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SUSTAINABLE MOBILITY IN EUROPE: PROBLEMS IN DEFINING AND IMPLEMENTING AN OPERATIONAL MEASURE

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Paper for the 38th European Congress, European Regional Science Association, Vienna, August 1998

ABSTRACT

Transport policy in Europe, both at the European Union level and the national level, has been dominated by the concept of sustainable mobility. This concept is rarely adequately defined, and even more rarely is an operational measure of the concept identified. We know that sustainable mobility is an attempt to relate both the environmental damage and other negative externalities associated with transport, on the one hand, and the positive benefits linked to the role played by an efficient transport system in sustaining and enhancing a given level of activity and its growth in the economy as a whole, on the other hand, to the mobility of both individuals and goods. Sustainability in any system implies that the system is capable of maintaining itself in the long term so that current levels of activity do not damage future prospects. These concepts are well known and broadly accepted, what has proved more difficult is the definition of operational measures in the context of a fully worked through model linking transport, the economy and the environment. This paper attempts to provide such a framework. It argues that sustainability can only be understood in a model which is explicitly spatial, since the distribution of economic activity and of the externalities associated with transport are a key element in the definition of sustainability. The paper provides a framework which synthesises recent work in the new economic geography, in the economics of transport infrastructure and the environmental effects of transport as the basis for assessing the sustainability of transport policy measures.

1. INTRODUCTION

The 1990s have seen a considerable increase in interest in the development of transport policy in the EU. However, most decisions concerning transport are taken within the context of individual transport projects. Sometimes these are major infrastructure projects such as bridges or tunnels, sometimes they are major improvements to networks as envisaged in the Trans-European Networks, but most frequently they are minor improvements to links or networks, involving either capital expenditure or improvements to the management of capacity such as through pricing measures. All these decisions are taken within a policy framework established at various levels, from the local through regional and national to the EU level, and indeed beyond with the commitment to world environmental targets following the Rio and Kyoto meetings. Transport is also affected by policy decisions in many areas other than transport, such as the general environment, general economic policy and specific policies such as those relating to competition, to physical planning etc. It is therefore critical that this policy framework provides consistent guidance to all projects, and moreover is itself internally consistent.

The main argument of this paper is that the policy framework has not been consistent, within the transport sector itself, in terms of the effects of other policy areas on transport and between the various policy-making bodies responsible for articulating and implementing policy. This lack of consistency has implications for the overall development of the European economy and, in particular, its spatial distribution. The key element of this argument, which is explored in most detail, is the problem of defining and measuring workable indicators of the main concepts found in statements of policy.

Four key themes can be identified which are used to organise the discussion in this paper. These relate to mobility, sustainability, competitiveness and cohesion. Much of the debate over TENs has focused on competitiveness and cohesion. Although competitiveness and cohesion have been the driving forces justifying expenditure on transport, they are not in themselves clear objectives of policy for the transport sector. In some sense they have hijacked transport policy for wider economic objectives, though without a clear specification of how that linkage works. In contrast the objectives of transport policy, at both national and European levels, have become more concerned with questions of mobility and sustainability. Mobility expresses the concern with the benefits to the users of transport. Sustainability expresses concern with the impacts which a given level of transport has on the performance of the economy and the external costs imposed on the environment. Perhaps too frequently they are combined into a composite idea of sustainable mobility which becomes the primary concern of transport policy, but one which lack any real measurability based on sound theoretical concepts. The argument advanced here is that sustainable mobility itself can only be understood in the context of the wider set of linkages between transport and the rest of the economy.

The remainder of this paper falls into four main sections. In Section 2 we outline a broad framework for further understanding. In Section 3 we explore the ways in which projects can be evaluated in the context of this framework. In Section 4 we outline some of the wider economic and spatial consequences of inappropriate policies and in Section 5 we outline some ways towards a workable measure.

2. A FRAMEWORK FOR THE ANALYSIS OF TRANSPORT POLICIES

A reading of transport policy documents at both EU and national level within Europe identifies four key concepts which emerge regularly. These four themes: mobility, sustainability, competitiveness and cohesion, involve issues of policy objectives which are difficult to reconcile. We start this process, first by defining the concepts, and then by erecting a simple framework within which the links between them can be better understood.

Mobility is frequently used as a measure of welfare. The evidence shows us that increased wealth has brought increased mobility. We tend to assume therefore that increased mobility implies increased welfare. But is mobility sustainable where it has the effect of both damaging the environment and damaging the workings of spatial markets (e.g. labour markets)? This has implications for the perceived need to equalise mobility as an objective of policy. EU policy documents demonstrate the inequalities in mobility across regions (European Commission, 1992) and highlight inequalities in infrastructure as a factor in this (European Commission, 1994b). This has particular, and worrying, implications for poorer peripheral regions of the EU and for the Central and Eastern European Countries (Vickerman, 1996). Should it be a clear objective to provide improvements in infrastructure to some "acceptable" level of provision in order to achieve greater equality in mobility? Alternatively, should we try and separate out the "right to mobility" from its assumed monotonic relationship with welfare on the one hand, and its determination by accessibility on the other?

