EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORT

14TH INTERNATIONAL SYMPOSIUM ON THEORY AND PRACTICE IN TRANSPORT ECONOMICS

WHICH CHANGES FOR TRANSPORT IN THE NEXT CENTURY?

INNSBRUCK, 21-23 OCTOBER 1997

ECMT

EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORTS

FOURTEENTH INTERNATIONAL SYMPOSIUM ON THEORY AND PRACTICE IN TRANSPORTCECONOMICS

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INTRODUCTORY REPORTS AND SUMMARY OF DISCUSSIONS

Innsbruck, 21-23 october 1997

LOGO ECMT

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Federal Minister of Science and Transport of Austria

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Minister of Transport and Communications of Turkey

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Head of Division to the Ministry of Transport of Denmark
on behalf of the Chairman of the ECMT Council of Ministers

Mr. Gerhard AURBACH
Secretary-General of the ECMT

Address by C. Einem

Mr. Secretary General,
Ladies and Gentlemen,

May I say how welcome you are to the 14th ECMT International Symposium in Innsbruck, the Tyrol region's beautiful capital city. I am particularly happy that so many of you are taking part in the proceedings, which is also a sign that you too attach great importance to the issue of the basic changes confronting the transport sector in the coming decades.

I am convinced that the forum provided by the ECMT and in particular this 14th Symposium are a perfectly appropriate medium for the extensive discussion of this specific issue from the transport science and policy viewpoints. This is especially true since the ECMT, already taking a prominent place in European transport policy before the European Community was set up, now plays an even more important role in stimulating pan-European transport policy, owing to the impressive figure for its full membership, which now comprises 35 eastern and western European countries.

In keeping with the tradition, high-ranking representatives of government bodies, universities, research institutes, enterprises and interest groups are taking part in this event. As you can see from the invitation and the meeting agenda, the focus in the next few days is on coping with the changes to be expected in the transport sector in the next century.

At the three half-day sessions and at the final Round Table meeting in which transport scientists and policy experts will take part, the extent of change in the transport sector will be examined and certain practical issues will be discussed, such as the action to be taken in response to the massive forecast increase in freight and passengers, particularly in road transport, the role to be played by transport policy in settling the conflict between the acceptable limits to the negative effects of transport and the continuing growth in transport demand, the responsibilities to be assumed in the future by the authorities for transport infrastructure management, etc.

The object of the Symposium should be to bring out practicable and widely acceptable solutions for the sustainable development of transport.

Since in recent years the transport sector has increasingly developed into a complex system with "man, the environment, the economy and technology" as its components, the key to the issues confronting us on the threshold of the next century lies, in my view, in an overall, intermodal approach that will take social, ecological, economic and technical requirements into account.

In particular, I believe that the challenge for the future is to apply realistic costs in transport, since distortion of competition to the detriment of environment-friendly transport media is now mainly due to the fact that the road transport sector neither meets the infrastructure costs nor the external costs -- relating to the environment, accidents and congestion -- generated by it. The rapid implementation of co-ordinated measures for developing rail infrastructure and improving rail's capacity and quality, action to promote and develop combined traffic and, lastly, the further improvement of the environmental safety standards of transport vehicles, are also major challenges for transport policy in the coming years.

I am convinced that, as a result of the dialogue in the next few days between transport science and policy experts, this Symposium can make an important contribution to achieving the objectives to which I have referred.

I thus hope that the 14th ECMT Symposium will be a great success and that you, ladies and gentlemen, will have a very interesting and pleasant stay in Innsbruck.

Address by N. Menzir

Distinguished Guests,

Firstly, I would like to express the great pleasure it is for me to address such an eminent group of participants in this 14th International Symposium organised by the ECMT.

The transport sector has played a leading role in economic, social and cultural development on a world scale, as well as in Turkey, and it has paved the way for the globalisation process. The breathtaking progress of technology in the field of transport has reflected on the development of other sectors, especially trade activities. This rapid change has urged governments towards structural changes in their economic policies, so that a common system of values has been agreed upon in the process of globalisation.

Economic notions, such as effectiveness, functionality, new financing models, risk sharing, risk management and revenue sharing underpin the development of an environment that can foster globalisation. State enterprises, seeking possibilities to implement these new notions, are urged to orient themselves towards a rapid privatisation process so that, in a more competitive environment, they may be more productive, improve quality and ensure lower costs to consumers.

However, the realisation of these objectives depends largely on the existence of an effective and independent regulatory body. The success of such a regulatory body is also closely linked to the existence of transparency and independence from political interventions. Only in such an environment can true market competition be assured and monopolies avoided. In transport and communications, Turkey has engaged in such a process, on the one hand, preparing a legal framework and, on the other, privatising its infrastructure and services to allow for private participation in infrastructure investment.

At this forum, where European transport policy is being discussed for the coming century, it is commonly agreed that guidelines on, for instance, the market economy, environmental considerations and new needs will shape a new, integrated European transport system. In this integrated system, the increasing volume of goods and passenger traffic is one of the main problems to be solved by seeking new models and infrastructural arrangements.

As the volume of movement increases in relation to European scale land use, a disproportionate utilisation pattern is revealed for some critical zones. Turkey, being located in one of these critical zones for maritime transport, due to its geographical position suffers, at the same time, from its peripheral situation where land transport is concerned. The location of Turkey as a concentration point for intercontinental traffic between the Mediterranean and the Black Sea, bestows particular privileges as well as imposing certain responsibilities. The importance of Turkey for land, maritime and air transport from Europe to the Middle East and Central Asia, necessitates the development of a transport network capable of meeting the required criteria of the sector in the region.

In the field of railways, the coming years will provide a new impetus for Turkish rail transport. Rail, which holds a special place among all the other transport modes, is experiencing a revival towards the end of this century. Road safety, environmental concerns and energy saving are the three main reasons for this regain in importance of the railways in Europe. Taking this into consideration, Turkey is preparing a new thrust, not only to develop its rail infrastructure but also to modernise its management system.

In this framework, besides the modernisation of the existing network, a new project for a high-speed rail link between Ankara and Istanbul constitutes an important step in connecting Europe and Asia by an uninterrupted line 416 km long, with a tunnel under the Istanbul Strait. In addition, the revival of the famous ancient route, the Silk Road, which extends to Central Asia via the Turkey-Georgia railway connection, has its specific place among Turkey's investment projects.

With these new projects, Turkey's railways will reach a level of modernity on a par with the existing European system, thereby offering new possibilities for connections between Europe and Asia. An international railway congress will be held in Istanbul in December and I hope that new ideas will be discussed for the revival of rail transport in Turkey.

In all the above-mentioned infrastructure projects for different modes of transport, we envisage B.O.T. besides other financing models. Here, I would like to state that the related departments of my Ministry are open to discuss every possible proposal, whether of a technical or financial content and to invite international investment and finance institutions to take their share in such enormous infrastructure projects.

Finally, I hope that Turkey, playing a significant international role in the transport sector, with its openness to co-operation and its economic potential as a country of opportunities, may promote international co-operation in the field of transport infrastructure to the highest possible level in the coming years.

Thank you.

Address by J. Holdt, on behalf of B. Westh

Ministers,
Ladies and Gentlemen,

The Danish Minister of Transport, Mr. Bjørn Westh, regrets that he could not be present at the Symposium and has asked me, on his behalf, to convey the following to you.

It is an honour and a pleasure for me to be addressing you today, as the new Chairman of the Council of Ministers of the European Conference of Ministers of Transport, at the opening session of the ECMT's 14th Symposium.

The ECMT was established in 1953 and, 10 years later, at an academic session held to celebrate the Conference's 10th anniversary, Mr. Louis Armand, a member of the French Academy and the most distinguished of the guest speakers present, concluded his speech with these words:

"*I think that one should consider bringing together all the expertise of the ECMT's 18 Member countries [there are now thirty-six], both those engaged in economic research in universities and institutes and those whose speciality is technology or statistics. Theory must be brought into contact with reality, engineers with professors of economics, if one is to tap an intellectual potential that is undeniably under-utilised at present*."

The idea of Symposia was thus launched and the first was held the following year, 1964, in Strasbourg.

At the time, Europe was in the middle of the "swinging sixties". In the transport sector, problems had not yet acquired the European or global dimensions that they have today, and were not yet as acute as they have now become with the mobility explosion.

What better way of tackling these problems than by bringing together in one forum all the specialists who are closely involved in these issues? What makes for the originality and strength of the ECMT is the fact that it underpins its policy work with research.

The realities facing transport today call, more than ever before, for a scientific approach.

Traffic growth, especially land transport, is a key issue. It seems to be a fact of life, since car ownership levels keep rising even in periods of recession. Then again, the costs of motoring have tended not to rise over the last few decades. Also, the private car has become so ingrained in modern society that it often seems irreplaceable.

This is a trend which stretches back for several decades. In fact, the central theme of the Athens Symposium, as far back as 1973, was “The impact of transport on the quality of life”.

Since that time, we have seen how destructive unchecked traffic growth can be. Energy sources are not infinite, pollutant emissions damage the ecological balance and are harmful to health. Transport is also the single largest source of noise. All of these factors should make us question our practices. In this respect, we have an undeniable dilemma on our hands: while everyone agrees that there is no going back on the opening up of markets in Europe or on the liberalisation of trade, we know that we cannot continue to treat the environment as we have in the past.

All of which leads me to raise a series of questions which go straight to the heart of the central theme of this Symposium on changes in transport in the next century.

The questions that spring to mind relate mainly to mobility. Is mobility likely to change radically in the future? Will car ownership levels reach saturation point, bringing a slowdown in traffic growth? What effects will demography and income trends have?

At an even more fundamental level, should more drastic measures be taken to curb the growth in car travel? What effect would higher fuel prices have? What about road pricing?

These are all relevant questions for policymakers and are equally valid for freight transport. Indeed, one may wonder how high the demand for freight transport will be in the coming century, even if growth remains moderate. What role will the various modes play in the future?

Of course, in the years and decades ahead, technology will make substantial progress. The first trials with automated motorways have just taken place. Vehicles will be cleaner and safer. Nevertheless, up to now, traffic growth has tended to undermine the advances in technology and one obviously wonders whether this trend will continue in the future.

These are among the questions that concern Ministers of Transport directly and indeed they have already been discussed in an ECMT framework when adopting their resolutions on transport and the environment. These resolutions state that vehicles must use the best available technology, that infrastructure users must bear all of the costs they generate and that infrastructure must be built and utilised in such a way as to minimise any adverse impact on the environment.

However, within this broad framework, certain issues, such as vehicle taxation, measures to curb transport in urban areas and land-use planning, warrant more in-depth discussion.

Clearly, we cannot assume that transport in the next century will be organised in the same way as it has been up to now, and that is the real challenge to the imagination of all those present at this Symposium.

In these opening remarks, I wanted to draw your attention to the issues as policymakers see them and, thus, start off what will surely be wide-ranging discussions.

It is also evident that any scientific debate must take into account the political factors. Even if all scientists are in favour of road pricing, there are substantial political issues that need to be resolved before implementation.

I am sure that your discussions will be fruitful and I am looking forward to discussing some of your ideas at the next Council of Ministers’ meeting to be held in Copenhagen in May next year.

It remains for me to thank my colleague, the Austrian Minister for Science and Transport, for inviting us to hold this Symposium here. I should also like to thank the Innsbruck City Authorities and all those who have helped to organise the Symposium.

On this note, I, on behalf of Mr. Bjørn Westh, declare the 14th ECMT Symposium open and wish you every success in your discussions.

Address by G. Aurbach

Ministers,
Ladies and Gentlemen,

This is the 14th International Symposium on Theory and Practice in Transport Economics to be organised by the ECMT since 1964. For the fourteenth time, the Conference is opening its doors to all experts interested in the transport field: researchers, representatives of the different modes, transport company personnel, users, policymakers, national administrations and international organisations. In so doing, it is continuing a tradition which goes back over thirty years. Thanks to the generous invitation of the Austrian Authorities, the City of Innsbruck provides a striking setting for this year's Symposium, the last one of which was held in Luxembourg two and a half years ago.

The ECMT organises symposia as part of its research activities, along with round tables -- at which topical issues are examined in depth by a limited number of experts -- and seminars, which are an intermediate format. With this long-standing programme of round tables, seminars and symposia, it is fair to say that the ECMT has kept abreast of progress in transport research over the last thirty years.

Symposia are a key link in the ECMT's research work, since they give us an opportunity to test the relevance of proposals on a very wide audience and to tap into any consensus of ideas emerging among the scientific community.

The ECMT's research work is fundamental to the functioning of the Conference. These days, policy decisions not substantiated by preparatory research work are virtually inconceivable. The ECMT was one of the first organisations to recognise the importance of research in sound policymaking and to put in place a system for co-operation on research and documentation for its policy work.

Within this framework, research topics are chosen by a committee of government experts who are close to the decisionmaking process. Moreover, the ECMT jealously guards the independence of its research activities with a view to ensuring that they achieve the purposes for which they were intended: forecasting, warning and generating innovative ideas. This is what makes research a powerful policy tool, one that has proved to be as important as ever as time goes on.

This Symposium will be much more concerned with the forecasting role of research than any of the previous symposia, since the topic you will be discussing is "Which changes for transport in the next century?"

So, what exactly can we say as the 21st century approaches?

It has become difficult to say whether transport policy should follow the demands of the public and business. The fact is that we all wish to be protected from transport's nuisances where we live, but we want quality infrastructure that will save us time when we travel. Of course, it is the constant increase in traffic that has brought us to the point where we make such contradictory demands on transport policymakers. Realistically, there is little prospect of seeing traffic decrease. All the signs -- economic globalisation, the integration of the countries in transition and leisure travel needs -- point to the opposite.

Whenever we speak of the future, it is tempting to think that technological advances will solve the problem. The argument goes that teleworking and the virtualisation of our economies will make for less travel in the future. However, one can also argue the opposite: that logistics relies on highly sophisticated information technologies, and logistics is a big transport user. This said, as far as personal transport goes, communications technologies may not necessarily be a substitute for actual travel, they might well just complement it. I, for one, think that there is no real substitute for face-to-face contact. So, logically, we have to admit that technology is no guarantee that we will make less use of our transport systems in the coming century.

However, the coming century will surely be a century of sustainable development, one in which we will have to reconcile our conflicting aspirations. Is our current transport system sustainable? That is open to debate, judging from the wealth of conflicting opinions. There are those who think that technological progress should lead to substantially improved cars. Others think that this will not be enough, with traffic growth as it is. While it is imperative that we become more environmentally conscious, many of the measures which might be taken to ensure sustainability will be unpopular: widespread road pricing, for example. So, how do we make what is unthinkable today palatable tomorrow? How do we explain the major choices that have to be made to the public? How do we take responsibility for such decisions on the political level? This is a far cry from the traditional debate on regulation/deregulation which exercised our minds in the eighties.

Regulation will still be needed in the coming century but, in the light of experience, we will more than likely try to make it less burdensome. We must not forget our CEEC partners, who are having to rebuild their regulatory framework, and some of whom are looking to membership of the European Union with this end in view. This means that our decisionmaking processes will have to change. In a networked world, where all stakeholders have a say, decisions are not taken in the same way as under the old hierarchical order. Decisions are taken by consensus these days. Modernisation of the decisionmaking process is certainly one of the changes which can be expected in the 21st century, but what we have to do is foresee these changes now. That is one of the tasks of this Symposium.

I have just touched on two of the topics you will be addressing over the next two days. These are: "What is the future for transport?" and "What role for government?" Another topic you will be discussing is "What type of infrastructure?" For some time now, there has been talk of using a mix of public and private finance to build missing infrastructure links. The private sector, naturally enough, has shown little interest, given the inherent characteristics of infrastructure investment. One of these is the long pay-back period, which means either that the framework conditions have to be very secure or that there has to be some sort of guarantee against the inherent risks of infrastructure construction and costs getting out of control. Significant progress in these areas will be necessary, together with an accurate estimate of capacity needs, given Europe's endemic capacity shortages. Being able to produce an accurate estimate of missing links, which should be given every priority, is definitely one of the most worthwhile goals for the next century. In all, there are so many infrastructure projects that might be considered necessary in an enlarged Europe that building them all at the same time would constitute a heavy drain on available funds and crowd out borrowers for other projects. It is important to rank priorities, which brings us back to the need for the right decisionmaking processes. On this point, too, I am sure that your discussion will be lively. From capacity management using road transport telematics, to the allocation of railway capacity in accordance with free market principles in a fragmented railway sector, and the construction of pan-European corridors, the infrastructure topic offers no shortage of subjects for discussion.

For the first time ever at a Symposium, the last session will take the form of a panel debate in which experts will give their views on all of the issues raised during the Symposium. Under the heading of this last sub-topic, "Scope for change", experts from different spheres, policymakers and senior government officials will debate the changes in store for transport in the next century.

As you will see, ladies and gentlemen, you will be discussing issues of crucial importance to the organisation of transport in the next century. The key ideas to emerge from the discussions will appear in a publication containing the introductory reports and summary of discussions which the Secretariat will put together after the Symposium, with the help of Mr. Grubert from the Austrian Ministry of Science and Transport.

The theme of change in the next century requires us to shed outworn ideas and to exercise our imagination. That is exactly what I would wish for this Symposium: that no-one should hesitate to voice even the boldest hypotheses about the future of our transport system. For it is by taxing our imagination that we may come up with the scenarios that will become tomorrow's reality.

It only remains for me to thank you all for doing us the honour of attending this 14th Symposium, which will be the richer for your presence, and particularly those who will be taking a more active part: the rapporteurs, panel chairmen and members and all those who will speak in the debate.

Lastly, of course, my thanks to you, Minister, and to all your team from the Austrian Ministry and the City of Innsbruck for taking care of all the practical arrangements for this Symposium.

I wish you every success in your discussions on topics which affect the entire future of the transport system in Europe. Thank you, Ministers, Ladies and Gentlemen, for your attention.

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Innsbruck, 21-23 October 1997

ECMT

EUROPEAN CONFERENCE OF MINISTERS OF TRANSPORT (ECMT)

The European Conference of Ministers of Transport (ECMT) is an inter-governmental organisation established by a Protocol signed in Brussels on 17 October 1953. It is a forum in which Ministers responsible for transport, and more specifically the inland transport sector, can co-operate on policy. Within this forum, Ministers can openly discuss current problems and agree upon joint approaches aimed at improving the utilisation and at ensuring the rational development of European transport systems of international importance.

At present, the ECMT's role primarily consists of:

– helping to create an integrated transport system throughout the enlarged Europe that is economically and technically efficient, meets the highest possible safety and environmental standards and takes full account of the social dimension;
– helping also to build a bridge between the European Union and the rest of the continent at a political level.

The Council of the Conference comprises the Ministers of Transport of 39 full Member countries: Albania, Austria, Azerbaijan, Belarus, Belgium, Bosnia-Herzegovina, Bulgaria, Croatia, the Czech Republic, Denmark, Estonia, Finland, France, the Former Yugoslav Republic of Macedonia (F.Y.R.O.M.), Georgia, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Moldova, Netherlands, Norway, Poland, Portugal, Romania, the Russian Federation, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, Ukraine and the United Kingdom. There are five Associate member countries (Australia, Canada, Japan, New Zealand and the United States) and three Observer countries (Armenia, Liechtenstein and Morocco).

A Committee of Deputies, composed of senior civil servants representing Ministers, prepares proposals for consideration by the Council of Ministers. The Committee is assisted by working groups, each of which has a specific mandate.

The issues currently being studied – on which policy decisions by Ministers will be required – include the development and implementation of a pan-European transport policy; the integration of Central and Eastern European Countries into the European transport market; specific issues relating to transport by rail, road and waterway; combined transport; transport and the environment; the social costs of transport; trends in international transport and infrastructure needs; transport for people with mobility handicaps; road safety; traffic management; road traffic information and new communications technologies.

Statistical analyses of trends in traffic and investment are published yearly by the ECMT and provide a clear indication of the situation in the transport sector in different European countries.

As part of its research activities, the ECMT holds regular Symposia, Seminars and Round Tables on transport economics issues. Their conclusions are considered by the competent organs of the Conference under the authority of the Committee of Deputies and serve as a basis for formulating proposals for policy decisions to be submitted to Ministers.

The ECMT's Documentation Service is one of the world's leading centres for transport sector data collection. It maintains the TRANSDOC database, which is available on CD-ROM and accessible via the telecommunications network.

For administrative purposes the ECMT's Secretariat is attached to the Organisation for Economic Co-operation and Development (OECD).

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Further information about the ECMT is available on Internet at the following address:
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INTRODUCTORY REPORTS

Topic 1

WHAT IS THE FUTURE FOR TRANSPORT?

IS FREIGHT TRANSPORT GROWTH INEVITABLE?

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SUMMARY

Antwerp, January 1997

1. INTRODUCTION

To attain economic growth is an important goal for any government. However, as demand for transport is a derived demand, economic growth has, hitherto, always been translated into greater demand for freight transport too. Freight transport is, after all, entirely dependent upon the spatial separation of production and consumption activities.

For this reason, prognoses regarding future freight transport invariably underline the derived character of the demand for transport. The effect of any capacity problems, however, are usually disregarded. The actual rate of growth will, of course, vary for different categories of goods and certainly also for different geographic links. This is where the problem of "new markets" arises.

Two complementary phenomena are significant in this respect. Firstly, it appears that certain areas are catching up in terms of economic growth, either with or without support of the European Union (cf. the policy with regard to the so-called "lagged regions"). Furthermore, there is the possibility of a shift in the logistics chain. It does not seem impossible, for example, that import flows of raw materials and containers, which have until now passed through the relatively large ports of Antwerp-Rotterdam-Hamburg, might in the future pass through the South Italian ports of Taranto and Gioia Tauro. This would result in a major shift in connecting hinterland transport. In addition, there would be serious consequences in terms of the utilisation rate of existing infrastructure, demand for new infrastructure, the technology used and the modal choice between road transport, inland shipping and rail transport.

The question thus arises how the need for more freight transport in the future and the corresponding need for more infrastructure can be dealt with. But, in order to answer this question adequately, one must first gain an insight into the true extent to which demand for freight transport may increase. It is precisely that aspect which is discussed in this paper. The first part consists of a short overview in figures of the phenomenon of freight transport. Then we shall take a closer look at the relation between economic growth and demand for freight transport, all the while paying attention to the issue of the modal split. Ultimately, this approach should result in the formulation of an answer to the question of whether a further growth of freight transport is indeed inevitable.

2. FREIGHT TRANSPORT IN FIGURES

The problem of measuring the economic significance of the transport sector to a country or to a group of countries can basically be approached in two ways (Blauwens, de Baere and Van de Voorde, 1996, p. 41). Firstly, one can, by means of various indicators (e.g. employment, Gross Domestic Product, expenditure, investments), make an estimate of the importance of the transport sector to the economy as a whole. Besides this approach, one can also calculate the economic significance of the sector by means of real transport performances. In what follows, we shall restrict ourselves to a selection of indicators that provide us with a rough sketch of European freight transport.

Table 1 gives a general overview of freight transport in a number of European countries. It is striking that, as far as national and international transport by land (road, rail and inland shipping) is concerned, road haulage accounts for about 88 per cent of the volume transported (i.e. 9.1 billion tonnes out of a total of 10.3 billion). However, there are national modal variations in transport by land. Inland shipping, for example, has a significant market share in Belgium (18 per cent) and in the Netherlands (33.8 per cent).

Table 1. **Freight transport in a number of European countries (1991)**

Countries	Total (mln t)	Modal share (%)		
		Road	Rail	Inland shipping
EUR 12	10 315.5	88.5	7.5	4.0
Belgium	507.0	70.1	11.9	18.0
Denmark	195.3	97.3	2.7	0.0
Germany	3 540.3	82.9	11.0	6.1
Greece	192.0	98.2	1.8	0.0
Spain	724.6	96.6	3.4	0.0
France	1 635.7	88.3	7.9	3.7
Ireland	83.2	96.0	4.0	0.0
Italy	984.1	93.8	6.2	--
Luxembourg	39.0	62.3	32.8	4.9
Netherlands	717.9	63.8	2.5	33.8
Portugal	278.7	97.5	2.5	0.0
UK	1693.4	92.0	8.0	--

Source: Eurostat (1995), p. 328.

When one compares the modal shares calculated on the basis of tonnage, one must, however, not forget that two-thirds of goods transported by road are in fact transported over a distance of less than 50 kilometres. The share of road transport would be even higher if one were to take into account goods transported by van or by lorry with a loading capacity of less than 3 tonnes (Eurostat, 1995, p. 327).

With regard to modal competition, it is important that one should make a distinction between different categories of goods, as well as between intra and extra EU-trade.

Table 2. **Intra EU-trade by mode of transport (1991) (%)**

Category of goods*	Road	Sea	Inland shipping	Rail	Others
1	54.4	27.0	10.8	7.8	0.0
2	59.7	19.7	6.5	3.7	10.5
3	27.3	33.0	18.8	20.9	0.0
4	3.1	42.3	17.0	0.9	36.7
5	15.0	15.5	54.8	10.0	4.7
6	43.7	24.8	6.0	25.4	0.0
7	43.0	16.4	35.4	4.5	0.8
8	29.2	38.7	23.3	8.7	0.0
9	54.7	24.8	9.6	7.3	3.7
10	73.9	18.3	0.4	6.2	1.2
Total	38.0	26.2	18.4	6.8	10.6

Source: Eurostat (1995), p. 326.

*Goods categories: Agricultural products (1), foodstuffs (2), solid mineral fuels (3), oil products (4), ores and metal waste (5), metal products (6), minerals and construction materials (7), fertilisers (8), chemicals (9), finished products (10).

Most commercial freight transport happens by road. However, the share per mode varies clearly according to different categories of goods. Inland shipping, for example, accounts for 54.8 per cent of all transport of ores and metal waste and 35.6 per cent of all transport of minerals and construction materials.

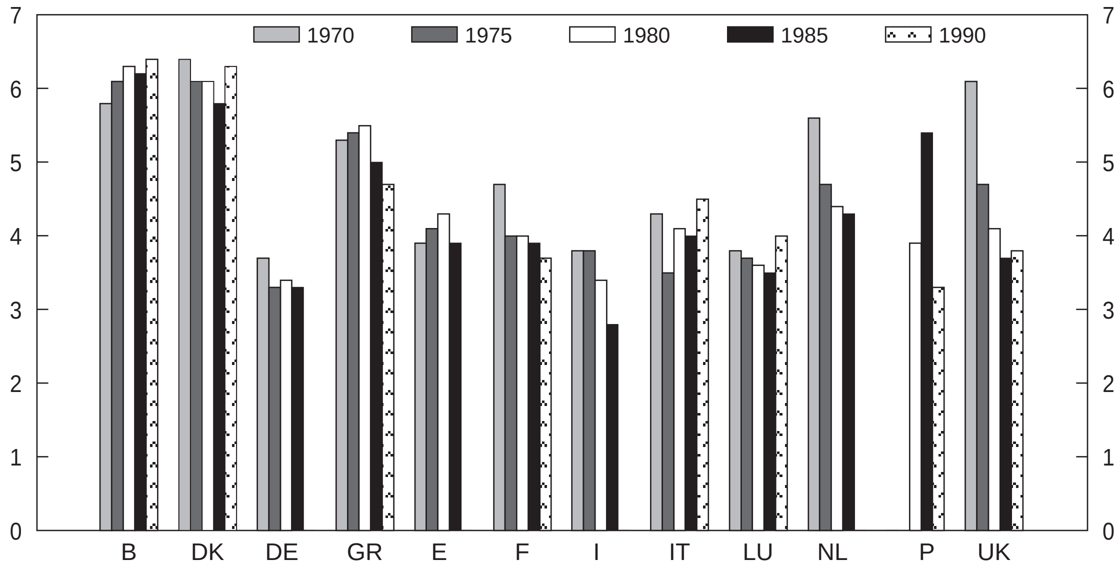
Similar tables could be compiled for extra EU-trade, whereby a distinction would be possible between imports and exports. Obviously, there are geographical reasons for the predominance of sea transport, which accounts for about 75 per cent of imports and 64 per cent of exports (Eurostat, 1995, p. 327).

The development of the transport industry has undoubtedly had a profound effect on economic growth and the expansion of international trade relations. The transport and communications sector comprises an important part of the Gross Domestic Product of European nations (between 5 and 8 per cent, according to Figure 1) and it is also significant in terms of employment.

However, the spectacular growth of transport in general and freight transport in particular does carry with it a number of problems which should not be ignored. In economic terms, increasing road congestion is resulting in higher costs for freight transport, e.g. through time loss. But undesired and negative effects on the environment are also an increasing burden on society, and a growing number of people feel that the resulting costs should be paid for by those responsible: the transport sector as a whole. As an illustration: transport for third parties and on the transporter's own account, represents about 30 per cent of all energy consumption.

Therefore, one may well ask whether economic growth, even if it is only moderate, will always lead to greater demand for freight transport.

Figure 1. **Transport as percentage of GDP**



3. ECONOMIC GROWTH AND FREIGHT TRANSPORT MODELS

The relation between economic growth and freight transport is twofold. In the first place, economic growth affects demand for transport. But clearly, changes in the transport situation, in turn, have an effect on economic growth. For this reason, the transport sector was (and still is) often used as a means to an end (i.e. for realising regional, social or other objectives). On the other hand, it is often said that future growth in international goods flows, resulting, among other things, from a further integration of national economies, may have a negative effect on the economic growth potential for the reason that the available infrastructure is inadequate.

The fact that the relation between freight transport and economic growth is not insignificant is illustrated by the following propositions:

-- *"Under the present regime of transportation policy the growth of the economy is closely linked to the growth of goods transport. The growth rate of goods transport is greater than the growth rate of the weight of the GNP but smaller than its value. A trend projection shows that the border crossing goods transport in West Europe will grow by more than 50 per cent in the time from 1988 to 2010."* (Rothengatter, 1991, p. 187);

-- *"La génération est fixe. Elle dépend du niveau d'activité économique et non des conditions de transport (en d'autres termes on fait l'hypothèse que l'élasticité du transport au prix est faible)."* (Quinet, 1990, p. 65);

-- *"Goods transport in Europe is growing fast at a speed which has not been anticipated by the forecasts. In particular the border crossing traffic shows a most dynamic motion due to the European integration and the development towards a free common market without any trade barriers."* (Rothengatter, 1991, p. 187);

-- *"An analysis of the trend development of the modal split yields the clear result that the modal shares of inland waterways and rail will drop while the share of road transport will rise dramatically."* (Rothengatter, 1991, p. 187).

To which extent are these statements confirmed by empirical data? Is it true that, at the level of transport generation, the price elasticity is very small, and that the close link between economic growth and demand for goods transport translates into an elasticity approximating to 1? Will road transport indeed continue to acquire a greater market share? As far as the latter question is concerned, one might, after all, intuitively expect further economic integration of Europe to result in greater transport distances, which should in fact increase the market potential of rail transport and inland shipping.

As regards the extent to which economic growth affects goods transport, it is not so easy to find useful information. This is largely due to the fact that transport models for goods transport are less sophisticated and less practicable than those for passenger transport. Furthermore, their application is often restricted to specific regions, certain categories of goods and/or sectors of industry. Tavasszy (1996, p. 2) quite justifiably asserts that *"part of the recent criticism (ECMT, 1995) on the existing transport studies of the future development of freight transportation concerns the inadequacy of transport models to provide information on the future developments of freight flows. This inadequacy is partly attributed to differences between national modelling approaches."*

Quinet (1990, p. 64) identifies three reasons why goods transport modelling is lagging behind in this way: a lack of relevant data: inaccuracy and/or unreliability of available data; the difficulty to *"modéliser le comportement de l'entrepreneur en matière de transport"*.

Nevertheless, there is a great need for knowledge about goods transport that is well-founded and has been field-tested, as strategic decisionmaking is constantly required in this field at a regional, national and international level.

3.1. Demand models for freight transport

Strategic and operational decision-making in transport requires traffic forecasts, not only for passenger transport but also for freight transport. As demand for freight transport is a derived demand, one needs a fairly accurate picture of the influence of economic activities in order to be able to formulate prognoses. If economic growth exceeds a certain percentage, then what effect will this have on goods transport?

The effect of economic growth on freight transport is not restricted to the global tonnage to be transported. There may also be an effect on the modal split, and on traffic conversion and assignment. However, the problem should not be formulated so statically, as it possesses certain dynamics. Other variables, too, may change simultaneously (e.g. price variables) and may thus amplify or reduce the effect of economic growth.

The complexity of modelling demand for goods transport results from the active interaction between the transport system and the rest of the economy. Firstly, there is the principle of derived demand, which implies that goods transport is entirely dependent upon spatially separated production and consumption activities (cf. location factors). In addition, transport policy generates dynamic and social effects on the rest of the economy, including on income distribution, entrepreneurship, investment policy, etc.

The complex nature of goods transport is also a direct consequence of the multitude of factors that determine demand for freight transport, and of the ensuing transport patterns [Meersman and Van de Voorde (1991); Ortuzar and Willumsen (1996)]: a strongly differentiated array of goods and specific transport requirements resulting from the great diversity of economic activities; the spatial distribution of these activities; a multitude of possible carriers; the various internal structures of the different modes; the rapid developments in handling of goods transport; a great many operational factors, determined by such elements as company size and distribution channels; dynamic factors (such as seasonal variations, changes in consumer behaviour); price setting factors.

As regards model types, a distinction is made in the literature between "aggregate freight demand modelling" and "disaggregated approaches". Aggregated models are concerned with goods flows between sectors of industry or geographical regions. Disaggregated models focus on the flows of goods associated with single companies.

Most freight demand models have, up to now, been of the disaggregated type, conforming with the classic four-step model (generation-attraction, distribution, modal split, route assignment). For typical examples of this approach, see Van Es (1982), Harker (1985) and, more recently, the Belgian Multimodal Interregional Model, MIM [Meersman, Van de Voorde and Gentil (1995)]. The techniques used under the heading "generation-attraction" are dependent upon the level of aggregation and the goods category: ranging from a direct survey of demand and supply for certain homogeneous products (e.g. iron ore, coal) to the use of macroeconomic models (Ortuzar and Willumsen, 1996, p. 392).

In the disaggregated approach, the transport issue is regarded in terms of a number of separate consignments for which the individual consignor must take a number of transport-related decisions. Each decision is seen as a choice from a discrete set of alternatives. The choice process is affected by, among other things, the characteristics of the transport services, the goods that need transporting, the market, as well as the characteristics of the shipping firm. So far, however, the applicability of this approach has been rather limited, not in the least as a result of the enormous amounts of data required for estimating this model effectively (Ortuzar and Willumsen, 1996, p. 397).

3.2. Economic activity and freight transport measured empirically

The starting point for our empirical study of the connection between goods transport and economic activity is our experience with regard to the Belgian situation. A model specified in Meersman and Van de Voorde (1996) (see Appendix 1 for specification) was re-estimated by means of time series data for the period 1974-92.

It appears from the empirical results that overall goods transport (in terms of t-km) is influenced to a great extent by industrial production. If this connection is stable, one may assume that this will also be the case in the foreseeable future. Obviously, severe structural shocks may disturb this relation profoundly.

It appears from Table 3 that an increase in industrial production (IP) of 1 per cent results in a short-term increase of total demand for goods transport (TOT) of 1.11 per cent and a long-term increase of 1.49 per cent. This result is not so surprising for a small, open economy which depends heavily on foreign countries both for its supply of raw materials and for selling finished and semi-finished products.

