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Agenda

Advancing economics in business

Sustainability: more than just hot air?

With the UN Climate Change Conference in Copenhagen this month, and ever-increasing concern about the impact of human activity, it is important to have a comprehensive framework in which to assess the impact. This article suggests one such framework by considering the economic, social and environmental impacts of long-distance transport

A growing body of scientific evidence[1] and debate, most recently at the United Nations Climate Change Conference in Copenhagen, focus on understanding the likely implications of ignoring climate change and the action required to avoid or mitigate its consequences. The debate strongly suggests that the study of all forms of human activity and its sustainability, and possible paths for corrective action, will continue. In the European Union (EU), transport accounts for around a quarter of all domestic CO_2 emissions, although within this travel by rail and air accounts for a relatively small proportion (0.6% and 12.2% respectively).[2] In order for the EU to meet its CO_2 reduction targets, an assessment of the sustainability of all modes of transport is likely to be important.

When discussing the environmental impact of human activity, the economic and social effects of the activity should also be accounted for in order to avoid perverse allocations of resources. Sustainability can be defined in many ways—for example with different weights being placed on the economic effects, as well as the environmental and social impacts. While the resolution of how to trade off the different aspects to arrive at a socially optimal outcome is ultimately a political issue, economic analysis can play an important role in informing the policy debate.

There are a number of important questions which an analysis of the sustainability of transport may wish to address, such as 'what is the true cost of travel?' and 'what are the impacts of this operation?' These require consideration as to the most appropriate framework in which to assess the impacts of—and ultimately the costs and benefits of—travel at both an individual and overall societal level. At the same time, there are significant pressures in many areas of public finances, and policy-makers need to balance the books in the short and medium term, while avoiding decisions that may harm economic performance in the long term, and achieving long-term environmental and social goals. This article presents one such framework for long-distance, inter-urban passenger travel, developed by Oxera in recent work for the Airport Operators Association and Railteam BV.

What is the impact of transport?

Three broad areas for consideration in an analysis of sustainability are:

- the contribution to the economy;
- environmental effects;
- the social impact.

Given that the different modes of transport compete for passengers and, in some cases, public funding, it is important to conduct a robust assessment of the impacts of different modes in order to make informed policy decisions founded on the full range of costs and benefits of alternative methods of transport. The analytical framework used in sustainability assessments should be suitable for all modes of transport.

A full assessment of the sustainability of different modes of travel should also take account of the economic, environmental and social impacts of the construction of transport infrastructure.[3] This aspect is not addressed here. In addition, a full assessment of sustainability should take account of transport's social impact, and some studies have looked at this issue.[4]

Economy

The economic impact of a mode of transport arises from a number of angles:

This article draws on the following Oxera reports, 'What is the Contribution of Aviation to the UK Economy?' November 2009, and 'Sustainability Performance of the Railteam Network', November 2009.

- direct impacts;
- indirect impacts;
- wider economic impacts.

Figure 1 shows how the economic impacts combine with the environmental and social impacts to give the full effects of a mode of transport.

The direct economic impacts on passengers consist of journey time savings, which can be made from using different modes of transport, the differing levels of comfort offered by alternative modes, and the productivity of the passenger in-vehicle—ie, the work which a passenger can undertake during their journey.

The direct impact on the economy arises from the income—measured by gross value added (GVA)—together with employment and tax revenue, generated by transport providers. This aspect of the contribution of transport to the economy is measured by official national statistics offices.