Sustainability is an ambiguous concept. Sustainable transport could just mean environmentally acceptable. On the other hand, sustainable transport could be argued to be the optimal transport system which supports a sustainable level of development in an economy. Nijkamp and Vleugel (1995) suggest that a policy aiming at a sustainable transport system "has to identify quantitative criteria which would offer guidelines on the maximum allowable contribution to environmental degradation by the transport sector", but fail to reach any clear answers on what these should be. Their search for a measure specific to the transport sector may, however, miss the key point, transport cannot be sustainable in itself, only with respect to its role in the sustainability of the wider economy. That sustainability includes the impact of changes in transport on the economy's sustainability.

Competitiveness relates to the production side of the economy as mobility does to consumption. This concerns the role of transport in achieving reductions in the costs of industry in such a way as to promote the competitiveness of European industry and

hence economic growth. Much of the TEN programme has been promoted on the basis of its role in increasing competitiveness, not just through the long term influence on production costs, but also through the short run creation of employment through infrastructure investment (e.g. European Commission, 1994a). Here there is a real international issue concerning trans-Atlantic comparisons since EU policy towards competitiveness could imply a move towards either a more protectionist stance or a more open stance in external trade policy. In the past transport has often been used as a covert way of assisting industry - a practice which the EU Common Transport Policy has sought to remove within the Union - this involves both internal and external transport markets. An important debate has emerged on the role of both infrastructure (e.g. Biehl, 1991, Aschauer, 1990) and transport (e.g. Krugman, 1991; Vickerman, 1998) in the economy at large, which needs greater understanding and treatment of the microeconomics of both to be properly understood (Gramlich, 1994, Quinet and Vickerman, 1997).

Cohesion relates to the reductions in regional disparities arising through an equalisation of transport provision and accessibility. Much of this has focused on inter-regional cohesion. However, the presumption that investment in infrastructure leads to genuine increases in accessibility, which automatically lead to reductions in income disparities, has to be questioned on both theoretical and empirical grounds (Vickerman et al, 1998). Intra-regional cohesion also raises important questions. Emphasis on the development of improved high level networks has frequently diverted attention from the question of accessibility to such networks which can lead to areas of poor overall accessibility within otherwise well connected regions. The *Citizens' Network* concept emerging from the European Commission (1995) starts to address this issue, but the clear message is the failure of understanding the way total, multi-modal, networks operate.

Figure 1 is an attempt to express the relationships between these four concepts. The transport sector itself is shown as involving an interaction between infrastructure, mobility and competitiveness. Infrastructure is largely an input to the production of mobility and an efficient transport system. Mobility of itself generates economic development, both through individual mobility and the movement of goods. The efficiency of the transport system, for a given level of mobility, promotes competitiveness in the transport using industries. We are here just concerned with the effects of transport on competitiveness and thus have treated it as part of the transport system. We also recognise that there is an important role of the policy framework which establishes the way in which infrastructure and transport services are financed and provided.