Table 3. **The relation between total demand for goods transport (TOT) and industrial production (IP) in Belgium in the period 1974-92(*)**

$$\Delta(\ln TOT_t = 1.112\Delta(\ln IP_t) - 0.534\,(\ln TOT_{t-1} - 3.52 - 1.49\ln IP_{t-1})$$

(4.502) (-2.14)

R^2 - 0.57 DW-1.28 $\sum u^2_t$ - .0299 sample 1974-1992

(*) Numbers between brackets are t-values.

The obvious thing to do, therefore, is to examine the effect of changes in international trade (TRADE) on overall goods transport. It also appears from Table 4 that a 1 per cent increase in common import and export flows results in an increase of demand for goods transport of 0.59 per cent.

Table 4. **The relation between total demand for goods transport (TOT) and total Belgian imports and exports (TRADE) in the period 1974-92(*)**

$$\Delta(\ln TOT_t) = 0.590\Delta(\ln TRADE_t)$$

(3.14)

$R^2 = 0.26$ DW = 1.71 $\sum u^2_t = .0521$ sample 1974-1992

(*) Numbers between brackets are t-values.

The above results concern the effects of economic activity on overall freight transport. The question remains to what extent can conclusions be drawn on this basis with regard to the separate transport modes. It is striking that the different transport modes react differently to an increase in industrial production and growth of imports and exports (for empirical results, see Table 5).

Table 5. **The effects of changes in industrial production and imports and exports on goods transport by road, by rail and by inland waterways in Belgium (1974-92)**

	IP		TRADE	
	Short term	Long term	Short term	Long term
Road	0.89	2.38	0.47	--
Rail	1.45	0.45	0.33	0.098
Inland navigation	1.44	-0.34	0.36	-0.19

It is clear that road transport reacted most forcefully to the growth in industrial production and swallowed up most of the transport activity, to the detriment of inland shipping in particular. This indicates that, if no policy changes are implemented, further industrial growth and/or an increase in foreign trade will result in more road transport. Rail transport would benefit only marginally from this growth, while inland shipping would continue to decline.

Perhaps there is a combination of explanatory factors for this development, as we shall try and illustrate by means of a number of examples. There is, for instance, a clearly discernible trend of commercial settlement away from railway infrastructure and certainly away from inland waterways. Another possible explanation concerns changes in the nature of the goods transported, with an increase in general cargo and a decline in bulk goods. Rail transport and inland shipping are, after all, mainly specialised in transport of bulk goods, which pose little danger in terms of the freight being damaged.

Taking the Belgian case as a starting point, we have tried to establish, in a broader European context, how demand for goods transport is related to economic growth. In the first instance, we made use of pooled data for the EUR12-countries for the period 1984-93. The rate of change of freight transport is related to the rate of change of GDP, of the industrial production, of imports and of exports. The results for total freight transport and for the three major transport modes are summarised in Table 6.

Table 6. **The relation between the rate of change of freight transport and the rate of change of GDP, industrial production (IP), imports and exports for the EUR12(°)**

Rate of change	Total freight transport	Freight transport by road	Freight transport by rail	Freight transport by inland waterways
GDP	.010 (1.05)	.006 (333)	.011 (.428)	.020 (.489)
IP	.156 (.528)	.460 (2.01)*	.596 (2.08)*	-1.55 (-1.53)
Import	.202 (1.27)	.085 (.717)	.224 (1.51)	.389 (793)
Export	.188 (1.13)	.066 (.517)	-.043 (-.27)	.670 (1.10)
Constant	.700 (2.13)*	1.08 (2.76)**	-1.01 (-2.06)*	-1.26 (-1.05)
Included observations	39	87	95	47
R^2	.257	.098	.076	.069
Standard error of regression	1.349	2.758	3.576	5.740
Sum squared residuals	62	624	1 151	1 384

(°) The results are based on regressions based on pooled data for the period 1984-93 for the countries of EUR12. Due to missing observations, it was not always possible to use the entire sample. The numbers between brackets are the t-values of the coefficients.
* The estimated coefficient is significantly different from zero at 5 per cent.
** The estimated coefficient is significantly different from zero at 1 per cent.

The results shown in this table correspond, to a certain extent, with the Belgian situation. Growth of industrial production is the main reason for growth of freight transport, even though the effects are less outspoken than they were in Belgium. As for the different modes of transport, here too, we see that road and rail transport increase as a result of greater industrial production, to the detriment of inland shipping.

The fact that the effects are less outspoken is, on the one hand, due to the use of pooled data, which smoothes out extreme effects. On the other, Table 6 is based on data for the period 1984-93, in contrast to Tables 3, 4 and 5, which are based on data for the period 1974-92. In order to obtain better insight into the influence of economic growth on freight transport in each of the European countries, it is necessary to consider separate analyses.

Tables 7 to 10 provide empirical results regarding the relation between economic growth and demand for freight transport for a number of European countries. Only those countries for which sufficient data is available were taken into account. For most countries, series were available for rail transport from 1978. This was, however, not the case for the other modes, so that certain nations were not included.

As was the case in the study on the Belgian situation, the starting point for this empirical study is formed by specifications that reflect a dynamic relation between the demand for freight transport on the one hand and indicators of economic activity on the other.

$$\Delta \ln X_t = \alpha_1 \Delta \ln IP_t + \alpha_2 \Delta \ln GDP_t + \alpha_3 \Delta \ln IMP_t + \alpha_4 \Delta \ln \mathrm{EXP}_t + \delta\, ECM + u_t$$
$$and \quad ECM = \ln X_{t-1} - \beta_0 - \beta_1 \ln IP_{t-1}$$

with

X	Freight transportation for the mode under consideration
IP	Industrial production
GDP	Gross Domestic Product
IMP	Import
EXP	Export

and where ECM = Error Correction Model.

With regard to total transportation (Table 7), industrial production has a positive, long-term effect on demand for freight transport. This effect varies between 0.48 (France) and 1.42 (United Kingdom). In the short term, a change in demand for goods transport will be influenced positively by an increase in industrial production in all countries. For France, we notice that there is a negative effect of a change to the GDP. This is due to a strong growth of the service sector at the expense of industrial production. Changes in imports and exports have hardly any significant influence.

In most countries, transport by road is predominant. The results in Table 8 indicate that industrial production has a strong long-term effect in all countries [except in Denmark (0.38)]. In most countries, short-term changes in road transport also occur under the impulse of changes in industrial production, and are perhaps further enhanced by changes in the GDP (cf. Denmark) or exports (cf. The Netherlands).

Table 7. **The relation between total freight transport (all modes) and economic activity**

	Denmark 1980-92	France 1978-93	UK 1978-93	Germany 1978-92	Netherlands 1978-92
Δln IP	0.38	1.94	1.088	1.34	0.69
	(1.56)	(2.68)	(6.73)	(3.13)	(1.25)
Δln GDP	-	-2.36	-	0.08	-0.68
		(-2.53)		(0.85)	(-0.81)
Δln IMP	-	0.53	-	0.028	0.066
		(1.16)		(0.086)	(0.204)
Δln EXP	-	0.22	-	-0.30	0.54
		(0.74)		(-1.57)	(1.21)
ECM	-0.56	-0.22	-0.31		-0.55
	(-2.69)	(-1.81)	(-1.82)		(-1.79)
Const.	2.36	5.14	4.82		4.34
IP_{-1}	0.79	0.48	1.42		1.34
R^2_c	0.46	0.62	0.73	0.62	0.24
DW	0.72	1.81	1.89	2.04	1.82
$\sum u^2$	0.011	0.013	0.0099	0.007	0.007

Numbers between brackets are t-values.

Table 8**. The relation between freight transport by road and economic activity**

	Denmark 1978-92	France 1978-93	UK 1978-93	Germany 1978-92	Netherlands 1978-94
Δln IP	0.38	2.15	1.21	1.12	0.13
	(-0.74)	(3.62)	(6.28)	(2.01)	(0.23)
Δln GDP	2.73	--	--	0.156	-0.63
	(1.996)			(1.29)	(-0.63)
Δln IMP	0.31	--	--	0.197	0.18
	(0.49)			(0.464)	(0.47)
Δln EXP	-0.28	--	--	-0.34	0.78
	(-1.21)			(-1.38)	(1.55)
ECM	0.366	-0.346	-0.254		-0.35
	(1.869)	(-1.86)	(-1.86)		(2.48)
Const.	2.46	4.66	4.67		3.73
IP_{-1}	0.35	1.81	1.64		1.87
R^2_c	0.39	0.43	0.68	0.49	0.27
DW	2.39	1.49	1.63	1.50	1.53
$\sum u^2$	0.009	0.041	0.014	0.012	0.013

Numbers between brackets are t-values.

Table 9. **The relation between freight transport by rail and economic activity**

	Denmark 1978-92	Spain 1978-94	France 1978-94	UK 1978-94	Germany 1978-92	Ireland 1978-92	Italy 1978-93	Luxembourg 1978-92	Netherlands 1977-94	Portugal 1978-94
Δln P	1.22	-0.49	2.94	-0.74	1.30	-0.23	0.63	-0.53	1.23	-0.19
	(0.82)	(-0.34)	(7.89)	(-0.77)	(3.08)	(-0.83)	(1.28)	(-0.33)	(2.59)	(-0.28)
Δln GDP	-5.97	4.34	-4.20	2.77			-0.84	-2.89	--	0.36
	(-1.93)	(1.90)	(-8.16)	(1.48)			(-1.09)	(-1.09)		(0.22)
Δln IMP	1.34	-0.79	-0.004	0.154			0.54	0.63	--	0.53
	(1.11)	(-1.58)	(-0.02)	(0.201)			(2.03)	(0.32)		(1.19)
Δln EXP	0.61	-0.76	0.795	-2.28			-0.16	1.81	--	-0.12
	(0.92)	(-1.79)	(4.98)	(-2.17)			(-0.88)	(1.01)		(-0.47)
ECM	-0.54	-0.78	-0.107	-0.557		-0.86	-0.31		-0.46	-0.797
	(-1.85)	(-3.31)	(-2.63)	(-2.63)		(-3.10)	(-1.56)		(-2.49)	(-3.82)
Const.	0.49	2.32	3.998	2.85		-0.50	2.83		1.10	0.20
IP_{-1}	-0.76	-1.02	-1.96	-0.39		-0.089	0.59		-0.106	1.07
R^2_c	0.19	0.37	0.90	0.21	0.40	0.38	0.55	0.06	0.49	0.40
DW	1.59	2.19	1.38	2.11	1.28	1.95	1.78	1.89	1.31	2.07
$\sum u^2$	0.114	0.083	0.004	0.099	0.040	0.066	0.014	0.19	0.051	0.056

Numbers between brackets are t-values.

Table 10. **The relation between freight transport by inland waterways and economic activity**

	France 1978-93	Germany 1978-92	Netherlands 1978-92
Δln IP	-2.14	0.93	0.58
	(-1.68)	(2.21)	(1.54)
Δln GDP	--	--	--
Δln IMP	--	--	--
Δln EXP	--	--	--
ECM	-0.37	-0.59	--
	(-1.53)	(-2.20)	
Const.	-2.19	3.83	--
IP_{-1}	2.22	0.89	--
R^2_c	0.04	0.17	0.013
DW	1.46	1.92	1.74
$\sum u^2$	0.14	0.030	0.030

Numbers between brackets are t-values.

Table 9 gives the empirical results concerning rail transport. The most striking aspect is that there appears to be a negative long-term relation between rail transport and industrial production in most countries, with the exception of Italy and Portugal (and also Belgium, cf. Table 5). This negative effect is quite outstanding in France.

As regards the changes in the short term, here the picture is pretty diverse. This is due to the very different structures of the economic and commercial activities in the countries concerned. In order to gain a better insight into this matter, one needs to break up the goods transported into different categories.

Besides Belgium, the only countries in the EU15 with an inland shipping industry of any significance are France, Germany and the Netherlands. The results confirm the downward trend in inland shipping in France, which is partly due to an infrastructure that is not always adequate. The strong long-term effect of industrial production on inland shipping in Germany, on the other hand, may well be due to the appeal of shipping on the Rhine (e.g. push tugs with six barges). This is also illustrated by short-term changes.

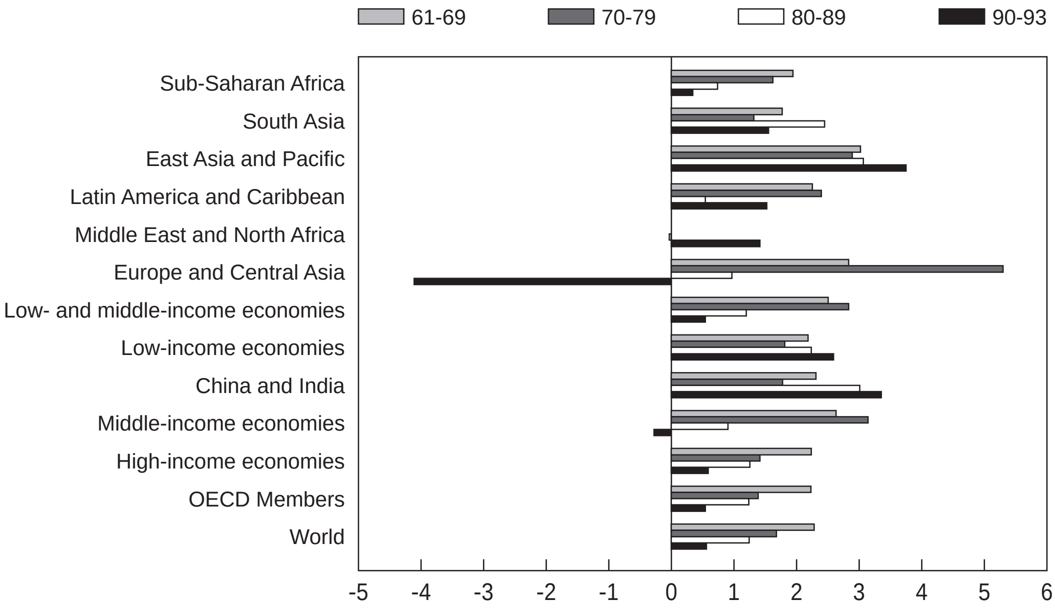
3.3. Economic interpretation and growth prospects

The derived nature of demand for freight transport is clearly confirmed by these models. If no measures are taken, an increase of industrial production and an expansion of trade relations will result in an ever-greater need for freight transport, predominantly by road. The question therefore is: what are the prospects in terms of economic growth and volume of international trade?

3.3.1 General trends on a world scale: globalisation

Figure 2 clearly shows that, on a world-wide scale, the growth of GDP is declining. This decline is, however, not divided evenly over the globe. In the low-income countries and in Eastern Asian countries, there is clearly a strong economic growth. This will obviously not be without consequence for the transport sectors in these countries, where a great number of cities are already experiencing massive congestion. In the low-income countries especially, it is questionable whether sufficient investments in transport infrastructure to deal with the predicted growth are at all possible.

Figure 2. **Average annual growth rate of GDP**



What is also striking on a world scale is the effect of global integration. Trade has, generally speaking, grown at a faster rate than the production of goods [WTO (1995), Chart II.1, p. 29]. Between 1950 and 1994, production of goods increased by 4 per cent per year on average, while world trade increased by just over 6 per cent annually. This means that, in real terms, production increased fivefold in this period, while volume of trade increased fourteenfold [WTO(1995), p. 15].

With regard to the future, developments in recent years are especially significant. Both in production and in trade, the growth rate has been slowing down since the 1970s. It is striking in this respect that, over the past decade, the growth rate of trade in industrial products has been picking up again, which compensates for the slower growth rate in trade of agricultural products. Generally speaking, one may therefore say that a slower growth rate in production is noticeable, but that, at the same time, world trade is clearly reviving (WTO, Figure 1.6, p. 16).

The reason for the growth of world trade in the post-war era is global integration, to which innovations in transport and communications have contributed greatly. However, it depends on a number of factors whether this global integration will continue. First and foremost, free trade zones and customs unions will have to manifest a degree of openness to each other and to the rest of the world. The implementation of the rules agreed upon in the Uruguay Round, too, will lead to a further globalisation. New, cost-reducing developments in transport (e.g. scaling-up of container vessels, including almost 6 000 TEU-vessels) may also contribute towards a further intensification of world trade.

When one looks at imports and exports per region (Figures 3 and 4), it is clear that western Europe still has the greatest share. In fact, in the period 1980-94, this share has increased further. The enormous growth rate in Asia is very noticeable. Equally striking is the decline of the share of Latin America, Africa and especially the Middle East. Obviously, this trend has consequences for transport to and from Europe, including with regard to the choice of port via which goods will enter and leave the continent. In turn, the choice of port has consequences for transport in the hinterland, thus affecting the flows of freight transport throughout Europe.

Figure 3. **Share in world merchandise exports**

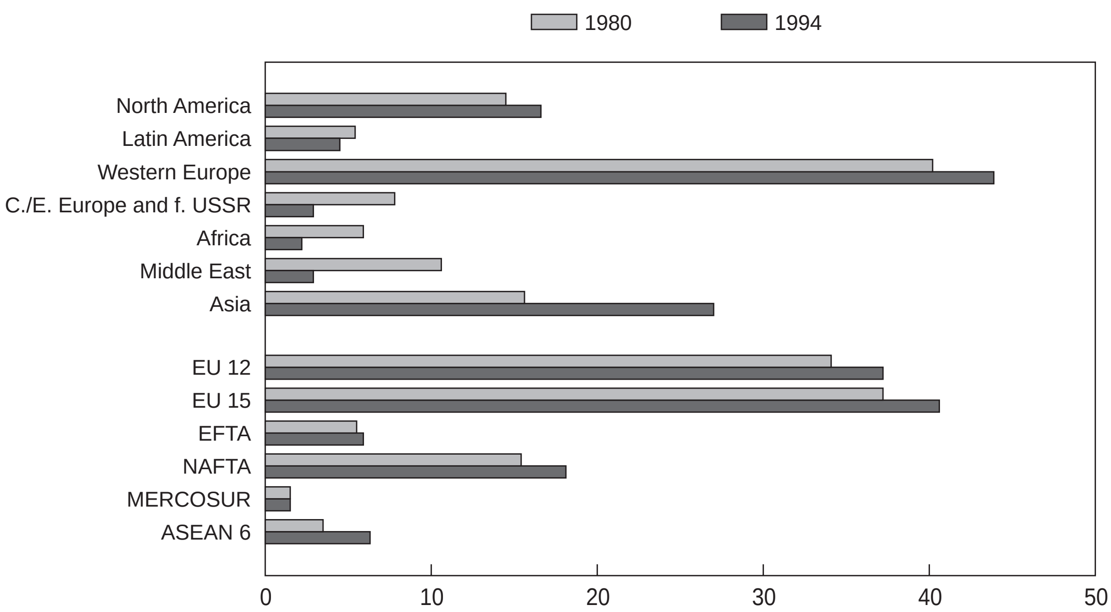
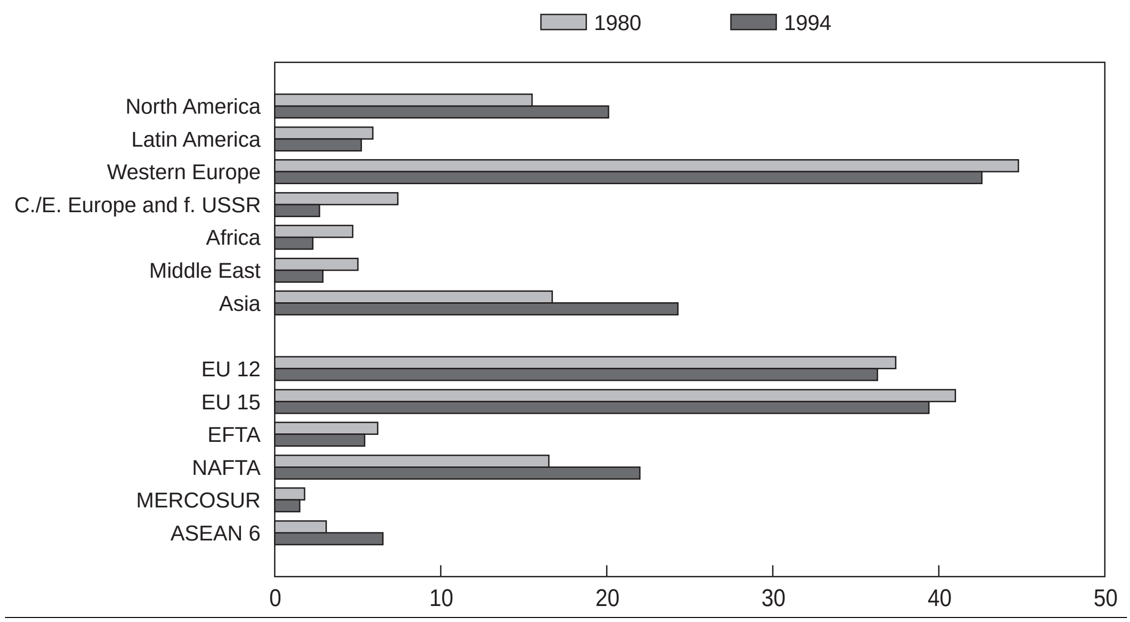


Figure 4. **Share in world merchandise imports**



3.3.2 Western Europe and the industrialised world

After the first oil crisis, the growth rate in western Europe and most industrialised countries initially slowed down, after which it recovered slightly in the 1980s. Industrial production in particular declined sharply in the 1970s, while GDP increased at a much slower rate.

Table 11. **Industrial production and GDP in important industrialised regions**

	IP (1970=100)			GDP (1970=100)		
	1980	1985	1990	1980	1985	1990
Western Europe	126	133	150	132	143	165
Southern Europe	173	192	203	153	167	200
Europe (W+S)	129	137	154	134	145	169
USA	139	159	183	132	151	173
Europe (W+S) + North-America	134	149	168	133	149	173

Source: Based on Tables 8A.1 and 8A.2 in Aldcroft (1993).

Table 11 shows clearly how industrial production in the 80s not only increased at a much slower rate in western Europe than in other industrialised regions, but also that this growth rate was slower than that of GDP.

If one looks at how the situation has developed in recent years (Table 12), it would appear that the trend has continued. One notices for both indicators (IP and GDP) that there are variations between the different countries and blocs, though they are more outspoken for IP. Moreover, the picture for the two indicators does not run parallel. Switzerland, for example, did not experience a growth of its GDP in the period concerned, but it did experience significant growth in terms of industrial production.

In a number of countries, industry appears to be shrinking or stagnating. Typical and, at the same time, quite important examples in this respect are France, Germany, Belgium and Portugal. By contrast, countries such as Norway, Sweden and Austria did experience growth. It is quite noticeable that, in terms of industrial production, the EU15 performed less well than the other aggregates (OECD-Total, Major Seven, OECD-Europe).

Table 12. **Gross Domestic Product (volume) and industrial production, period 1992-95, (1990 = 100)**

Countries	Gross Domestic Product				Industrial Production		
	1992	1993	1994	1995	1993	1994	1995
Canada	99.0	101.2	105.3	107.7	101.2	108.3	112.0
Mexico		107.2	112.0	105.1	106.8	111.9	103.5
United States	101.7	104.0	107.7	109.8	105.2	111.4	115.0
Japan	105.1	105.2	105.7	106.7	92.0	93.1	96.2
Australia	101.3	105.4	110.5	114.0	100.4	107.1	108.1
Austria	104.9	105.3	108.5	110.5	98.5	102.4	107.9
Finland	89.6	88.6	92.5	96.4	97.2	108.3	116.4
France	102.0	100.6	103.4	105.7	93.9	97.4	99.0
Germany	114.4	113.1	116.5	118.9	93.6	96.9	98.9
Italy	101.7	100.5	102.7	105.7	95.7	102.2	107.8
Netherlands	104.3	104.6	107.4	109.9	100.2	103.2	105.6
Norway		108.8	114.3	118.0	112.2	120.0	127.2
Portugal	104.2	103.1	103.9	105.8	95.2	95.0	99.4
Spain	103.0	101.7	103.9	106.8	92.0	98.7	103.3
Sweden	97.5	95.3	98.5	102.0	93.3	103.8	114.1
Switzerland	99.7	98.9	99.9	100.0	100.0	108.0	111.0
UK	97.5	99.5	103.4	105.9	98.4	103.4	105.9
OECD-Total	103.1	104.2	107.0	109.0	98.8	103.5	106.6
Major Seven	103.1	104.1	107.0	109.1	98.7	103.2	106.4
OECD-Europe	104.0	103.9	106.4	109.2	95.7	100.5	104.1
EU15	103.9	103.4	106.3	109.0	95.3	100.0	103.5

Source: OECD, Main Economic Indicators (November 1996).

It is also striking that, in these countries, industrial production accounts for an ever-smaller share of GDP. In western Europe in particular, the service sector is becoming increasingly dominant at the expense of industry. This is also noticeable in the make-up of imports and exports. In the total consumption of goods produced by industry, an increasingly large proportion is imported (Figures 5 and 6).

Figure 5. **Import penetration rate**

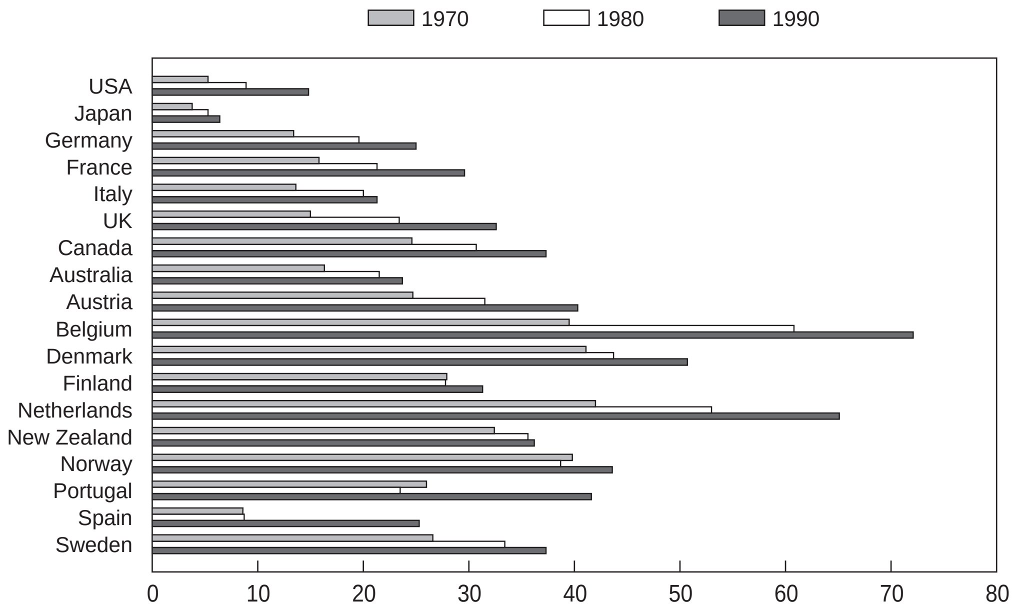
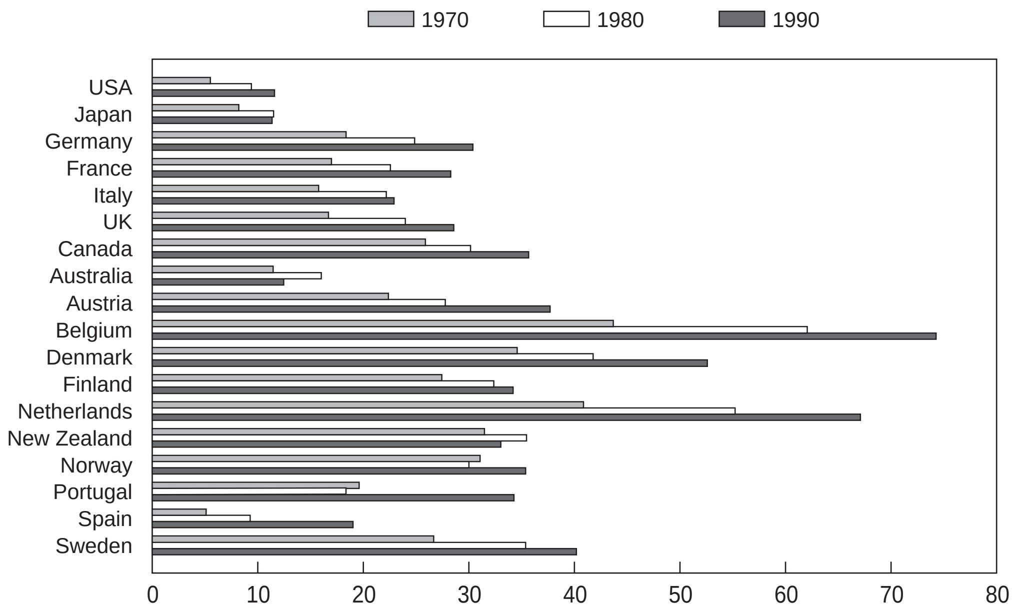


Figure 6. **Export intensity rate**



Source: OECD (1996), pp. 68-69.

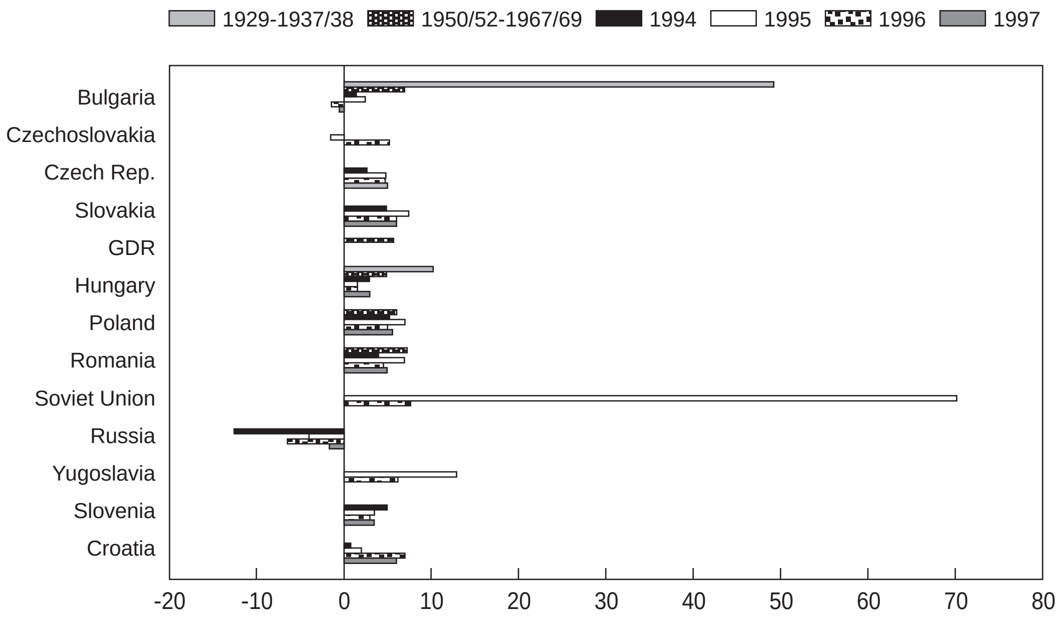
In a nutshell, we may say that, in western Europe, industry accounts for an increasingly small part of overall economic activity. This could be an indication that, in the future, the role of industrial production as a generator of freight transport will decline, but will be replaced by increasing trade. As a consequence, demand for freight traffic may continue to increase, though shifts would inevitably occur in interregional patterns.

3.3.3 Central and eastern Europe

The political and economic changes that have occurred in central and eastern Europe over the past decade will, of course, have effects on goods flows in Europe.

It appears from Figure 7 that the predicted growth for central and eastern European countries is not really all that spectacular. Countries such as Poland, the Czech Republic, Slovakia, Romania and Croatia will see their GDP increase by about 4 per cent.

Figure 7. **Central and eastern Europe**



But most significantly to the European Union, the former eastern bloc has become its third most important trading partner, after Asia and North America. Between 1991 and 1994, exports of goods from the EU to central and eastern Europe and the former Soviet Union increased by 47 per cent (in value) and imports from this region increased by 40 per cent. By way of comparison, total exports and imports by the EU increased over the same period by 11 and 5 per cent, respectively. In terms of international trade, the former eastern bloc has become very dependent upon western Europe. In 1994, 60 per cent of all exports from the former eastern bloc went to western Europe, while about 70 per cent of all its imports came from western Europe [WTO(1995), p. 8, box 1]. Goods transport between western Europe and the former eastern bloc has, in other words, increased a great deal, and a further increase of traffic on the East-to-West axis may be expected.

4. CONCLUSION

Economic growth has, in recent years, definitely had a positive effect on the demand for freight transport. This study indicates that, within Europe, it is not so much the growth of GDP which is the driving force behind the increase of freight transport as the growth of industrial production. These two indicators do not always develop concurrently, mainly because in a number of western European countries economic growth is, in the first place, stimulated by the service sector, while industry is somewhat pushed into the background.

As regards the most important transport modes, road transport in particular has reacted strongly to changes in industrial production. In the short term, this effect may have been enhanced by changes in international trade and the GDP. Important infrastructure realignments on the supply side have certainly not hampered this development. In most countries, the growth of road transport has clearly occurred at the expense of rail transport. As regards the effects on inland shipping, empirical findings are quite divergent: a negative effect in certain countries, including France, and a positive effect in others, such as Germany.

With regard to the future, a slower growth rate of industrial production in most European countries may lead to a slower growth rate of goods transport. But in view of globalisation, the increasing significance of the service sector in western Europe, and developments in central and eastern Europe, goods transport will certainly not decline.

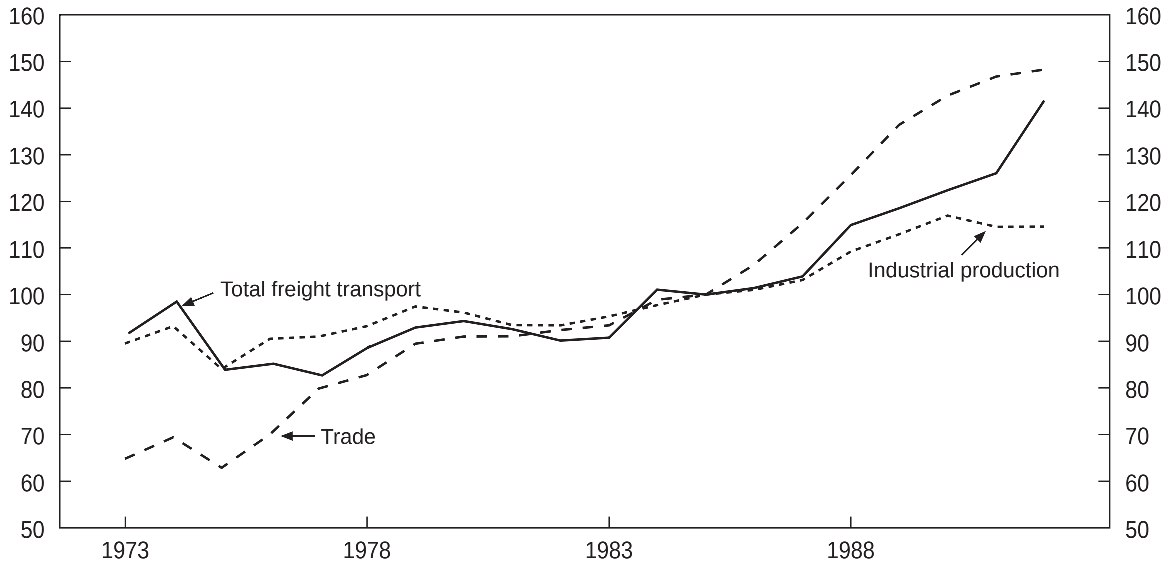
It is, however, important that shifts will mainly take place in interregional transport patterns. Volume of transport will increase at a stronger rate on some axes than on others, while ports will become increasingly important junctions.

