation*, 17-18 August 2009.

Estache, A. and T. Seberisky (2004), "Where Do We Stand on Transport Infrastructure Deregulation and Public Private Partnerships?", *World Bank Research Working Paper*, No. 3356.

European Commission (1995), "Towards Fair and Efficient Pricing in Transport", DG for Transport, COM(95)691.

European Commission (2006), "Guidance on the Methodology for Carrying out Cost-Benefit Analysis", *DG Regional Working Document*, No. 4, 08/2006.

Eurostat (2006), "Competitiveness in EU Road Freight Transport – 2006", *Statistics in Focus*, 97/2008.

EVA-TREN (2008), *Improved Decision-Aids Methods and Tools to Support Evaluation of Investment for Transport and Energy Networks in Europe*, Final Report.

Fang, B., X. Han, S. Okubo and A. Lawson (2000), "U.S. Transportation Satellite Accounts for 1996", Bureau of Economic Analysis United States, *Survey of Current Business*, Vol. 80, No. 5.

Flikkema, H. and J. van der Waard (2001), "Impacts of the New Dutch National Traffic and Transport Plan NTTP Analysed Using the National Model", Association for European Transport.

Flyvbjerg, B. (2009), "Survival of the Unfittest: Why the Worst Infrastructure Gets Built – and what we Can Do about it", *Oxford Review of Economic Policy*, Vol. 25, No. 3.

Forslund, U. and B. Johansson (1995), "Assessing Road Investments: Accessibility Changes, Cost Benefit and Production Function Effects", *The Annals of Regional Science*, Vol. 29, No. 2.

Friebel, G., M. Ivaldi and C. Vibes (2008), "Railway (De)Regulation: A European Efficiency Comparison", *Economica*, Vol. 77, No. 305.

Friedström, L. and R. Elvik (1997), "The Barely Revealed Preference Behind Road Investment Priorities", *Public Choice*, Vol. 92, No. 1-2.

Geerlings, H. and D. Stead (2003), "The Integration of Land Use Planning, Transport and Environment in European Policy and Research", *Transport Policy*, Vol. 10, No. 3.

Glaister, S. and J. Smith (2009), "Roads: A Utility in Need of a Strategy", *Oxford Review of Economic Policy*, Vol. 25, No. 3.

Golub, S. and B. Tomasik (2008), "Measures of International Transport Cost for OECD Countries", *OECD Economics Department Working Papers*, No. 609, OECD, Paris.

Graham, J.D. and S. Glaister (2002), "The Demand for Automobile Fuel. A Survey of Elasticities", *Journal of Transport Economics and Policy*, Vol. 36, No. 1.

Gressier, C. (2005), " Analyse comparative des méthodes d'évaluation des grandes infrastructures de transport ", Ministère des Transports de l'Équipement du Tourisme et de la Mer, No. 2005-0353-01.

Guthrie, G. (2006), "Regulating Infrastructure: The Impact on Risk and Investment", *Journal of Economic Literature*, Vol. 44, No. 4.

Hamilton, C. (2010), "Revisiting the Cost of the Stockholm Charging System", *ITF/OECD Joint Transportation Research Centre Discussion Paper*, No. 2010-5.

Helm, D. (2009), "Infrastructure Investment, the Cost of Capital and Regulation: an Assessment", *Oxford Review of Economic Policy,* Vol. 25, No. 3.

Hepburn, C. (2006), "Regulation by Prices, Quantities or Both: a Review of Instrument Choice", *Oxford Review of Economic Policy,* Vol. 22, No. 2.

Hummels, D. (2007), "Transportation Costs and International Trade in the Second Era of Globalization", *Journal of Economic Perspectives,* Vol. 21, No. 3.

Iaione, C. (2009), "The Law, Economics and Policy of Urban Congestion", *New York University Public Law and Legal Theory Working Papers,* No. 119.

IDEI (2003), "The Economics of Passenger Rail Transport, a Survey", Institute d'Économie Industrielle, Toulouse.

INFRAS/IWW (2004), "External Costs of Transport, Update Study, Final Report", University of Karlsruhe and INFRAS.

Jansson, J.O. (2001), "Optimal Transport Pricing. Editorial", *Journal of Transport Economics and Policy,* Vol. 35, No. 3.

Johnston, R., J. Lund, and P. Craig (1995), "Capacity-Allocation Methods for Reducing Urban Congestion", *Journal of Transportation Engineering,* Vol. 121, No. 1.

Kierzenkowski, R. (2008), "The Challenge of Rapidly Improving Transport Infrastructure in Poland", *OECD Economics Department Working Papers,* No. 640, OECD, Paris.

Kim, J. (2000), *Road Transport Externalities and Optimal Congestion Taxation*, Korea Institute of Public Finance.

Koopmans, C. and E. Kroes (2003), "Estimation of Congestion Costs in the Netherlands", Association for European Transport.