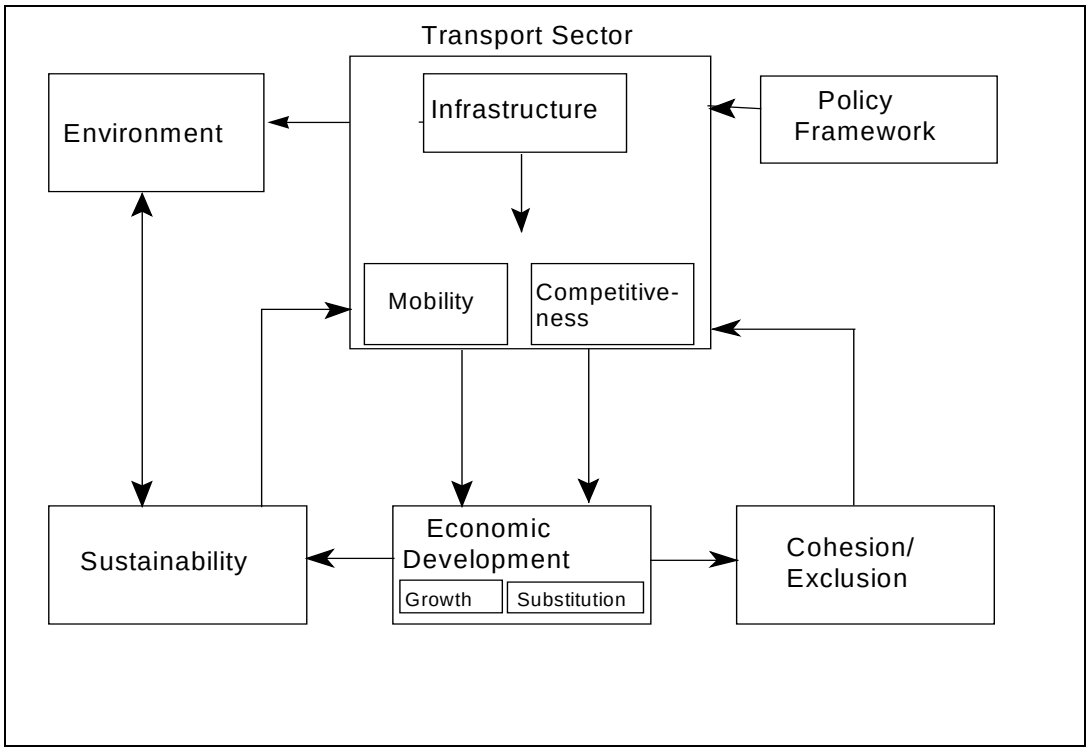


Figure 1 The role of transport in the economy - a schematic approach

The transport sector is shown as having direct impacts on the environment, for example infrastructure (whatever its level of usage) will have impacts on landscape, wildlife, ground water etc. Other effects depend on the usage of that infrastructure which is filtered through the way the economy uses transport. We have shown the economic development impacts as involving two elements, growth and substitution. Economic growth arises for many reasons. It is probably misleading to make too strong a claim for the growth inducing effects of transport, but it is clear that the lack of efficient transport can act as a constraint on economic growth. That growth of itself induces an increased demand for transport and this interplay has a strong effect on the sustainability of any level of growth consistent with maintaining appropriate environmental standards, hence the feedback to the transport sector and the interaction with the environment through sustainability.

It is not proposed to examine this inter-relationship between sustainability and the environment in detail. As noted above sustainability is often taken to imply a particular emphasis on the environment over economic development (and particularly over a narrow measurement of economic growth). It is important to regard this as a balance between the development of the economy and its environmental impact. A given level of development could be achieved with different levels of mobility, different levels of transport provision and different levels of infrastructure provision and thus have different environmental consequences.

However, changes in the transport sector can also imply substitution rather than growth. Substitution can involve the substitution of transport for other factors of production, which may also involve the substitution of production between one

location and another. Cheaper transport may therefore encourage firms to re-source supplies from more distant locations, thus the improved efficiency of one business has negative effects on others in the same area (with environmental consequences in addition). Similarly firms may be encouraged by cheaper transport to relocate production to regions with, for example, lower labour costs thus substituting transport for direct labour inputs. On the other hand lower transport costs may have a stronger effect on market areas leading to increased concentration of production in core regions.

These substitution impacts may also affect the sustainability of the economy, but in addition have what we have termed cohesion and exclusion effects. The cohesion argument is the best known, operating at the more macro regional level with results which are ambiguous depending on the interplay between the transport costs elements and other elements. The term exclusion has been more commonly applied at the more micro level to individuals or social groups, but it is clear that even without any overall impacts on the degree of cohesion at a regional level, changes in transport provision can have important impacts on different groups within society leading to exclusion if for example the unemployment of certain types of labour increases or inclusion if improved transport for one purpose leads to better levels of provision and accessibility for all groups. An example of the latter is where attempts to make local public transport more user friendly in order to enhance sustainability where there is strong growth in mobility lead to better provision for certain disadvantaged groups (e.g. low floor buses).

Once again we expect there to be some feedback on the transport system. Where for example exclusion and divergence result, the ability of the transport system to provide efficiently is reduced and this may lead to increased problems. The fall in ridership experienced by local public transport over many years leads to exclusion which leads to greater falls in profitable traffic and increased exclusion. Similarly convergence and cohesion can lead to better levels of provision which provide a renewed level of benefits to all.

The purpose of this section has been to show the way in which the four principal objectives inter-relate. This does not mean that they are necessarily in conflict with one another, but achieving objective levels in all of them may prove more difficult than the way that policy has traditionally assumed. Perhaps the key concerns relate to the degree of synergy between mobility and economic growth as primary objectives of policy and those concerned with the distribution of that development between different groups, different regions and the environment.

3. IMPLICATIONS FOR PROJECT EVALUATION

Transport policy at the EU level has concentrated particularly on the development of the European network. This has focused on the TENs, within which there has been a particular emphasis on rail, and, for passengers, high speed rail. This offers a good

example of some of the problems in defining clear policy impacts and conflicts. On the surface, the high speed rail network appears to offer a set of characteristics which is likely to meet most of the policy objectives outlined above: increased capacity and speed between the major European centres, reduced time penalties faced by peripheral regions, lower environmental costs than both road and air. This appears to meet all four of the objectives. A simple measurement of accessibility surfaces based on these improved timings suggests an immediate gain in both potential competitiveness (lower total transport costs for business services) and in cohesion (the time-based map of Europe shrinks) (Spiekermann and Wegener, 1996).