There is every indication that transport by road will occupy an increasingly important position in freight transport, and that, in the future, more import- and export-related goods flows will pass along a number of important transport axes connected to ports.

The question is whether existing infrastructure will be adequate to deal with such growth and such changes. Does transport infrastructure (especially the road network) need to be expanded or should a modal shift be promoted, e.g. towards combined transport methods, short sea shipping, etc.? These questions in themselves merit a separate study, including an analysis of available capacity and capacity utilisation per mode of transport and per geographic relation. The Belgian experience has shown in this respect that a significant modal shift is only possible in the case of extreme price changes (Meersman and Van de Voorde, 1996). In addition, such a study would have to take account of other derived effects, including with regard to the pivotal position of seaports.

Appendix: Econometric specifications for the demand for freight transportation

The figure below represents the index of total freight transportation, industrial production and international trade for Belgium.



It is clear that each of the variables increases over time. As a consequence, the relation between total freight transportation (TOT), on the one hand and the industrial production (IP) or international trade (TRADE), on the other hand, is often approximated by a simple linear or loglinear specification such as:

$$TOT_t = \alpha_0 + \alpha_1 IP_t + \varepsilon_t$$

or

$$\ln(TOT_t) = \beta_0 + \beta_1 \ln(IP_t) + \varepsilon_t$$

with

TOT_t	total t-km of freight transportation in year t
IP_t	industrial production in year t
ln(.)	logarithm of the variable between brackets
$\in_t$	random shock which is normally distributed with for each t: $E(\varepsilon_t)=0$ and $var(\varepsilon_t)=s^2$ and $cov(\varepsilon_i,\varepsilon_j)=0$ for $i\neq j$.

Traditionally the coefficients α_0, α_1, β_0 and β_1 are estimated with the method of ordinary least squares. The upward trend in total freight transportation and the industrial production, however, result in unreliable standard errors of the estimates due to the so-called "spurious regression[1]". The upward trend in both variables can be so strong that it masks the underlying, true relation between the variables.

In order to discover this underlying relation, it is necessary to remove the trend from the variables. In most cases this can easily be established by taking first differences (or higher order differences if needed). The specification (in logarithms) of which the coefficients have to be estimated, can then be written as follows:

$$\Delta\ln(TOT_t) = \delta_0 + \Delta\ln(IP_t) + u_t$$

with $\Delta\ln(x_t) = \ln(x_t) - \ln(x_{t-1})$.

The disadvantage of this specification is that it only indicates how annual changes in the industrial production affect annual changes in the demand for freight transportation, but it gives no information on the relation between the level of freight transportation and the level of the industrial production.

Under certain conditions, more specifically when both variables are cointegrated of order (1,1), the relation between both variables can be represented by an error-correction-model (ECM)[2].

$$\Delta\ln(TOT_t) = \alpha_1\Delta\ln(IP_t) + \alpha_2[\ln(TOT_{t-1}) - \beta_0 - \beta_1\ln(IP_{t-1})] + u_t$$

The idea behind the ECM is that there is a long run equilibrium relation between the two variables which is represented by

$$\ln(TOT) = \beta_0 + \beta_1\ln(IP)$$

and an adjustment process represented mainly by

$$\Delta\ln(TOT_t) = \alpha_1\Delta\ln(IP_t) + \textit{error correction}.$$

Changes in the demand for freight transport are related to the change in industrial production. If, however, in the previous period the demand for total freight transportation was overestimated $[\ln(TOT_{t-1}) > \beta_0+\beta_1\ln(IP_{t-1})]$ the change in the demand for freight transportation will be smaller than the change in industrial production because the overestimation in the previous period requires a correction. In case of an underestimation, the opposite will hold. The error correction is a function of the mistake made in the previous period.

The time series models in the text are all based on the theory of integrated and cointegrated variables. When the variables under consideration are cointegrated, the relation is represented by an error-correction-model with a long-run equilibrium relation and short-run adjustments. If the variables are not cointegrated, the relation is specified in first differences. There is no long-run equilibrium relation and only short-run adjustments can be considered.

NOTES

1. An introduction to the problem of spurious regressions can be found in Gujarati (1995).

2. Two non-stationary variables are cointegrated when there exists a linear combination of the variables which itself is stationary. More information on integration, cointegration and stationarity can be found, on an introductory level, in Gujarati (1995).

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IS PASSENGER TRANSPORT GROWTH INEVITABLE?

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SUMMARY

Arcueil, January 1997

INTRODUCTION

Since the early 1990s, a number of trends marking a departure from those observed in previous years have started to emerge in France (slower growth of the size of the private car fleet, with a marked slowdown in 1995; slower growth in urban mobility, reflected in declining levels of public transport patronage -- particularly with regard to suburban rail services in the Ile-de-France region, etc.). While the contrast between the period of growth which followed the second oil shock and the gloomier economic climate which was characterised by the 1993 recession has undoubtedly made us more aware of these changes, can these new trends be explained simply in terms of the general economic climate, or are users actually starting to modify their behaviour in response to a prolonged economic crisis, whose impact is making itself felt as much in growing social inequalities as in slower economic growth?

Besides air transport, the main engine of growth in the passenger transport sector is the private car. French national transport surveys (Madre and Maffre, 1995) show that, since at least the early 1980s, the strongest growth in this sector has been in two specific domains (see Table 1): travel within areas on the periphery of conurbations (within a radius of 30 km) and long-distance trips (over 100 km). We shall therefore focus our attention on these two areas, notwithstanding the thorough review which the issue of growth in urban mobility, and the containment of such growth, recently received in the course of Round Table 102 (ECMT, 1996).

For our long-term forecasts (up to the years 2010 to 2020), we have developed a methodology which draws on the techniques of both demographic and econometric analysis. Our approach, described in Annex 1, occupies an intermediate position between disaggregated models and time-series analysis of data aggregated at national level, and our findings will be compared with those obtained using other methodologies whenever such results are available (long-distance car traffic on the national highway network). In view of the impact that car ownership levels have had on growth in mobility, one of the central assumptions on which our study has been based is that the principal factor in the growth of traffic levels in the long run is growth in the private car fleet; we shall therefore begin by outlining, in a number of scenarios, the long-term trend in the size of this fleet and the total volume of traffic. We shall then examine the two areas we have specifically identified as being of importance: long-distance trips and urban growth.

1. GROWTH IN THE PRIVATE CAR FLEET AND THE VOLUME OF TRAFFIC IT GENERATES

1.1. Are car ownership levels reaching saturation point?

A demographic approach to car ownership levels, based on the behaviour of successive generations, has been adopted in several countries: Sweden (Jansson, 1990), the Netherlands (van den Broek and van Leusden, 1987, etc.). In the case of France, we have used this approach at both the national (Gallez, 1994 and 1995) and regional levels (Madre and Pirotte, 1991) and, working in collaboration with Canadian colleagues, we have also applied this technique to major conurbations (Bussière, Madre *et al.*, 1995).

Table 1. **Trends in the distance travelled by private car trips according to length of trip (vehicle log-books)**

	Vehicle-km (millions)			Speed (km/h)	
	1981	1994	1981-94	1981	1994
<2 km	54	59	+10	9.6	9.7
2-3 km	220	264	+20	17.4	17.9
4-5 km	249	323	+30	22.3	22.7
6-10 km	506	748	+48	28.8	29.4
11-15 km	406	604	+49	35.6	36.8
16-20 km	303	477	+57	39.9	42.3
21-25 km	231	407	+77	42.0	45.2
26-30 km	181	341	+89	46.2	47.8
31-40 km	287	487	+70	48.6	50.9
41-50 km	194	323	+67	52.3	55.8
51-60 km	162	234	+44	49.8	59.8
61-80 km	208	321	+54	56.7	63.3
81-100 km	110	186	+70	59.8	65.9
>100 km	610	1 070	+75	69.7	77.4
Total	3 721	5 846	+57	36.3	40.2

The simplest model for France as a whole (additive effects of specific generation and age group, excluding income and price effects) clearly demonstrates the significant slowdown observed in the growth in the size of the car fleet: +10 per cent between 1990 and 1995 (i.e. scarcely more than 500 000 additional light vehicles a year) compared with the +24 per cent growth observed between 1975 and 1980 (i.e. an additional 750 000 vehicles a year). Introducing income into the demographic model yields an elasticity of 0.6 in the early 1980s, declining to 0.4 by the year 2010. This sensitivity is markedly lower than the elasticity of unity usually estimated on aggregate series for the period of strong growth in car ownership: the greater the slowdown in growth in car ownership as levels start to reach saturation, the weaker the impact of income on growth. The cost effects are low (elasticity declining from -0.2 to -0.1 over the same period). Paradoxically, the effects of these economic variables make themselves felt on the overall economic climate and are probably too heterogeneous among the different age groups to appear at an individual level (i.e. by cohort).

These relationships can be used to construct a number of scenarios based on different assumptions regarding economic growth (see Table 2). By the year 2020, the number of cars owned by households could range from 35.2 million, if incomes rise by 2.6 per cent a year, to 32.9 million if incomes rise by only 1.9 per cent a year. The influence of fuel prices (which will mainly depend upon the trend in fuel taxes) remains modest. In the central scenario (incomes rising at a rate of 2.3 per cent a year), an increase in the rate of growth of fuel prices from 0.57 per cent a year to 1.28 per cent would only reduce the size of the car fleet by 0.4 million vehicles by the year 2020.

Table 2. **Forecast growth in the size of the household car fleet in France calculated by the demographic method**

Units: vehicle millions		1990	1995	2000	2005	2010	2015	2020
Age-cohort model without economic variables								
		22.2	24.5	26.7	28.7	30.5	32.3	33.7
Inclusion of economic factors (per cent/year)								
Income	Fuel prices							
+1.9%	+0.57%	22.2	24.5	26.8	28.7	30.3	31.6	32.9
+2.3%	+0.57%	22.2	24.5	27.0	29.1	31.0	32.6	34.2
+2.3%	+1.28%	22.2	24.5	26.9	29.0	30.8	32.2	33.8
+2.6%	+0.57%	22.2	24.5	27.2	29.5	31.6	33.3	35.2

Source: INRETS report, based on INSEE economic surveys of households.

1.2. Growth in traffic volumes and trend in favour of diesel-engined cars

Let us now introduce annual kilometrage into the demographic model by distinguishing between cars owned by single-car households and first and second cars owned by households with more than one car. Despite the anticipated ageing of the population, which is even more significant when considered solely in terms of drivers, the model indicates slight growth in the average kilometrage by car for the fleet as a whole (of the order of +4 per cent over 20 years).

This paradox is explained by the fact that the model does not explicitly take account of the principal factor behind the current growth in traffic volumes: the shift from petrol-engined to diesel-engined cars. In France, diesel fuel is 40 per cent cheaper than petrol. Sales of diesel-engined models therefore rose rapidly during the 1980s and in recent years have levelled off at slightly under half of the new car market. The example of the United Kingdom, where there is no difference between petrol and diesel prices, shows that other factors (such as robustness, maintenance costs, company fleets, etc.) can also contribute to growth in this market, but to a lesser extent than fuel prices.

At present, diesel-engined cars account for around 30 per cent of the total private car fleet in France and, paradoxically, the increasingly widespread availability of diesel versions of car models (small car ranges from the mid-1980s onwards; ageing diesel car fleet) has not significantly narrowed the gap between average annual kilometrage rates for petrol- and diesel-engined vehicles. The average annual kilometrage still remains around 12 000 km for petrol-engined cars (rising sharply for higher-range models) and 20 000 km for diesel-engined cars (with no significant differences between model ranges). Over the past few years, the growing size of the diesel-engined fleet has largely been responsible for the increased intensity of car use.

A simulation based on observations of several generations of vehicle (Gallez, 1994) shows that the trend in annual kilometrage rates is highly sensitive to assumptions regarding the transfer to diesel-engined cars. The average annual kilometrage rate of 14 200 km observed in 1995 would rise to over 15 000 km by around 2005 if petrol- and diesel-engined cars continued to share the new car market more or less equally; in contrast, in the unlikely event of an immediate return to the situation prevailing in the early 1980s (diesel-engined cars accounting for less than 10 per cent of new car registrations), annual kilometrages could fall back to less than 13 000 km by the year 2010.

Table 3. **Impact on kilometrage rates of two scenarios for diesel car ownership**

Units: Average annual kilometrage per car and %

	1985	1990	1995	2000	2005	2010
Average kilometrage per car						
Rising sales of diesel models	12 800	13 400	14 200	14 700	15 100	15 300
Rising sales of petrol-driven models	12 800	13 400	14 200	13 600	13 300	12 900
% of diesel fleet						
Rising sales of diesel models	6%	16%	27%	36%	40%	42%
Rising sales of petrol-engined models	6%	16%	27%	20%	13%	9%

Source: C. Gallez, 1994.

However, with the exception of Belgium, France's experience appears to be somewhat atypical in this area. The situation in Italy, which matches the results of French surveys (Hivert, 1996), shows that motorists are highly sensitive to taxes targeted on car use, particularly those based on car ownership (road tax in France is cheaper for diesel-engined cars). The public authorities therefore have instruments at their disposal which are undoubtedly effective and which could be used to limit growth in traffic levels (fuel taxes, road tax, etc.). However, the impact of such instruments on the car market, where there is fierce competition between manufacturers who are not all specialised to the same extent in diesel-engined models, needs to be mitigated. In addition, since diesel fuel is also widely used by industry (notably the socially sensitive road haulage sector), it is practically impossible to increase the price of diesel fuel for private motorists without charging a different rate to commercial users; such a measure, which would be difficult to implement from a technical standpoint, might well lead to widespread fraud in an area which at present is virtually free of such corruption.

2. TRAFFIC ON THE NATIONAL HIGHWAY NETWORK AND LONG-DISTANCE TRIPS

In this section we shall compare the results of three approaches:

-- The highly disaggregated MATISSE model, used for long-distance domestic trips (Morellet and Marchal, 1995);

-- The econometric analyses of nationally aggregated time series carried out by OEST/SES as part of the revision of French Infrastructure Master Plans (*Schémas Directeurs d'Infrastructures* -- SES, 1996); the scope of these analyses is slightly broader than the MATISSE model, but also more heterogeneous in that, in addition to domestic air transport, it also encompasses main line rail services and traffic on the national highway network;

-- An intermediate, semi-aggregated approach to car traffic based on regional series; this work is currently in progress and has not yet produced any results.

Let us first consider the total volume of light vehicle traffic, measured in terms of deliveries of the fuel consumed by this type of traffic, deflated by specific rates of consumption (litres per 100 km) for petrol- and diesel-engined vehicles. This yields a fleet elasticity of unity, a relatively low income elasticity of 0.2 and an average price-elasticity per litre of fuel consumed by light vehicles (including the substitution of diesel for petrol) of -0.3. Using other approaches, this value is moderated by the sensitivity of traffic to fuel prices. Does this mean that raising taxes on oil products would not be an effective means of combatting growth in energy consumption? Obviously not, since the long-term price elasticity of fuel consumption is -0.8 (Orfeuil, 1990). The consistency of these two apparently contradictory results derives from the fact that the price elasticity of specific consumption is of the order of -0.5 (Schipper and Johansson, 1995). The main long-term effect of increased fuel taxes is therefore not to limit growth in traffic, but to stimulate technical progress to improve the fuel efficiency of vehicles and thus to reduce emissions of toxic or greenhouse gases. It prepares motorists for a future in which fuel will be scarcer, while at the same time delaying the onset of that future.

Annex 2 presents motorists' behaviour with regard to long-distance trips revealed by the disaggregated MATISSE model and Annex 3 the behavioural responses estimated on the basis of national series by the SES, together with a number of forecasts up to the year 2015. An initial analysis indicates that these two contrasting approaches yield converging descriptions of driver behaviour (Table 4): the predominant role of the socio-economic factor (growth in household consumption, car ownership levels, etc.) in growth in traffic levels, except for the rail sector where demand is driven by the supply of high-speed train (TGV) services. However, in other respects (e.g. the price-elasticity of domestic air transport), the estimates are more divergent. Account must be taken of the fact that each approach focuses on specific aspects. A disaggregated model (notably from a geographical standpoint) such as the MATISSE model will provide a better indication of whether or not projected TGV lines will allow greater competition with domestic or international air transport services.

Table 4. **Apparent elasticities of long-distance traffic**
A comparison of different types of model

	Estimate for 1980-92		Forecast for 1992-2015		Differences	
	SES 1	MATISSE 2	SES 3	MATISSE 4	SES 5=3-1	MATISSE 6=4-2
Motorway traffic						
FHC	1.6*	1.3	1.5*	1.0	-0.1	-0.3
Per capita income (1)	1.6	-	1.2	-	-0.4	-
Fleet (1)	0.8	-	0.8	-	0.0	-
Length of network	0.4	0.6	0.3	0.4	-0.1	-0.2
Price of fuel	-0.45	-0.5	-0.45	-0.3	0.0	0.2
Rail traffic/FHC	0.44	0.2	0.44	0.5	0.0	+0.3
Air traffic/FHC	>1.6	1.5	1.6	1.3	-	-0.2

FHC: Final Household Consumption.
(*): Estimate based on the impact of fleet effects and per capita income on FHC.
(1) In the MATISSE model, elasticities integrated implicitly into FHC elasticity.
Source: SES.

The superiority of the disaggregated approach for measuring supply effects is clear, not only with regard to the construction of infrastructure but also in terms of price-effects, since it takes account of tariff structures. However, the requisite data have been lacking for many years, even with regard to infrastructure. The construction of new motorways cannot therefore be considered to constitute the sole improvement of the quality of service provided by the national highway network. After constructing the necessary series, we have shown, in the regional panel mentioned earlier, that the construction of expressways (2x2 lanes) stimulates traffic levels on the toll-free network (main roads and toll-free motorways) with a supply elasticity of the order of 0.3.

When behavioural models are used to make long-term forecasts, the main source of uncertainty lies in the assumptions regarding the levelling-off of curves as they near a given saturation point; we shall use the example of car traffic to illustrate this point, although the same question arises with regard to air transport or overall demand for long-distance travel. We have shown that growth in the car fleet is gradually slowing. A greater intensity of vehicle use (linked in France to the rising share of diesel-engined models in the car fleet and in the United States to economic growth in a relatively sparsely populated country) cannot reverse this trend towards a slowdown (average annual kilometrage is unlikely to vary much outside the range of 12 000 to 15 000 km in France). While, admittedly, we have shown that long-distance travel (over 100 km) is one of the two most dynamic components of car use, it still accounts for only 56 per cent of motorway use by French households and for an even lower share of trunk road use. It is for this reason that we have always included fleet size as one of the variables explaining growth in traffic. A fleet-elasticity of 0.5 on trunk roads (above 1 on motorways) simply indicates that a declining (growing) share of total traffic is carried by these networks, but does not explain why. We shall therefore attempt to set this elasticity at 1 (by taking the ratio between traffic volume and fleet size as a variable to be explained) in order to use the other variables (construction of infrastructure, cost of tolls and fuel, income, etc.) to explain the reasons for these substitutions. Given that the correlations (notably between fleet size and income) were strong in the past but will gradually weaken in the future, the size of elasticities largely depends upon the overall explanatory scheme adopted. This is the case, for example, for discussion of the dynamic income-elasticity of long-distance trips; the example of North America, where car ownership levels are closer to saturation point, since car use was already widespread before the Second World War, could be used as a reference scenario.

3. URBAN SPRAWL STIMULATES GROWTH IN URBAN MOBILITY

What will be the trends in the number of cars and volume of traffic in major urban areas over the next twenty years? To answer this question, we shall consider the examples of the Metropolitan Region of Montreal (3 million inhabitants and a city where cars were widely used before the Second World War), the Ile-de-France region (11 million inhabitants, a capital region) and the urban region of Grenoble (0.5 million inhabitants). The method used to forecast car ownership levels is based on the behaviour of successive generations of households according to the age of the head of the household by area of residence. Mobility forecasts were also made by means of an age-cohort model based on the behaviour of generations of individuals according to their area of residence, sex and the number of cars owned by the household.

3.1. Size of car fleet and volume of traffic by the year 2010

Table 5 shows that there should be few changes in the number of cars owned by the inhabitants of the central areas of cities (declining in Montreal, rising by less than 10 per cent in Paris and Grenoble). Growth in car ownership levels among residents of suburban areas is expected to be moderate (ranging from 10 to 25 per cent over twenty years). In contrast, the size of the car fleet in peripheral areas is expected to rise dramatically at a rate of over 60 per cent, half of which as a result of population growth and the other half accounted for by strong growth in car ownership levels stimulated by purchases of second cars.

Table 5. **Projected growth in the size of the car fleet in three major urban areas by area of residence**

	Centre (1)	Suburbs (2)	Conurbation (3=1+2)	Peripheral areas (4)	Total (5=3+4)
Number of cars (thousands)					
Ile-de-France region					
in 1990	601	1 374	1 975	1 806	3 781
in 2010	659	1 617	2 276	2 971	5 346
2010/1990	+10%	+18%	+15%	+65%	+41%
Metropolitan Region of Montreal					
in 1991	306	325	631	625	1 256
in 2010	299	360	659	1 069	1 728
2011/1991	-2%	+11%	+4%	+71%	+38%
Urban Region of Grenoble					
in 1990	55	90	145	80	225
in 2010	58	112	170	144	314
2010/1990	+5%	+24%	+17%	+80%	+40%

Sources: INRETS calculations, based on Overall Transport Surveys for 1976, 1983 and 1991 in the Ile-de-France region;
Origin-Destination surveys carried out by the STCUM in Montreal;
the 1975, 1982 and 1990 census surveys in Grenoble; and demographic forecasts.

Table 6. **Forecast traffic volume in three major urban areas by area of residence**

	Centre 1	Suburbs 2	Conurbation 3=1+2	Periphery 4	Urban Region 5=3+4
Passenger-km per day (thousands)					
Ile-de France region					
in 1990	21 900	48 800	70 700	83 900	154 600
in 2010	22 300	50 900	73 200	121 100	194 300
2010/1990	+2%	+4%	+4%	+44%	+26%
Metropolitan Region of Montreal					
in 1991	16 800	16 400	33 200	40 200	73 400
in 2011	20 000	22 000	42 000	62 100	104 100
2011/1991	+19%	+34%	+27%	+54%	+42%
Urban Region of Grenoble					
in 1990	1 600	3 100	4 700	n/k	n/k
in 2010	1 600	3 200	4 800	n/k	n/k
2010/1990	+0%	+3%	+2%	n/k	n/k
Distance travelled per day and per person (km)					
Ile-de-France Region					
in 1990	10.8	13.2	12.3	20.1	15.6
in 2010	11.0	13.2	12.4	21.6	16.9
2010/1990	+2%	+0%	+1%	+7%	+8%
Metropolitan Region of Montreal					
in 1991	16.6	23.1	19.3	28.9	23.6
in 2011	19.5	26.8	22.7	31.8	27.4
2011/1991	+17%	+16%	+18%	+10%	+16%
Urban Region of Grenoble					
in 1990	11.0	15.6	14.1	n/k	n/k
in 2010	12.2	15.8	14.4	n/k	n/k
2010/1990	+11%	+1%	+2%	n/k	n/k

Sources: INRETS calculations, based on Overall Transport Surveys for 1976, 1983 and 1991 in the Ile-de-France region;
Origin-Destination surveys carried out by the STCUM in Montreal;
the 1975, 1982 and 1990 census surveys in Grenoble; and demographic forecasts.

n/k: Mobility surveys do not cover peripheral areas around the city of Grenoble.

Overall mobility (the total distance travelled per person irrespective of mode of transport) should remain stable in heavily built-up areas in Paris and Grenoble; in contrast, it may rise significantly in Montreal (see Table 6). There will be a rising trend in mobility in peripheral areas. Growth in peripheral areas will be higher than that in central areas in the Ile-de-France region, but will be lower in Montreal where, once trips exceed 30 km a day and per person, mobility should be nearing saturation point.

Urban sprawl (changes in the distribution of the population by area) will have a major impact, since growth in overall mobility (within the conurbation or the entire urban area) will sometimes be higher than that observed within the areas making up the city (centre, suburbs, etc.). The increase in the volume of traffic therefore mirrors the growth in the population. The increase will be very low with regard to the inhabitants of the main conurbations in the two French regions mentioned above, with the maximum increase found in peripheral areas. Future levels of congestion will therefore primarily depend upon the choices (of mode, destination and travel time) made by the inhabitants of peripheral areas. Two simulations should now help to provide an insight into the impacts on growth in the size of the car fleet and traffic volumes.

3.2. Some paradoxes to emerge from the different demographic scenarios: example of the forecast regarding the size of the car fleet in Montreal

In order to measure the impact of the three main factors shaping trends in the population (growth, ageing and diffusion), we have constructed six scenarios showing the impact of each factor in isolation and in combination with one of the other two factors; the main (or trend) scenario combines all three. The results show that:

- Population growth increases the size of the car fleet due to the increased number of households, as determined by the rate of population growth and the pattern of cohabitation as a result of the age structure (elderly people usually constitute smaller households);

- By the year 2011, the ageing of the population will lead to an increase in the number of households with more than one car, since by then the baby-boom generation will be fifty years old, the age at which a second car (usually driven by children of adult age) is the most widespread;

- Urban sprawl lends greater weight to outer areas where there are more households with more than one car and fewer non-car owning households than in other areas, although this effect is weaker than the two previous effects.

If the scenarios are ranked in increasing order of traffic volume by the year 2011, the following results are obtained:

- Urban sprawl alone;
- Population growth alone;
- Ageing of the population alone;
- Growth and sprawl without ageing;
- Ageing and sprawl without growth;
- Growth and ageing without sprawl;
- Growth, ageing and sprawl (trend scenario).

By the year 2011, since the three factors studied stimulate growth in the car fleet, it is the trend scenario which will result in maximum growth. After that date, once the baby-boom generation has reached retirement age, ageing of the population will slow such growth instead of accelerating it.

3.3. A second example: overall mobility in the Ile-de-France region

The age-cohort model makes it possible to determine levels of mobility (expressed as the number of trips or passenger-km) of different categories of the population through comparisons of sex, age (in five-year classes), area (Paris + two concentric outer rings) and number of cars per household (0, 1, 2 or more cars). These simulations show the effect of these structural factors by varying the demographic weight (number of individuals) of each of these categories in order to calculate the overall volume of traffic by two horizon years: 2000 and 2015. This provides an analysis, *ceteris paribus*, of the effects of growth in car ownership (model 1 compared to model 2 in which car ownership levels are frozen at the 1990 level), urban sprawl and the ageing of the population. The “population growth” factor has not been isolated as such; it is taken simply as a coefficient of proportionality (+8.1% from 1990 to 2000; +19.8% by the year 2015).

In Paris, as in Montreal, the ageing of the population has a negligible impact on the distribution of the inhabitants of the city by the number of cars owned per household. In contrast, urban sprawl has a much stronger impact on individual levels of car ownership, as the contrast between car ownership levels between outer rings is less marked in Montreal than it is in the Ile-de-France Region (the city of Paris is very densely populated).

Of all the factors analysed, it is almost always increased car ownership which has the greatest impact on mobility (Table 7): in the number of trips, from 0.8 per cent by the year 2000 and by 1.5 per cent by the year 2015; in passenger-km, by 2.0 per cent by the year 2000 and by 3.6 per cent by the year 2015. Urban sprawl only ranks top by the year 2000 in terms of passenger km (+4.5 per cent compared with +1.7 per cent by the year 2000); its influence on the number of trips is negligible. The effect of the ageing of the population is very weak: by the year 2000 it is slightly positive in terms of number of trips and slightly negative in terms of passenger-km; by the year 2015, it will amount to around -1 per cent regardless of the unit used to measure mobility.

Table 7. Simulations of the overall mobility of the inhabitants of the Ile-de-France region

	Number of trips		Passenger-km	
	2000/1990	2015/1990	2000/1990	2015/1990
TOTAL TRAFFIC	+6.9%	+14.4%	+13.7%	+31.9%
Population (resident for at least 6 years)	+8.1%	+19.8%	+8.1%	+19.8%
Mobility/inhabitant	-1.1%	-4.5%	+5.2%	+10.1%
Effect of car ownership	+0.8%	+1.5%	+2.0%	+3.6%
Effect of urban sprawl	0%	-0.1%	+1.7%	+4.5%
Effect of population ageing	+0.2%	-0.9%	-0.4%	-1.0%

Sources: INRETS calculations, based on Overall Transport surveys for 1976, 1983 and 1991.

Let us now examine the impact of these structural effects on the trend in mobility once the effect of population growth has been subtracted. In terms of the number of trips, mobility should decrease by 1.1 per cent between 1990 and 2000 and by 4.5 per cent by the year 2015. In terms of passenger-km, mobility should increase by 5.2 per cent between 1990 and 2000 and by 10.1 per cent by the year 2015. The main factor in traffic growth is therefore the trend in mobility, which is primarily linked to the intergenerational differences highlighted in the age-cohort models; structural factors are merely secondary, even though rising levels of car ownership and urban sprawl have a non-negligible impact on traffic growth measured in passenger-km.

CONCLUSION

To conclude this paper, let us now return to the two questions asked in its title. The trend in the passenger transport sector identified in the various studies presented in this paper is neither a continuation of the rapid growth experienced until the late 1980s, nor immediate stagnation at saturation levels which might already have been reached. In plotting a likely trajectory of a gradual slowdown in growth, which lies somewhere between these two extreme hypotheses, the choice of methodology is extremely important. We have proposed a demographic approach in which the behaviour of successive generations is treated historically and in which mobility is based on car ownership since, in almost all domains, the car is now the dominant mode of transport. The inevitable ageing of the population, which simply reflects the arrival of the baby-boom generations at different stages of their lives, will, in the long-term, fuel this slowdown. However, this trend is by no means uniform in that, until around 2010, the ageing of the population will exert an upward pressure on car ownership levels. It will only be later, as the baby-boom generations start to reach retirement age, that the demographic factor will start to act as a relatively powerful brake on mobility.

As for the second question regarding the possibility of avoiding growth in passenger traffic, we have identified a number of instruments which might work to this effect. Admittedly, higher fuel prices (obtained by transferring as much as possible of the tax burden on cars towards variable costs) can somewhat slow growth in car traffic, more so on motorways than in the rest of the network; but the main effect of such an increase, in the long run, is to stimulate technical progress aimed at increasing the fuel efficiency of engines, thus directly combatting the nuisances which make lower growth in transport desirable. Furthermore, the large difference between petrol and diesel prices probably plays an enabling role which encourages growth in traffic levels; in this respect, equalisation of fuel taxes would be an effective instrument, although certain taxes on car ownership (e.g. road tax) would seem to have a major impact on motorists. The aim must nonetheless remain that of limiting growth in traffic without causing too much damage to the automobile market.

The construction of infrastructure can also induce traffic. In France, the construction of new road infrastructure should now be limited, since the most "profitable" motorways have already been built. In contrast, growth in the rail transport sector will largely depend upon the construction on new high-speed rail lines, which offer strong competition to the airlines.

It would seem to be in urban areas that growth in traffic levels, particularly car traffic, needs to be avoided, since it is in densely populated areas that the adverse impact of nuisances is greatest (ECMT, 1996). General fuel taxes and tolls (which up until now have primarily been levied on intercity motorways in France) cannot compensate for the highly differentiated impact of external effects in urban areas and in the open countryside. Adoption of the "polluter pays" principle would require the introduction of charges (or even regulatory measures) for parking, access to central areas and use of roads and highways (urban road pricing). Urban sprawl also encourages traffic growth by adding to the length of trips; in densely populated conurbations in Europe, this trend should begin to slow since, despite comparable expansion of the population since the early 1980s, traffic volumes have risen twice as slowly in the Paris region than in other major conurbations in the provinces. Limiting the construction of residential housing in sparsely populated areas which cannot easily be served by public transport would slow demand for car ownership and mobility in precisely those areas where demand is greatest. In addition, the development of intermodal forms of transport would encourage each area to adopt the most appropriate mode of transport: cars in peripheral areas, and public transport to continue trips towards the centre. The various factors we have mentioned above are, in fact, partially linked: motorists attempt to optimise their costs (notably by switching to diesel engines in those segments where traffic is growing fastest (e.g. motorways, trips from one suburb to another).

But do we really need to avoid growth in passenger traffic? Transport is, in fact, a kind of "intermediate good" consumed by households. Growth in transport conditions growth in many sectors of the economy (tourism, leisure, etc.). Limiting growth in transport might therefore have an adverse impact on overall economic growth. In fact, proportional growth in all sectors of activity would seem to be both unlikely (since saturation points would be reached) and undesirable (i.e. once they start to create nuisances). It is by diversifying the economy that we can generate job-creating growth and foster the type of sustainable development in which natural equilibria are preserved.

ANNEX 1

DETERMINING THE LONG-TERM DYNAMICS OF BEHAVIOUR

Two contrasting approaches are usually adopted when constructing a dynamic model:

-- An aggregated approach based on national time-series data [revision of Infrastructure Master Plans (SES, 1996), etc.] identifies the effects of economic variables (income and prices), but often fails to represent supply effects which are felt at a more local level and which are thus diluted at the national level;

-- Highly disaggregated approaches [micro-simulations, MADITUC for urban areas, MATISSE (Morellet and Marchal, 1995) for long-distance trips] are theoretically more satisfactory, but are frequently limited by the inadequacy of the data used for the estimation (income data rarely available in urban surveys, impossibility of estimating generational effects using data collected at one point in time, etc.).

We have adopted a middle course and have chosen a limited number of options based on experience.

Data collected over a sufficiently long period of time are needed to analyse long-term dynamics. The notion that cross elasticities are long-term elasticities is based on highly restrictive assumptions regarding the uniformity of data and behavioural responses (Pirotte, 1994). The use of pseudo-panel techniques (Deaton, 1985; Gardes *et al*., 1996) makes it possible, after an initial investigative phase using French and Canadian budget and family survey data, to estimate the cross and dynamic elasticities (by separating short and long term data) of the transport component of household consumption in various European countries (part of the SCENARIOS project for the 4th PCRD).

1. Demographic approach

If there are sufficiently long survey data series available (or at least two or three data sets sampled over a relatively long period of time), then a genuinely dynamic approach can be adopted. We have developed a demographic approach based on data reflecting the behaviour of successive generations throughout their lifetimes (analyses of car ownership levels and use at the national level (Gallez and Madre, 1992; Gallez, 1994) and of mobility in large urban centres (Bussière, Madre *et al.*, 1995). The comparison with North America (Montreal) is particularly revealing in that car use developed there twenty years earlier than in Europe; however, not all of the components of the Canadian experience can be properly transposed (the harsh climate, for example, discourages older drivers in Quebec from continuing to drive). This method is nonetheless sufficiently flexible to:

-- account for contrasting situations (declining mobility in Grenoble, stagnant mobility in the Ile-de-France region and rising mobility in Montreal);

-- properly describe the current slowdown in growth in the car stock and traffic levels, without necessarily setting a saturation ceiling beforehand;
-- anticipate trends which break with previous trends (for example, an increase in the proportion of households without a car in heavily built-up areas, a trend already observed in Montreal).