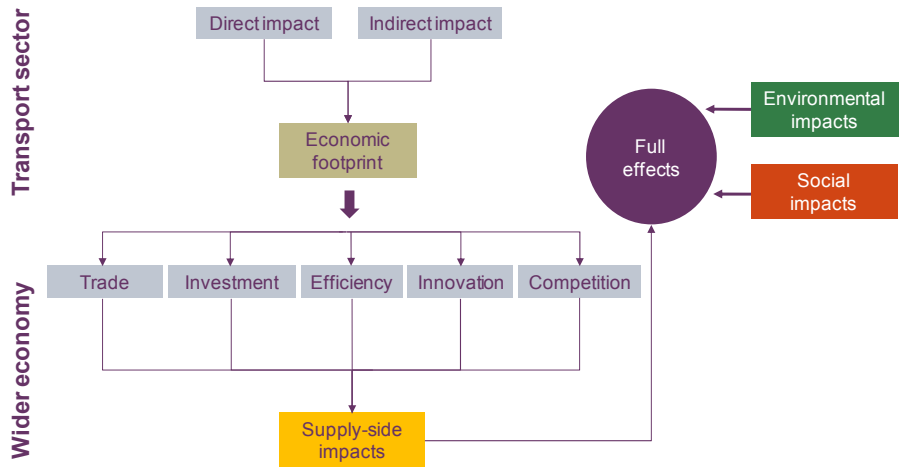
Indirect economic impacts arise through the supply chain of the transport companies—operators pay their suppliers, which in turn generate output and employment, pay tax, and so on—resulting in an increase in the economic effect of the sector. The magnitude of this effect can be measured through the use of input/output tables, a commonly used tool in economics.

In addition to the direct and indirect economic impacts, which flow directly from the production of outputs, the transport sector has wider impacts which affect the supply side of the economy. These impacts are important since they act to increase (or decrease, in the case of under-provision) the long-term productive potential of an economy and the prosperity of the population.[5]

While both the direct and indirect economic impacts of transport are relatively straightforward to assess and quantify, the wider impacts—which have influences outside the transport sector—are harder to quantify. There are a number of mechanisms through which transport affects the wider economy, including the following:

- increases in the availability of transport links and reductions in the time or financial costs of transport between two points, leading to reduced transport costs;
- development of transport hubs through the co-location of related firms, which can increase the productivity and innovation of those firms (agglomeration effects);
- investment and innovation: additional transport links and lower transport costs can facilitate both inward and outward investment. The greater choice of investment locations should improve the efficiency with which those investments are made. Innovation can also spread along transport links which, all other things being equal, should increase the speed with which new innovations are adopted in the wider economy;
- connectivity (in relation to the ability and ease with which destinations may be reached): increases in connectivity will tend to reduce transport costs once the wider costs to the consumer (or user) of transport services are taken into account (eg, travel time);
- impacts on the level of competition between businesses in any particular location, resulting from reduced transport costs.

Figure 1 Impacts of transport



Source: Oxera.

For example, recent studies suggest that through these mechanisms, in the right circumstances, a high-speed rail line may increase productivity in the affected region by up to 3%.[6]

Environment

There are a wide range of environmental impacts created by transport, ranging from CO_2 emissions, noise and local air pollution, vibrations, barrier effects (where the infrastructure creates a physical barrier to people or wildlife) and so on. As previously noted, construction impacts are not considered here, but an analysis of the differences between the construction impacts would be important to draw complete conclusions about the environmental impact of each mode of transport. The environmental impacts of travel are illustrated in Figure 2.

Since transport accounts for approximately a quarter of EU CO_2 emissions, the initial focus of analysis is often on such emissions, although other impacts of local noise and air pollution are also important.

A number of factors affect the CO_2 emissions of a vehicle, including the primary energy source used to power the vehicle, the efficiency with which that energy source is used, and the altitude of dispersion of the emissions.

While CO_2 emissions have a global impact, transport also has more local impacts, particularly noise and local air pollution. The distribution of local air pollution differs between modes, with aviation and surface access by car producing pollutants around airports, while the impact of rail will depend on how the train is powered. For diesel trains, the pollution will be spread along the route between the origin and destination, while for electric trains, local air pollution may arise around the power station (and will vary—depending on the primary fuel used in the power station).

All modes of transport create noise pollution, whether it is from aircraft taking off and landing, or noise created by wheels running along a rail. Consequently, the assessment of the impact of noise effects should take into account the particular characteristics of the transport modes, the country and the area where the impacts are assessed.