We need to ask certain questions, however. First, the goal of enhanced mobility raises certain problems. If reduced time costs for travel between major centres induces more longer journeys at the expense of shorter journeys this expansion of passenger kilometres is more difficult to justify on welfare grounds. This is especially the case if the money cost of travel by new services is subsidised. Such subsidies may be given to rail to correct the wrong relative prices faced by rail vis a vis road, but if they result in increased travel rather than mode switching the overall impact may be more costly. Certain environmentalists have questioned the obsession with high speed rail on this basis (see for example Whitelegg, 1993), especially to the extent that it is less environmentally efficient than traditional rail, particularly when the cost of land take for new lines is correctly costed. This argues that high speed rail is less sustainable than classic rail. Furthermore the attempts to co-ordinate high speed rail and air travel through new lines serving major airports in a number of cities, can be argued to exacerbate this problem.

A pure sustainable transport policy would aim to co-ordinate transport provision with activity location in order to minimise the level of mobility needed to achieve a given level of welfare, instead of which we have tended to use mobility as an indicator of welfare. There is for example evidence (reported in Goodwin, 1994) that the total time spent travelling by individuals in the course of a year has remained roughly constant over the past 50 years despite the increase in the time efficiency of transport. People travel further in the course of work, to and from work, and for recreation and pleasure. The arrival of telecommunications, instead of substituting for travel, enables people to organise their journeys more efficiently and thus travel even further. Telecommuting in the form of working from home on a proportion of days, or increased use of flexitime to avoid congested peaks, may lead to people decentralising their residence from the workplace, but the two or three days a week journey to the workplace results in a more travel in total. This fundamental question has been seriously overlooked in current transport policy which still too often takes activity locations as given and fails to allow for the way individuals' preferences may cause an improvement in transport to change those activity patterns. The recognition that new transport capacity may lead to increases in traffic and not just a redistribution of existing traffic (SACTRA, 1994) leads to questions as to whether it is possible to define concepts of unnecessary or unproductive travel.

If this is correct then the claims regarding competitiveness and cohesion also require

some close examination. Instead of reducing overall transport costs, the improvements to transport, may be increasing the so-called transport intensity of the economy. This concept of transport intensity is an interesting concept, but extremely difficult to specify. The term has been borrowed from work on energy where concerns were expressed about economic growth leading to increases in the amount of energy needed to produce each unit of output. The same idea has been applied to transport (see, Peake, 1994), but here the lack of a common unit of account with which to aggregate different types of transport poses a major problem. It may be that the concept is not workable in terms of producing a measure for use as a policy objective. Nevertheless there is clear evidence that the growth of road transport in terms of passenger kilometres and tonne kilometres has been faster in most European countries than the growth in GDP in recent years.

As well as difficulties with competitiveness, there are also some questions to be raised about cohesion. This is best illustrated by reference to the development of accessibility indices. If accessibility is related to continuous space rather than the discrete regions which are typically used we can observe two key characteristics (Vickerman et al., 1998). First, there is by most measures a continuing concentration of accessibility into the core economic regions of Europe at the expense of the periphery. Secondly, within all regions there is an increasing divergence between the accessibility gains of the key centres and those of their hinterlands. Of course, we must be careful not to confuse accessibility changes with changes in GDP or welfare, but we do have to be careful of using indices that suggest major gains for certain regions, but ignore the costs to others. The "shrinking Europe" effect may be in reality a "fragmenting Europe" in which the greater cohesion of the major metropolitan areas is bought at the cost of the increasing exclusion of the rest. The multi-speed Europe is not of simple geographical areas of core, intermediate and peripheral regions, but of major metropolitan areas, middle sized cities, small towns and rural areas, more of a patchwork. The discussion of this section is summarised in Table 1.

Table 1. Summary impacts of TENs on major transport policy objectives.