Of course this approach does not allow as many analytical dimensions to be introduced as disaggregated models. However, in addition to age profiles and inter-generational differences, national forecasts take include the income and cost effects of car use (Gallez, 1995), and studies of the major conurbations similarly include urban sprawl and growth in car ownership levels; these dimensions are properly accounted for in the demographic forecasts available (urban sprawl, ageing of the population) and/or serve as a framework in which to construct a few contrasting scenarios (prices and income), which cannot be done for all the dimensions of disaggregated models. Once the structural factors are properly under control, the effect of economic variables appears to be less powerful than in the case of aggregated series. Here again, progress needs to be made in the estimation of supply effects. The demographic framework, which accurately describes uniform categories of the population, offers a suitable vehicle for simulating situations in which travel is constrained (e.g. in order to consider the limits to modal transfers).

2. Time-series approach

In cases where survey data are not available (e.g. traffic levels on the national highway network), use must be made of aggregated time-series, although a cross-sectional dimension will be maintained as far as it is possible to do so [the region (Madre and Pirotte, 1991)]. We have therefore opted for the co-integration approach for two reasons which represent the main justification for use of this method:

-- It would be pointless to attempt to find a stable long-term linear relationship between variables without checking beforehand that their profiles do not differ too widely over the period considered;

-- Short-term variations (Madre and Pirotte, 1994) are deviations from the long-term relationship initially estimated, whereas methods based on the use of lagged variables (Box Jenkins, ARIMA, etc.) consider long-term effects to consist of the accumulation of short-term effects.

In formulating our traffic forecasts, we have paid particularly close attention to problems arising from collinearity. There is a strong correlation between the size of the car fleet and household income over the period observed; this relationship should gradually weaken as growth in car ownership levels off as it nears saturation point. This difficulty can be circumvented by taking the relationship between traffic levels and car fleet as a variable to be explained and by forecasting trends in the car fleet independently by means of the demographic method described above.

In all of these analyses, we have paid great attention to the functional forms used in equations. While the technique of indicative variables offers the greatest flexibility for identifying exceptional periods (first and second oil shocks, for example), we have also shown that a linear relation without logarithmic conversion provides a constant representation of behaviour during periods of strong price fluctuation. Similarly, the simple additive model for analysing variance provides a better description of the trajectories of car ownership for successive generations than the logit model, although the latter models variables between 0 and 1 that are theoretically better suited to describing ownership rates. Since models are usually limited to a few major dimensions, it is best to avoid functional forms that fit data perfectly (as in the logit model, for example), given that the error term accounts for factors that we have had to discard due to the lack of data or a firm basis for forecasting.

ANNEX 2

SOME RESULTS FROM THE MATISSE MODEL

Approximately 60 per cent of the growth in the number of passenger-km for domestic trips of over 100 km in France between 1980 and 1992 can be attributed to changes in the socio-economic context (growth in income, household car ownership levels, etc.), which represent a powerful engine of growth in the volume of private car and air traffic, but less in the rail sector. The remaining 40 per cent is attributable to improvements in the transport supply through -- in descending order of importance -- lower car usage costs, the opening of new motorways, the introduction of high-speed train services, variable rail fare pricing and improved air transport supply.

The following results were obtained by mode of transport:

i) Growth in private car use is primarily due to changes in the socio-economic context and, in almost equal measure, improvements to the road network (mainly the opening of new motorways) and lower per km car use costs. It has only been influenced slightly by improvements to the public transport supply.

ii) The growth in rail traffic is primarily due to improved services (chiefly the introduction of high-speed train services) and, to a lesser extent, changes in the socio-economic context and the introduction of fares priced according to the distance travelled. The impact of the last two factors is more than offset by the increased services offered in the air transport sector and improved supply in the road and air sectors.

iii) The growth in air traffic is due, in almost equal measure, to changes in the socio-economic context, the improved availability of air transport, increased frequency of services and lower tariffs, although 20 per cent of the potential growth has been lost to high-speed train services.

[Short excerpts from the report by O. Morellet and P. Marchal (1995), "*MATISSE, un modèle de trafic intégrant étroitement contexte socio-économique et offre de transport*", INRETS report No. 203.]

ANNEX 3

MAIN RESULTS OF THE WORK BY THE SES ON DEMAND FOR TRANSPORT IN THE YEAR 2015

"The difference between the annual growth rates forecast in the upper and lower limit macroeconomic scenarios amounts to one percentage point for GDP (+1.9% to 2.9%) and 0.7 percentage point for final household consumption (+1.9% to 2.6%). This breaks down into a difference in growth rates between the two scenarios of 0.6 and 0.9 percentage point for road and motorway traffic respectively, 0.3 percentage point for rail transport and 1.2 percentage points for air transport, thus reflecting the sensitivity of each mode to economic growth. The impact is particularly high with regard to road and air transport in view of the high values of their elasticities to economic growth, unlike rail transport whose elasticity to household consumption is merely around 0.4 (see Table 4). The difference in passenger traffic growth rates in the upper and lower limit scenarios, which is equal to 0.6 percentage point, matches that of road transport which is the dominant mode."

"The shift from a 'liberal' to an 'activistic' transport regulation policy translates into a 0.7 per cent annual increase in average fuel prices and passenger rail transport tariffs, and an annual increase of 1.2 per cent in air tariffs. A number of econometric studies indicate that the following values, which are higher than those initially taken into account, should be adopted for long-term price elasticities:

-- -0.3 and -0.45 respectively for the elasticities of traffic on the national network and toll-motorways with regard to average fuel prices;

-- -0.7 and +0.2 for the elasticities of rail transport to rail tariffs and average fuel prices respectively;

-- -0.7 for the elasticity of air transport to the average air transport tariff.

An 'activistic' traffic regulation policy reduces growth in passenger transport in each of the three modes. Road traffic and rail transport only vary slightly from one type of regulation to another. The aggregate volume of traffic in all three modes appears to be relatively insensitive to the contrasting scenarios for traffic regulation: the annual growth rate varies by 0.3 per cent from the 'liberal' to the 'activistic' scenario. The decline in rail transport from one scenario to the other might seem surprising, but is the result of two opposing effects. The increase in average fuel prices results accounts for an 0.14 per cent annual increase in transport growth, but in contrast the increase in average rail tariffs produces a 0.49 per cent decrease which explains the negative outcome. The increase in rail tariffs is based on the assumption that the operator will use the room for manoeuvre afforded by higher fuel prices to improve its financial position."

“In the econometric models studied, the elasticity of traffic on the national highway network to the length of the motorway network is frequently equal to 0.15. However, given that the volume of traffic on the motorways due to enter service will be lower, it was ultimately decided to adopt the value of 0.12, which is more consistent with the forecast volume of traffic on these future motorways. Similarly the elasticity of traffic levels on toll motorways to the length of the network, which is estimated by the models at 0.4 over the past period covered, should decline over the next twenty for the same reason. The average value of 0.3 for the whole of the period 1992-2015 has been used in the transport forecasts. The assumptions regarding growth and regulation policy used in the ‘median’ scenario yield a difference between the average annual growth rate in passenger traffic and the two assumptions regarding supply (the first assuming an additional 280 km of motorway and 80 km of high-speed train line per year, and the second an additional 350 km of motorway and 120 km of high-speed train line) of 0.06 percentage point for road transport on the national highway, 0.15 percentage point for transport on toll-motorways, 0.35 percentage point for rail transport and -0.50 percentage point for air transport, which is adversely affected by the increased competition from high-speed rail in the higher of the two increased supply scenarios. Total growth increases by 0.1 percentage point. The supply assumptions have a strong impact on rail transport, whose total volume would be increased by 8 per cent by the additional 765 km of high-speed line. It should be noted that this forecast does not provide a value for the impact of increased high-speed rail supply on passenger transport by road, nor of the impact of increased motorway capacity on rail transport.
[The results obtained from the MATISSE model would seem to indicate that at least the first of these effects remains limited.]

The ranking of effects is extremely clear with regard to road transport and thus the transport sector as a whole. Transport is principally sensitive to the assumptions regarding economic growth (which are not notably different), to assumptions regarding regulation policy, and lastly to assumptions regarding infrastructure supply. In contrast, rail transport is subject above all to the supply of high-speed rail infrastructure, which has a particularly strong impact on air transport in view of the competition between high-speed rail and air transport. Rail transport is relatively insensitive to regulation policy given the opposing effects of average fuel prices and rail tariffs. It varies only slightly with regard to economic growth.”

[Excerpts from the SES report (1996) “*Elaboration des Schémas Directeurs d’Infrastructures de Transport : perspectives d’évolution de la demande de transports à l’horizon 2015*”.]

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WHICH TECHNOLOGIES FOR WHICH MOBILITY?

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SUMMARY

Dublin, April 1997

1. INTRODUCTION

Much has been written about the impact of transport on society, longitudinally over time and latitudinally between regions. Historically, there has been a close relationship between advances in communications and economic progress, in some cases involving leaps in knowledge such as when it was discovered the world is round, or when aviation became a mainstream mode of transport.

Today, we take transport and mobility somewhat for granted. Yet, every so often, we get polite reminders of transport's important role in our lives. It may be a fogbound airport, a road haulage blockade, delays in a tunnel, snow on a mountain pass, or a storm which leads to the cancellation of ferry services. Some of our assumptions about human interaction begin to look a little tentative on these occasions. The ability to attend important meetings may be in question, or the ability to go on vacation. It may be the delivery of critical components into a production line, or the arrival of fresh food produce in a supermarket.

Modern society relies heavily on the availability of sophisticated levels of physical mobility. Here, like Bonnafous (1993), we shall define physical mobility in terms of day-to-day movement from place to place (i.e. excluding issues of migration, residence mobility and social mobility). So hungry are we for this commodity of short-term human interaction that the demand for transport continues to grow and seems always to outstrip supply.

Where transport supply is inadequate for the amount and pattern of demand, adjustments must be made. When infrastructure is fixed, as it is in the short term, the emphasis of adjustment falls on the demand side. Thus, the commuter may have to depart early for work to allow for expected traffic congestion; the holidaymaker may sleep overnight at an airport or port to meet the requirements of cheap packages; the transport firm may operate through the night and weekends to avoid peak traffic periods; the manufacturer may use inventory to protect production against fluctuations in the supply chain caused by uncertainties; and, at the end of the chain, the consumer may make do with frozen or tinned food at the supermarket or more generally bear inventory costs to guarantee product availability.

There is a limit to the acceptability of short term market compromise possibilities. People attach a value to the time they spend in traffic jams or wasted at ports or airports; the commercial market has a resistance to excessive inventory costs; there are environmental objections to heavy vehicles working at night and weekends. The other, longer term, option is to expand transport supply and capacity.

Traditionally, policymakers have tended to follow a cycle of: *infrastructure supply* -- *transport service supply* -- *traffic growth* -- *traffic congestion* -- *demand adjustment* -- *infrastructure supply*. In recent years doubts have arisen regarding the ability of this loop to operate quickly enough and indeed about the long-term sustainability of this cyclical approach (ECMT, 1993). There are increasing concerns about whether road infrastructure can meet the ever-growing population of cars indefinitely (OECD, 1993), whether cities can sustain commuting demands (OECD/ECMT, 1995), whether the environment can absorb projected vehicular resource usage and emissions (CEC, 1992*a*) and various other aspects of transport growth (CEC, 1996).

To the extent constraints in transport infrastructure supply act as a brake, demand must be accommodated on existing networks through increased levels of operational inefficiency (OECD, 1994*a*). The haulier whose truck is stuck in a traffic jam is bearing a limitation on the vehicle's potential productivity and output; as is the bus operator whose fleet size has to be geared for the peak, or the shipping company whose vessels queue at a congested port. In principle, the user may absorb network congestion by:

a) absorbing delays on the routes chosen (i.e. accepting longer transit times);
b) re-routing to less busy or more expensive routes (i.e. accepting higher costs);
c) changing destinations (i.e. substituting inferior destination activity);
d) postponing travel to off-peak times (i.e. increasing waiting/inventory times);
e) not travelling at all.

The inability of the transport system to provide the vectors of mobility required by the user forces the acceptance by the user of alternative vectors of mobility (Figure 1). Ideally, this involves an allocation or rationing process which achieves the appropriate redistributions in an equitable manner.

While it may be acceptable from the viewpoint of congestion control that the marginal user who finds the compromise vector unacceptable may opt to postpone or abandon the plan to travel, from the societal point of view this represents a failure and an overall loss against the goal of providing each citizen with his/her entitlement of physical mobility. The magnitude of the loss depends on how users subjectively value the inconvenience of delays, reroutings or suppressed travel.

At the macro level and from a longer-term perspective, it is interesting to reflect, as the transport policymaker must, on the level of transport infrastructure provision which would be necessary to ensure every community and industry regularly received its desired envelope of mobility vectors. It could be that the ideal transport system should provide services which are continuous, costless and available in all directions with no adverse impact on the environment.

Clearly, the ideal does not exist. In practice, transport infrastructure tends to be provided where it is most likely to give the greatest number of users the greatest level of satisfaction and each community or industry adjusts its required mobility vectors a little, in timing, cost or direction. Ultimately, this may lead to relocation decisions or to variations in the pace of development of communities. It may influence the overall configuration of industry in a region. It may influence the degree of "vertical integration" achievable between units of production in different regions. It may influence the strength of interregional "cohesion" (Cecchini, 1988).

2. VIRTUAL MOBILITY

Given that transport may have difficulties in responding to society's seemingly insatiable needs for mobility, it may be fortunate that today's citizen has possibilities for the substitution of physical mobility, using various forms of electronic mobility. While transport seems to be increasingly constrained in its mission to supply services which are continuous, costless and available in all directions, the telecommunications system seems to have no such constraints and to be developing ever more rapidly in terms of interconnectivity, falling costs and multidirectionality (Mansell, 1993; Giannopoulos and Gillespie, 1993).

The traditional definitions of mobility have tended to focus on specific categories of human interaction involving physical movement for a definite purpose. However, most citizens now accept the substitution of virtual mobility for physical mobility in the case of at least some forms of human interaction, most notably conversations made by telephone. Additionally, the range of substitutions which have broad acceptance is growing. There is the fax, which is substituting for printed paper mobility. There is e.mail, which is substituting for telephone conversations, printed paper mobility and some types of meeting. There is the Internet, which is substituting for some traditional forms of marketing and service-product distribution. Theatre tickets, holidays, conferences can be booked using the combination of telephone, Internet and the credit card system. Instead of going to the cinema we watch movies on videotape. Live sports events can be watched through television at home or on large screens in remote stadia.

Table 1 lists some basic trip purposes, the traditional transport modes associated with them and some new modal possibilities. In each case one can reflect on (a) the characteristics of the interaction which influence the feasibility of substitution for the traditional transport modes and (b) the potential market extent of the substitution, in terms of those market segments which initially are most amenable to the substitution and the degree of substitution which is likely to take place in the longer term.

It would be useful to have a new typology of trip/interaction purposes, which would permit a categorisation of the service at the core of each interaction purpose and a reconceptualisation of purpose on the basis of its information-transfer content and the significance of physical proximity to the effectiveness of the transaction. Many hospital operations are now carried out by “keyhole surgery”, with the surgeon using robot-type equipment. Will the location of the surgeon at the location of the patient always be a necessity?

For the purposes of this paper, the most relevant observation may be that the list in Table 1 is far from complete -- because mankind's substitution possibilities seem to be growing all the time as information technology develops and as the level of “intelligence” in information systems increases.

Even though the concept of “virtual mobility” is still in its infancy, we can state some basic “hypotheses”:

- There seems to be a “life-cycle” in the pattern of acceptance of new possibilities for substitution, involving innovation, experimentation and a gradual spreading of the application as experience grows and improvements are made;
- There are some forms of virtual mobility which now have widespread acceptance as a substitute for physical movement (e.g. the telephone, the fax) and others which are well on their way to widespread acceptance (e.g. Internet applications);
- Behavioural patterns to date suggest that while few people may, in the case of any given application, opt for 100 per cent substitution of virtual for physical mobility, many will accept partial substitution;

-- For passenger transport, the potential for substitution depends on the trip purpose, especially the information content of the transaction associated with the purpose and the importance of human proximity for effecting the transaction;
-- For freight transport, the potential for substitution depends on the information content of the goods, especially in the context of the trend towards the "de-materialisation" of products and the ability of the material content and information content to travel separately;
-- As the traditional transport options are subject to increasing delays, costs or restrictions, the relative attractiveness of options for virtual rather than physical mobility will increase;
-- The propensity to substitute will differ by transport mode, given the known links between trip purpose, origin-destination distance and mode choice;
-- The reaction to substitution possibilities seems to be generational, i.e. young people appear to be generally more accepting of electronic media than older people and become proficient more easily; over time, therefore, the population as a whole should be expected to become more accepting of virtual mobility;
-- Notwithstanding traditional differences between nations in values and behaviour, the propensity to substitute virtual for physical mobility seems to be culturally independent, but strongly influenced by the quality of local infrastructure;
-- In the evolution of new equilibria between physical and virtual mobility, elements of the new information technologies may contribute to the enhancement of the traditional transport options (e.g. telematics for better control, routing, scheduling; onboard telephone/fax facilities to enhance passenger services, etc.).

3. TWO KEY ISSUES

There can be little room for argument about the "explosion" of innovations and advances in the field of information technology and about the spatial impact which the various innovations are having -- even though in most cases they are early in their life cycles and often may be less than user-friendly in the early stages. To quote *Time* magazine: "*It took humanity more than 2 million years to invent wheels but only about 5 000 years more to drive those wheels with a steam engine. The first computers filled entire rooms and it took 35 years to make the machines fit a desk -- but the leap from desktop to laptop took less than a decade* (Lemonick, 1995)." Today, the marginal cost of a telephone call has become so insignificant that distance is no longer a determinant of telecommunications cost; there are views that this development will be the single most important economic force shaping society in the first half of the next century (Cairncross, 1995).

One key issue for transport policymakers, however, is whether virtual mobility actually substitutes for physical mobility or whether both are potentially part of the same "explosion" of mobility, ultimately synergising, leading to overall growth in both fields and adding to rather than ameliorating transport demand.

In air transport, for instance, there is debate about whether teleconferencing technology will reduce or increase business travel: here, it could be that while physical mobility (air travel) ultimately may cater for a reduced market share of the total conference market, the total market will be greatly increased by the stimulation provided by teleconferencing. Similar considerations apply to the relationship between television and leisure travel: for example, while the market share of those watching events from home has increased, television has helped stimulate the overall market so that there are increased attendances at many major events. There have been numerous analyses of actual and potential interactions between telecommunications advances and travel demand (e.g. Salomon, 1986; Banister *et al.*, 1995). Button (1995) examines the question of whether telecommunications acts as a substitute or complement to transport and the difficulty in predicting the overall effect.

The co-evolution of communication and transport has been observed in history. Alt *et al.* (1996) recall that for the vast majority of human history, communications beyond the carrying power of the human voice were subordinate to the transport infrastructure of the time. Written correspondence or other physical tokens had to be carried physically until the advent of the telegraph in the mid-19th century. The subsequent co-development of the railroad and the telegraph in the USA provides an early example of communication/transport growth synergy.

A second key issue is whether the advent of virtual mobility offers real possibilities for proactive responses by the transport sector and new opportunities to address endemic problems. In principle, the availability of acceptable substitutes for physical mobility should lessen the impact on society of "failures" of transport supply. Assuming one can identify those trip purposes for which there are good substitutes for physical mobility and those segments of the transport market that may be diverted to the substitutes without an unacceptable level of hardship, the supplier of transport infrastructure may find there is more room to manoeuvre than would otherwise have been the case. This is especially relevant where there are severe constraints on the expansion of transport supply, e.g. for financial or environmental reasons.

Any spatial or social impacts of virtual mobility to date have, however, been the outcome of a predominately passive, rather than pro-active, disposition of policymakers with regard to the substitution of virtual for physical mobility -- i.e. the take-up has been largely market-driven or *laissez faire* and the question of "optimisation" of the virtual/physical balance has been more or less unaddressed in transport policymaking.

There are reasons for this: in most countries, transport and telecommunications are regarded as separate sectors and transport firms have tended to define their interests and competences in terms of physical movement. There are various work-practice constraints and traditions which make it difficult to redefine the role of transport as one of *mobility provision through either physical or virtual means*. Additionally, it must be recognised that the developments in telecommunications have occurred very quickly and were neither planned for nor foreseen.

One way or the other, it is interesting to consider in more detail the possible benefits which the transport sector might accrue through a more proactive approach to demand management and substitution using the opportunities presented by the various new modes of telecommunications. The indications are that the demand for mobility in total, i.e. whether physical or virtual, is increasing at unprecedented rates. In developed countries, there are signs that transport growth is at a plateau, while electronic communications are growing at exponential rates. In developing countries, there is a more even balance between the growth of transport and telecommunications, given that both are growing from a low base. In some countries which are facing abnormal economic adjustment, such as those in eastern Europe, there are indications that telecommunications investment may be used to redress inadequacies in existing transport infrastructure.

It would seem to be impossible to contemplate the future demand for transport in isolation from the future demand for telecommunications and the question of the optimal interaction between the two mobility modes.

4. IMPLICATIONS FOR PASSENGER TRANSPORT

People travel for a variety of reasons. Invariably some form of benefit, broadly defined as a service, is received by the traveller at the destination. This may be of a subjective nature, as in the case of social/leisure trips involving visits to friends and relatives, or more objectively measurable as in the case of formal services such as those supplied by hospitals, banks or restaurants. Many movements of people may be interwoven with the movement of goods. For example on holiday trips there is the movement of baggage and on shopping trips there is the carriage of purchases. The choice of mode and service may be influenced by the goods element of the trip as well as purely human considerations: for instance, the convenience of the car boot is often quoted as a reason for the choice of that mode and also for the choice of ferries.

The literature links transport demand to basic land use: mankind has choices between the extremes of *self-sufficiency,* involving minimal interaction and the provision of essential requirements locally at low cost and with low standards of living and of *mutual dependency*, involving exchanges or trading, regional specialisations and generally higher standards of living (degli Abbati, 1986).

Where people and communities opt for dependency, the role of transport is to provide the connections. A traditional if simplistic view of transport is that **railways** provide "backbone" connections between regions, **road transport** the local connections between households and **sea and air transport** the longer intercontinental connections. Cities are places where humans congregate to organise common services (e.g. schools, hospitals, banks) economically. Humans are both the providers and consumers of these common services, so cities have become places of high-density, short-distance travel. For operational convenience, work hours have been co-ordinated. Travel patterns have become peaked as large cohorts of workers travel to and from their places of employment at the same time. Public (collective) transport seems the logical way of dealing with these demand peaks, but somehow the automobile has become the favourite mode of travel.

The pattern is repeated in many cities, with minor variations for local geographical and regulatory circumstances (Thomson, 1977; Kenworthy and Newman, 1989). One may ask whether the pattern is now so deeply entrenched that it would be virtually impossible to "re-engineer" it. Must every city have a Central Business District? Must office workers all work in close physical proximity? Must we all travel to supermarkets by car? Can hospital economies be achieved only by scale? Must morning school traffic coincide with the commuting peak?

There have been some minor but interesting innovations in travel patterns, suggesting at least that change is possible. We are able to order home-delivery meals instead of going to the restaurant. We can get money from automatic teller machines instead of going to the bank. We can take university degrees using distance learning packs. We can make travel arrangements on Internet. We can purchase certain products using electronic terminals. Soon we will print our own newspapers in the home from teletext. Maybe when we go on holidays we will be able to hire our baggage at the destination.

A trip/interaction category which traditionally has been given much analytical attention is the infamous “journey to work”. In the debate on "sustainable transport", commuting during peak hours by low-occupancy cars in heavily trafficked cities is high on the list of public concerns, given its resource wastages and environmental impacts. Among the common approaches to the commuting congestion phenomenon have been:

- enhancements to public transport;
- restrictions of city centre car parking;
- incentives for car pooling and car sharing;
- heavy commercial vehicle bans during peak hours.

These conventional solutions are based on conventional notions of business, in particular the presumption that workers must be in the same or adjacent buildings at common work times and that face-to-face interaction is essential for most business transactions and management activities. Evidence supporting these assumptions is actually quite weak: international firms seem to function quite satisfactorily with employees located in different cities and working in different time zones; much commercial activity is now accomplished by telephone and over the computer network; and there are many negative organisational implications of the close proximity of workers in offices (e.g. institutionalised time wasting, bad group “chemistry”, interpersonal friction and disputes, illness epidemics, etc.).

4.1. The growing feasibility of telecommuting

In principle, the availability of improved communications between office and home offers opportunities for increased flexibility in the timing and frequency of the journey to work, as the need to be at work at a particular time to deal with documents can be reduced. Also, it may be that some office tasks can be performed as well, if not better, by transferring them to a remote location and spending a period of time processing them in relative peace.

The term “telecommuting” implies a straight substitution of virtual for physical commuting, with workers communicating with their places of employment from home via information communications technology (ICT) and eliminating or reducing their need to travel to a central place (Kinsman, 1987).

For individuals, the potential attractions of home-based work include a greater sense of autonomy, flexibility regarding the timing of the work activity, avoidance of time wastage in commuting, enhanced availability for family or home commitments and freedom from various distractions at the conventional workplace. Disadvantages include the increased potential for social isolation, possible loss of team identity, a sense of disconnection from the organisation, uncertainty about career prospects and colleague perceptions, a lack of routine and the loss of traditional boundaries between work and leisure time. Factors inhibiting home-based work include personal circumstances (the home setting, inadequacies of space and privacy etc.), personal characteristics (the need for self-discipline, personality type including dependence on peer support and feedback) and uncertainties about taxation and self-employment status (Quittnet, 1996).

For the employer, the potential incentives include cost reduction (for example, less capital investment in premises and fixed costs), greater flexibility (particularly where workers have part-time contract status), enhanced employee wellbeing and reduced stress (adding to performance effectiveness) and a reduced tendency to unionise. Disadvantages include reduced control over the employee/contractee and issues of corporate culture and worker loyalty. The set-up costs of telecommuting may be high, involving the purchase of computing and telecommunications equipment on an individual worker basis. Some employers may be concerned with security issues, particularly where sensitive information and intellectual property is involved. A further disincentive may be the potential impact on management effectiveness, for instance, where control and monitoring are a key feature.

There have been numerous investigations of the impact of telecommuting. Earlier studies tended to take an "all or nothing" approach, i.e. they focused on two partitioned groups of workers, those who continue to work traditionally and those who are home-based and connected only loosely to the traditional organisation and they emphasized the social impacts of this partition.

The experience of Rank Xerox has, for instance, been extensively quoted (e.g. Judkins *et al.*, 1985). In this experiment, motivated by the company's own desire to reduce non-salary-related fixed costs, employees volunteered to set up their own homed-based limited companies, while continuing to work for the company on a "network contract" basis. Particular attention has been given to the entrepreneurial successes of the home-based former employees and the difficulties experienced by the "core managers" at headquarters in managing workers at "arm's length".

4.2. Impact of telecommuting on transport

Telecommuting involves a reduction or displacement in the flow of commuters. Whether this has an impact on traffic flow depends on the volume of telecommuters, the transport modes they previously used and the timing of their previous tripmaking in relation to the peak.

The overall transport benefit must be offset by the effects of any incremental transport activity undertaken by the home-based workers connected with new patterns of social interaction, suburb-to-suburb commuting where work involves suburban telecentres, or intra-suburban travel for office supplies or support services. The exact impact depends on existing suburban traffic levels, the transport modes used by the home-based worker and the effects of household trip reorganisation. Nilles (1996), for instance, suggests that telecommuting leads to an overall reduction in household trips due to a redistribution of non-commuting trips among household members. Suburban driving by car can be surprisingly costly due to the relatively high fuel consumption of the average car when it is driving predominantly over short distances and especially when frequent cold engine starts are involved.

The transport benefit is generated by the subgroup of workers who choose or are forced to be home-based and who develop innovative home-work-home relationships, but it is experienced mainly by other workers who continue to have traditional home-work-home commuting patterns.

4.3. Telecommuting and global outsourcing

A more recent phenomenon, again involving two partitioned groups of workers, is the international trend towards "global outsourcing" of information processing functions (teleprocessing). This involves the replacement of workers, who previously were located at company headquarters and engaged in the "back office" processing information or customer enquiries by telephone, with a new group of workers at a distant "satellite" location.

For the employer, the advantages are mainly labour-related. In transport terms, there is a trade-off between reduced commuting at the headquarter city and additional commuting at the satellite location. The trade-off may take place in different cities and countries. In the current trend to locate teleprocessing facilities in Ireland (Table 2), there is a tendency to place facilities not in city centres but in outer-suburban and rural locations where there are lesser transport implications. Thus the outsourced workers telecommute both in terms of their status with their parent firm and in relation to their own city centre. The net transport effect involves two different continents.

4.4. Partial telecommuting

Recent advances in information-communications technology (ICT) raise possibilities for more flexible forms of telecommuting and especially the notion of partial, or part-time, telecommuting. Each worker could, for instance, spend a part of the working week (e.g. a day, a half-day) at home, in rotation. Work concepts could be redefined and redesigned into “core attendance” components, where physical attendance at the workplace is essential and “information processing” components where physical attendance at the workplace may be unnecessary or even a disadvantage.

Part-time telecommuting is of interest because, *for a minimal impact on traditional social patterns, there could be a significant reduction in traffic volumes*. Looked at in very simple terms, were all office workers to be based at home one day each working week, commuter demand would be scaled down by 20 per cent. The traffic impact would depend on changes in vehicle flows. In the case of those travelling in public transport vehicles or as car passengers, the impact would be on vehicle occupancy rates rather than vehicle flows. In the case of car drivers, the impact would be directly on vehicle flows. Given that congestion effects are non-linear, a 20 per cent saving in car driving could have disproportionate benefits on traffic flows. A 1985 study by the Southern California Association of Governments found that a 32 per cent reduction in freeway congestion could be achieved by just 12 per cent of the workforce telecommuting. In the case of voluntary telecommuting, one might expect a higher proportion of car drivers to opt for working at home on a rotating basis given the flexibility of this mode and its suitability for local suburban travel.

There would be organisational implications of part of the workforce being absent on any given day, mainly in connection with those aspects of the work for which face-to-face interaction is essential. However, it could be argued the position would not be substantially different from that pertaining in conventional business during summer holiday periods or during periods of illness epidemics. The absences created by telecommuting would have the advantage of being pre-scheduled, with options such as teleconference linkages in the event of meetings and other required interactions. The process would not necessarily be limited to back-office workers, given the periodic administrative requirements of many other production sectors.

4.5. Acceptance of new home-work-home concepts

There is growing evidence of a readiness to accept new home-work-home relationships. A survey in Sweden in 1989 found that more than a quarter of the country's 4 million employed (excluding farmers) did all or part of their work in the home, with a strong emphasis on part-time rather than full-time formats (Engström *et al.*, 1989). The survey showed that about a quarter of the people who already worked to some extent in the home felt it would be feasible to carry out more work at home, while 13 per cent of those who did not work in the home at all felt it would be possible to carry out some of their work in the home.

In the United States, a recent estimate of the number of people working at home, whether full-time or part-time, was 30 per cent of the labour force (US DOT, 1993). A 1995 survey found that 64 per cent of Fortune 1000 companies had implemented telecommuting programmes and that 92 per cent of executives with telecommuting programmes believed such programmes reduce costs, increase productivity and improve employee morale (*PC Week*, 1995). It must be noted that these developments are taking place within a wider scenario of contract employment, outsourcing and down-sizing (Quinn and Hilmer, 1994).

A recent study in Ireland found a general preference from both employers and employees for an average of 1-2 days spent in telecommuting mode (Bertin and O'Neill, 1996). According to the results of a more general survey in 1994 (TELDET, 1994), the penetration of telework in European organisations is around 5 per cent and the actual number of teleworkers in the five largest EU countries approximated 1.1 million. The UK and France were reported to be the countries with the highest telework penetration, with around 7 per cent of organisations practising telework. In the course of the survey, between one-third and one-half of the workforce in Europe indicated an interest in and willingness to practice some form of telework. The aim of the European Commission is for there to be 10 million teleworking jobs by the year 2000, or 5 per cent of the workforce. There appears to be no connection, however, between these plans and those of the transport sector.

4.6. Opportunities to reconceptualise passenger transport

The author submits that considerable scope exists for a reconceptualisation of the various sectors of passenger transport in the light of ICT developments. These developments are already generating many innovations in interoffice and interpersonal information exchanges, which are concurrent with more general changes in employment, work and marketing concepts. It is argued that a proactive response by the transport sector within this scenario is likely to create many new opportunities for demand management. The focus of the argument has been on home-work-home commuting, since the intensity of peak-time commuting has been an endemic transport problem. To quote a contributor to a recent OECD report:

> *The traditional concept of the workplace as a fixed geographical space will become increasingly outmoded and will be replaced by more abstract notions of "online communities", "networking", "intellectual spaces", etc. ...Traditionally urban planning has tried to remedy, rather than to prevent, traffic congestion problems and information technology is still used for traffic planning purposes, to cure the patient rather than prevent the malady. With telework, a unique opportunity for prevention is presented: in the long term, transportation structures can be modified and peak-hour problems reduced* (Qvortrup, 1992).

The rationale can, however, be applied more widely than the commuting domain. There is a need, surely, for a systemic analysis, involving a creative assessment of transport, social and institutional implications and opportunities in the context of the ever-growing technical possibilities of telecommunications (Capello and Gillespie, 1993).

The need for such an assessment is driven not only by problems of endemic congestion, but also by the reality that many existing infrastructure systems and networks are coming to the end of their technical life cycles and becoming obsolete (OECD, 1994*b*). Their reconstruction will be costly; especially if the renewed facilities are to be merely facsimiles of their predecessors and prove technologically inappropriate to the future needs of commerce and human interaction and become prematurely obsolete.

Ideas of the "Postmodern Metropolis", emphasizing flexible, information-based activities and inverting traditional typologies of architecture, were put to the ECMT by Gibelli (1987). Ten years later, transport planners have done little to respond to the challenges of design and reconceptualisation posed by her forecast.

5. IMPLICATIONS FOR FREIGHT TRANSPORT

Developments in information technology have impacted on freight transport in at least three different ways: (a) the increased information content of many products, coupled with a general trend towards dematerialisation, has changed the character of products being transported and in some cases has created new distribution options; (b) the use of information technology to “integrate” product supply chains, with a strong emphasis on inventory reduction, has redefined the role of freight transport; and (c) information technology has provided new management and control possibilities for the freight transport function itself.

5.1. Value chain developments

In the traditional perspective of business processes (Figure 2), each stage of the value-adding sequence was seen as an independent economic activity. Exchanges of materials and goods between stages of production occurred in an open market. Efficiency optimisation was fragmented, since it was constrained within the boundaries of the independent firms. Scale was a key competitive variable and “horizontal” integration a favoured path towards it. The value-adding chain involved multiple inventories, with stock used to cushion against the uncertainties of action of other participants in the chain. Transport was a passive agent in the production process and pursued its own internal objectives, which were usually those of cost minimisation on the assumption that that was what the user wanted.

The contemporary perspective is a contrasting one (Figure 3): it is of the process of production as an integrated chain of value-adding activity extending “vertically”, from the basic extraction and processing of raw materials to the final distribution and sale of products at retail outlets (Hines, 1993). Firms along the chain, regardless of whether they are centrally owned or not, become partners, with information flowing freely between them to reduce uncertainty and the need for buffering between the production stages. Operations along the chain, including transport, are tightly controlled, co-ordinated and synchronised.

