Rail Transport and Environmental Costs—Policy and Research in Europe

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Introduction

Rail transport is seen as being of growing importance in Europe and elsewhere due to its lower environmental impact than other transport modes. Previously, the advantage of rail was seen in terms of noise, visual and local air pollution. While all these factors are still important, energy consumption and greenhouse-gas emissions have become the main concerns.

Regulation, pricing, and investment decisions can maximize these advantages. However, this requires quantification and monetary valuation of environmental externalities so they can be reflected in the price of alternative modes and for cost benefit analysis when appraising regulations and investment proposals.

This article discusses recent research in Europe to determine the monetary value of these factors and offers some results. Then, it discusses how to use these monetary values in pricing and investment decisions.

Valuation of Environmental Externalities

In an efficient market economy, prices indicate the costs of alternative goods and services. Consumers can choose whether particular goods and services are worth the cost, or whether they prefer cheaper alternatives. In turn, companies will decide whether to invest in productive capacity on the basis of a comparison between the revenue they earn from the facilities and the cost of providing them.

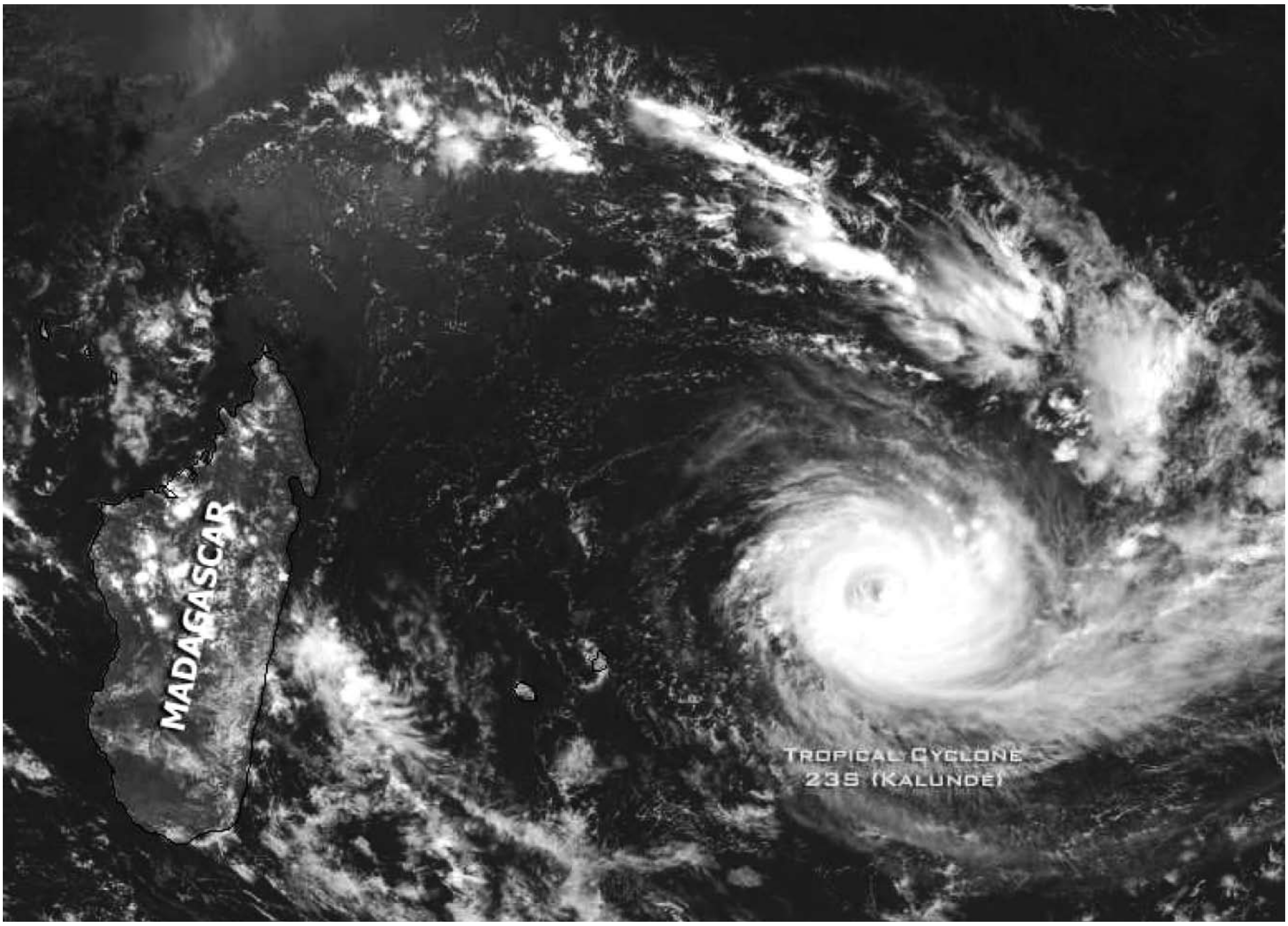
However, in the absence of specific regulatory intervention, environmental costs and benefits have largely been ignored in these decisions, because environmental effects are largely what economists describe as externalities. This means they are inflicted on persons who are not party to the transactions causing them. The textbook solution is for governments to quantify and value the externalities and to levy charges or taxes that reflect externalities in the price paid for goods causing them. In private investment decisions, such taxes may be used to ensure companies take externalities into account; in the case of government decisions, social cost benefit analysis explicitly considers the value of such costs and benefits alongside all other relevant factors. This internalization of environmental costs provides incentives for an efficient trade-off between costs and environmental impact in decisions both about technology (what infrastructure to provide, what vehicles to use) and behaviour (how much to travel, where, when and by what mode).