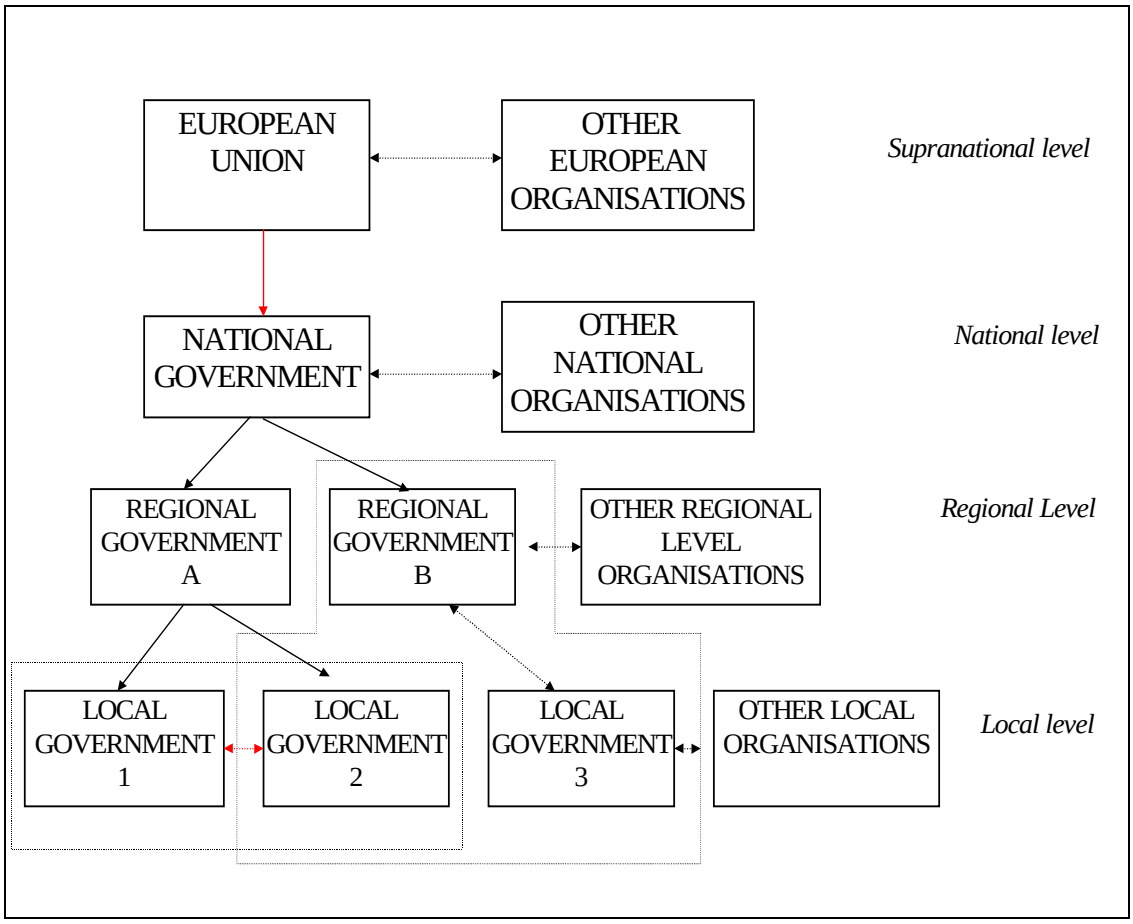
	Positive	Negative
Mobility	Faster speeds enhance mobility	Encourages unnecessary journeys or longer journeys
Competitiveness	Faster speeds reduce travel costs	Cost of new infrastructure imposes excessive burden on providers
Sustainability	Induces substitution from less sustainable modes	Construction of new infrastructure destructive of natural environments, plus noise etc.
Cohesion	Faster speeds reduce peripherality	Faster speeds increase the centralisation of activity into the major nodes served

4. WIDER ECONOMIC AND SPATIAL CONSEQUENCES OF TRANSPORT POLICIES

The key issue is the way in which policy objectives impact at a local level, especially where there are local consequences of decisions to implement high level infrastructures such as TENs. However, lower level decisions can also involve clear spatial conflicts. In Figure 2 we outline ways in which policy and decision making at different levels interact.

The structure outlined in Figure 2 proposes a system where there are policy units, bodies which can take decisions, at four different levels, supra-national (EU), national, regional and local. These policy units can include both the elected governmental bodies at each level and, parallel to these, sets of other representative bodies which are either involved directly in the decision making process or have influence over decision taken. These can include important planning and environmental advisory bodies and the operators of transport services. Each of these policy units will take decisions regarding transport policy or projects for its own area of responsibility. In some cases bodies at different levels are limited in their powers by bodies at other levels, e.g. local government typically operates within a statutory framework determined by national government and most operational transport policy decisions are vested at national rather than EU level by the principle of subsidiarity.

Figure 2 Interaction of Policy Units in Policy Making



Conflicts arise between these levels by virtue of both value and impact conflicts. A particular policy may be selected because of its perceived national benefits, but may impose negative impacts on the local areas on which it directly impacts. Even where there is not a negative impact, residents in one area may perceive a negative effect because of different values placed on certain environmental factors. A good example of the latter is the very different values placed on noise in different environments such that the same noise impact is valued very differently according to where it occurs and by different groups of individuals.