Logistics has played a key role in the development of this new perspective of business. It provides the framework within which information substitutes for inventory, activities are co-ordinated and the sequence of production activities can be optimised over the complete chain. Traditionally, inventory was used to buffer against incompatibilities of adjacent links in supply chains and against operational uncertainties.

Now, due to the many advances in ICT, it has become feasible for information to substitute for inventory and, since information is becoming increasingly cheap and inventory increasingly costly, the trend towards this substitution seems likely to continue. Electronic Data Interchange (EDI) is permitting inventory/information trade-off to be optimised along the entire value chain. The advent of expert systems and artificial intelligence suggests that logistical optimisation will become increasingly sophisticated and wider in scope.

New organisational formats have emerged — ranging from centralised ownership along entire and often international processing chains, to complex contractual arrangements between firms which internalise risk sharing and enshrine co-operation, to the elaborate interorganisational dependencies common in Japanese industry and for which the integration of production is strongly cultural (Miles and Snow, 1986).

Within the various frameworks, product quality and delivery reliability have become central to competitiveness and the concept of product is defined not merely by the nature of goods sold but by a combination of the goods and the quality of the service with which they are delivered to the end customer. In this business environment, the traditional boundaries between manufactured produce and services have become blurred and many hybrid products (well-known examples include computer software, instantly developing photographic film, fast food outlets, auto-diagnosis health devices) have emerged.

As products become lighter in terms of their material content (through the use of plastic materials and better design concepts) and more information rich (through the use of microchips), trends towards the "dematerialisation" of products have been observed. Figure 4 shows the trend in rail freight traffic in Europe for the period 1980-93. Chatelus *et al.* (1995) provide an interesting analysis of freight traffic versus GDP in central European countries as they transform from planned economy to market economy status.

5.2. Possibilities for innovation

The thrust of technology and of product innovation is towards the "tailoring" of individual product designs for each consumer; a growing task for the logistics function is to find ever more innovative ways of allowing the marketplace the level of choice it demands while maintaining distribution cost and efficiency at affordable levels (Fuller *et al.*, 1993). Some forecasters envisage that, in those retailing sectors which currently favour the large-store format, traditional retailing, involving the movement by car of the customer to a retail premises, may be replaced by a channel structure in which manufacturers interact with consumers directly through telecommunications and use home delivery services to bypass conventional retail outlets (Business Week, 1993*b*). Ultimately, shops may become less central in commerce, as direct distribution from electronically-triggered warehouses grows.

Entrepreneurial logisticians may begin to organise new types of distribution service focused not as traditionally on the producer as origin, with multi-drop destinations, but on the consumer as destination, with multi-pickup origins [“Just for You” or “J4U” distribution (Figure 5)]. Late changes in orders or in destinations will be accommodated via a telecommunications link with the freight train or delivery van and by the use of product-finishing facilities which will be not at the factory but on board the vehicle (e.g. final assembly, sorting, printing, labelling, packaging). Principles of value-adding distribution have always been applied within the transport sector (e.g. the traditional sorting of mail on trains), but the full potential of the delivery vehicle, given the capability of onboard computers and of miniaturised manufacturing equipment, has yet to be realised.

The more accurate knowledge of customer requirements coupled with the technological ability to fine-tune delivery parameters will lead to a greatly enhanced customer service capability. The role of the marketing function will continue to be that of finding customers and exploring, understanding and communicating their needs; the role of manufacturing will continue to be the pursuit of low unit costs through technical innovation, efficiency and component standardization; the role of logistics will be to pinpoint individual customer needs in place, time and design specifications and deliver the completed product in a way which meets these needs creatively and economically.

Helping this process will be an increased use of "artificial intelligence" in the logistics function. Apart from measures to enhance vehicle performance and co-ordination in the form of "intelligent" vehicles and road infrastructure, there will be "onboard intelligence" in freight consignments, in the form of embedded information and scannable codes.

Alt *et al.* (1996) observe the evolution of what they term "transport governance systems" aimed at driving costs out of transport value chains and enhancing efficiency levels with greatly reduced labour inputs and faster speeds. They see the future of both passenger and freight transport as fundamentally dependent on information infrastructure, ironically just as communication was once dependent on transport. They see the great payoffs in transport over the next two decades as coming from the leveraging of existing infrastructure through an interlinking of future transport and telecommunications development.

The future scenario therefore is one in which the freight transport firm will play an integral role in the production processes, or value adding chains, of its customers (Figure 6). Its task will be to provide the links between suppliers and manufacturers at the various stages in the chain, with materials and goods flowing under careful control to minimise inventory levels and respond accurately to consumer trends (OECD, 1992). The freight firm will play an increased role in the final stages of production, helping to provide flexibility of destination choice, delivery timings and product presentation (i.e. value-adding distribution). All this will be possible only through a heavy linkage with information technology.

5.3. The virtual value chain: marketplace and marketspace

As for passenger transport, there is a need for a new typology of freight traffic categories, involving a reconceptualisation of the concept of goods movement. Rather than focusing merely on weight or distance as hitherto, it would be useful to identify the core purpose and characteristics of the goods as seen by the consumer, their required delivery characteristics and their embedded information content, including accompanying services (which could have passenger transport implications).

It is said that today every business competes in two markets: the *marketplace*, in which resources and products exist physically and require traditional freight transport services and the *marketspace*, which is a virtual world of electronic commerce in which the main object of transaction is information (Figure 7). Managing two interacting value-adding processes, in the two mutually dependent realms, is seen as posing new conceptual and tactical challenges for every firm (Rayport and Sviokla, 1995).

Some firms may choose to operate wholly or heavily in the virtual world, in which case their output may be mainly information. In the case of some products, for example, computer software, the ratio of physical to electronic transport may change over time to the point that the entire product travels electronically. Where firms operate predominantly in the virtual world, the challenge of catering for their physical freight flows may be less that of ensuring the required origin-destination speed than that of coping with rapidly-varying origins and destinations (Business Week, 1993*a*).

In responding to these developments, the transport firm is faced with a choice of (a) continuing to play the traditional role of carrying physical freight or (b) redefining its role to include the conduiting of information flows.

a) **Traditional Role**: Catering for the traditional transport marketplace will have the advantage of corresponding to the expertise and traditional scope of the transport profession. However, in many sectors, physical goods are likely to be a decreasing portion of the modern firm's total output and a progressively weaker predictor of its mobility requirements.
b) **Redefined Role**: Catering for the customer's marketspace requirements (information conduiting), in addition to those of its marketplace (physical freight) will have the advantage of permitting the full picture of the firm's mobility requirements to be addressed. However, it could be argued, this role may be beyond the scope and competence of the conventional transport firm.

Apart from the question of defining its main market, the freight transport firm should also consider its involvement in ancillary markets appropriate to the era of electronic commerce. Most transport firms generate and use information as a by-product of their main activity. This information and the systems which handle it may themselves have commercial value and permit the offering of products in the marketspace.

For instance, the Computerized Reservation Systems (CRS), which have been developed and used by the larger airlines to co-ordinate bookings and assist yield management, have value to smaller airlines and travel agents. Latterly, they have become available to prospective customers via Internet. Airlines may earn substantial revenues from their hosting of CRS services, in addition to their mainstream aviation activities. Similarly, express freight firms can earn additional revenue through the provision of public access to their package-tracking services in addition to their mainstream freight carrying activities.

6. WHICH TECHNOLOGIES?

In the light of the many developments foreseeable in the evolution of and demand for mobility, it is relevant to consider the appropriate response of the supply side of the transport industry. In the first place there is the question of transport infrastructure. Considerable analysis has already been conducted into the appropriate Trans-European Networks for the next century, taking account of the continent's mobility requirements in the light of its political goals for regional integration, cohesion and economic development.

The most basic question is that of the appropriate geographical configuration of transport infrastructure, in terms of the routes, nodes and traffic capacity to be provided for each of the transport modes. In the case of the railways, there already is a commitment to facilitate high-speed trains on the principal links of the network. Also, some important "missing links" have been or will be filled in -- such as the Britain-France Tunnel and the Scanlink connection between Denmark and Sweden. There also has been an identification of the busiest ports and airports and the priorities for expansion taking a systemic view. In the case of roads, there is the never-ending question of which of the congested links to expand, always mindful of the environmental balance sheet. There is a concern that future transport should be "sustainable" and that it be economic and competitive.

To minimise unnecessary duplication between transport modes and to promote intermodal synergy, there is widespread interest in the promotion of *Combined Transport* and transport intermodality generally (CEC, 1997). This is partly a matter of infrastructure development and partly a matter of transport service co-ordination.

The concept of *Logistics Platforms* is especially relevant in this context. These are nodes which provide "hub-and-spoke" type route connections and vehicle-load transfer facilities and, as such, provide the essential interface between transport infrastructure and transport services. Increasingly, there will be the capability of bringing enormous amounts of computing power and intelligence to bear on routing and vehicle loading decisions, with the additional advantage of allowing these decisions to be made on a whole-network basis.

In principle, delays caused by schedule clashes or late traffic changes can be foreseen and eliminated through a widening of the appraisal scenario in both time and space. In principle, the computer can pre-store arrays of contingencies for myriads of possible events and instantly provide the most appropriate system response to every operational problem.

Not only has information-communications technology (ICT) the capability of overcoming the various management and combinatorial complexities that are endemic in transport systems, but it also can help the transport system to harmonize with the new transport requirements of the virtual world.

In freight transport, for instance, the shipper may require real-time space booking facilities, automatic monitoring of consignment status and automatic delivery confirmations. The merging of physical product components with virtual product components may be part of the distribution task: for example, the programming of computing devices at their final destinations, the printing of newspapers at their delivery points or the cooking of hot meals for home delivery.

In urban passenger transport, the worker could, for instance, work at home on Mondays and Wednesdays, on Tuesdays travel to the city centre in a pre-organised carpool with pre-booked parking space and on Thursdays and Fridays travel by bus, the timetable and routing of which might adjust according to the dialled-in requirements of each day's passengers.

In both freight and passenger transport, the parallel systems providing physical and virtual mobility would complement and interact according to the technical flexibility of the former and the computing power of the latter. The gains to the consumer would not be solely in relation to the more sophisticated matching of transport supply and demand. Intelligent transport vehicles with onboard collision avoidance systems can travel in closer formation, resulting in a more efficient usage of infrastructure. Safety levels, especially at night time and in poor weather conditions, such as in fog or rain, can be enhanced. Delays at toll booths can be eliminated through the use of electronic transponders. Parking spaces can be found and paid for electronically. In general, the benefits of telematics, with regard to both transport system operation and transport demand management, tend to combine synergistically (DRIVE, 1991).

In the context of the *"Information Society"*, the transport planner must consider carefully the dual requirement for a robust, long-term perspective of infrastructural needs and a highly flexible short term perspective of service needs. Some elements of transport have been and will remain patently inflexible — fixed rail infrastructure, airport runways, canals, harbour berths, for example. The construction of these elements in the wrong shape, at the wrong location or at the wrong time has always been associated with problems of early obsolescence and financial loss. While the transport system may have rallied round such mistakes in the past and adjusted or compromised traffic patterns to ameliorate the negative consequences of imperfect planning, this tactic may not be as easily engaged in a fast-changing, demand-driven market environment.

Some long-lived fixed investments such as airports and undersea tunnels may be less vulnerable than others where they provide central or pivotal elements of the network and are robust against changes in traffic composition. Part of the planning task will be to identify such "core" elements of the transport network. For these elements it is possible that state-of-the-art, "conventional" technology will suffice and that obsolescence will not prove to be a major concern. For the non-core network elements, however, the task will be to plan for usage flexibility, in both traffic operations and market composition and to ensure that fixed investments are robust against a variety of contingencies. Consider, for example, the following observations:

- Several small airports catering for STOL aircraft might, in the context of the requirements of the vertically integrated value-adding chains prevalent in modern industry, serve a region better than one large airport;
- Multi-purpose railway carriages, providing rapid interchangeability between passenger and freight configurations, could reduce train marshalling and scheduling constraints and so help provide the rapid market responsiveness required by both markets;
- High-speed ships generate higher service frequencies and shorter average waiting/inventory times at port; additionally, they reduce the route-specificity of vessel design requirements and permit greater degrees of interchangeability between routes;
- The provision of onboard value-adding facilities (such as information processing support for passengers, product processing/finishing facilities for freight) is likely to enhance the flexibility of every transport mode;
- All transport modes must plan for extensive use of ICT (telematics) both to enhance modal efficiency and to provide the necessary integration between marketplace and marketspace;

- The nodal positioning of logistics platforms should be kept as flexible as possible (i.e. they should match the "footlooseness" of industry), by minimising fixed installations and storage infrastructure and maximising redeployability;
- Where the information content of a product is transmitted electronically and the material content is transported in parallel, the value of "material only" may be low enough to permit moderate increases in inventory levels in the transport system and corresponding increases in operational flexibility;
- Technologies for unit costing of transport are likely to improve enormously, for both internal resource usage and externalities; revenue collection will be by smartcard and highly transparent; all support activities of transport firms (customer information, timetable changes, tracking systems, etc.) will be conducted in the marketspace;
- As the emphasis moves from the pursuit of scale to the pursuit of market flexibility, urban public transport vehicles are likely to become smaller; routes and schedules will be more fluid; and the provision of onboard electronic communications for passengers will be paramount;
- In urban freight distribution, the emphasis will swing from single-origin-multidrop towards multiorigin-single-drop as electronic shopping from retail warehouses becomes prevalent; the vans used for delivery will be "intelligent", i.e. provide for controlled refrigeration of perishable goods, controlled heating of pre-cooked meals, onboard printing of labels, etc.;
- As concern for the conservation of natural resources continues, industry will increasingly emphasize the re-use/re-cycling of materials in product and logistical design; the provision of economical reverse logistics channels will be a major new transport preoccupation;
- As concern for the reduction of waste emissions continues, it is likely that the technology of electric road vehicles will become commercially viable; new road infrastructure concepts may emerge to address battery recharging requirements and new speed-flow characteristics.

In the light of these and many other similar observations which could be made, it may be argued that the task of the (regional) transport planner will in future revolve around:

- The identification of the elements of the core transport network, in the context of forecast population and industrial trends together with anticipated regional and political priorities;
- The specification of non-core network elements, recognising that nodes (platforms) may require to be adjustable in capacity (scaleable) and location (footloose) and that traffic will be interchangeable between physical (marketplace) and virtual (marketspace) modalities;
- More creativity than hitherto at the level of transport operations, on the basis that there will be an increasing level of technological capability and an ever-expanding computational capability, so that traditional operational constraints will be decreasingly important.

7. LOOKING TO THE FUTURE

It could be said that the changes discussed in this paper are within the normal range of change which the transport industry has encountered at various times in the past and that transport has always succeeded in addressing and accommodating such changes and will continue to do so. In the long run, it can be argued, people always will travel, whether by public or private transport and whether on land, sea or air and freight always will flow through the arteries of the world's industrial system as the planet's natural resources are converted or reconverted into useful goods.

There have been step changes in transport technology in the past which have had severe effects on the industry. When aeroplanes replaced passenger ships in ocean transport, there was a sudden and devastating decline in demand for oceanliners. When the internal combustion engine became available, road transport grew rapidly and removed a large share of what was hitherto the railways' market, notwithstanding various attempts to contain or ignore the threat. Earlier, when the railways were built, the change in technology was quite sudden and in this case had a major impact on the demand for horse-drawn transport.

These past step changes in technology had the common feature of being on the transport supply side. They were to an extent controllable by the transport sector and they involved an extension rather than contradiction of existing paradigms about mobility and travel demand.

Today, one can continue to observe the impact of changes in transport technology which have been initiated by the transport sector and do not entail paradigm shifts. For instance, due to advances in engine technology and the use of lighter materials in aircraft construction, flying ranges have been extended progressively. Some airports and routes may have grown in importance as a result, and some may have declined, but the overall effect can be explained in conventional terms.

The Cross-Channel and Scanlink projects, daring and ambitious though these ventures are and extensive though their impact on the respective ferry markets may be, are also supply-side developments and do not involve major paradigm shifts.

The changes which are being produced by advances in information and communications technologies are, it is submitted, in a different category. For the first time, they provide opportunities to circumvent the need for physical mobility, without the corollary of declines in economic activity and living standards.

As a *strategic threat*, they imply that if the transport sector does not satisfy the mobility needs of some or all segments of the transport market, by imposing unacceptable transit delays, reroutings or postponements, these segments may quite literally evaporate. Because the alternative forms of mobility appear to be habit-forming, market losses may not be easily reversed. Because virtual mobility is developing progressively in its sophistication, the alternative forms of mobility will appeal to a widening market segment.

As a *strategic opportunity*, the changes produced by advances in information and communications technologies provide the transport sector with the means of "re-engineering" itself to resolve endemic issues such as congestion and difficulties in management and co-ordination.

A difficulty in addressing the potential impact of telecommunications on transport is that its impact is so invisible, diffuse and difficult to quantify. Nobody will deny the impact that computerized reservation systems have had on airline market shares, or the impact which the fax has had on the transport of printed paper, yet either change is difficult to quantify. According to present indications, it is clear that the advent of e.mail will have a substantial impact on the postage sector, that Internet will change the role of travel agents fundamentally and that tracking systems will have a positive impact on express freight flows. Again, however, it is difficult to quantify these effects.

It is possible that ICT will simply have a continuous "trickle" effect on the transport sector, always diverting demand at the margin and always injecting efficiency opportunities at the core. Yet that is not the central message which this paper has sought to deliver. The "trickle" effects are what will happen if there is no intervention, if nothing is done. If, on the other hand, the transport sector chooses a pro-active response, decides to use ICT to manage and harness transport demand, to create new variants of transport services and to find innovative solutions to endemic problems, then the changes and opportunities are bound to be more fundamental. The future could indeed be very bright if the transport sector found itself eliminating the daily peak in commuting traffic, dealing more satisfactorily with real-time market needs through flexible routing and scheduling and being an integrated part of industry's value-adding chains.

8. RE-ENGINEERING THE ANALYTICAL FRAMEWORK

The traditional transport planning analytical framework has proved remarkably versatile and robust over several decades. Yet, as pointed out by Bieber *et al.* (1994), there are certain drawbacks to the use of the aggregated econometric approach in the investigation of changes in mobility, which concern a "small-scale" or micro-social domain. Instead, it may be appropriate to engage time/geography or travel budget concepts, based on the notion that the individual travels within the limits of a defined time or financial budget. These authors worked from the notion of an "average weekday" and distinguished between:

a) Journeys or contacts which are necessary for daily activities whether physical or not (i.e. which involve either transport or telecommunications);
b) Time spent in making these contacts (the time budget);
c) The "spatial range" of these journeys or contacts, expressed as the distances covered for whatever mode.

In an attempt to capture the more recent developments in ICT which establish it as a real satisfier of mobility need and also the various transport-telecommunications interplays discussed in this paper, a framework such as that outlined in Figure 8 may be appropriate. Here, various geo-sociological characteristics of a region are taken as given and act as generators of profiles of "desired interaction patterns". These could include, for instance:

-- A profile of social interactions, spatially and in time, for the average individual in each defined socio-economic grouping in each zone;
-- A profile of information-rich services, spatially and in time, required by the average individual in each socio-economic grouping in each zone;
-- A profile of material-rich services, spatially and in time, required by the average individual in each socio-economic grouping in each zone;
-- A breakdown of the information-processing content of the various work categories available in the zone, flagged according to their suitability for remote-based execution;
-- A breakdown of the information/material content of various product categories available in the zone.

Each zone would be defined by its mix of individuals and their types of household affiliation, its mix of industries and their value chain characteristics (i.e. required supplier-buyer affiliations) and its mix of work (employment) categories including product/retail categories.

As an originator of interactions, each zone would generate a set of desired social interactions, desired information-rich services, desired material-rich services, desired work opportunities for the population, product manufacturing capabilities and desired product acquisition or retail shopping opportunities. Of particular relevance in the categorisation of individuals would be age and/or educational qualifications, as an indicator of propensity to use ICT channels, suitability of household type to home-based work (i.e. availability of space, adequate telecommunications capacity, etc.) and the normal indicators of access to the various transport modes.

The decision rules of the model would focus on the fulfilment of required social interactions by either transport or telecommunications, the purchase of desired information-rich and material-rich services, the performance of work, the manufacture of the various product categories and the acquisition of the consumer goods required by the population.

The modal split between transport and telecommunications would, in the first instance, be according to the current or an anticipated equilibrium between the two mobility modes and then between the various submodes of each mobility mode according to the more conventional mechanisms of cost and/or transaction time. In the case of information-rich services, the split would be appropriately biased towards telecommunications and, in the case of material-rich services, towards transport. Work opportunities in the zone would be categorised according to the conventional descriptors and additionally according to the need to commute physically. The manufactured output would be categorised according to its logistical needs (i.e. marketplace/marketspace proportions and value-chain requirements). Consumer goods acquisition channels would be categorised according to the existing or desired balances between physical and electronic shopping and between multi-drop and multi-origin distribution in effecting deliveries.

Interactions between a given {zone **i**} as originator and the other {zones **j**} as attractors would be distributed according to the available infrastructure connections and predetermined rules (e.g. always give preference to own {zone **i**} or to cheapest/most adjacent next best option; or, alternatively, allocate between all {zones **j**} according to relative costs/times/distances). As suggested by Bieber *et al.*, the allocations could be subject to time or financial budgets, with appropriate "second best" allocation rules once the budget thresholds are exceeded. Axhausen and Gärling (1992) provide an interesting review of several conceptual frameworks and models within the activity-based approach to the analysis of travel behaviour. These frameworks would need to be extended to accommodate both forms of mobility and to deal with the "time compression" implications of physical→virtual mobility substitution.

In the case of services or industries with a strong interregional or international character, the routing of transport connections would be through selected ports, airports, rail terminals or logistical platforms, including combined transport interchange nodes. Where a certain industry type had overriding value chain preferences (such as where multinational firms pre-specify their supplier locations or where a teleprocessing facility has a specific country or firm affiliation), this could be imposed at the interaction distribution stage of the model.

Clearly, the model structure as specified could permit various characteristics of the transport system to be highlighted as parameters and, likewise, the various drivers of modal split between transport and telecommunications. In conventional fashion, the model could be used to check various "what if?"-type permutations of the pivotal variables and various policy scenarios embracing transport, telecommunications and/or various aspects of social organisation. For instance, in their work, Bieber *et al.* distinguished three over-arching scenarios: "conservative" (in which importance is given to the cultural role of cities), “modernist” (characterised by a concentration of banking power and an emphasis on technology) and “post-modernist” (associated with an individualistic, liberal dynamic).

9. CONCLUSION

As we contemplate the 21st century, there seems little doubt that information and communications technologies (ICT) will play a major role in our lives. To the extent that the activities of these technologies involve the transfer of data, they are of interest to the transport analyst. Previously, the transfer would have occurred through the medium of printed paper, which would have been transported from the location of generation of the data to the location of analysis. In the case of a direct substitution, there is a loss of traffic volume for transport. In the case of new applications, i.e. where new information transfers are stimulated by ICT itself, there may be no loss of traffic. To the extent that ICT stimulates economic activity generally, there may be a net increase in traffic flow for transport.

Those in the transport sector have the option of ignoring these developments and catering for the continuing market for physical mobility. ICT will provide valuable assistance to the task of the transport manager. As has been pointed out in this paper, the market for transport will change in character, as those who use transport for their social and marketplace needs also use telecommunications for their virtual-social and marketspace needs. The transport market will be part of the mobility picture and difficult to predict and address in the absence of the full picture.

Those in transport also have the option of recognising a fundamental change in paradigm and adjusting their thinking and *modus operandi* accordingly. By understanding the full picture and participating in both marketplace and marketspace, the transport firm has every opportunity of bringing itself successfully and excitingly into the 21st century.

The transport industry truly is at a crossroads.

TABLES

Table 1. **Trip purposes, traditional transport modes and new modal possibilities**

Trip purpose	Traditional modes	New modal possibilities
Visit a friend	Walk/bicycle/car	Telephone/videophone
Commute to work	Car/public transport	Telecommute
Long distance meetings	Air/rail	Videoconference
Supermarket shopping	Car	Teleshop, van deliveries
Dine at a restaurant	Car	Home deliveries
Rural schools	Car/bus	Satellite broadcasts
Go to the cinema	Car/bus/walk	Hire a video
Attend a sports event	Car/bus/train/air	Watch on television
Post a letter	Rail/ship/air/road	Fax or e.mail
Deliver a typed report	Car/van	Send via modem
Distribute newspapers	Road/rail	Display on WWW homepage
Distribute software	Road/rail/ship	Auto-install via Internet
Go to a concert	Car/public transport	Listen to quadraphonic CD

Table 2. **Examples of international firms with call centres or centralised teleprocessing facilities in Ireland (1996)**

Firm	Facility
American Airlines	European reservations
Becton Dickinson	Shared services centre
Best Western	Freephone hotel reservations
Dell	Manufacturing, technical support
Electrolux	Logistical management support
Gateway 2000	European technical support
Informix	Centralised finance, treasury, MIS
IBM	Sales, technical support
ITT Sheraton	Pan-European freephone centre
Quarterdeck	European technical support
Software Spectrum	European sales support
UPS	Freephone teleservices for Europe
Whirlpool	European shared services centre

Source: IDA, Ireland.

FIGURES

Figure 1. **Vectors of mobility**

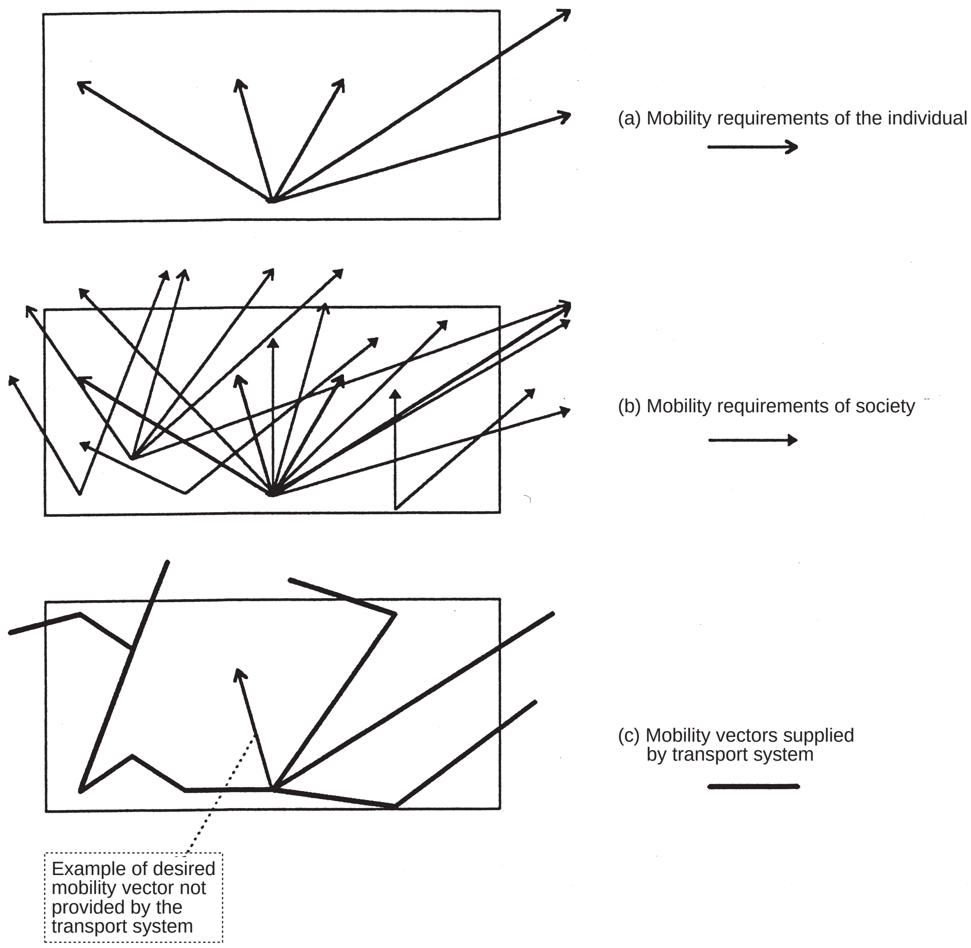


Figure 2. **The traditional perspective of business: fragmented value adding chain**

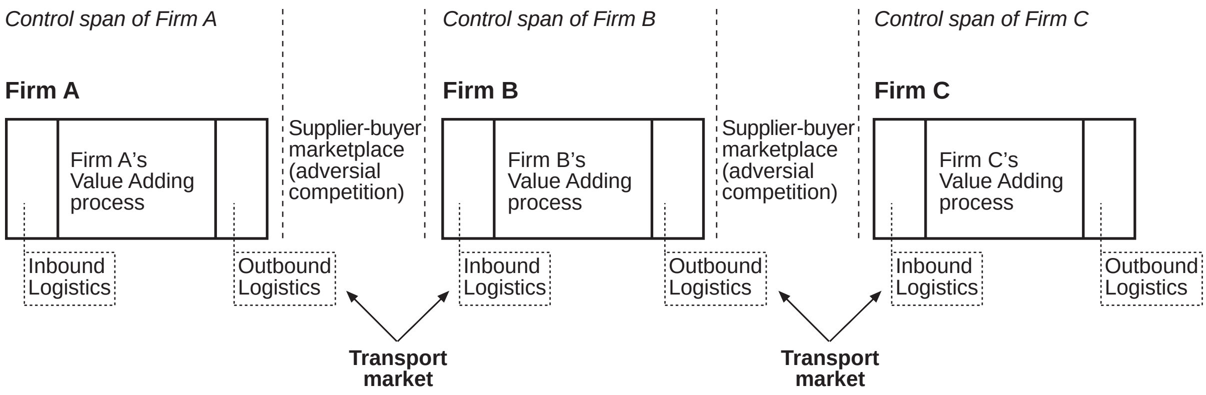


Figure 3. **A conventional perspective of business: vertically integrated value adding chain**

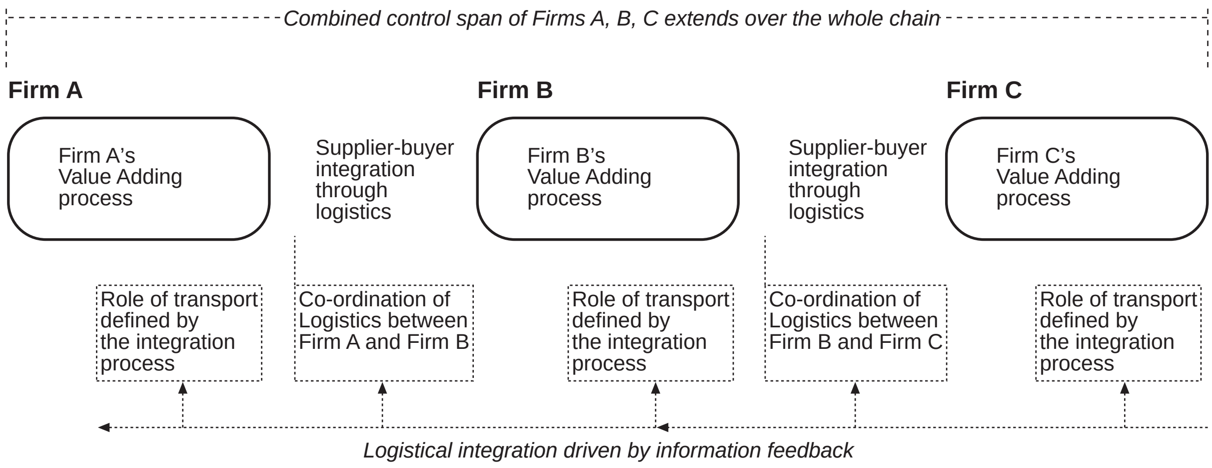


Figure 4. **Rail freight traffic trends in Europe**

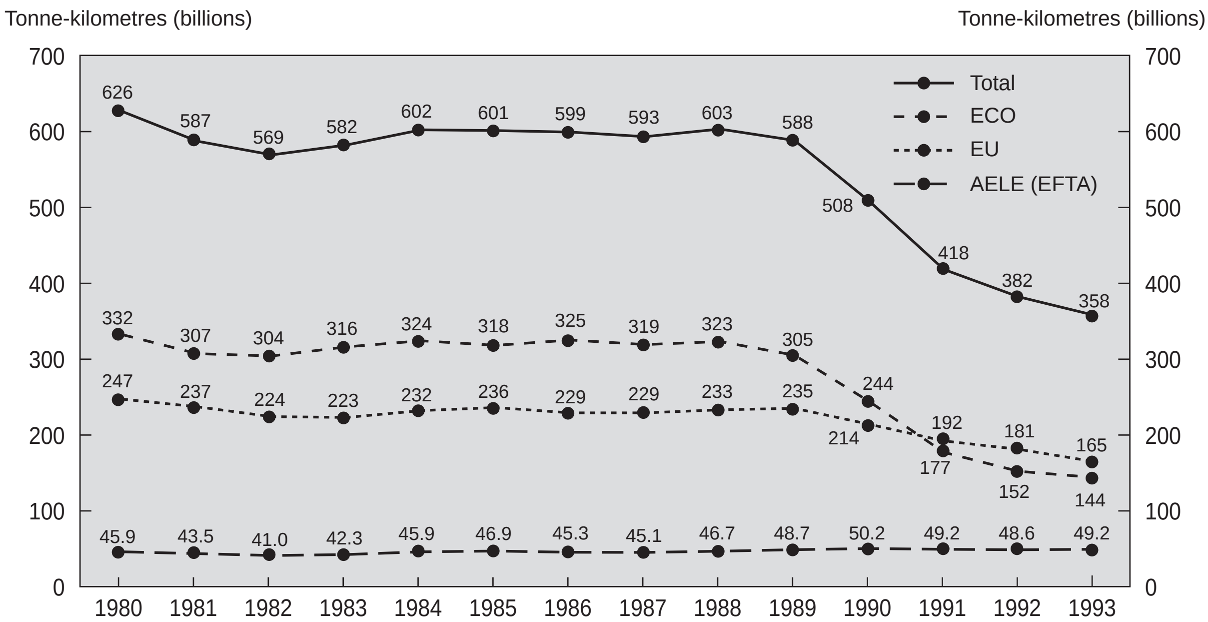


Figure 5. **"J4U distribution"**

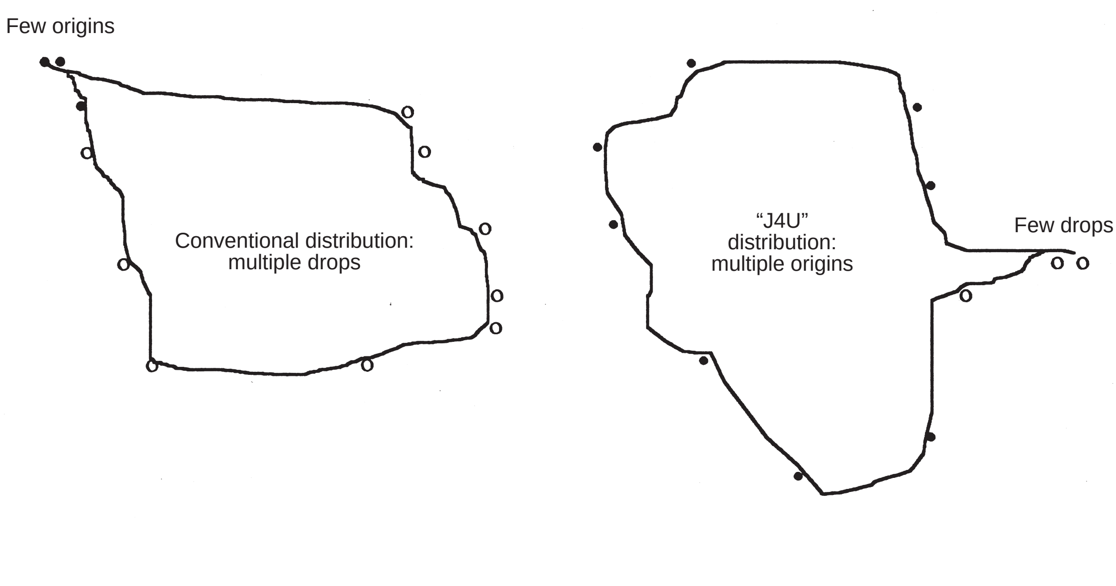
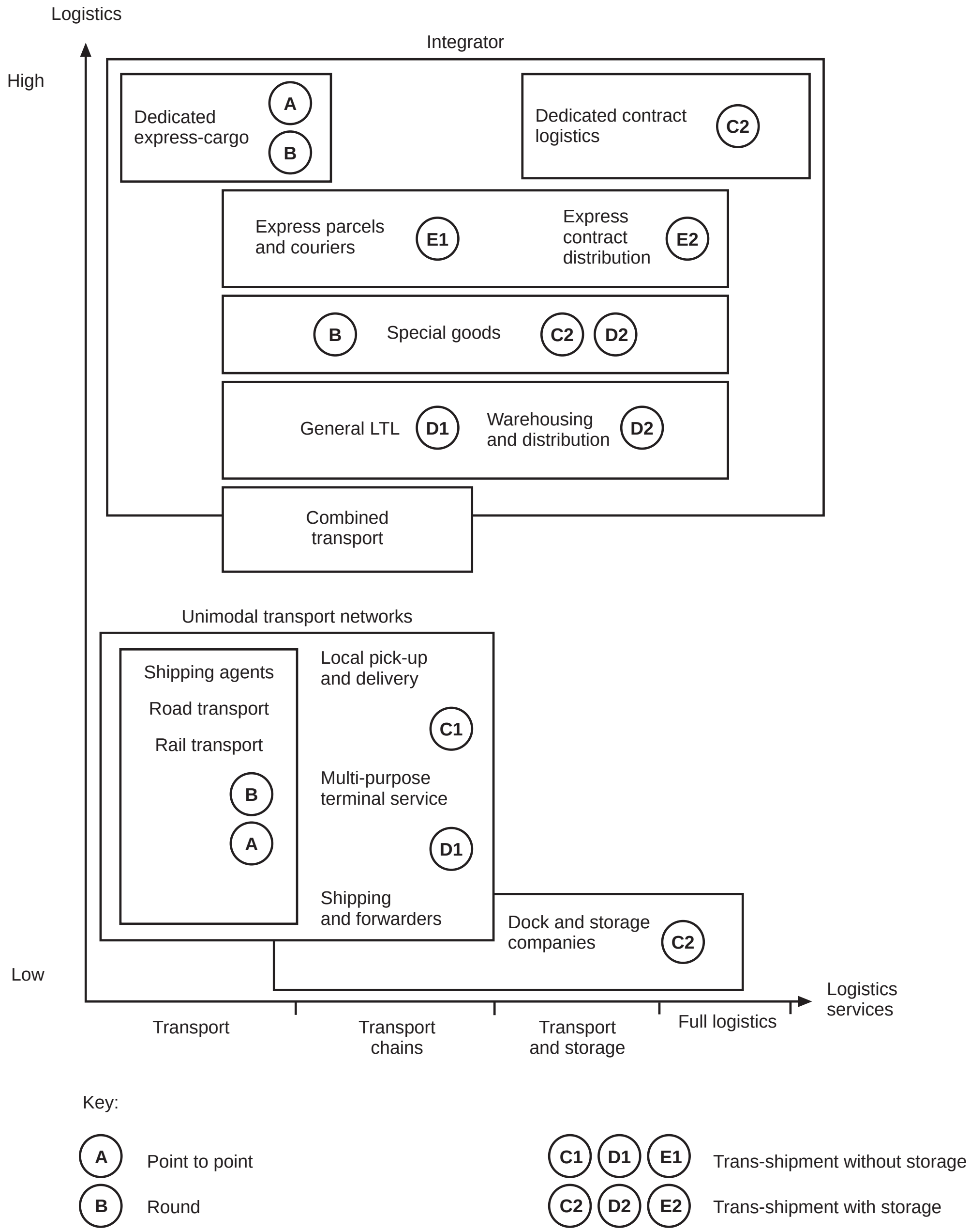


Figure 6. **Freight transport as an integral part of the value chain -- taxonomy of logistics service providers**



Source: OECD (1992).