This approach to handling environmental effects requires valuing environmental costs and benefits in money terms at the amount people are willing to pay for benefits or the compensation they need to accept costs. There are a number of ways to achieve this. Sometimes, the costs or benefits are traded directly in markets; for example, when crops are damaged by pollution, healthcare costs are incurred or output is lost through time off work. In cases where the costs are not traded in any market, such as the disamenity effects of noise and air pollution, there may be markets where individuals show their willingness to pay as part of the price they pay for a good that is traded in markets.

For environmental effects, the house purchase and rental accommodation markets commonly use this method. For example, houses enjoying lower noise or air pollution, and having higher visual amenity sell for higher prices; price reflects the present value of the stream of additional benefits such a house offers. Consequently, the common analysis approach performs statistical analysis of large samples of house prices to find the impact of environmental variables on price.

However, this has some weaknesses. For example, the change in house price represents a stream of benefits over time, but the discount rate used in summing them is unknown. From this viewpoint, rents are easier to analyze if there is a sufficient market for rented property. In addition, house prices only reflect people's perceptions of environmental quality. Thus environmental impacts directly affecting amenity, such as noise and visual pollution, will be measured more accurately than indirect effects, such as the impact of air pollution on health. Indeed, some forms of pollution may not be perceived at all.

Another approach to environmental valuation is to rely on hypothetical surveys. These can ask about issues such as willingness to pay to avoid health risks, which might otherwise not be perceived. The disadvantage is that people may not answer accurately when faced with a hypothetical question,



Mitigating climate change is one of the most important challenges for the transport sector

either because they do not give the issue sufficient thought, or because they perceive an advantage in deliberately distorting their answer. (For example, if they perceive questions about noise nuisance as presaging plans to build a motorway near their homes and for which they might not be adequately compensated, they may wish the authorities to value noise at an inaccurately high level). Carefully designed surveys that give respondents hypothetical choices between realistic options but with no obvious incentive to distort their answers can minimize these problems.

For indirect effects, such as health, the lack of knowledge by the general population about the consequences of pollution mean that it is better to use scientific evidence to try to predict the effect, and then to value the risk of ill health or loss of life itself. This approach—known as the impact pathway approach—has been much used in European research.

The most difficult of all valuation problems is global warming. While there is much research on the final consequences of global warming, it is subject to high uncertainty. On the other hand, governments do make political decisions on the levels of greenhouse-gas emissions that are acceptable and sign-up to achieving them. Consequently, for the transport sector, if these constraints are indeed binding, the cost of more greenhouse-gas emissions from transport is not more global warming but more action to reduce greenhouse-gas emissions elsewhere. Although still not easy to quantify, this is much easier than forecasting the long-term consequences of global warming.

However, we can state that the work done in European transport and environmental research over the last decades to improve methods and data input has led to a significant increase in the quality of standard values and in acceptance by the science community. The challenge for now is how to convert the scientific output to concrete pricing policy proposals, as the ongoing EU debate about taxation of heavy goods vehicles (HGVs) shows.

Values of Environmental Externalities by Mode

Many studies have been undertaken of environmental costs of transport in Europe, sponsored either by the European Commission or individual member countries. Evidence on social cost estimation has recently been synthesized in the form of a EU handbook published by the IMPACT project.

Using examples from this handbook, Table 1 shows the position of road and rail passenger transport. The figures represent short-run marginal costs for an additional vehicle or train km. Note that the units are Euro cents per vehicle or train km; for trains, the data relates to a typical German train, which on average carries around 100 passengers, but certainly has a capacity of more than double that. It is clear that electric trains have major advantages over diesel trains, and petrol cars over diesel cars. However the electricity generation mix is important for the level of upstream and downstream costs. Beyond that, the other crucial issue is load factor. For example, an urban electric train carrying 100 passengers has only a fifth of the environmental impact per passenger of 100 single-occupancy petrol cars; in the case of diesel trains, many more than 100 passengers are needed to produce a significant advantage for rail. The position of rail relative to road is slightly less advantageous in inter-urban markets, but rail—and especially with electric traction—is very much superior to air over the distances that the two compete.