Conflicts can also arise horizontally between authorities at the same level of government (e.g. between national governments over the routing of a new line either side of a national frontier, between local governments over route details for new projects). Here the conflict does not arise so much as part of the decision making process where one body has the right to take a decision which it can impose on another body by virtue of some hierarchical assignment of powers, but rather because one body takes a decision which has a direct impact on another whose interest it specifically does not consider. This type of behaviour is typically for transport projects characterised as NIMBY behaviour in which one group tries to ensure that the negative impacts are felt by anybody but itself. However, it can also work in reverse where one area seeks a new road, an interchange or a station in its jurisdiction because

of the perceived improvements to accessibility and business interests which this will bring.

The hierarchical structure in Figure 2 is a good way of representing the various dimensions of conflict which can arise in policy making and implementation. Because there is such a hierarchical structure, it does not make it inevitable that conflict will occur. The typical source of conflict is equivalent to the recognition of negative externalities, but externalities can also be positive and furthermore a complex hierarchical structure, where there is more than one policy unit at each level, can give rise to altruistic or coalescent behaviour by such policy units. Such coalitions may occur both within a given level of decision making and between levels. The idea here is that concerns expressed by other policy units may have a direct impact on the values and the decision of a different policy unit referred to as its outside decision context. Examples of this are the impact effect of recognising that it may be superior to have an interchange or new station in the neighbouring authority to not at all, a type of second best decision, or the wish to support another policy unit in its fight on a particular issue in order to establish a set of rules, compensation criteria etc. which could be of long term benefit to other policy units. Where such coalitions or altruistic behaviour occurs it is termed the outside decision context of the decision, in contrast to the inside decision context of the policy unit's own decision making (see Norman and Vickerman, 1998b). Figure 2 shows two possible sets of outside decision contexts. One of these includes the two local government authorities 1 and 2, the other involves local governments 2 and 4 together with regional authority B. This is to illustrate that coalitions can occur both horizontally and vertically and can involve coalitions outside the direct line of the hierarchical organisation. This may be particularly the case where one of the local authorities is at the boundary between two regions.

We have illustrated the ways in which conflicts arise both between policy objectives and between different policy units. One of the purposes of the case studies in this project is to demonstrate the ways in which the articulation of policy by each policy unit and the problem in clearly ascribing specific policy objectives to specific policy units together cause conflict in transport planning.

If we try and identify the various policy objectives with policy units at different levels, we find a further problem, that the articulation of policy at the European Union (TEN) level is actually very poor. Thus national, regional and local governments can identify very specific concerns and advantages associated with a particular scheme. This scheme is identified as part of a transport TEN and thus has clear impacts on competitiveness and cohesion, but these are difficult to incorporate in the matrix of outcomes and there is little or no direct involvement of the EU dimension in the final decisions.

Many of the benefits associated with the development of TENs occur at the supranational or national levels, many of the costs accrue at the local or regional level. Direct benefits accrue to either international travellers or freight passing through

regions and indirect benefits to more distant regions through reduced travel times and national economies as a whole through a shift to more environmentally friendly means of transport. The costs are borne by the region and the communities through which the new lines pass. Direct costs such as noise and disruption are partially balanced by access to the line, but there are little clear signs of indirect benefits from increased economic activity given the competition with other regions better placed to take advantage of these (see Vickerman, 1998, Norman and Vickerman, 1998a, b).

5. TOWARDS A MEASURE OF SUSTAINABLE MOBILITY

Much of what has been discussed with respect to sustainability relates to the direct environmental impacts which transport has. Although there is a policy notion of sustainable mobility, this has not been explored as fully as it should have been. In this section of the paper we illustrate some of the trends and issues which arise here. In particular it must be assessed how true it is that limiting either the growth or the rate of growth of traffic will be beneficial to the environment, but harm the economy.

Nijkamp and Vleugel (1995) discuss sustainability in terms of its direct environmental effect though the definition of *maximum environmental capacity use* which they then try to apply to transport at the sectoral level. Although they identify transport as having a peculiar position in the economy, "an integrating function" the measures which are used do not specifically include the impact on other sectors. In particular we would need to know whether policies to reduce transport emissions would lead to less transport, decentralised production, but more and more dispersed emissions from transport using industries. In a further study Nijkamp, Rienstra and Vleugel (1998) have explored further the spatial dimensions of sustainable transport policies, but the economic issues are left only to deal with the possible role of market structure rather than the process of economic development itself.

In order to explore this a little further we look at attempts to define a simple measure which relates transport use to the economy as a whole. This has been defined as *transport intensity* following earlier attempts to undertake the same exercise for the energy industry (see in particular Peake, 1994). Peake defines the concept of *gross mass movement* which is an attempt to add together both passenger and freight mobility into a single index expressed in terms of tonne kilometres. Transport intensity is the ratio of gross mass movement to GDP and indicates the amount of transport necessary to produce a unit of GDP. Peake suggests that this figure has been increasing for the UK over a long period, but it is suggested that this may have reached a peak and that future trends will be downwards. There are differences between the passenger and freight data which are hidden by the gross mass movement index. Passenger trends have shown a much steeper rise. The data for freight alone suggests a rather slower rate of growth of freight than of GDP. These figures are corroborated by Voigt (1995) who estimates an income elasticity of freight transport of a little less than unity with passenger transport rather greater than unity. There is some evidence that road freight intensity increased dramatically in the late 1980s

which could be either a product of recession given the degree of decentralisation achieved in many economies, or the result of changing supply structures in the transport sector itself. The interesting question then becomes whether passenger traffic should be expected to display the sort of saturation levels implied by most car ownership models, assuming that car ownership and use are closely related (Vickerman, 1996).