Figure 7. **Marketplace and marketspace**

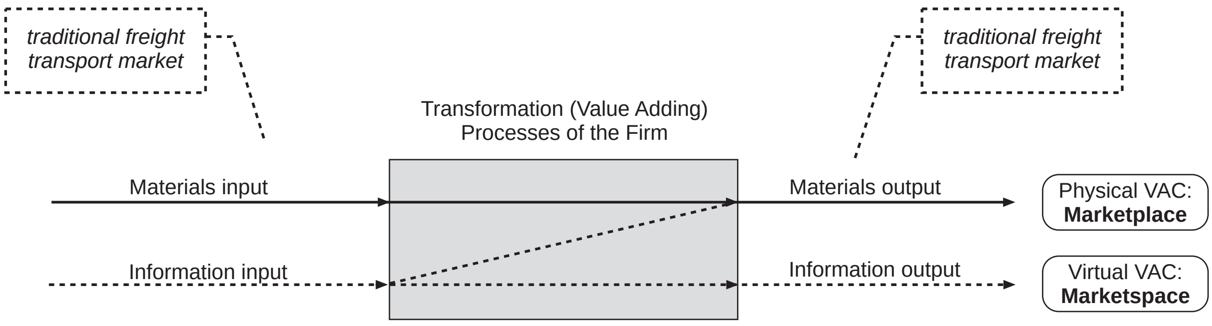
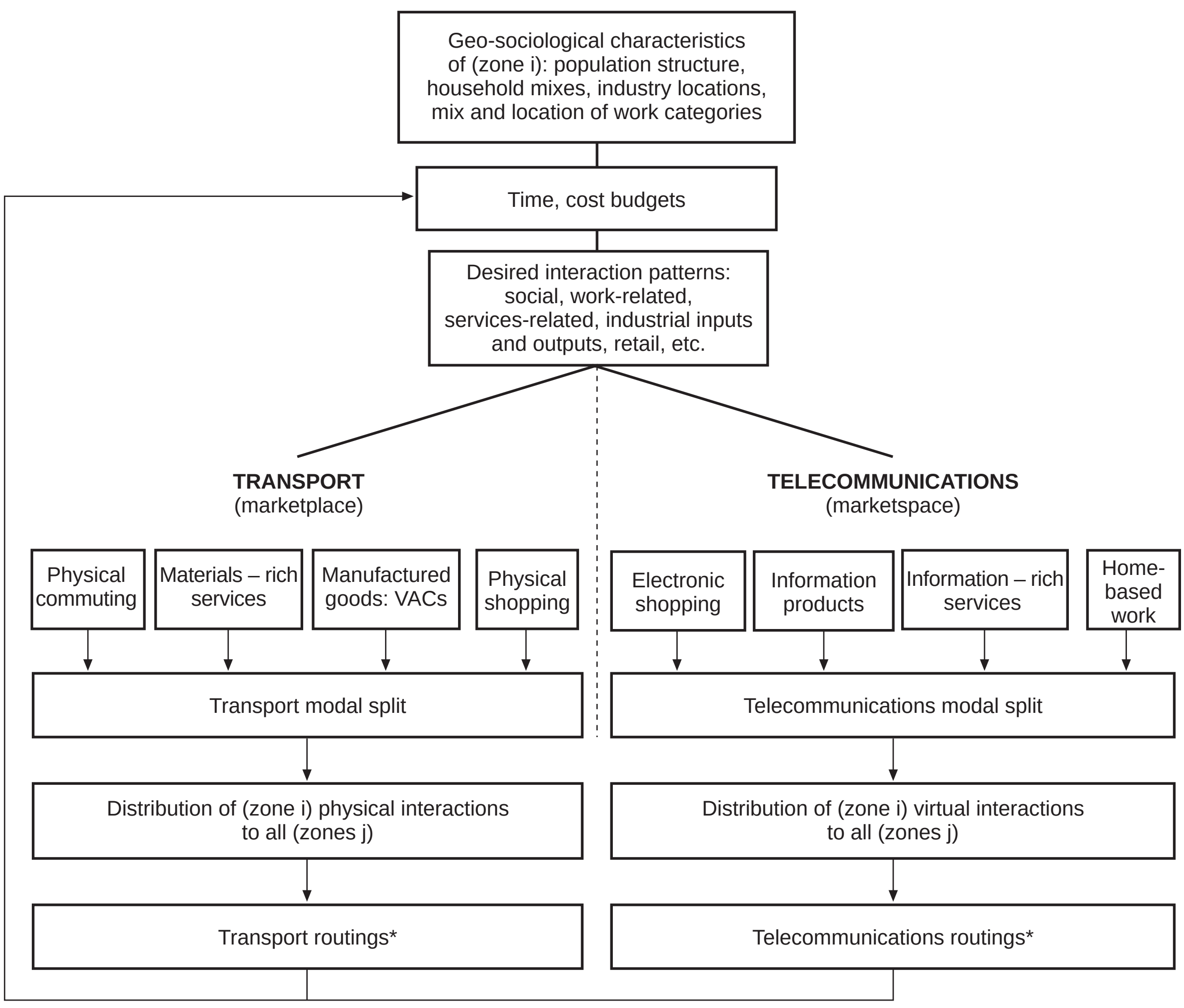


Figure 8. **Composite transport-telecommunications model framework**



* Including predetermined VAC preferences

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THE NEW TRANSPORT MARKET GENERATED BY TRANSITION IN THE CEECs
THE CASE OF HUNGARY

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SUMMARY

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1. THE RELATIONSHIP BETWEEN TRANSPORT DEMAND AND THE ECONOMY -- THE IMPACT OF ECONOMIC CHANGE ON THE TRANSPORT MARKET

Demand for transport is governed by a number of factors. Demand for passenger transport, for example, is primarily determined by the characteristics of the population (demographic breakdown, qualifications), settlement patterns (density of population, size of urban population), standards of living and consumer preferences, rates of employment, foreign and domestic tourism, geographical and climatic factors and the level of development of transport services. Demand for freight transport is mainly determined by changes in economic output, the distributive characteristics of production processes in terms of labour (heavy industry, agriculture or even the dominance of services), patterns of production and consumption (e.g. concentration of production and consumption in the steel industry versus concentrated production but widely dispersed distribution in the fertiliser industry), the level of development of logistics systems, transit traffic and international links, the level and efficiency of the transport system.

Despite the large number of factors which determine transport demand, the close relationship between Gross Domestic Product (GDP) and transport outputs provides some revealing insights at a macroeconomic level in that, while growth in the passenger transport sector outpaced growth in GDP, growth in the freight transport sector lagged behind that in GDP.

Between 1970 and 1990, for example, the average annual rate of growth in the GDP of EU Member States amounted to 2.6 per cent, while over the same period annual growth in passenger and freight traffic amounted to 3.1 per cent and 2.3 per cent, respectively [1].

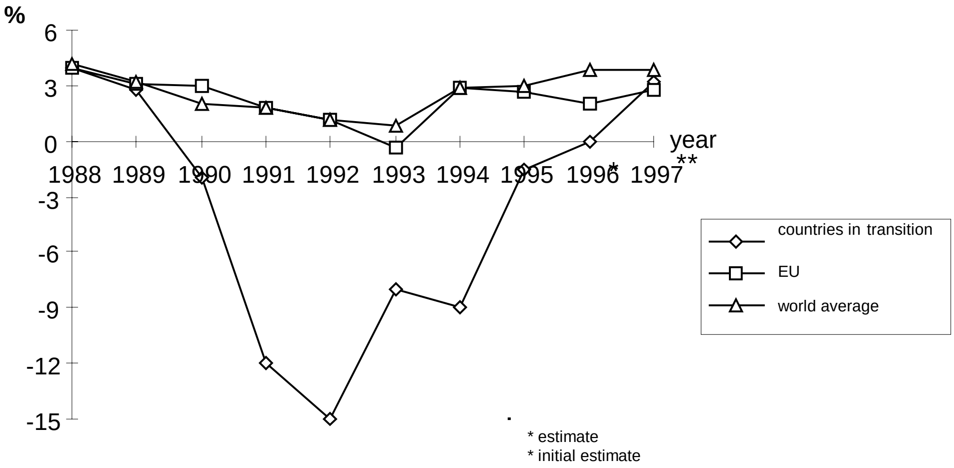
At the same time, the prolonged economic recession which the Central and Eastern European Countries (CEECs)[1] in transition have experienced shows that, when GDP declines continuously, output in the passenger transport sector declines at a lower rate than GDP and output in the freight transport sector at a higher rate (detailed figures are given in later sections of this paper). Therefore, before discussing future trends in the transport market, we must first examine or determine the rate of economic growth.

In 1996, the world economy grew at an average rate of 3.8 per cent, the highest rate of growth since 1988 and the International Monetary Fund (IMF) has forecast that the rate of growth will rise to an average 4.1 per cent in 1997.

Against the background of growth in the world economy, the United States maintained its position, the economies of EU Member States slowed virtually to a standstill, the developing countries outside Asia started to find their feet and some of the countries in “transition” began to make progress while others continued to decline [2].

In short, the economies of the so-called countries in “transition" have been in constant recession since 1990 -- the largest decline being in 1992 when GDP fell by 15 per cent -- and 1996 was the first year in which this trend finally halted (Figure 1).

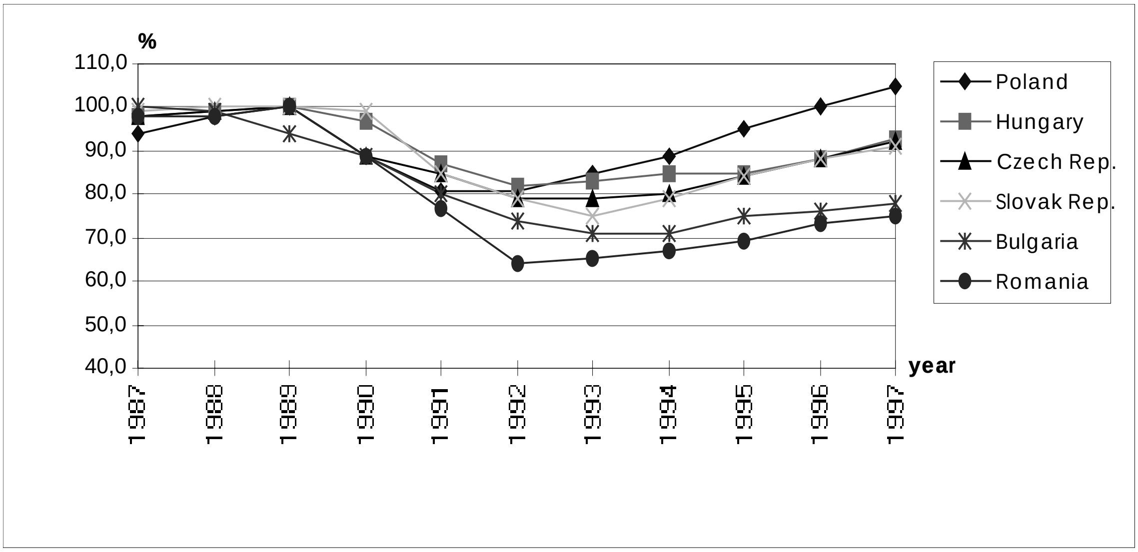
Figure 1. **Economic growth -- year-on-year percentage growth in GDP, 1988-97**
(World average, EU, countries in transition)



Source: [2].

Of the countries in transition, those which were not originally part of the former Soviet Union are now in a relatively better position. The average annual growth in the economies of the CEEC-11 countries in 1995 and 1996 amounted to 4 per cent. The debt burden of the countries in this area fell to US$ 90 billion from the total of US$ 160 billion five years earlier. However, in none of the six CEECs **--** apart from Poland **--** has GDP risen back to the level observed prior to transition (Figure 2).

Figure 2. **Trends in GDP in the CEEC-6 countries (1987-97)**
(100 per cent in 1988 or 1989)



Source: M. Gaspard [4] and OECD.

Compared with the EU average, the 1990 level of the economy in the CEEC-6 countries -- expressed in terms of per capita GDP -- was only slightly over 40 per cent. Again, the average economic performance of the region in 1992 fell almost by 30 per cent compared with the 1989 level.

In the meantime, in response to the introduction of an open market economy and the reduced purchasing power of eastern European countries, the pattern of central and eastern European freight traffic flows shifted away from the East towards western Europe and currently over 60 per cent of the region’s traffic flows are to EU and EFTA Member States. Despite a significant increase in international traffic, compared with the 1988-89 "peak" year for domestic freight transport performance, the economic changes stemming from the transition to the market economy coupled with the permanent recession resulted, over a period of five years, in a decline of over 30 per cent in the total freight transport output of the region due to the 50-100 per cent decrease which certain countries experienced.

This decrease affected individual subsectors in different ways. The decline amounted to almost 50 per cent for rail transport, less for inland waterways and, all in all, 10-20 per cent for road freight transport. Given these differences, the size of the share of the modal split accounted for the different modes has changed.

A comparison of the CEECs with the twelve most developed western European economies shows that over the ten-year period 1985-1994/5, the volume of passenger traffic in western European countries (in passenger-kilometres) grew by 39 per cent but declined by 25 per cent in the CEEC-11 countries. Between 1985 and 1994/5, the volume of freight transport (tonne-kilometres) rose by 30 per cent in western European countries but declined by 44 per cent in the CEEC-11 countries (Table 1).

Table 1. **Changes in passenger and goods transport performances (1980-1985-1995)**

Sector	**Year**		
	1980	**1985**	**1995**
Passenger transport (billion pass-km) excluding air traffic			
Western European countries$^{\triangledown}$	2 748.5	2 933.9	4 071.6
CEEC-11$^{\triangledown\triangledown}$	344.4	383.3	286.4*
CEEC-6$^{\triangledown\triangledown\triangledown}$	303.1	335.6	266.5*
Freight transport (billion tonne-km) Maritime navigation excluded			
Western European countries$^{\triangledown}$	1 043.3	1 069.3	1 397.0
CEEC-11$^{\triangledown\triangledown}$	547.8	528.5	305.9*
CEEC-6$^{\triangledown\triangledown\triangledown}$	470.9	440.5	269.5*

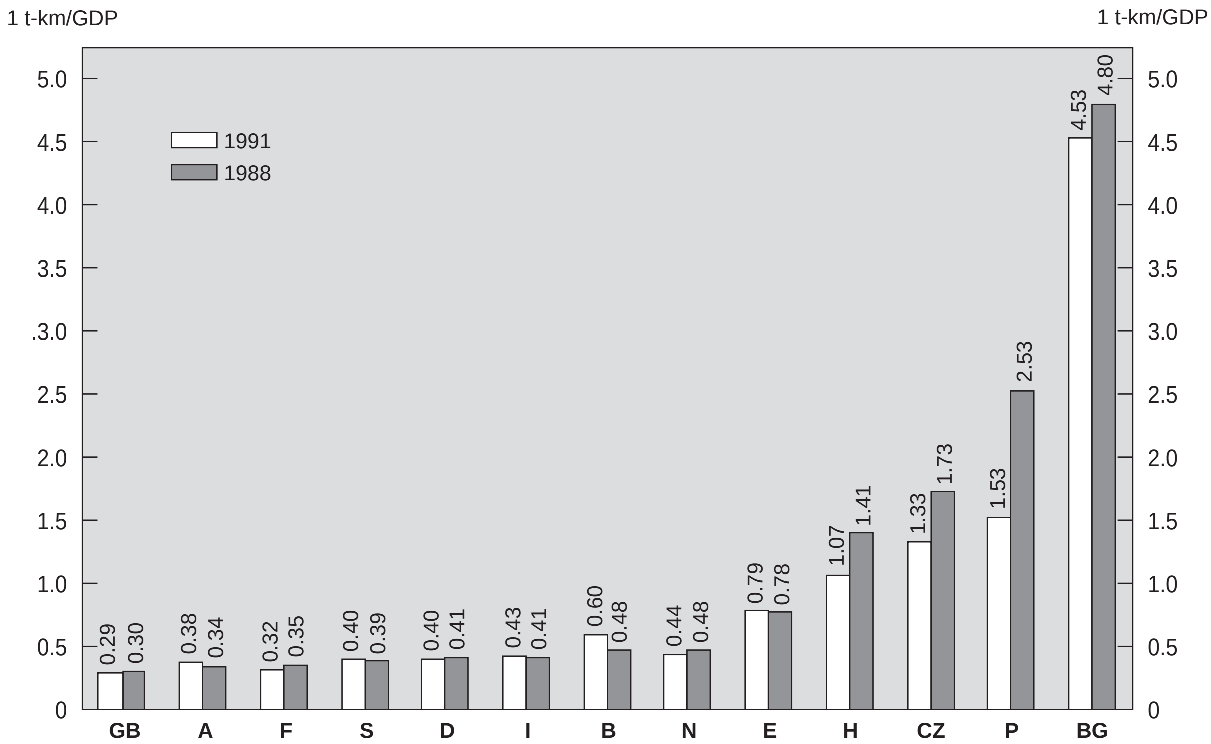
Key:
* 1994 data
** 1993 data
$^{\triangledown}$ A, B, CH, D, DK, E, F, FIN, GB, I, NL, S (total population** = 363 million)
$^{\triangledown\triangledown}$ BG, CZ, EST, H, HR, LT, LV, PL, RO, SK, SLO (total population** = 111 million)
$^{\triangledown\triangledown\triangledown}$ BG, CZ, H, PL, RO, SK (total population** = 96 million)

Source: ECMT, KSH.

In 1994-95, while yearly per capita passenger transport performance (passenger-km) in the CEEC-11 countries was 77.7 per cent lower than that in western European countries, per capita freight transport (tonne-km) was only 27.4 per cent lower.

A correlation of per capita GDP to the transport performance of the CEECs and EU Member States shows that low GDP is accompanied by low passenger traffic but high freight transport output (Figure 3).

Figure 3. **Freight transport output by GDP unit**



The previous magnitude of specific freight transport outputs is well illustrated by the fact that in 1980 the per capita freight transport output in the group of CEEC-11 countries measured in tonne-kilometres was 71.7 per cent higher than the average per capita output in tonne-kilometres of the advanced western European countries.

In addition to geographical location and the relatively low density of the population, the volume of freight transport **--** which is high, given the economic output of the CEECs **--** may be explained by a number of factors such as the misguided and less cost-sensitive organisation of the transport sector in previous years, the absence of a logistical approach, the often politically-oriented selection of industrial and commercial sites, outdated industrial, agricultural and commercial structures, lack of adequate transport infrastructure (networks, bridges). In the course of the socio-economic transition, the role of the enlisted factors faded, some of them even became totally irrelevant and there is now strong competition **--** especially in the fully liberalised market for road haulage services.

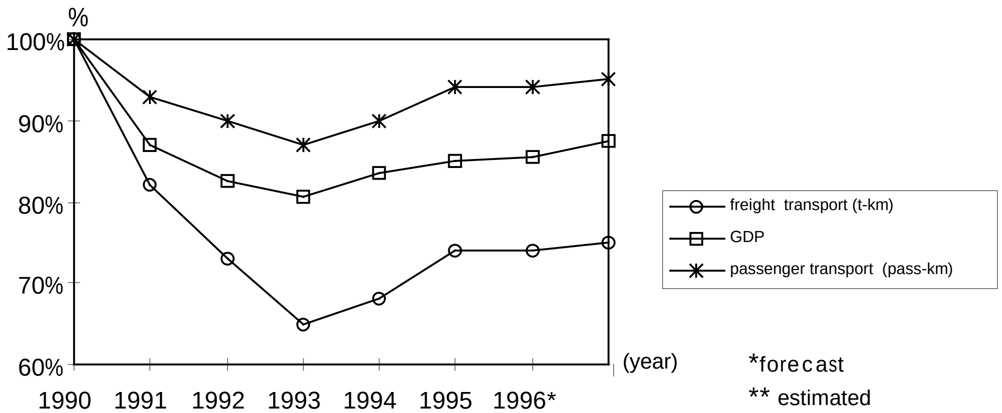
The decline of GDP in absolute terms reduced demand for freight transport in the CEECs, while the economic transition and strong market competition also exerted downward pressure on demand by reducing rigidities.

Nevertheless, in the long term, demand for passenger transport in the CEECs can be expected to grow at a faster pace and demand for freight transport -- stemming from the removal of rigidities -- can also be expected to rise, although to a lesser extent than demand for passenger transport. This forecast is based on independent estimates by several international experts, according to which, over the period 1996 to 2000, the economies of the CEECs are expected to grow at an average annual rate of 4 to 6 per cent, while annual growth in GDP in real terms is expected to amount to 6-9 per cent over the period 2000-2005. (The author considers the lower limits to be more realistic.)

2. ECONOMIC GROWTH AND GROWTH IN PASSENGER AND FREIGHT TRAFFIC IN HUNGARY

Hungary's transition to a market economy since 1990 has also had a significant impact on the structure and output of traffic.

Figure 4. **Trends in GDP and passenger and freight transport outputs from 1990 to 1997**



Hungary's Gross Domestic Product (GDP) declined by a total of around 20 per cent between 1990 and 1993, but from 1994 to 1996 grew by almost 3-4 per cent.

While the decline in passenger transport outputs remained below the rate of decline in GDP, the decline in freight transport outputs was higher than that in GDP.

The volume of passenger traffic (in passenger-kilometres) in 1995 was 6 per cent lower than in 1990, while over the same period the volume of freight traffic (in tonne-kilometres) declined by 26 per cent.

While the volume of public transport traffic declined, the number and utilisation of passenger cars increased, despite the fact that the rapid increase in running costs significantly reduced the overall performance of the passenger car fleet. The sharp decline in demand for public transport is attributable to rising levels of car ownership and the tariff increases of recent years, which were substantial although economically sound (Table 2).

In 1995, the road sector's share of the modal split in Hungary amounted to 82.5 per cent, rail to 11.1 per cent, urban trams and metros 3.2 per cent, air transport 3.1 per cent and inland waterways 0.1 per cent; private cars accounted for 53.5 per cent of the total.

Table 2. **Passenger transport outputs in Hungary (1990-97)**

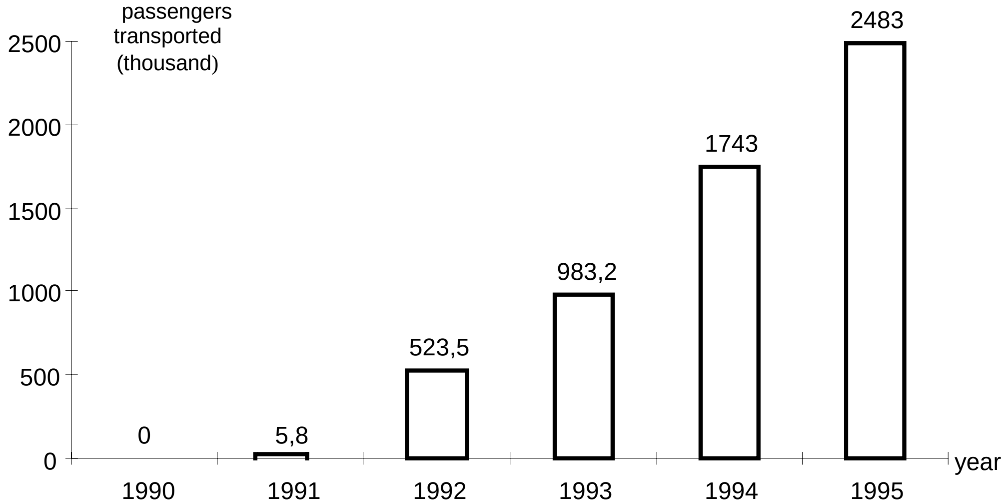
(million pass-km)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996***	**1997****
passenger car	48 725	47 375	45 100	44 498	45 700	45 800	47 200	48 900
bus	27 411	27 386	29 370	24 805	25 491	25 701	25 730	25 500
tram/metro	3 306	3 048	2 967	2 654	2 706	2 648	2 590	2 550
rail/suburban railways	12 193	9 861	10 608	9 077	9 199	9 040	9 031	8 900
rivers and lakes	67	55	58	60	52	55	50	50
air traffic	1 695	1 287	1 478	1 631	2 235	2 383	2 499	2 700
Total:	**93 397**	**89 012**	**84 581**	**82 725**	**85 383**	**85 627**	**87 100**	**88 600**

* expected value
** estimated value

Source: KSH, KTI.

The shares of private car transport and air transport in the modal split both grew, while that of bus transport remained unchanged. The share of tram/metro traffic declined, although the number of railway passengers using intercity lines, which provide higher quality service, has increased (Figure 5).

Figure 5. **Growth in intercity rail traffic in Hungary**



Source: MÁV Rt.

However, higher levels of passenger comfort will not be sufficient for the railways to halt the advances made by road. Nevertheless, in comparison with western European countries, the share of rail in total passenger traffic in Hungary in 1994 was still almost twice the European average, while that of bus was four times the European average (Table 3).

Table 3. **Modal split of passenger traffic in Hungary and given country groups**
(Passenger-kilometres)

(%)

Mode	**1970**	**1980**	**1990**	**1994**
Rail (1)	9.9	8.6	6.9	6.5
Hungary	*32*	*18*	*13*	*11.5*
Car (1)	77.7	79.4	83.7	85.1
Hungary	*28*	*48*	*56*	*56.8*
Bus (1)	12.4	12.0	9.4	8.4
Hungary	*39*	*33*	*31*	*31.7*
Total	**100.0-100.0**	**100.0-100.0**	**100.0-100.0**	**100.0-100.0**

(1) 1970-90 EC Member States
1994 EU Member States

Source: ECMT, KTI.

As a result of improved market mechanisms in the freight transport sector, coupled with structural changes in the Hungarian economy in which demand for transport still remains high by international standards, demand for freight transport has fallen and, reflecting the decline in production since the late 1980s, transport outputs too have decreased in absolute terms. The shift in the direction of trade flows from East to West and the rapid increase in manufacturing and commercial outputs as part of the modernisation of the Hungarian economy has led to priority being given to the transport of goods with higher added value over that of high-volume bulk goods. In addition to international transport, demand for deliveries of smaller local and regional consignments has increased significantly. This process has transformed the structure of truck traffic and has further weakened the position of the railways. As a result of the recession in manufacturing sectors which had previously generated strong demand for transport, the output of inland waterways has also declined.

In 1995, excluding maritime transport, the road sector accounted for 49.9 per cent of the modal split in the freight market, the railways 29.7 per cent, transport by pipelines 13.7 per cent and inland waterways 6.7 per cent (including ferry and harbour services; if the latter are excluded, the output amounted to less than 4 per cent.)

Between 1985 and 1995, the share of the freight transport market accounted for by road and pipelines has increased, while that of rail and inland waterways has declined (Table 4).

Table 4. **Freight transport outputs in Hungary, 1990-97**

(million ton-km)	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**	**1996***	**1997****
road	15 179	13 760	12 946	12 951	13 405	14 203	14 500	15 000
rail	16 782	11 939	10 015	7 708	7 724	8 409	7 500	8 400
inland waterway	2 087	1 719	1 575	904	866	1 900	2 200	2 700
pipeline	5 287	4 912	4 326	4 108	4 106	3 900	4 300	4 400
Total:	**39 336**	**32 330**	**28 862**	**25 671**	**26 101**	**28 412**	**28 500**	**30 500**

* expected value
**estimated value

Source: KSH, KTI.

Despite these changes, which mirror the modal split in the passenger sector, there is also a significant difference between the modal split in the freight transport sector in Hungary and the CEECs compared with that in western European countries (Table 5).

In 1994, within the CEEC-11 area, the share of the railways in the modal split was more than three times that in western European countries, while the share in Hungary was about two times higher.

In comparison with western European countries, the road sector’s share of the modal split for freight transport in all CEEC-11 countries is low, although road’s share of the modal split in Hungary is closer to the western European than to the CEEC average.

The share of inland waterways, even when calculated retrospectively over the past 25 years and despite the changes in the economy, remains small. The low share of inland waterways is particularly obvious in the case of Hungary, where the share accounted for inland waterways fell from almost 10 per cent in the 1970s to 3.9 per cent in 1994, compared with the western European average of almost 8 per cent.

Table 5. **Modal split of freight transport in Hungary and some country groups**
Freight transport (tonne-km)

(%)

Mode		**1970**	**1980**	**1990**	**1994**
Rail	(1)	31.3	23.2	17.3	15.9
	(2)	80.9	72.8	68.0	59.4
	Hungary	*68*	*64.1*	*49.3*	*35.2*
Road	(1)	55.2	66.0	74.2	76.2
	(2)	16.2	24.5	29.2	38.4
	Hungary	*22*	*30.6*	*44.6*	*60.9*
Inland waterways	(1)	13.5	10.8	8.5	7.9
	(2)	2.9	2.7	2.8	2.2
	Hungary	*10*	*5.3*	*6.1*	*3.9*
Total		**100.0**	**100.0**	**100.0**	**100.0**

(1) B, CH, D, DK, E, F, FIN, I, L, N, NL, S, TR, UK
(2) CEEC-11 = BG, CZ, EST, H, HR, LT, LV, PL, RO, SK, SLO

Source: ECMT, KSH, KTI.

2.1. Freight traffic flows in Hungary

Hungary has traditionally had an open economy. In recent years, over half of each Hungarian *Forint* generated in the national economy was acquired through the international division of labour.