Table 2 makes the same comparison for freight. A mean load for a German freight train is about 480 tonnes (or at least 15 times that of a typical HGV), but varies greatly with commodity. Again, with electric traction, rail has an enormous advantage over road at any reasonable load, but for diesel the advantage is marginal. Water also has advantages over road, and is competitive with diesel trains.

It is worth noting that although environmental externalities are seen as an important reason for favouring rail transport there are other reasons too. Rail has increased safety and lower external accident costs (i.e. costs not borne by the user either directly or through insurance) than road transport. In European conditions, road congestion poses a greater external cost. Consequently, to the extent that rising congestion is not offset by increased road capacity, dealing with the problem of congestion is an even more important factor favouring rail over road in Europe. In an ideal world, this would be reflected in charges for use of roads. If it is not,

Table 1 Environmental Costs of German Passenger Transport

2000 Euro cents per vehicle-km/train-km

	Noise (daytime)	Air Pollution	Climate Change	Up and Downstream (e.g. electricity production, grey energy)	Total
Petrol car					
urban	0.76	0.17	0.67	0.97	2.57
inter-urban	0.12	0.09	0.44	0.65	1.30
Diesel car					
urban	0.76	1.53	0.52	0.61	3.42
inter-urban	0.12	0.89	0.38	0.45	1.84
Electric train					
urban	23.7	0	0	24.8	48.5
inter-urban	20.6	0	0	15.9	36.5
Diesel train					
urban	23.7	144.8	11.4	13.8	194
inter-urban	20.6	90.7	8.6	10.3	130
Air					
(200 seats, 500-km flight)	120	42	124	142	428

Source: *IMPACT* (2008)

there is a case for reducing rail infrastructure charges below the level of the costs extra rail use causes to offset road underpricing. Similarly, reduced road congestion as well as environmental pollution is an important factor in making the case for rail investment in Europe.

Policy Uses of Environmental Valuations

There are three main ways in which environmental values are used in Europe—regulation, pricing, and investment appraisal.

Regulation is used in a number of contexts. For example, there are noise and air pollution standards that all new road vehicles in Europe must meet, and there is debate on whether to extend this to regulation of the average greenhouse-gas emissions of new cars. There are requirements about noise levels of aircraft and of railway rolling stock. Once the value of the environmental externality is known, the appropriate level of these standards may be determined by comparing the benefits with the costs, taking care to include any indirect effects—for example, energy consumption standards that reduce the cost of motoring may lead to additional travel, offsetting some benefits.

Pricing is used to reflect the real costs of different transport modes, and may impact in a number of ways: how many motorized trips to make, where to go, what mode of transport to use, what type of vehicle if the choice is road, etc. For this reason, pricing has major advantages over regulation; for example pricing may lead someone travelling short distances in a rural area to choose a low-cost but more-polluting car, but would give someone covering long distances in urban areas where the cost of emissions is much higher a much greater incentive to buy a low-emission car.

Generally, environmental externalities are produced by use of transport infrastructure, and vary with the type of vehicle, location, and time of day. Thus, ideally they must be incorporated into an infrastructure charge. (The obvious exception is the effects of global warming, which do not vary with where and when the carbon is emitted, so a fuel tax that is proportional to the carbon content of the fuel

Table 2 Environmental Costs of German Freight Transport

2000 Euro cents per vehicle-km/train-km

	Noise (daytime)	Air Pollution	Climate Change	Up and Downstream	Total
HGV					
urban	7.01	10.6	2.6	3.1	23.31
inter-urban	1.1	8.5	2.2	2.7	14.5
Electric train					
urban	23.7	0	0	44.4	68.1
inter-urban	20.6	0	0	34.8	55.4
Diesel train					
urban	23.7	367	28.9	44.4	464
inter-urban	20.6	306	28.9	34.8	390
Water					
< 250 tonnes	0	89	8	8	105
1000–1500 tonnes	0	254	23	22	299

Source: *IMPACT* (2008)

Road traffic causes significant external noise and air pollution cost in urban areas

Train running in urban area in Germany

is an ideal internalization instrument.) For roads, the ideal would be universal electronic road pricing; in its absence, second-best methods such as simple kilometer-based charges (differentiated according to vehicle categories considering environmental performance), fuel tax, and annual licence duty have to be used. For rail in Europe, there is now a requirement that explicit charges are levied for use of infrastructure. This has occurred because of the policy of opening-up infrastructure to new entrants. Some countries differentiate these charges by type of vehicle according to the noise level produced, and one or two countries charge for air pollution and/or global warming through tax on diesel fuel. For air and water transport, the choice is between adding such charges to port or airport charges, or to air traffic control or specific fees for the use of coastal waters. Whilst some countries do differentiate airport landing charges according to noise nuisance, this is generally used to recover the cost of noise countermeasures rather than to price the noise nuisance itself; Sweden is unique in charging fees for the use of coastal waters to reflect air pollution costs.