Table 2 gives an overview of measures of road transport intensity for a selection of EU countries. This demonstrates both the diversity in the evolution of intensity and the changes through time.

Table 2 Traffic Intensity Measures

	Car traffic growth (pkm)/ GDP growth		Freight traffic growth (tkm)/ GDP growth	
	1970-1985	1985-1994	1970-1985	1985-1994
U.K.	1.05	1.23	0.92	1.15
France	1.31	1.21	0.88	1.13
Sweden	1.06	1.12	0.96	1.13
Netherlands	1.26	0.98	1.06	1.11
Italy	1.11	1.23	1.58	1.09

The question of the link between car ownership and car use has been raised above. Since there is evidence that the elasticity of car ownership with respect to income has been falling in most countries, this could lead us to believe that so will car traffic intensity. However, cross-sectional evidence suggest that there are substantial differences in car usage which are not related to either car ownership or income. Table 3 shows clearly how inconsistent the pattern is. Countries with high income and car

Table 3 Car Ownership and Car Use 1994

	GDP/head 1994 ($PPP)	Cars per 000 pop.	Car traffic/head 000km
Belgium	20314	416	5.4
Denmark	20438	309	6.2
Finland	16274	368	7.0
France	19232	430	6.1
Germany	19671	486	6.2
Greece	11582	188	n.a.
Ireland	15794	263	6.4
Italy	18648	532	5.6
Luxembourg	30198	567	8.2
Netherlands	18273	383	5.8
Portugal	12027	263	3.7
Spain	13596	343	2.9
Sweden	17583	409	6.2
U.K.	17621	372	6.1

ownership such as Italy and Germany have lower actual car use than countries such as Ireland and Finland with much lower car ownership where presumably spatial structure and the supply of alternative forms of transport are less. The UK also displays rather a high level of car usage for its level of car ownership with similar levels of usage to France and Germany despite car ownership levels only 75 per cent of the German level, and much higher than Italy despite a car ownership level of only 70 per cent and only marginally lower income levels.

Figures 3 to 5 investigate the cross-sectional evidence a little further relating the traffic intensity figures for car, all passenger and freight traffic, expressed as passenger or tonne kilometres per unit GDP ($000), to GDP per head. The intention here is to see how far traffic intensity is related to the level of economic development.

What Figures 3 to 5 show is that there is a general tendency for traffic intensities to reduce as GDP per head rises (Luxembourg and Greece are omitted from this due to lack of relevant data). The correlation coefficients for car traffic, passenger traffic and freight traffic, respectively are -0.31, -0.35 and -0.39 and these give rise to estimated elasticities with respect to GDP/head of -0.25, -0.30 and -0.91. This suggests that freight traffic intensity may be expected to fall at approximately the same rate as income levels rise, confirming the income elasticity of around unity or little below reported above. Passenger traffic is more worrying however since the rate of growth of such traffic is so strong as to lead to only a 25 to 30 per cent fall in intensity for any given rise in income.

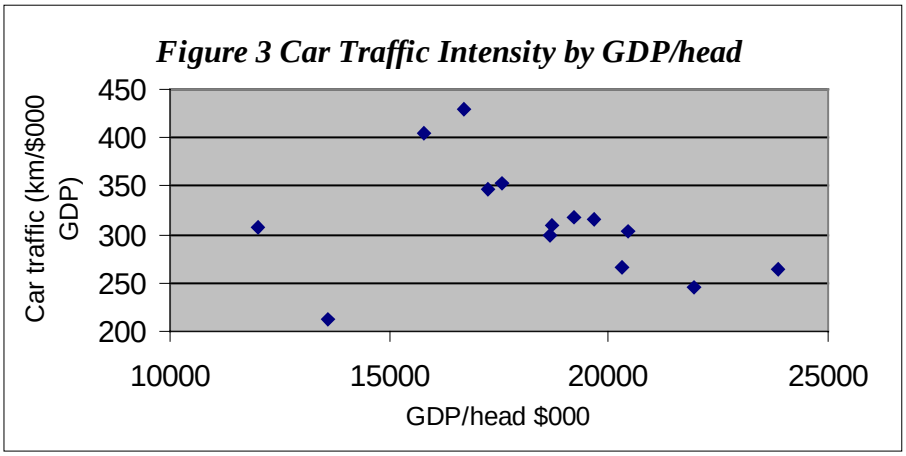


Figure 3 Car Traffic Intensity by GDP/head
Car traffic (km/$000 GDP)
450
400
350
300
250
200
10000
15000
20000
25000
GDP/head $000