Evidence of impacts

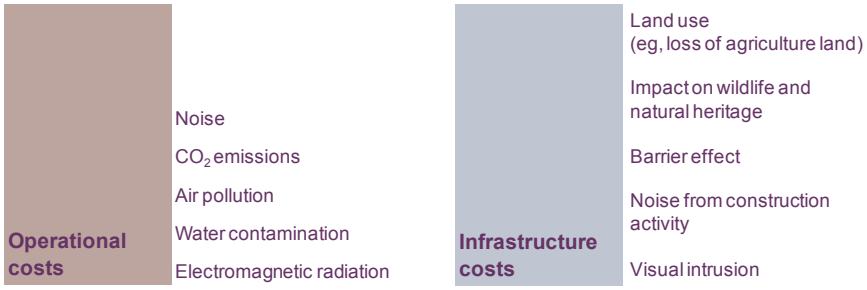
Recent research carried out by Oxera has suggested that there are aspects of rail and air travel where the effects may be similar, as well as aspects where the modes are clearly different. For example, in terms of CO_2 emissions per passenger, high-speed rail (HSR) appears to emit less than aviation across all distances. However, the journey time on a plane is considerably less than that of HSR for longer distances.[7] This suggests that each mode has an important role to fill within the transport sector.

Oxera's analysis suggests that the contribution to the UK economy by the aviation sector can be substantial and that the annual tax paid by the aviation sector outweighs the external costs (CO_2 emissions, noise, and local air quality) by up to £0.6 billion (2007 prices).[8] Given the difficulties in determining the true climate change costs (because of a lack of conclusive scientific evidence), uncertainty remains around these estimates.

The wider economic impacts of both aviation and rail may be similar, since both modes provide improved accessibility between areas, and hence may be expected to change the volume and distribution of economic activity in a given area. It is difficult to characterise either of the modes as providing a 'better' option as the effect of any improvements will vary from case to case (depending on the transport links which are already in place, cultural factors, etc).

As far as the environmental impact is concerned, Oxera has estimated that using HSR rather than air saves at least 60% of the CO_2 emissions generated by making the journey.[9] The noise and local air pollution impacts of the different modes are more difficult to generalise, as they are likely to depend on the fuel mix

Figure 2 Examples of potential environmental costs from travel



Source: Oxera.

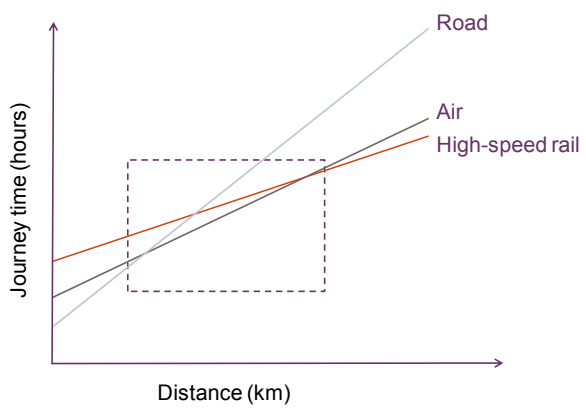
and type of vehicle considered. However, both modes will have an impact on the local population, which would need to be considered in an impact assessment.

Assessing the impact of the transport sector: a holistic approach

Different modes of transport fulfil different purposes, and a single transport mode is unlikely to be optimal for all distances and journey purposes. Figure 3 provides a stylised example of how journey time changes with distance for different modes.

Different modes of transport can act either as complements or substitutes, depending on the length of journey—for example, passengers may either catch the train to the airport in order to take the plane, or where the modes are substitutes (denoted in the figure by the dotted box) may use either mode for their complete journey. This suggests that different modes are likely to be optimal for different distances and journey durations. However, there is also a substantial overlap between the different modes, and this is the area where impact assessments can inform the policy debate in determining the relative scales of the different modes (eg, road compared with rail, or HSR compared with air).

Figure 3 Stylised relationship between journey length and duration, by mode of transport



Source: Oxera.