Appraisal refers mainly to investment projects but may also be applied to broader policy questions. The point here is to allow for the impact of new rail, road or (air) port infrastructure, not just on the mode in question but also on other modes. Consequently, for example, the environmental externalities produced by a new railway line will be at least partly offset by reduced externalities from other modes. However, it must be remembered that when new railway infrastructure is provided, not all the railway trips using it would otherwise have used road or air. In the UK, it is estimated that about half of the additional rail travel generated by improved inter-city rail services would otherwise have used car, with a load factor of around 1.8 per vehicle, so that on average an additional rail passenger-km removes about 0.25% of a car-km from the roads.

The EU now includes 27 countries in western and central Europe; the main non-members, such as Switzerland and Norway, largely follow its lead. Since the mid 1990s, EU policy has been to internalize externalities in transport prices, but progress in implementing this through EU Directives has been slow. (EU Directives must be agreed by the European Parliament and Council of Ministers, and then must be implemented by all member countries). The EU only legislates on issues affecting competition between and integration of its members, so in the transport field it is concerned with commercial traffic, particularly international, rather than private cars.

In the rail sector, marginal social cost is taken as the basis for track access charges (EU Directive 2001/14/EC). Charges may be differentiated with respect to environmental impacts, but this must not add to the average level of charges, unless environmental costs are also reflected in charges for other modes. Mark-ups on marginal social cost are permitted where necessary in order to finance particular schemes or rail infrastructure in general when the government does not provide sufficient funding for the applied pure marginal social cost pricing. In the case of electricity for rail traction, the costs of global warming are internalized to a degree by inclusion of electricity generation in the European emissions trading scheme; there are proposals to extend this approach to air transport and possibly to water. Otherwise, there are currently no proposals for European legislation to internalize the costs of environmental externalities for the air and water transport modes.

For the road sector, following EU Directive 2006/38/EC on road charges (amending 1999/62/EC), the EU allows introduction of tolls on HGVs on all roads. Differentiation is possible according to congestion and accident costs and the environmental performance of vehicles, indicated by the EURO category of HGV. This differentiation must be designed so that the total revenues from tolls do not exceed the total allocated infrastructure costs, except that a surcharge of up to 25%—which can be used to fund alternative modes of transport—is permitted in environmentally sensitive areas, such as the Alps. Switzerland (a non-EU country) was the first to introduce a kilometer-based charge for HGVs; Germany and Austria have followed suit and many more countries are considering doing so. The European Parliament has argued strongly that the overall level of charges should reflect levels of externalities. Further proposals to amend the above Directive to allow full charging of external costs of congestion, noise and air pollution, with any additional revenue to be used for improving the environmental performance of the transport system, were brought forward by the European Commission in July 2008. (Costs of climate change are thought to be best internalized through fuel tax, and external accident costs through improved methods of insurance.) Charging for private cars is regarded as a matter for individual member states.

With respect to assessment approaches for infrastructure, the development of the Trans-European Networks is the most important issue for the European Commission, because it is the only transport infrastructure with explicit European funding, although there is greater funding of transport from structural and cohesion funds designed to benefit poorer and peripheral countries. At the EU level, methodological baselines have been developed, especially for evaluation of infrastructure projects in Eastern Europe (e.g. the TINA programme). The results of the HEATCO European project have—for the first time—harmonized guidelines for cost benefit analysis (CBA) in transport at the European level. These guidelines will set the standard for the assessment of future transport projects in Europe. However, most countries still have their own guidelines concerning CBA in transport including social costs: e.g. the Netherlands (Overzicht Effecten Infrastuctuur, OEI), United Kingdom (New Approach to Appraisal, NATA), Austria (Strategische Prüfung im Verkehrsbereich, SP-V), Finland (Guidelines for the Assessment of Transport Infrastructure Projects in Finland), and Germany (Bundesverkehrswegeplan).

Conclusion

Typically, rail is much less environmentally polluting than other transport modes, and this must be reflected in regulation, pricing, and investment appraisal. The advantage of rail varies greatly with circumstances, being much greater for a heavily loaded urban electric train using electricity generated from renewable resources than for a lightly loaded rural diesel train. Pricing will automatically give the correct incentives provided it is sophisticated enough to reflect such differences; regulation and appraisal must also take differences into account for rail to play its optimum role in tackling environmental problems. ■

Further Reading

IMPACT, 2008: Handbook on estimation of external costs in the transport sector.

CE/INFRAS online at http://ec.europa.eu/transport/costs/handbook/doc/2008_01_15_handbook_external_cost_en.pdf

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