Kopp, P. and R. Prud'homme (2007), "The Internalisation of External Costs in the Transportation System", *Discussion Paper 12*, The European Automobile Association.

Kune, B.C. and N. Mulder (2000), "Capital Stock and Productivity in French Transport: An International Comparison", *CEPII Working Paper*, No. 2000-18.

Lafointaine, F. and L. Valeri (2009), "The Deregulation of International Trucking in the European Union: Form and Effect", *Journal of Regulatory Economics*, Vol. 35, No. 1.

Lakshmanan, T.R., P. Nijkamp, P. Rietveld and E.T. Verhoef (2001), "Benefits and Costs of Transport", *Papers in Regional Science*, Vol. 80. No. 2.

Lauridsen, H. and I.A. Ravlum (2001), "National Transport Planning in Norway and Sweden – A Comparison", *Report 536/2001,* Institute of Transport Economics, Oslo.

Lee, J., S. Han and H. Shin (2008), "A Plan to Improve Fuel Taxes Considering Social Costs in Transport", *Research Paper,* KTI (Korean Transport Institute).

Leheis, S. (2007), “Transportation Planning in France and the Challenge of Sustainable Development: Actors, Tools and Methods”, XXI AESOP Conference, Naples, July 2007.

Leonardi, J. and M. Baumgartner (2004), “CO_2 Reduction and Efficiency in Road Freight Transport – Measures, Baseline and Potential”, Presentation for the 23rd meeting of the International Energy Workshop, 22-24 June 2004, Paris.

Lijesen, M. and V. Shestalova (2007), “Public and Private Roles in Road Infrastructure. An Exploration of Market Failure, Public Instruments and Government Failure*”, CPB Netherlands Bureau for Economic Policy Analysis Document*, No. 146.

Manteau, P., D. Finon and M. Lamy (2003), “Price Versus Quantities: Choosing Policies for Promoting the Development of Renewable Energy”, *Energy Policy*, Vol. 31, No. 8.

Mayeres, I. (2002), “Taxes and Transport Externalities Constraints”, *Energy, Transport and Environment Working Paper Series* 2002-11, Center for Economic Studies, Katholieke Universiteit Leuven.

McCubbin, D.R. and M.A. Delucchi (1999), “The Health Costs of Motor-Vehicle-Related Air Pollution”, *Journal of Transport Economics and Policy*, Vol. 33, No. 3.

The Ministry of Transport and Communications (Norway) (2008), “Investment in Infrastructure in Norway – Financing by Grants or/and by Toll”, Presentation at the Chilean-Norwegian seminar, Santiago, 25 January 2008.

The Ministry of Transport, Public Works and Water Management (the Netherlands) (2005), *A Different Way of Paying for Road Use: Impacts of Policy Options on Traffic*, Management Summary, March.

The Ministry of Transport, Public Works and Water Management (the Netherlands) (2008), *Policy Framework for Utilisation*, the Netherlands.

Nash, C. (2007), “Road Pricing in Britain”, *Journal of Transport Economics and Policy*, Vol. 41, No. 1.

Newbery, D.M. and G. Santos (1999), “Road Taxes, Road User Charges and Earmarking”, *Fiscal Studies*, Vol. 20, No. 2.

Nicoletti, G. and S. Scarpetta (2005), “Regulation and Economic Performance: Product Market Reform and Productivity in the OECD”, *OECD Economics Department Working Papers*, No. 460, OECD, Paris.

Odgaard, T., A.S. C. Kelly and J. Laird (2005), “Current Practice in Project Appraisal in Europe”, Association for European Transport and contributors.

OECD (2005), *National Systems for Transport Infrastructure Planning*, OECD, Paris.

OECD (2007), *OECD Environmental Data: Compendium 2006/2007, Transport*, OECD, Paris.

OECD (2008), *Public Private Partnership*, OECD. Paris

OECD (2009), *The Economics of Climate Change Mitigation*, OECD, Paris.

OECD/IEA (2009), *Energy Prices and Taxes 2nd Quarter 2009*, OECD, Paris.

OECD (2010), *OECD Economic Surveys: Netherlands*, OECD, Paris.

Økland, A. (2008), "Samfunnsøkonomi i jernbane", Project Report, Department of Production and Quality Engineering, Norwegian University of Science and Technology.

Oum, T.H., W.G. Waters II and C. Yu (1999), "A Survey of Productivity and Efficiency Measurement in Rail Transport", *Journal of Transport Economics and Policy*, Vol. 33, No. 1.

Palma, A. de and N. Zaouali (2007), "Monétarisation des externalités de transport: un état de l'art", *L'Úniversite Clergy Pontoise,* No. 2007-8.

Parry, I.W.H. (2002), "Comparing the Efficiency of Alternative Policies for Reducing Traffic Congestion", *Journal of Public Economics,* Vol. 85, No. 3.

Parry, I.W.H. (2007), "Are the Costs of Reducing Greenhouses from Passenger Vehicles Negative?", *Journal of Urban Economics*, Vol. 62, No. 2.