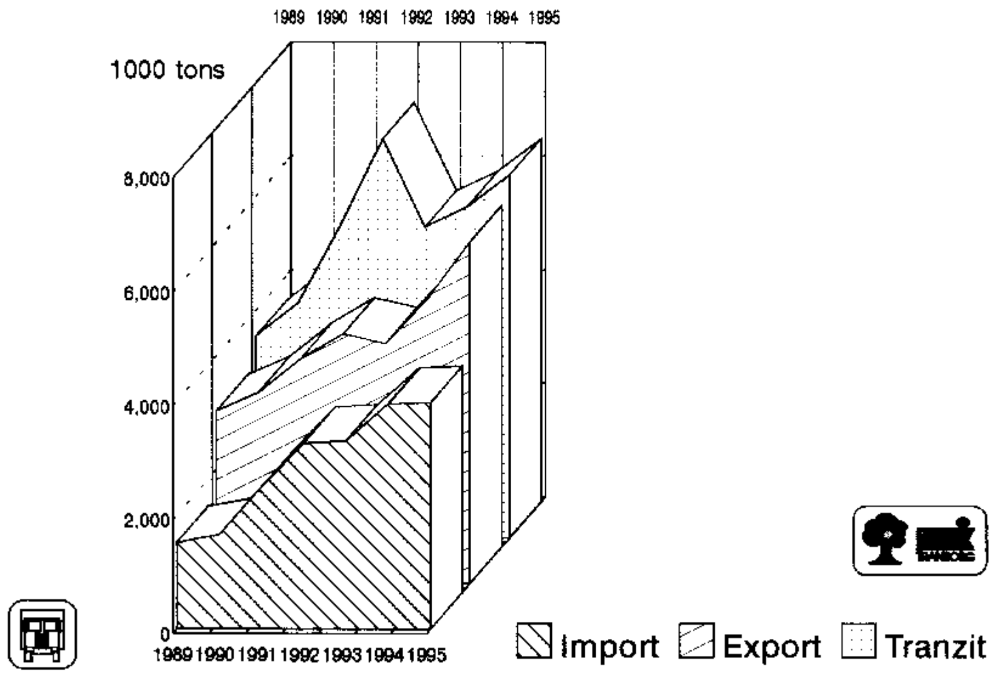
The relationship between trade and production and consequently freight traffic flows, has significantly changed as a result of the socio-economic changes in Hungary. In 1986, over half of Hungary's exports (52.6 per cent) were to the former socialist countries, but by 1991 this share had fallen to merely 23.6 per cent. In 1995, about a quarter of Hungary's exports in terms of value were with the former socialist countries and nearly 70 per cent with the EU, EFTA and other countries associated with the EU.

A similar trend may be seen in the pattern and size of Hungarian imports, too. While in 1986 half of Hungary's imports (49.6 per cent) came from the former socialist countries, in 1990 this share had dropped to less than a third (29.2 per cent) and appears to have stabilized at this level.

Against this background of social and economic change in Hungary, while overall freight transport outputs declined during the years of transition, the volume of exports/imports as well as transit traffic has practically doubled (Figure 6).

Figure 6.

The trend of the international roadtransport of goods in Hungary



The increased level of truck traffic reported at border crossings was especially significant (Figures 7, 8).

In terms of import and export traffic and also the direction and turnover of road freight transport, Hungary's most important trading partners are: Germany, Austria and Italy (Figure 9).

A map of cross-border rail traffic for Hungarian export-import flows also shows that, proportionally, the highest volumes of railway traffic were towards Slovenia, the Ukraine and Austria (Figure 10).

Figure 7. **Truck traffic at border crossings**

Figure 8. **International road, railway daily average freight traffic 1993**

Figure 9. **The main export-import traffic directions on the road in Hungary**

Figure 10. **Export-import traffic on the railway, 1995 (%)**

Figure 11. **The proposed areas for logistic centres in Hungary**

In view of the openness of Hungary's economy to international trade and the importance of Hungary's geographical position for transit traffic (corridors 4, 5 and 7 transiting Hungary) together with the increasingly widespread use now being made of the logistic systems in manufacturing and distribution introduced by multinational companies, there are positive signs that Hungary may enhance its role as a logistic centre.

The Transport Policy adopted by the Hungarian Parliament in 1996 places particular emphasis on securing greater recognition of Hungary's importance as a country of transit as a way of promoting integration into the European Union.

One of the goals of this policy is therefore to enhance the attractiveness of the Hungarian sections of European corridors which, together with the provision of adequate infrastructure, could also be promoted through the creation of freight traffic centres.

In Hungary, ten economic districts have been identified as suitable candidates for the construction of logistical centres (Figure 11).

The services of a given logistical centre from the standpoint of traffic may be determined on the basis of its collection and distribution activities, the volume of long-distance traffic within the country and by the volume of export-imports and transit forwarding. This classification by traffic means that in choosing a location, the requirements of a regional or central site, based primarily on transit traffic, will be entirely different.

In terms of Hungary's economic development, the provision of logistical centres catering to transit traffic has been given top priority, on the basis that collection and distribution functions -- which are also important for the country -- will develop later. Thus, when choosing the site of such centres, account must be taken of locations where changeovers in large volume transport forms are either unavoidable (e.g. rail gauge change at Záhony) or advantageous (e.g. combiterminal/Sopron/ port/Gyõr-Gönyû, etc.).

2.2. Structural changes in the different transport modes in Hungary

2.2.1 Road transport

In Hungary, the road sector accounts for a substantial share of transport outputs. Between 1990 and 1995, the size of the vehicle fleet grew by 14.4 per cent. The largest increase was in the truck fleet which grew by 23.2 per cent, including a 3.5 per cent increase in light commercial vehicles. Over the same period, the number of private cars rose by 15.4 per cent, while that of motorcycles and buses declined (Table 6).

A good indication of how the Hungarian freight transport market has evolved may be seen in the fact that, for the reasons described earlier, while the volume of goods to be transported declined during the period of transition in the Hungarian economy, at the same time, the number of trucks increased and, within the transport sector as a whole but particularly within the road freight sector, the number of economic units and small enterprises has multiplied (Table 7).

In 1993, the Hungarian road freight transport sector (with the exception of the international road haulage company, HUNGAROCAMION) was fully privatised.

Table 6. **Number of road vehicles in Hungary**

	Motor vehicles (1000 units)				
Year	**Passenger cars**	**Buses**	**Motor cycles**	**Trucks**	**Total**
1990	1 945	26	169	263	2 403
1991	2 016	24	166	265	2 471
1992	2 058	23	163	266	2 510
1993	2 093	22	156	274	2 547
1994	2 177	21	157	298	2 653
1995	2 245	20	159	324	2 748
1996*	2 315	20	159	345	2 839
1997**	2 400	19	160	351	2 930

* expected
** estimated

Source: KSH, KTI.

Table 7. **Economic organisations in the transport sector according to management structure (1980-95)**

(unit)

Management structure	**1980**	**1990**	**1991**	**1992**	**1993**	**1994**	**1995**
Company	43	71	74	56	23	20	14
Private companies	1	585	913	1 672	2 087	2 461	3 033
of these: KFT/Ltd.	-	575	903	1 646	2 032	2 400	2 934
Rt /share co./	1	5	7	18	52	56	66
Co-operatives	3	78	69	68	73	74	71
Total:	**47**	**734**	**1 056**	**1 796**	**2 183**	**2 555**	**3 118**
Organisations funded by government	13	13	44	44	44	44	44
Small enterprises	8	29 500	58 903	60 224	62 818	60 745	57 868

Note: End-of-year data.

Source: KSH, KHVM, KTI.

Following privatisation, most companies were downsized, with the result that 80 per cent of the Hungarian vehicle fleet is operated by road haulage firms with fewer than 6 trucks. In the CEECs, companies smaller than these are only to be found in Slovakia and the Czech Republic (Table 8).

In spite of strong competition in the freight market, mainly due to capital forces and the level of transport organisation and also to the fact that the average age of the Hungarian truck fleet is over ten years, in the mid-nineties nearly 60 per cent of Hungarian export-import traffic was carried by companies under foreign ownership.

The State has either full or majority ownership of all the public transport companies providing scheduled local and long-distance bus services. However, fully privatised companies which have been awarded a concession are also authorised to provide scheduled bus services.

Table 8. **Size of road freight companies on the basis of the number of vehicles owned in 1993**

(%)

Number of vehicles	BG	CZ	EST	H[5]	PL	RU[6]	RO	SK[7]
1-5	80	87.7	45	80	75[2]	48[3]	16.8	94.5
6-20	10	9.6	25	12	-	52[4]	1.0	4.6
21-50	6	2.7[1]	15	5	25[1]	-	2.8	0.7
51 and above		-	15	3	-	-	79.4	0.2

(1) 21 or more vehicles
(2) 1-20 vehicles
(3) 1-10 vehicles
(4) 11 or more vehicles
(5) estimate
(6) ASMAP members only
7) Fleet operated by international road hauliers only.

Source: [7].

Under the 1996 legislation on concessionary tenders, concessions are gradually being granted for local public transport services. Efforts are currently being made to privatise the State-owned VOLÁN bus companies which provide scheduled public bus services. However, it is doubtful whether this exercise will be a success given the high capital requirements, the fact that the average age of the fleet is eleven years and the low and regulated tariff structure.

Nevertheless, in the longer term, the strong competition among bus companies which already prevails in the public transport sector may, through further privatisation and increased levels of car ownership, match the level achieved in the freight transport sector.

2.2.2 Rail transport

The performance of the rail transport sector has been significantly affected by a 26 per cent decline in passenger traffic (in passenger-kilometres) and a 50 per cent decline in freight traffic (in tonne-kilometres).

Hungarian railways (primarily Hungarian State Railways Ltd., MÁV Rt) is responsible for the two separate activities of infrastructure management and business operations. A number of regional railway companies have been set up on an experimental basis to operate secondary lines. Economic rationalisation of resources requires the elimination of unused capacity. Between 1990 and 1995, the number of staff employed by the railways fell by 25 per cent.

The number of traction units has remained practically unchanged, apart from the number of diesel locomotives which has fallen by 25 per cent. The number of freight wagons has been reduced by 45 per cent and the number of carriages has also been reduced although to a lesser extent.

In addition to the reduction and scrapping of traction units and rolling stock, a programme of modernisation is also underway (acquisition of new rolling stock for combined mode operations, the intercity system, diesel multiple-unit trains, etc). Despite the scrapping and modernisation, however, there is still a very high proportion of rolling stock over 15 or 30 years old.

2.2.3 Combined transport

Given Hungary's surface area, combined transport does not play an important role in domestic transport in Hungary but is becoming increasingly significant for transit traffic.

In 1995, the output of the combined freight transport with regard to export and import flows and transit traffic was twenty times higher than output for domestic combined freight transport.

Despite the rising numbers of enterprises engaged in combined transport and the expansion of technical facilities and capacities, growth in output from combined transport operations largely depends upon the number of quotas and transit permits issued and is therefore constrained by regulations.

As shown in Table 9, combined road-rail transport (Ro-La) has grown particularly strongly and, compared with 1993, 96 per cent more truck combinations were transported by the railways in 1995.

In 1996, the share of combined transport in the volume of freight transported by rail in Hungary **--** including piggyback and containerised shipments **--** amounted to over 7 per cent and by the turn of the century is expected to reach 10 per cent. Due to inefficiency, however, combined inland waterway and road transport modes (Ro-Ro) are currently stagnating, although a number of trial schemes are underway in an attempt to revive them.

Table 9. **Combined transport: Growth in the road-rail (Ro-La) outputs (1992-97)**

	Number of trailers transported (unit)		
Period	**Starting**	**Arrival**	**Total**
2nd half of 1992	6 185	8 445	15 030
1993	13 860	15 043	28 903
1994	14 821	10 639	25 460
1995	22 640	33 960	56 600
1996*	40 777	48 000	80 000
1997**	38 000	57 000	95 000

* forecast value
**estimated value

Source: [8], KTI.

2.3. Human resources

Between 1990 and 1995, the number of people employed in the transport sector in Hungary fell by almost 100 000 and in 1995 accounted for 7.4 per cent of those in gainful employment. However, over the period 1985-95, this represents a 0.7 per cent increase in the share of the working population. This is due to the fact that the number of persons employed in the transport sector declined to a lesser extent (e.g. by 5 per cent in 1994) than the number working in financial sectors (where employment fell by 12 per cent in 1994). In the transport sector as a whole, the proportion of persons employed in the field of road transport is over 40 per cent but still below the 44-47 per cent level reported in the

EU. However, the number of specialists working in the areas of shipment, packaging, storage and logistics -- also connected to road traffic -- is rising both in terms of numbers and share of the total employed.

2.4. Development of transport infrastructure

The territorial density of the Hungarian road network (319 km/thousand km^2) is close to the European average. Motorway accessibility (km/1000 inhabitants) in Hungary, however, is four times lower than the European average, despite the fact that Hungary is ranked higher than Greece or Portugal. In 1993, the territorial density of Hungary's motorway network (km of motorway/ 1000 km^2) was 6 to 9 times lower than that of Austria, Italy and Germany. The main objectives of Hungary's transport policy are to develop links with neighbouring countries and thus promote the process of European integration by extending the Hungarian motorway network, increasing the number of border crossings and constructing by-passes to relieve congestion on main roads on which traffic loads are high. The opening of the Gyõr-Hegyeshalom toll-section of the M1 motorway in 1996 has now linked the Hungarian motorway network to the western European road network via Austria. The new western section of the Budapest-Belgrade M5 motorway up to Kiskunfélegyháza is currently under construction and in 1996 work began on widening the Gyöngyös-Polgárdi section of the M3 motorway to Ukraine and the Mosonmagyaróvár-Rajka section of the M15 motorway (a link road to Bratislava). While the State will continue to provide various levels of funding for motorway construction, concessions will be offered for all future motorways which will therefore be operated on a toll basis.

In view of the fact that the State made no financial contribution to construction of the new section of the M1, other than providing the land, the tolls charged on this new section are currently the highest in Europe (DM 10/42 km). However, since the State expects to provide greater funding for motorway construction in the future, the tolls on other motorways are likely to be lower. This is essential if domestic traffic is to be encouraged to use these motorways and thus avoid vehicle traffic transferring onto secondary roads.

Work is proceeding on the widening of several border crossings and, due to weekend restrictions on trucks over 7.5 t gross weight, a number of lorry parks will need to be built (in view of the results of trial bans on weekend traffic between 1 July and 31 August 1996, weekend restrictions are to be introduced by 1 January 1997). The widening of the road bridge at Záhony will substantially improve traffic flows between Ukraine and Hungary.

The upgrading of the Budapest-Hegyeshalom line up to the Austrian border in order to accommodate train speeds of 160 km/h is of major importance to the development of the Hungarian railway network and is due to be completed by 1997. Construction of a direct line linking Slovenia to Hungary through Murakeresztúr is currently at the planning stage and the upgrading and electrification of several lines is also underway.

2.5. Road safety and environmental protection

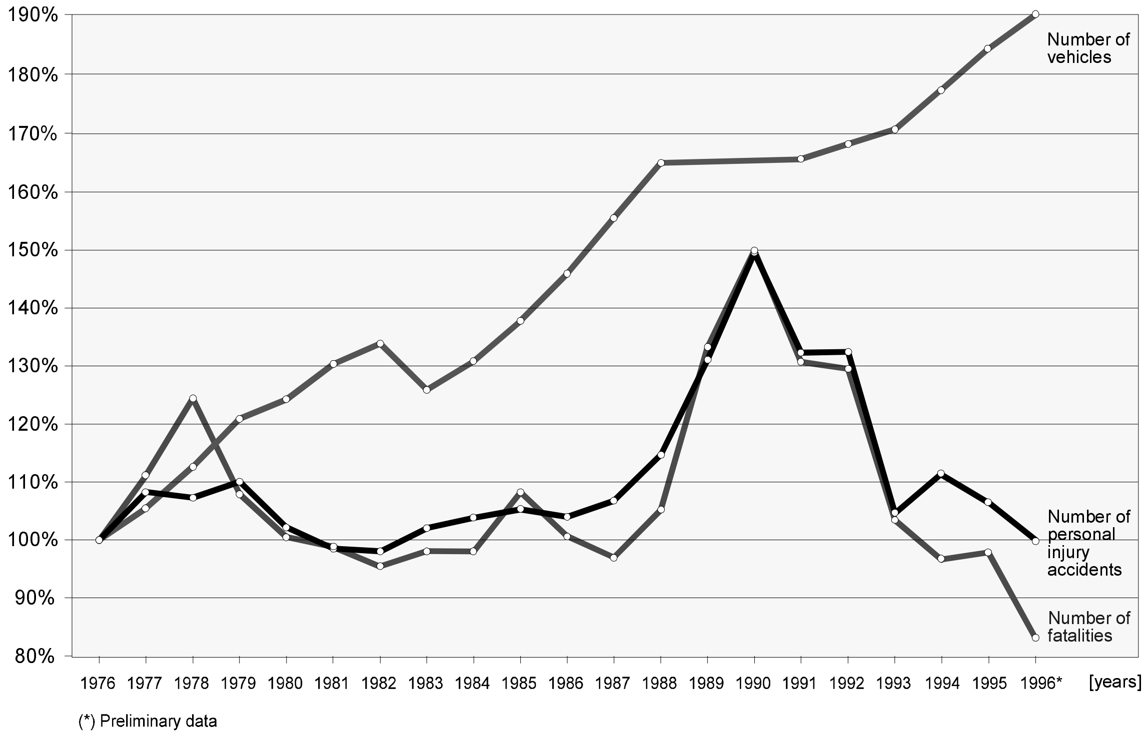
There was no great change in road accident statistics in Hungary over the period 1980-87. The number of accidents resulting in casualties and fatalities remained relatively stable, despite continual improvements in the quality of the domestic vehicle fleet. While the number of accidents remained more or less the same in absolute terms, given the increased numbers of cars on the road the actual trend change was downwards.

However, road safety began to deteriorate from 1987 onwards as a result, in particular, of the adverse impacts of social change.

Over the next three years, i.e. until 1990, the number of road accidents resulting in casualties rose by more than 40 while the the number of fatalities was two to three times higher than the European average.

In 1990, the number of accidents and casualties rose to unprecedently high levels: 27 801 road accidents involving casualities, of which 2 432 fatalities and 36 996 slightly or seriously injured (Figure 12).

Figure 12. **Trends in the number of motor vehicles and road accident casualty rates between 1976 and 1996 (1976=100)**



Changes in the number of vehicles, personal injury accidents and fatalities due to them between 1976 - 1996

In order to halt, if not reverse, this trend, the existing regulations were extensively amended in early 1990 and policing measures stepped up. In 1993, the Government adopted a "National Traffic Safety Programme (NKP)[2]". The number of accidents resulting in casualties and fatalities fell spectacularly due to the introduction of appropriate measures, the stability of vehicle performances, the implementation of the objectives set out in the NKP and to more effective public awareness campaigns.

The number of accidents involving casualties fell by around 37 per cent between 1990 and 1996, while the number of fatalities declined by 49 per cent. Despite these declines in the number of killed or injured, which are an improvement both in themselves and compared with other eastern European countries, the current level of casualties and particularly fatalities, resulting from road accidents are still above the EU average.

Apart from the losses attributable to road accidents, motor vehicles are also one of the main causes of environmental damage in Hungary. The damages caused by motor vehicles, in decreasing order of importance, are as follows: air pollution; noise and damage through vibration; land consumption; soil and water pollution.

The main factor in the generation of air pollution is the structure of the vehicle fleet. The number of passenger cars and the partly obsolete design of the haulage fleet are also determining factors.

The fact that between 1985 and 1995 carbon monoxide, hydrocarbon and nitrogen oxide emissions from motor vehicles decreased and that lead emissions fell to negligible levels, represents a favourable trend. By April 1996, it was compulsory for all cars to be fitted with a catalytic converter and the introduction of a system of green cards to prove compliance with environmental regulations has reduced environmental damage, despite the fact that the Hungarian road vehicle fleet is relatively old.

Vibration and noise caused by traffic has less of an impact on the environment than air pollution. Although traffic noise is a nuisance for almost a third of all flat-owners in Hungary, growth in noise levels has recently begun to slow.

The transport sector is responsible for about 5 per cent of all soil, water and waste pollution in Hungary.

2.6. Projected growth in demand for transport in Hungary

According to the long-term forecasts for the CEECs presented in Chapter 1, Hungary's economy is not expected to grow as fast as that of certain other CEECs. Although up to 1996 Hungary has managed to attract over US$15 billion in foreign investment (more than the total foreign investment in all the other CEECs combined), the Hungarian economy is not expected to grow substantially, given the fact that it is starting at a relatively higher level and that Hungary still has a significant debt burden.

According to the forecasts made by Hungarian economic researchers, between 1997 and 2005 Hungarian GDP is expected to grow at an average annual rate of 3.5-4.0 per cent.

The overall trends in transport demand may be expected to be as follows:

- Traffic flows towards the West will gradually increase and may be fueled by growth in trade between Germany and countries to the south of Germany;

- Renewed political and economic stability in the NIS may lead to a recovery in trade and growth in traffic between those countries and Hungary which may be further fuelled by the ever-growing East-West traffic;

- In view of Hungary's central location in Europe, further economic integration at the European level may offer prospects for potential growth in transit traffic;

- [3]The pace of economic change in neighbouring countries will have a considerable impact on freight traffic; there are many possible scenarios which could lead to substantial increases or decreases in transit traffic or the direct transportation of goods;

- The lifting of the embargo on the rump Yugoslavia may result in another reversal in traffic routes with trade flows again being directed through the southern border crossings, although the volume of trade would not be as high as before.

Of course, the decisive factor in the development of Hungary's transport market will be when, and with which other CEEC countries, Hungary will be allowed to join the European Union.

NOTES

1. CEECs: Central and Eastern European Countries (CEEC-6 = Bulgaria, the Czech Republic, Hungary, Poland, Romania, Slovakia. CEEC-11 = the above-mentioned six countries plus Slovenia, Croatia and the three Baltic States).

2. Government Decree No. 2036/1993(IX.9) on the National Traffic Safety Programme.

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Figure 7. **Truck traffic at border crossings**

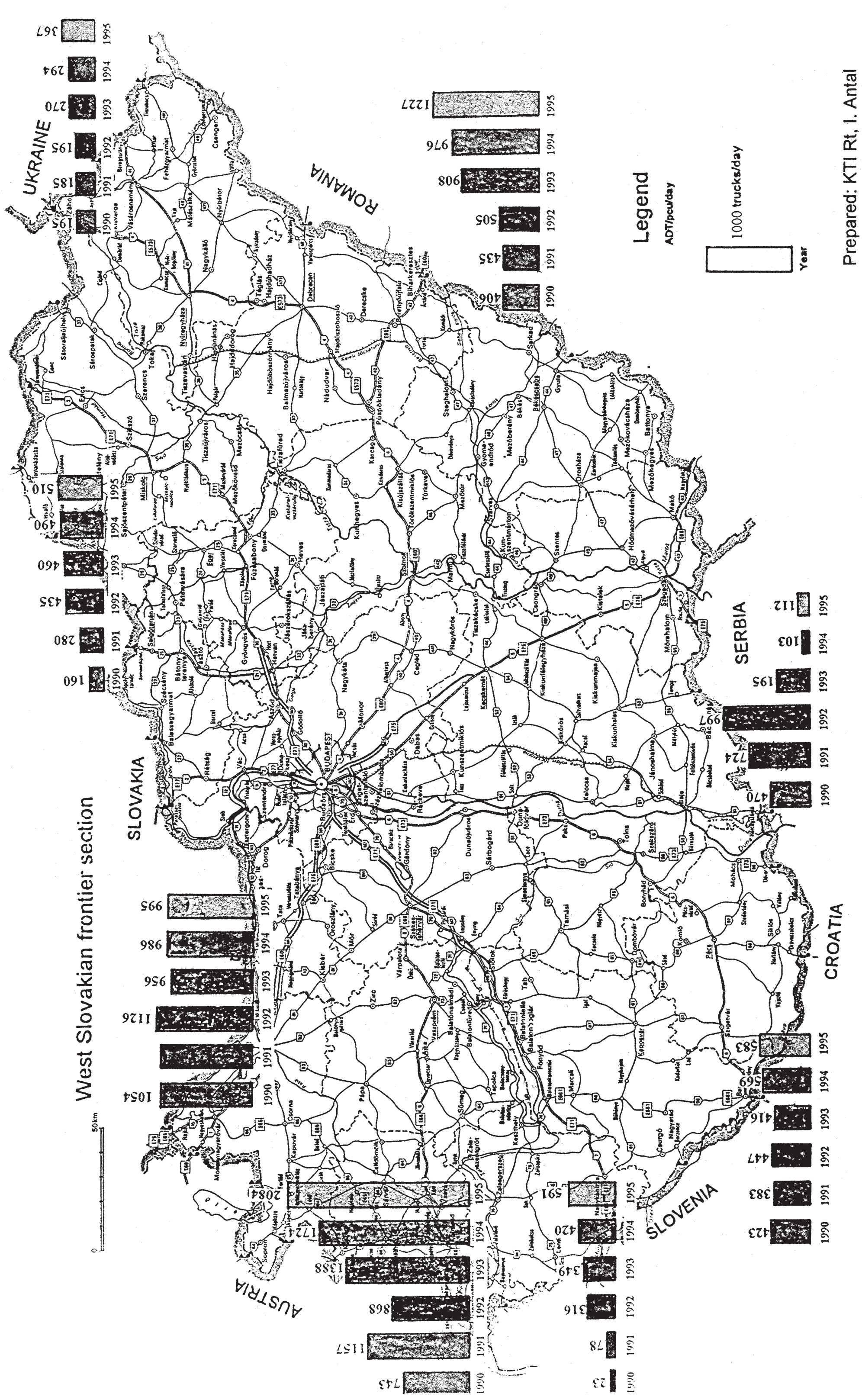


Figure 8. **International road, railway daily average freight traffic 1993**

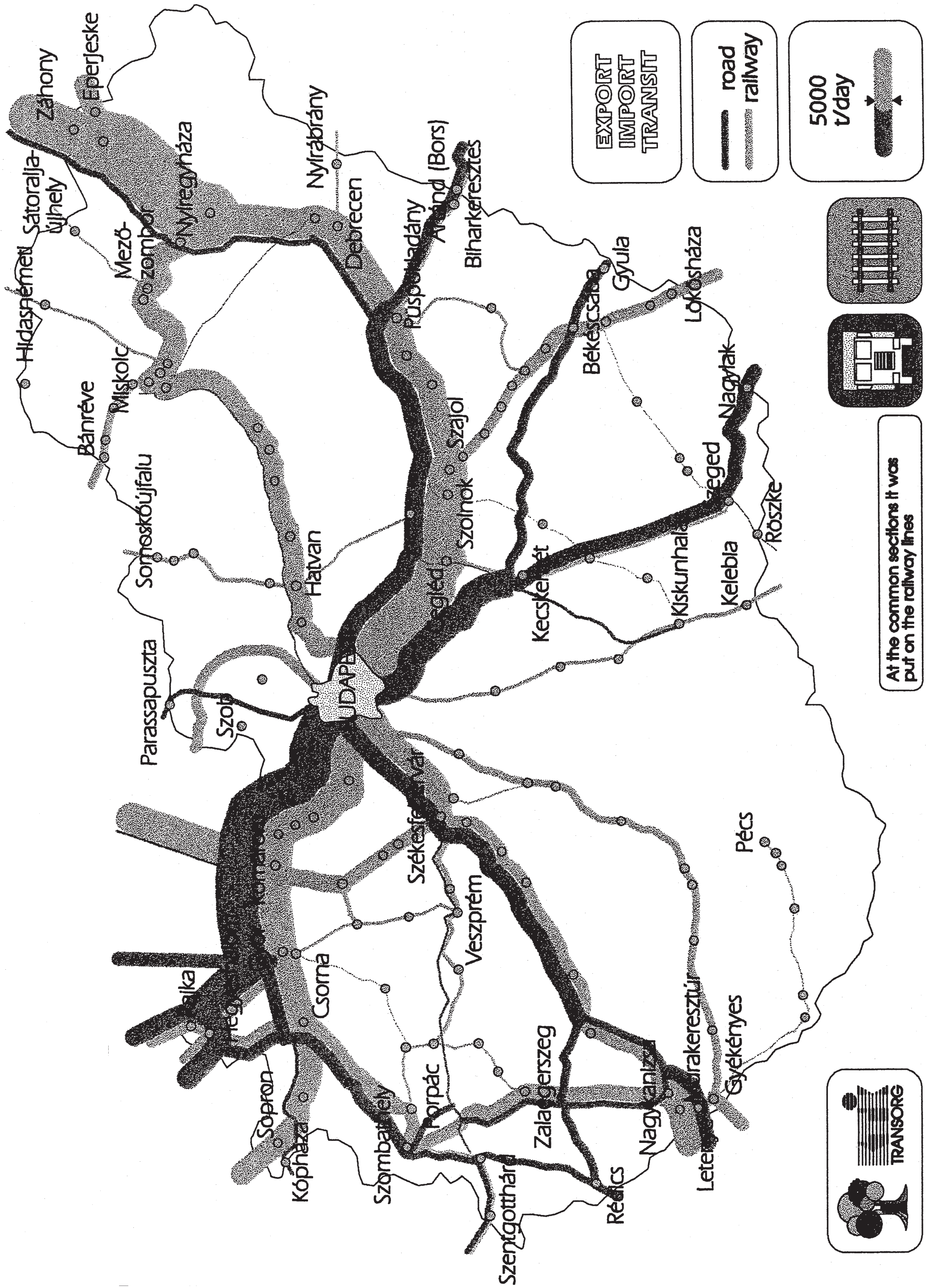


Figure 9. **The main export-import traffic directions on the road in Hungary**

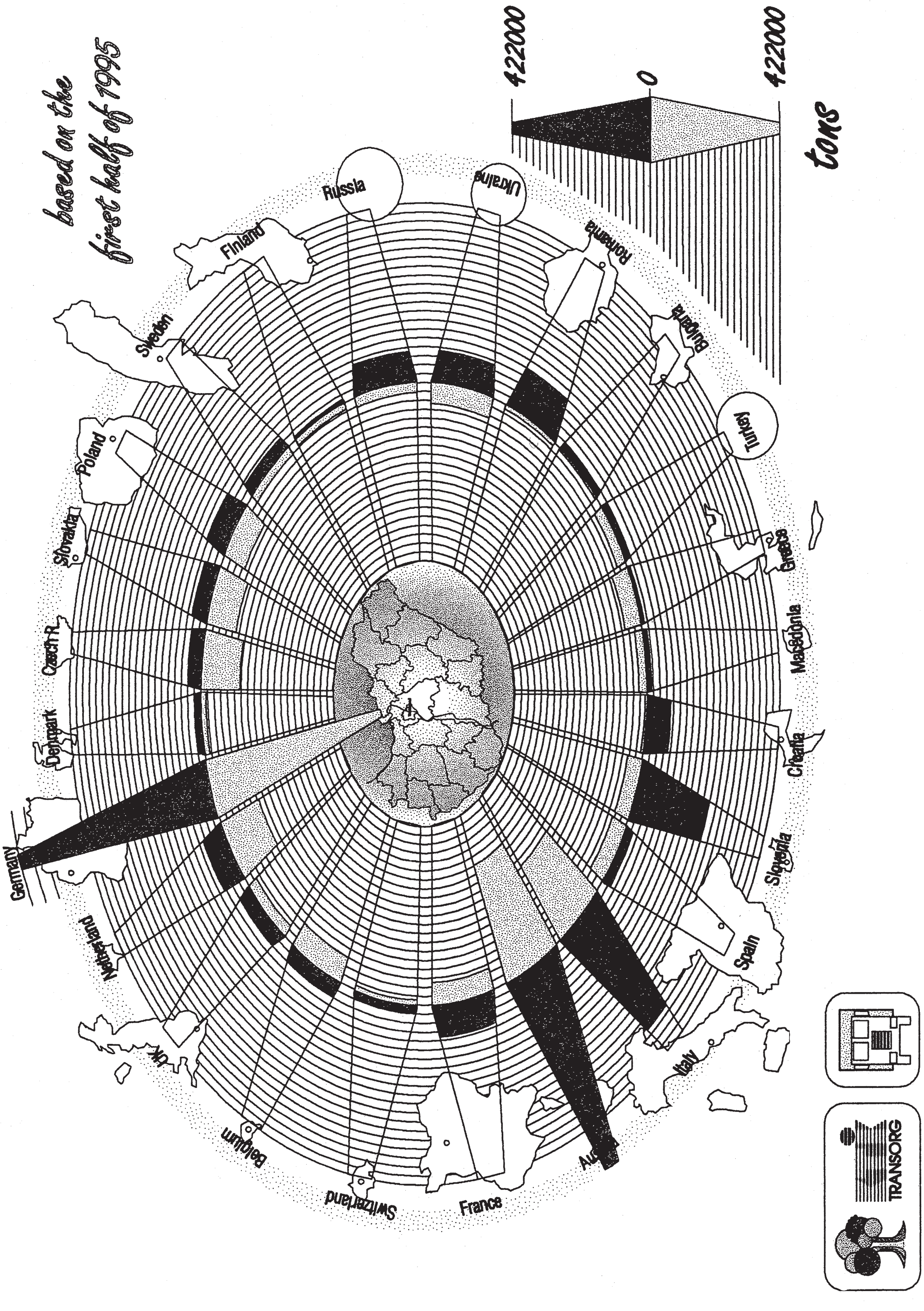


Figure 10. **Export-import traffic on the railway, 1995 (%)**

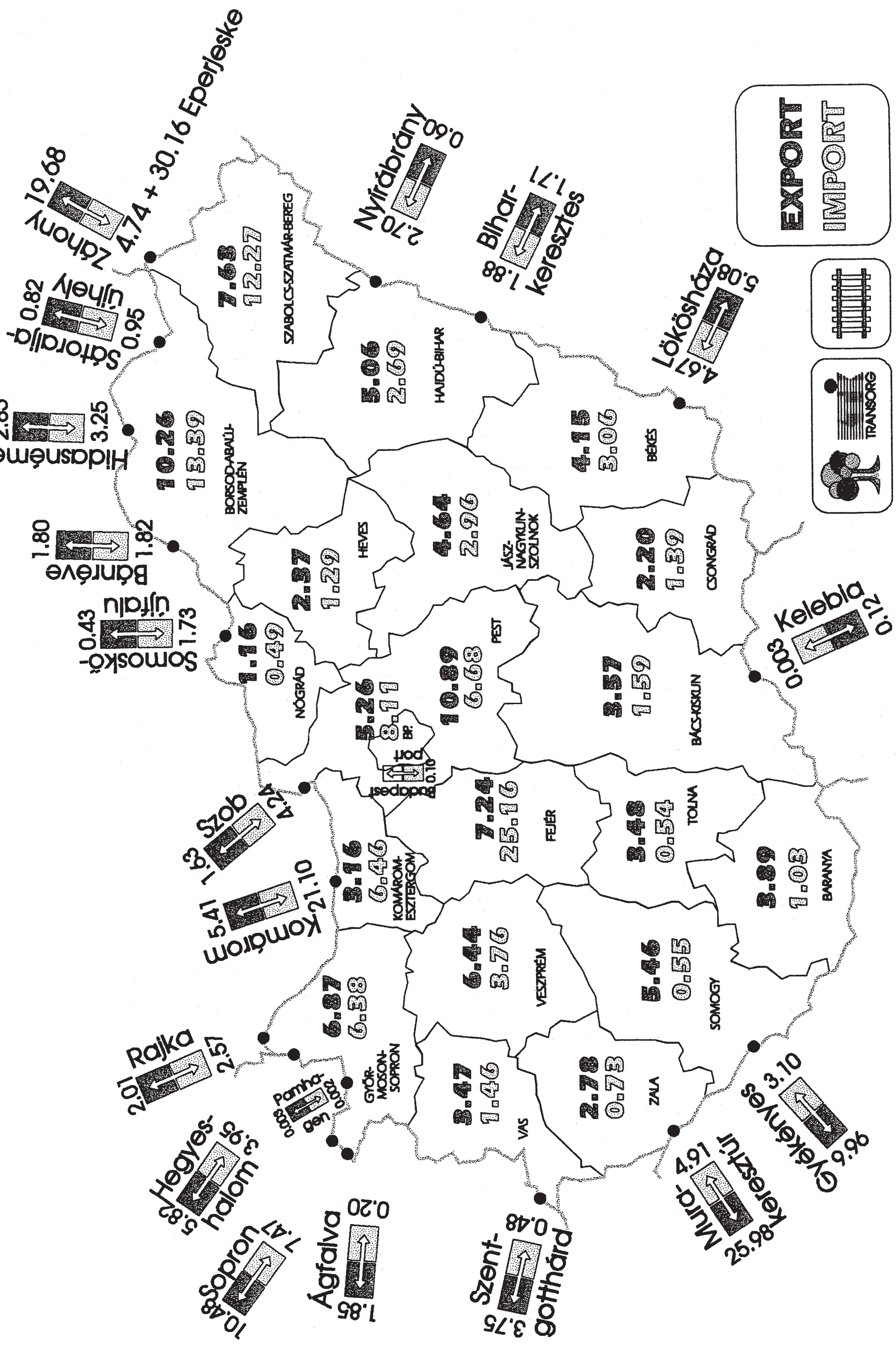
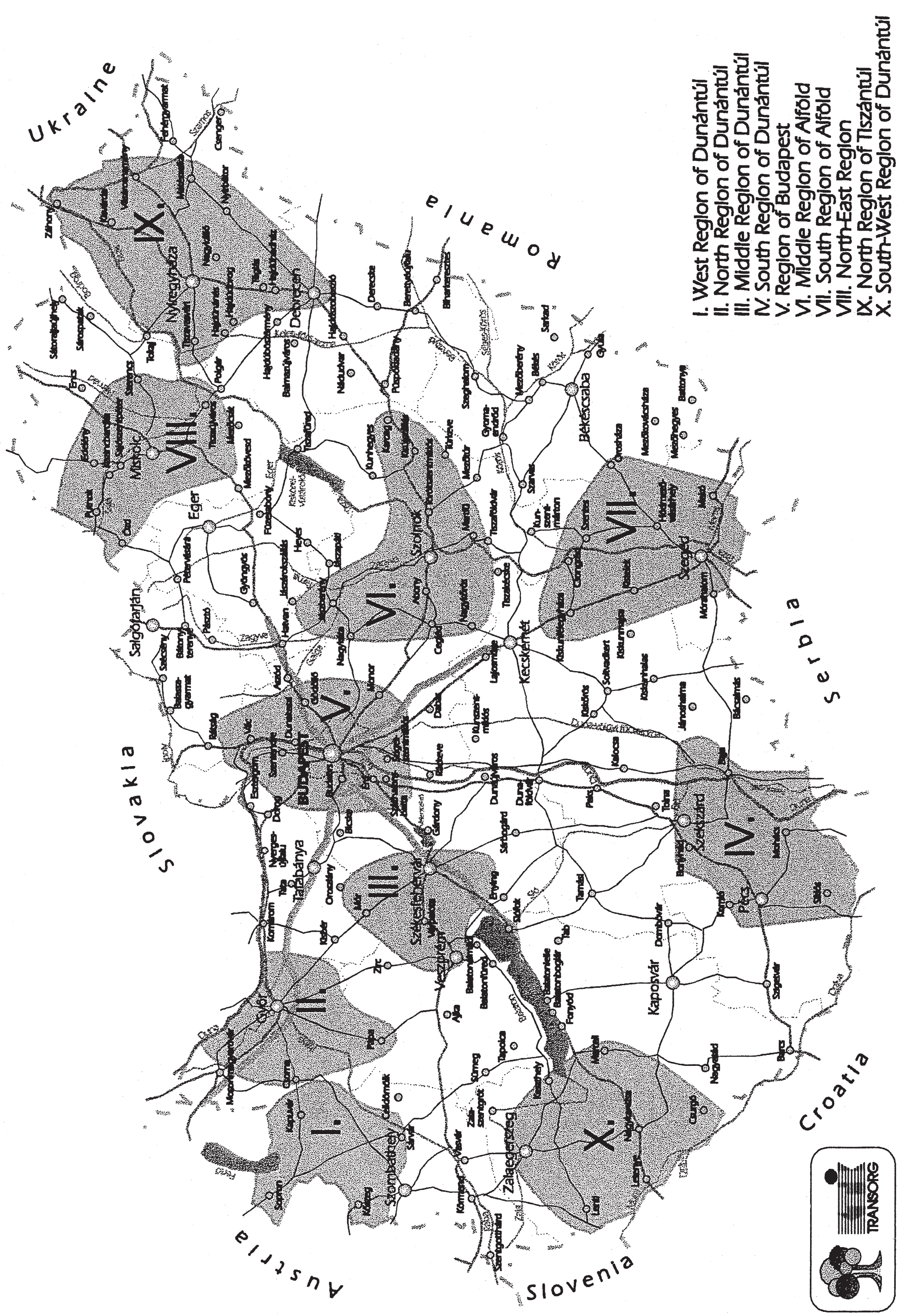


Figure 11. **The proposed areas for logistic centres in Hungary**



Topic 2

WHICH ROLE FOR GOVERNEMENT?