Conclusion

The sustainability of transport is an important question for policy-makers and other stakeholders in the sustainability debate. The framework presented in this article moves the debate away from assessing the question of the impact of transport per se, towards assessing specific policy packages. While the complete absence of a mode is of little practical relevance, policy packages (towards the transport sector) have a significant impact, such as those affecting the decision to build a new HSR line (in a particular location) or the size of an airport.

Focusing on specific transport modes in isolation is useful to understand the impact of particular policies. However, when designing policy it is critical to assess complete packages towards the transport sector overall—eg, reducing growth in air passenger volume and accelerating HSR use, or vice versa—to assist the evaluation of different impacts. Additionally, in the presence of significant budget constraints, it can be tempting to focus on the short run, where the tax revenue from particular sectors is maximised at the cost of an overall long-term reduction in the productive potential of the economy.

The trade-offs between economic growth, environmental effects (including, but not exclusively, CO_2 emissions) and social effects are complex. Economics cannot dictate how those trade-offs are made, but it can point out that the trade-offs exist and must be addressed explicitly, while suggesting a framework for assessing them. Different modes of transport have different costs and benefits, and it is important that the policy debate acknowledges this. The relative size of transport modes is an important subject for discussion, but the framework within which this debate is conducted should take these complexities into account.

[1] Stern, N. (2006), *The Stern Review: The Economics of Climate Change*, UK: Cambridge University Press.
[2] European Commission (2009), 'EU Energy in Figures 2009'.
[3] See, for example, SNCF (2009), '1er Bilan Carbone ® Ferroviaire Global', September.
[4] See, for example, Vickerman, R. (2007), 'Cost-benefit Analysis and Large-scale Infrastructure Projects: State of the Art and Challenges', *Environment and Planning B: Planning and Design*, **34**:4, pp. 598–610; and Cartea, Á., Meaney, A., Oxley, P., Riley, C., Worsley, T. and Zamani, H. (2008), 'How Should Real Transport Options be Measured?', *Papers and Proceedings of the European Transport Conference*, Leeuwenhorst, October.
[5] In the short term, the output of an economy can depend on changes on the demand side, such as the fiscal policy measures used by governments around the world to stimulate economic activity to help the recovery from recession. However, in the long term, the output of an economy, using standard measures of output such as GVA, or the prosperity of the population living in an economy (eg, measured using GVA per head), is determined by the underlying productive potential or supply side of the economy. The supply side depends on the size of the workforce and the productivity with which labour is used in the production of output. (Growth in the size of the workforce increases the size of the economy, and greater productivity delivers growth in average incomes.)
[6] Studies have suggested an elasticity of productivity with respect to accessibility of between 0.12 (Rice et al., 2006) and 0.29 (Prud'homme and Lee, 1999). In these studies, 'accessibility' was described in terms of changes in average speed between cities, and hence altered journey times. Based on the figures given for the introduction of the high-speed train (HST) network in Spain, which indicated an average reduction in travel time of around 10% (López et al., 2008), this would imply an increase in productivity of between 1% and 3%. López, E., Gutiérrez, J. and Gómez, G. (2008), 'Measuring Regional Cohesion Effects of Large-scale Transport Infrastructure Investments: An Accessibility Approach', *European Planning Studies,* **16**:2, pp. 277–301. Prud'homme, R. and Lee, C.-W. (1999), 'Size, Sprawl, Speed and the Efficiency of Cities', *Urban Studies,* **36:**11, pp. 1849–58. Rice, P., Venables, A.J. and Patacchini, E. (2006), 'Spatial Determinants of Productivity: Analysis for the Regions of Great Britain', *Regional Science and Urban Economics*, **36:**6, pp. 727–52.
[7] See Oxera (2009), 'Sustainability Performance of the Railteam Network', November, for a selection of routes.
[8] Oxera (2009), 'What is the Contribution of Aviation to the UK Economy?' November.
[9] These calculations are based on information extracted from the 'ecopassenger' tool (available at ecopassenger.com).