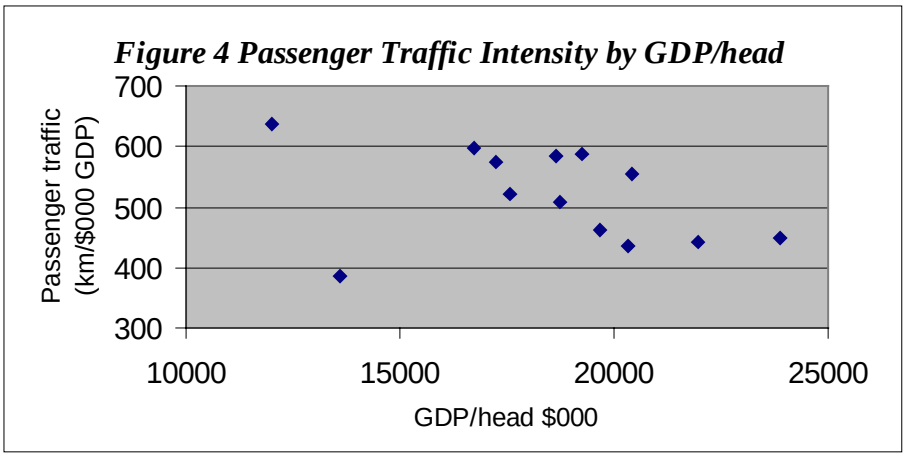


Figure 4 Passenger Traffic Intensity by GDP/head
Passenger traffic (km/$000 GDP)
700
600
500
400
300
10000
15000
20000
25000
GDP/head $000

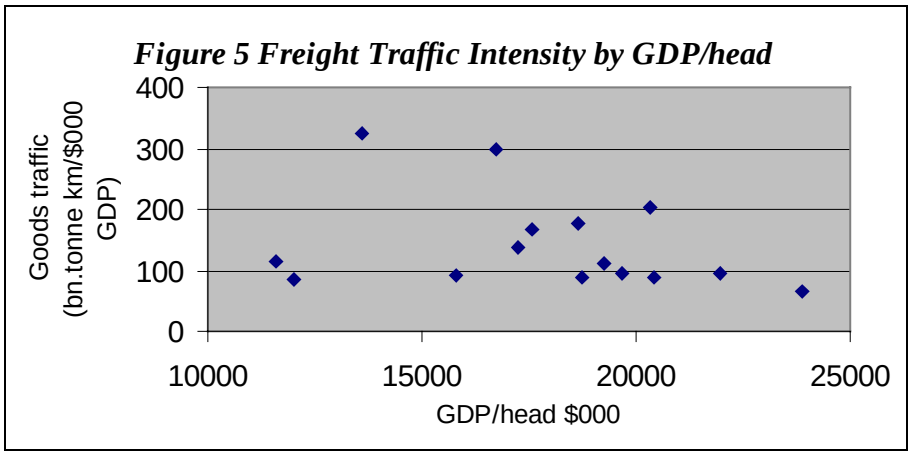


Figure 5 Freight Traffic Intensity by GDP/head
Goods traffic (bn.tonne km/$000 GDP)
400
300
200
100
0
10000
15000
20000
25000
GDP/head $000

Our conclusion from this discussion is that there is still much to be done to unravel the complex interaction between transport use and the economy, but that this may be as critical as understanding the more conventional emissions story about transport. Workable definitions along the lines of those presented here are themselves only telling part of this story.

6. CONCLUSIONS

This has been a wide ranging paper in which we have attempted to establish a framework for thinking about the relationships between transport and the development of a sustainable economy. Two major themes have emerged from this, that the focus on traditional measures of sustainable transport, which concentrate on the direct environmental damage due to transport, may lead to problems both in terms of the cohesion/exclusion dimension and that of economic development itself. Some elements of an approach to further development of appropriate indicators has been included.

Perhaps the over-riding conclusion is, however, that within Europe there is too little clear focus on what the elements of a sustainable transport policy which can also promote competitiveness and cohesion should be. From the EU perspective this is too often left to individual member states to implement. From the perspective of individual regions or individual projects it is often nearly impossible, even for large projects, to assess the practical implication of the European dimension into which they are supposed to fit.

Clearly there is much to be done at both technical and policy levels to develop a clear policy framework which can secure a genuinely sustainable transport policy for Europe. Within that the control of mobility to a level consistent with economic efficiency is going to be difficult and calls into question a wide range of other policy measures relating to land-use planning, regional development and economic performance generally.

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