Parry, I.W.H. and K.A. Small (2005), "Does Britain or the United States Have the Right Gasoline Tax?", *The American Economic Review,* Vol. 95, No. 4.

Parry, I.W.H., M. Walls and W. Harrington (2007), "Automobile Externalities and Policies", *Journal of Economic Literature,*Vol. 45, No. 2.

Parry, I.W.H. and K.A. Small (2009), "Should Urban Transit Subsidies Be Reduced?", *American Economic Review,* Vol. 99, No. 3.

Pels, E., V.E. Daniel and P. Rietveld (2004), "Returns to Density in Operations of the Netherlands Railways", *Tinbergen Institute Discussion Paper,* No. 004/3.

Perez, B. and S. Lockwood (2006), "Current Toll Road Activity in the U.S. A Survey and Analysis", Prepared for the US Department of Transportation, Federal Highway Administration, Office for Policy Studies.

Proost, S. and K.V. Dender (2003), "Marginal Social Cost Pricing for All Transport Modes and the Effects of Model Budget Constraints", *The Center for Economic Studies, Energy, Transport and Environment Working Paper Series,* No. 2003-11, Katholieke Universiteit Leuven.

Quinet, E. (2006), "Transport Cost-Benefit Analysis in France: Recent Changes, Progress and Shortcomings", *Department of Economics Working Paper,* No. 2006 – 22 University of Milan.

Ramjerdi, F., L. Rand, I. Saetermo and K. Saelensminde (1997), "The Norwegian Value of Time Study", *Institute of Transport Economics,* Report 379/1997, Oslo.

Raux, C. (2007), "Tradable Driving Rights in Urban Areas: Their Potential for Tackling Congestion and Traffic-related Pollution", Laboratoire d'Économie des Transports, Úniversité de Lyon.

Raux, C. (2008), "How Should Transport Emissions be Reduced? Potential for Emission Trading Systems", *OECD - International Transport Forum Discussion Paper,* No. 2008 – 1.

Rienstra, S. (2008), "Rol van kosten-batenanalyse in de besluitvorming", Knowledge Institute for Policy on Mobility, the Netherlands.

Rodríguez-Pose, A. and A. Bwire (2003), "The Economic (In)efficiency of Devolution", London School of Economics.

Savolainen, V.V. (2007), "Relative Technical Efficiency of European Transportation Systems", *Lappeenranta University of Technology Research Report 187,* Finland.

Serres, A. de, F. Murtin and G. Nicoletti (2010), "A Framework for Assessing Green Growth Policies", *OECD Economics Department Working Papers,* No. 774, OECD, Paris.

Short, J. and A. Kopp (2005), "Transport Infrastructure: Investment and Planning, Policy and Research Aspects", *Transport Policy,* Vol. 12, No. 4.

Sloboda, B.W., B. Fang and X. Han (n.d.), "1997 U.S. Transportation Satellite Accounts".

Sørensen, R.J. (2008), "Geographical Redistribution with Disproportional Representation: a Politico-Economic Model of Norwegian Road Projects", *Public Choice,* Vol. 139, No. 1-2.

Townroe, P. and G. Dabinett (1995), "The Evaluation of Public Transport Investments within Cities", *The Annals of Regional Science,* Vol. 29, No. 2.

Treasury, H.M. (United Kingdom) (2003), "The Green Book – Appraisal and Evaluation in Central Government".

Twomey, A. and G. Withers (2007), "Australia Federal Futures", *A Report for the Council of the Australian Federation*.

Waters, W.G. (2007), "Evolution of Railroad Economics", *Research in Transportation Economics,* Vol. 20, No. 1.

Watkiss, P. *et al.* (2005), *The Impacts and Costs of Climate Change. Final Report: Benefits and Cost of Climate Change Policies and Measures,* Commissioned by European Commission DG Environment.

Weitzman, M. (1977), "Is the Price System of Rationing More Effective in Getting a Commodity to Those Who Need it Most?", *The Bell Journal of Economics,* Vol. 8, No. 2.

Willett, K. (2005), "The Economics, Ideology and Politics of Anti-Congestion Policy for Brisbane", Australian Royal Automobile Club of Queensland Limited.

Winston, C. (1993), "Economics of Deregulation: Days of Reckoning for Microeconomics", *Journal of Economic Literature,* Vol. 31, No. 3.

Winston, C. (1998), "U.S. Industry Adjustment to Economic Deregulation", *Journal of Economic Perspectives,* Vol. 12, No. 3.

Winston, C. (2005), "Deregulating the Rails", *The Examiner,* 8 December, Washington, DC.

Winston, C. (2009), "Lessons from the U.S. Transport Deregulation Experience for Privatization", *OECD – International Transport Forum Discussion Paper,* No. 2009–20.

Ypma (2007), "Productivity Levels in Transport and Storage", Groningen Growth and Development Centre, *Research Memorandum GD-85.*

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