REGULATION OR COMPETITION

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SUMMARY

Leeds, February 1997

1. BACKGROUND

The approach in this paper will be to consider this question from the perspective of UK experience. The UK has been in the vanguard of the liberalisation movement and the aim will be to consider what lessons can be learned. This introductory section provides a brief outline of the development of the UK transport policy, discusses the elements of the liberalisation programme and reviews the main economic issues and arguments which arise when considering the case for liberalisation.

In the period following the second world war, Britain's transport sector was tightly controlled. The infrastructure and much of the operations including railways, long-distance road freight transport, inland waterways and most of the local bus transport, was owned either by the State or by local municipal authorities. Operations were regulated by a variety of licensing systems restricting entry to or exit from the market. The national railways were obliged to carry all kinds of passenger and freight traffic regardless of profitability (the common carrier obligation). Prices and freight rates were controlled. Investment in transport was, of course, determined by the owner, that is, in most cases, the Government.

This level of control was necessary in the circumstances of the time. The transport systems, especially the railways, had been devastated by lack of investment during the war and could not continue in the private sector. The economy was weak, investment resources very scarce, fuel was rationed. In such circumstances, the need for central planning and control of the transport sector was dominant.

Since those times, the transport sector in the UK has been transformed. The changes have occurred over a longer period of time and have been brought about by both conservative and socialist governments (see Table 1).

We can think of the post-war period in two parts. From 1945-79, there was a general political consensus in favour of a mixed economy. That is, in sectors such as energy and transport, a mixture of market intervention, including public and private ownership, regulation, control over prices and investment, was seen to be required in order to achieve social and economic goals. Within the consensus, the boundaries changed; for example, the transport of freight was deregulated during the 1960s. But both conservatives and socialists accepted the mixed economy approach, arguing only about the details of the mixture.

During the Thatcher years from 1979 onwards, this consensus has largely disappeared. Successive conservative governments have believed that allocation of resources through a planned regime is inherently inferior to allocation through commercial market decisions. A fundamental objective of economic policy has therefore been to free as much of the economy as possible so that decisions are made, inputs purchased, goods produced and sold, on a commercial basis. By 1997, the terms of the debate have been shifted -- a change of UK government would not make a great difference to this position.

Table 1

1950s	-- Privatisation of most long-distance road transport -- Abolition of fixed rail freight rates (maximum rates only) -- Railway modernisation and motorway investment plans
1960s	-- Abolition of railway common carrier obligation -- Freedom of rail freight pricing -- Closure of loss-making rail passenger and freight services -- Abolition of restrictive controls on entry to road freight transport market -- Abolition of price controls for long-distance rail passenger market
1970s	-- Direct subsidies for local bus services -- Integrated planning of urban transport -- New financial framework for railways
1980s	-- Deregulation of express coach services -- Abolition of price controls for local buses -- Privatisation of remaining public road freight operation (National Freight Co.) -- Deregulation of local bus industry -- Privatisation of National Bus Company operations and some municipal bus operations -- Reductions in subsidies for local bus operations -- Privatisation of tolled bridges/tunnels (Dartford Crossing, Severn Crossing) -- Private finance and construction of Channel Tunnel
1990s	-- Privatisation of London bus operators -- Privatisation of British Rail

2. LIBERALISATION

The overall objective of exposing markets to greater commercial freedom has been achieved by a number of different policy measures which it is important to identify.

Privatisation is the sale of state assets into the private sector. Examples include the sales of British Airways, British Airports, British Ports, British Telecom, British Gas and the sales of the water and electricity industries. All of these have been sold as public limited companies and have stock exchange quotations. In other cases -- National Freight Consortium and some National Bus subsidiaries -- the companies have been sold to the existing management (management buy-outs) or to consortia of management and employees.

A crucial distinction needs to be made according to the market conditions into which these firms were sold. In some cases (National Freight, National Bus, British Ports) underlying market conditions were perceived to be pro-competitive, so that no specific market regulation other than general policies on mergers, monopolies and fair trading practices were required. In other cases (British Telecom, British Gas) the firms were so obviously dominant or natural monopolies that special agencies (OFTEL, OFGAS) were established with power to regulate market behaviour. The railway industry has both a regulator and a franchising director.

Commercialisation refers to a much greater emphasis on the commercial profitability and performance of state-owned enterprises. The Government believes that, wherever possible, users and not taxpayers should pay for the provision of transport services. Users' willingness to pay market prices is seen as the most reliable test of efficiency in resource allocation. This policy has affected the provision of public transport by all modes, leading to substantial cuts in subsidies for both bus and rail services, even when these industries were in public ownership.

It is recognised that some subsidies are required in order to support unprofitable but socially necessary services, but where these are warranted, they should be:

-- Specific subsidies set in advance and clearly related to the services required, rather than *ex post* general subsidies to cover deficits;

-- Where possible, given to the consumers who require support (old people, students, etc.) rather than to producers;

-- Where possible, competed for in a tender competition so that the lowest cost or best value-for-money producer can be found in the market place through supply-side competition.

Furthermore, particular transport operators should not be required to perform social obligations financed by cross-subsidisation from other commercial activities. Any social services should be explicit and should be paid for and justified through the political process.

Deregulation refers to the removal of regulatory constraints on market behaviour, in particular, restrictions on freedom of entry to and exit from markets and on pricing freedom. The UK has seen a relaxation of regulation of scheduled air services with a second carrier (British Midland) on the main domestic routes between London and Glasgow, Edinburgh and Belfast. Far more dramatic, however, has been the complete deregulation of entry and prices in the express coach market in 1980 and of the local bus industry in 1986. Deregulation is perhaps the most interesting of the policies described here, because it represents a direct attempt to change market performance by moving from regulated to unregulated conditions.

3. THE ECONOMIC ISSUES

The economic paradigm of general equilibrium and Pareto efficiency through all-round perfect competition is an obvious starting point. In such a world, the role of government would be reduced to providing the mechanisms to enable transactions to take place (money, a framework of law, etc.) and to effecting such redistribution as was required through (costless) taxation.

In reality, a variety of well-known market failures exist. It is perhaps worth giving some examples as they relate to the transport sector.

Natural Monopoly implies economies of scale or scope. Marginal cost pricing is inconsistent with the existence of the firm. Competition will be both undesirable and unsustainable because of the commercial impulse to merger or acquisitions so as to reduce costs. The free market -- absent perfect price discrimination -- does not achieve efficient resource allocation. Solutions suggested include public ownership or public regulation of private firms together with either subsidy or some form of price discrimination (e.g. two-part tariffs). Road and rail infrastructure is generally thought to possess natural monopoly properties.

Externalities imply the existence of unpriced factors which therefore enter marginal social costs but not marginal private costs. They will be neglected in private commercial transactions, with resulting misallocation of resource. Obvious transport examples include congestion and pollution.

Information is assumed to be freely available to all economic agents, producers and consumers. In practice, information may be costly to produce and costly for the consumer to acquire. The costly nature of good information has been an important issue in the deregulation of bus services.

Wasteful competition is a less precise concept, yet an important one for transport regulation. The concept is difficult because of the problems of distinguishing healthy competition from excessive or wasteful or destructive competition. The latter condition may exist where goods are differentiated, or in the presence of externalities, or where long-run continuity of supply is important. It can be shown that, where differentiated profits involved sunk set-up costs or are produced under increasing returns to scale, competition can result in brand proliferation -- an excessive range of products selling at too high a price. Unregulated public transport may suffer from this type of problem if competition takes place in the service (frequency) dimension rather than on price. Another traditional argument has been that excessive competition in bus service or in freight transport could cause non-internalised dimensions of output -- such as safety quality -- to be reduced. Quantity regulation to promote quality has been a persistent theme of transport regulation. The idea that the market mechanism results in myopic choices which neglect long-run stability of supply in favour of low short-run prices is also found in the literature.

Equity may also be a legitimate motive for intervention. In the real world, optimal redistribution cannot be achieved through costless income transfers. Transfers of goods in kind (free education, health care, public transport) may be seen either as promoting equity or as improving efficiency through beneficial social externalities (merit goods). In some societies, the concept of rights to minimum levels of these social goods, including a right to some minimum level of accessibility through public transport, may be relevant.

Transport services also tend to be complementary or competitive with one another, so that market failures in parts of the sector can have consequences for policies towards the complementary or competing services. Two examples will illustrate this point.

In the early part of this century, railways had substantial monopoly power over all but very short-distance freight traffic. As a result, a form of tariff regulation (value of service pricing) was used, in which freight rates related to the value of goods carried. The location of economic activities, mines, steelworks, etc. was based upon this tariff structure. With the development of road haulage, railways began to lose high-value goods to road transport, which based its rates upon costs. As a result, road haulage -- itself a competitive industry -- was regulated in order to protect the railways and preserve the regime of cross-subsidisation which was under threat. Regulation was used as a form of second best response

.

More recently, it has been widely argued that, in the absence of a direct response to urban road congestion (i.e. road pricing), a surrogate policy, subsidising urban public transport so as to moderate congestion, shall be followed. Much work has been done on the elasticity and cost conditions under which such a policy might be justified. Again, it is a second-best policy in the sense that the best policy (internalise the externality directly) is assumed not to be available.

Now, these examples, while relevant in themselves, are intended to show that the traditional view of transport in the UK was that it needed to be planned and managed *as a system*. That is, policy decisions needed to consider the interaction between transport modes and between transport and the rest of the economy. The instruments of ownership, regulation and subsidy were there to be used to promote the social efficiency and performance of the system as a whole.

Since 1979, we have returned to an older, simpler doctrine: "every tub must stand on its own bottom"; that is, agencies, must be commercially self-sufficient. Attempts at global optimisation and integrated policies have been abandoned and the policies of liberalisation described earlier introduced. Why? Concerns over market failure have been replaced by concerns over g*overnment failure* -- that public ownership and heavy government intervention could not deliver economic goods and services as effectively as private ownership. Several arguments are used to support this position:

Firstly, that public ownership invariably leads to productive (or x-) inefficiency. Public firms operate at a cost penalty relative to private firms because of a mixture of higher-than-market wages and lower-than-market productivity. Fundamentally, there is argued to be a lack of market discipline, together with powerful labour unions capable of exploiting this lack of discipline to create economic rents for their members at the expense of consumers and taxpayers.

Secondly, that public enterprises lack capital market discipline. Investment decisions may themselves be inefficient but, more seriously, there may be shortages of public sector capital which make it difficult to innovate at an appropriate rate. This is a crucial argument for relatively dynamic sectors such as telecommunications.

Thirdly, that public ownership leads to chronic misallocation of resources between the goods which public enterprises produce. Public enterprise is said to be characterised by standard rate structures, cross-subsidisation and a pattern of services and prices which do not reflect costs.

Fourthly, that the political nature of public enterprise makes for uncosted political meddling in day-to-day management of these industries and also makes long-term restructuring of services and prices to reflect market conditions almost impossible to achieve. On this view, managers operate best within a simple, explicit commercial framework.

It is, of course, naive to see liberalisation in the UK as driven solely by these economic arguments; there were many other factors at work, not least, naked political advantage. Even in saying that, one must acknowledge that the liberalisation policy has been controversial on all sides. It is worth concluding this section with two quotations, both from prominent Conservatives.

> *"Even if Ministers were recruited exclusively from the legendary one-armed Aberdonians with sewn-up pockets, I would argue that it is impossible for public services to be as cost conscious as private suppliers who have to compete to win customers."*
>
> *(Lord Harris of High Cross)*

> *"First of all the Georgian silver goes and then all the nice furniture that used to be in the saloon. Then the Canalettos go."*
>
> *(The late Lord Stockton -- ex Prime Minister, Harold Macmillan)*

4. REGULATION OR COMPETITION?

Particularly in the early days of the liberalisation programme, the political rhetoric was that once a particular industry had been privatised it would be up to the market to determine the outcome for consumers and producers. Government could take a back seat. It has not quite worked out like that. In many privatised deregulated industries, government involvement has changed rather than disappearing; we have deregulation with rules. The interesting problem for government is to determine the rules which are appropriate to the economic conditions of the market.

A preliminary point to make is that both regulation and competition are means, not ends; they are both potentially means of producing a good social outcome from the organisation of a particular industry or market. Both can involve costs. Maintaining economic regulation over a sector which can deliver a good social result without it is inefficient. Maintaining competition by intervention in a natural monopoly sector is also inefficient. So the two-word answer to the question, "Which role for government -- regulation or competition?", is: it depends. The answer may be either, both or neither, depending on the economic circumstances.

Let us consider the following theoretical market structures, considering the appropriate government stance for each of them and assuming that government is acting purely for the good of the public.

Perfectly contestable market. In this case, neither regulation nor actual competition in the market place is required. The discipline exerted by potential competitors will be sufficient to ensure a good social result.

Strong natural monopoly. In this case, promoting competition is both hopeless and undesirable. Some form of price-cap regulation (UK) or rate of return regulation (USA), presided over by a specialist regulator, is required to prevent/limit monopoly exploitation of consumers.

Weak (non-sustainable) natural monopoly. Here, the best social result is obtained if a single firm provides all the output in a multi-product industry, but the firm is unable to prevent entry on some of its product lines: the Government must consider regulating to *prevent* competition. This situation is typified by the arguments surrounding open access to telecommunications and railway networks. Should access be denied, or restricted, or opened and on what terms? This leads to the debate on interconnection and access pricing rules.

Moderate but imperfect contestability. This is perhaps the least clear of all the categories from the government's point of view. A formal regulator is unlikely to be the solution, but government does have various options. One is to pursue a hands-off policy, that is, to allow the market to develop as it will. Business interests will normally argue in favour of this. A second is to provide a framework of pro-competitive rules, through regulations on antitrust, predatory behaviour and restrictive practices. This is designed to support and maintain competition in the market-place against the natural tendencies for merger and acquisition. A third is to maintain public control over the market while introducing competition within it -- this is the franchise or tender option. Many arguments in the UK concern the choice between these strategies.

If the preceding argument is correct, then two things follow. Firstly, the Government has a critical role to play when planning the privatisation or deregulation of an industry, because it must decide which of the above cases and options is the relevant one. Things are never so clear on the ground as they are in the economic textbooks. There are examples where the actual economic behaviour of a sector has been very different from that expected *ex ante*, as we shall see. It is both extremely difficult to get it right and yet critically necessary because the value of the privatised company and of shareholders' funds depends on the competition regime into which the company is privatised. It is therefore impossible or at least very costly to rectify regulatory mistakes.

Secondly, having established the regulatory regime, the Government must bring the resources to bear to enforce it. This may involve everything from advice and consultation to legal enforcement, by both specialist agencies such as single-industry regulators and general agencies such as the Office of Fair Trading and the Monopolies and Mergers Commission. Although we have written so far as if government is a single entity, we shall see later that maintaining a coherent regulatory line by all the agencies involved is, in practice, extremely difficult.

In the remainder of this paper, we consider four case studies of regulatory policy in the UK, before trying to draw the lessons together in the concluding section.

5. CASE STUDY 1 -- THE ROAD HAULAGE INDUSTRY

Regulation of road freight had originally been introduced in 1933, at the climax of the economic depression, with the aim of improving public safety, promoting the economic stability of the road haulage industry and protecting the railways from the severe competition of this growing industry. The chosen method of regulation was control of entry to the road transport market. Operators wishing to carry other people's goods -- professional transport operators -- had to apply for a licence (Carriers' Licensing). Other operators and the railways could object to the award of the licence on the grounds that there was no need for the service. This test of "proof of need" was the basis for restricting entry to the road transport market. In contrast, there has never been a quantity restriction on carriage of a firm's own goods by road in its own vehicles.

By the early 1960s, economic and social conditions had changed and an inquiry was made into the principles and operation of the Carriers' Licensing systems (Geddes, 1965). The report concluded that the licensing system was no longer useful:

-- It had no effect, directly or indirectly, on public safety standards. Operators who committed offences against public safety almost never had their licences suspended or withdrawn;

-- Efficiency was reduced because of the restrictions on types of goods carried, destinations served and the inability of own-account operators to carry return loads for other firms. The system created a bias between professional haulage and own account and the resources spent administering the system were substantial;

-- The railways were not significantly protected by the licensing system. The great improvements in the quality and productivity of roads and road transport meant that for many types of traffic, road transport offered faster carriage with less handling, fewer breakages and greater control than rail, often at lower cost. In other words, the railways very often could not prove that their service was better than that proposed by road carriers.

Accordingly, the report recommended the abolition of *quantity* restrictions on entry to the road haulage market. After much debate, this recommendation was accepted and quantity control of entry through Carriers' Licensing was replaced in 1970 by a new system, Operators' Licensing.

This is a system of *quality* licensing which requires operators wishing to enter the market to satisfy a series of quality standards. The applicant must:

-- be of good repute;
-- have adequate financial resources to run the business;
-- be professionally competent;
-- have adequate maintenance facilities;
-- have a suitable operating base for his vehicles.

Provided that these conditions are met, entry is open and uncontrolled, regardless of the state of the market. There is no system of price control -- no actual or reference tariffs.

What has been the outcome? One side-effect of deregulation is that good data on the performance and efficiency of freight transport is difficult to obtain. However, a major review of the system was made almost ten years after the deregulation, which contains many interesting results (Foster, 1978).

The Foster Report found the following:

- An increase in the market share of professional haulage and a decline in transport on own account;
- No clear change in the physical productivity of goods vehicles;
- No change in the proportion of empty running;
- No evidence of serious instability;
- Low average real rates of return on capital employed;
- No evidence of fragmentation of the industry;
- No evidence of failure to provide a high quality of service to meet the needs of industry.

These results were interpreted by the Foster Committee as indicating that the road freight transport sector was workably competitive. This still seems the right conclusion today. As with other forms of transport such as bus or aircraft operation, there are few if any production economies of scale available in road transport operation above a small fleet size. Therefore, road transport operations themselves should not be highly profitable. Entry is easy, the technology is readily available and the market is inherently competitive. The opportunities for profit arise in the organisation of the supply chain, where economies of density and scope do exist and where expertise in balancing the transport, warehousing and inventory costs against the customer requirements is scarce and valuable. This is why in the 1970s and 1980s, large firms such as the National Freight Consortium virtually abandoned low-margin businesses such as general haulage in favour of contract distribution, of which the transport function is only a part (Beesley, 1992). Even in distribution, there is sufficient competition to result in efficient operation and service quality. Where dissatisfaction arises, companies can and do change contractors or revert to own-account operation.

The conclusions which we draw from the case of road haulage deregulation are as follows. Firstly, deregulation cannot be shown to have specifically improved the productive efficiency of the industry. Secondly, the most important contribution of deregulation was to permit complete flexibility in the nature of the contract between manufacturer, distributor and retailer according to market circumstances (Tweddle and Mackie, 1994). Licensing creates rigid choices between using professional haulage or operating a fleet on own account. Freedom to adapt according to market conditions has been an important benefit of deregulation. As a result, as well as being “a nation of shopkeepers”, the UK is also now a leading European force in physical distribution.

Finally, the residual role of regulation and enforcement must be noted. Competition can only work within a legal framework so that proper enforcement of drivers’ hours, overloading, maintenance requirements and other laws is the key to quality in a competitive market. Although quality regulation is partly a matter of regulating for safety and environmental externalities, maintaining a level playing field for competition to take place is an important aspect of public policy. Overall, the switch from quantitative to quality regulation of the road haulage industry has been a success.

6. CASE STUDY 2 -- DEREGULATION OF EXPRESS COACHES

Long-distance coach services were heavily regulated for fifty years from 1930 to 1980, by a licensing court which strictly controlled entry to the market, the frequencies offered by existing operators and fares. The result was that the service pattern offered could not easily be adapted to market demands. For example, it was not easy to take full advantage of the motorway network, nor to cater for important new destinations such as airports.

Quantity control of entry and capacity was abandoned under the 1980 Transport Act and fares setting was liberalised. The *ex ante* expectation of government was that the market, dominated by the National Bus Company subsidiary, National Express, was inherently competitive, so that the competitive process would generate new services and fares according to market principles.

The actual process of competition has been rather different from that. It has turned out that the incumbent operator, National Express, has been too strong for most competition to survive, although competition has been maintained in some markets such as London, north-east England and Scotland. The reasons for National Express's dominance include:

- -- Network advantages, particularly the ability to offer a wide range of destinations;
- -- Marketing advantages, particularly a national network of booking agents;
- -- Sole or preferred access to key hubs, in particular Victoria Coach Station;
- -- First mover advantages, including an experienced management team with good knowledge of the market.

So one lesson from this case study is that predicting the way in which deregulated markets will behave is not straightforward. However, even though market structure has not been as expected, market performance is generally believed to have been good. Real fares fell, service levels rose on the trunk routes and because the market is largely discretionary, demand was quite responsive, creating further gains in service levels and patronage. Furthermore, the railways were forced to behave in a much more commercial manner towards their leisure traffic, creating a mixture of off-peak and advance purchase fares in order to segment the market and compete effectively with coach competition on the main trunk routes. An interesting recent regulatory case has been the acquisition of the Midland Mainline rail franchise by National Express, passed subject to conditions by the Monopolies and Mergers Commission.

A study of the first ten years' experience, to 1990, found that in England, frequencies increased substantially (on average 70 per cent) (Thompson and Whitfield, 1994). Journey times fell substantially (5-25 per cent), as a result of faster routings via motorways and on-board catering replacing refreshment stops. Real fares fell on the main routes -- for example, the real fare on the London trunk routes was 10 per cent below its 1979 level. Since the discretionary nature of the market for coach travel means that the relevant elasticities are relatively high -- Douglas (1987) estimates an average price elasticity of -1.1 and a general mileage elasticity of +0.6 -- it is not surprising that the market has developed substantially.

The overall verdict must be that deregulation of the express coach market has been a success, demonstrating in particular that a high degree of actual competition is not necessarily required to give a good result. The pattern of services and fares are driven by market considerations, but competition from rail and, on the longer-distance routes, potential competition from other coach operators, discipline the incumbent. The product offered is sufficiently different in its characteristics to have a definite market niche with less affluent groups such as elderly people and students. Although there have been service withdrawals on cross-country services previously cross-subsidised from other activities, there have also been new services, particularly to airports not well served by rail. In this case, allowing commercial pressures to determine the outcome, without artificially maintaining competition or regulating the sector, has been the correct policy.

7. CASE STUDY 3 -- LOCAL BUS DEREGULATION

The deregulation of the local bus industry under the 1985 Transport Act has been one of the most interesting of all the UK economic experiments. Whereas industries such as gas, electricity and water contain distribution networks which are obvious natural monopolies requiring regulation, the economic characteristics of the bus industry are much less obvious. Yet, in deciding on the balance between regulation and competition, an assessment of those characteristics had to be made. What is the basic economic model of the bus market? How therefore should the industry be privatised; how far should it be fragmented? What form is competition expected to take? What is the expected effect on operators, workers, consumers and resource allocation? What residual regulation is required? To its credit, the Government produced a substantial White Paper which generated a wide-ranging academic and professional debate about these questions.

The stated assumption of academic supporters of deregulation, such as Beesley and Glaister (1985), was that the local bus market would be highly contestable. The principal barrier to entry was the licensing regime; once the regulatory barriers were removed, the economic barriers to entry and exit were low. Sunk costs were minimal, the main asset -- the bus -- was a fixed rather than a sunk cost. The technology was very well known and the minimum efficient scale was small relative to market size, at least in the urban markets.

The opponents of deregulation, such as Gwilliam, Nash and Mackie (1985), saw the commercial sector of the market as imperfectly contestable because the incumbents would retain some natural advantages. Firstly, there are *some* sunk or irrecoverable costs from market entry associated costs and the length of the learning period for the public to acquire knowledge of and confidence in the service. Secondly, there are economies of experience enjoyed by the incumbent in the form of local managerial knowledge. Thirdly, the response lag by the incumbent to a new entrant is rather short -- the profitable hit and run entry required for full contestability is not feasible in this market.

The point is that when considering deregulation of a market which has been heavily controlled for fifty or more years, a view has to be taken of the merits of these arguments. Particularly where privatisation is concerned, there is a degree of irreversibility about whatever is decided. Here, if the Beesley and Glaister view of the world is correct, then the government stance should be pro-competitive, involving minimal regulation. If the market is considered to be highly imperfect, then a *laissez-faire* policy is much less likely to produce good results. The bet has to be placed before the race is run.

What has actually happened? The story since deregulation may best be summarised in terms of six key indicators shown in Table 2.

The first column shows a large, 40 per cent, fall in real costs per bus kilometre. Although to some extent explained by changes in fuel costs and a switch from big buses to minibuses, the main sources have been a large increase in productivity of operating and maintenance staff and a lesser fall in real wages of those staff. A large gain in productive (or x-) efficiency has occurred. The next three columns show what has happened to that gain. Partly, it has accrued to central and local taxpayers in the form of reduced subsidies; partly it has been spent on increasing the bus kilometres run by 20 to 30 per cent. As a result (col. 4), real fares have needed to increase -- substantially in London and other cities, where high subsidy regimes were previously in place, less so in the other areas. Outside London, bus passenger journeys have declined by 27 per cent over an eight-year period, so that operating costs per passenger journey outside London have remained unchanged. The whole of the productive efficiency gain has been given up in the reduced passenger load factors with which the system is now operating.

Table 2. **Per cent changes in performance of local bus sector, 1985-86/1993-94**

% Change, 1985-96 / 1993-94						
	Cost/bus km*	Real subsidies**	Bus km	Real fares	Passenger Journeys	Cost/Pass Journey
London	-35.1	-47.0	+25.6	+29.2	-3.0	-20.0
Eng. Mets.	-46.5	-42.5	+20.5	+48.9	-35.5	0.0
Eng. Shires	-36.8	-20.7	+24.5	+8.8	-20.2	0.0
Scotland	-40.0	-30.5	+26.6	+2.3	-21.6	-2.0
Wales	-46.8	-33.3	+33.7	n.a.	-20.3	-9.5
TOTAL	-39.8	-38.3	+24.2	+19.2	-22.5	-3.8
Excl. London	-41.9	-34.9	+24.0	+17.4	-27.4	0.0

Source: Department of Transport (1994), *Bus and Coach Statistics*, HMSO, London.
* Excluding depreciation.
** Loss-making services plus concessionary travel reimbursement.

To what extent is the loss of patronage simply the result of historical and external trends such as income and car ownership growth? The period since 1985 has seen a faster-than-average rate of patronage loss of 2.6 per cent per annum, against a long-run decline of 2 per cent per annum. It is also instructive to compare the actual rate of patronage loss with predictions based on best estimates of elasticities. Given the long-run patronage decline of just over 2 per cent per annum, it might be reasonable to posit a secular decline of 1.5 per cent per annum, together with a real fares elasticity of -0.4 and a service (bus kms) elasticity of +0.4. Applying these values to the observed changes in bus kms and real fares shown in Table 2, gives the predicted changes in patronage in Table 3.

Table 3. **Predicted and actual changes in bus patronage, 1985-93 (%)**

	Predicted	Actual	Difference
London	-12.6	-3.0	+9.6
Eng. Mets	-22.6	-35.5	-12.9
Eng. Shires	-4.9	-20.2	-15.3
Scotland	-1.5	-21.6	-20.1
Wales	n.a	-20.3	n.a
TOTAL	-9.2	-22.5	-13.3

Assuming that these values for the time trend and fares and service elasticities are indeed reasonable, there are two obvious conclusions. First, London did a lot better than predicted. This can possibly be explained partly by the different role of public transport in London; by congestion levels inhibiting use of the car, by the maintenance of a free concessionary scheme for elderly travellers and by improved efficiency of London Transport. However, an important ingredient, in our view, is that bus service in the London area has not been deregulated, but opened to a planned competitive tender regime under the control of London Transport. We return to this in the next section.

The second conclusion is that everywhere else outside London (not just the Metropolitan areas) did much worse than the equation predicts. This is the *patronage puzzle* -- why did patronage decline so much faster than conventional elasticities suggest should have happened? Possible explanations include :

-- *Socio-economic changes including lifecycle effects:* the bus industry is rapidly falling back to its bedrock markets -- children and students, the elderly, the poor and commuters in cities -- which themselves are declining. For example, the numbers in the age group 16-29 and the age group 60/65-70 were expected to decrease by 20 per cent and 5 per cent respectively between 1985 and 2001. For bus travel, this has been referred to as the demographic time bomb (Hill *et al.,* 1989). Furthermore, car ownership among the mobile elderly is increasing rapidly as a generation with higher licence-holding and greater driving experience reaches that stage in the life-cycle.

-- *Changes in real motoring costs:* the DOT's index of motoring costs fell from 103.7 in 1983 to 91.0 in 1990-91. Moreover, we would suggest that, outside London, the non-money costs of private transport, representing time, reliability and comfort, have continued to improve over the period. The pace of decline may have increased independently of deregulation.

-- *Fares effects not picked up in the index:* changes in fares for scholars, elderly and multi-journey ticketholders. This is likely to be particularly favourable to patronage in London with the introduction of Capitalcard (January 1985) and Travelcard (January 1989), but unfavourable elsewhere, with the tightening of concessionary and discount travel schemes.

-- *Low service elasticities:* this is a very probable cause, especially in the context of on-the-road competition, where increased bus miles may either not have reduced schedule delay or not been perceived to have done so. Case studies by Mackie and Preston (1988) and others reported by Evans (1990) are suggestive of very low responses to large service changes during competitive battles, with service elasticities of around 0.1 being typical. In short, much of the increased bus mileage operated in the commercial sector may have been wasted.

-- *Loss of consumer confidence*: associated with increased uncertainty, loss of information and route/network instability. This, of course, has varied from area to area. Some PTEs have made great efforts to maintain information levels and some areas, for example the West Midlands, have seen a high degree of service and operator stability. But in other areas, the position has been much worse, with very high levels of service changes and poor communication with the public. The costs of information failure and instability fall on the user and are added to the generalised costs of travel in the form of enhanced waiting times, queuing to acquire information, the need to rememorise schedule data and so on. Our studies in West Yorkshire showed particularly sharp declines in customer ratings for these

> "soft" factors, such as information and reliability. In some areas, the transitional period straddling deregulation was particularly devastating in service quality terms. We think that the resulting shock to confidence must explain a significant part of the excess loss of patronage (Preston, 1988).

Overall, the verdict of most commentators is that the performance of the deregulated bus industry, from a social point of view, has been mediocre at best. This has left the Government with an acute regulatory dilemma. One possibility is to argue that the failures which have occurred result from imperfections in the market place, so that a pro-competitive stance is required in order to promote market contestability. This has broadly been the position taken by the Office of Fair Trading and the Monopolies and Mergers Commission in their dealings with the bus industry (Mackie and Preston, 1996).

Suppose that the problem for the regulators is to maintain the contestability of a weak natural monopoly with low entry barriers. Then we would conclude that the British style of regulation is probably too weak. The way forward might be a modified rule of reason or case-by-case approach incorporating certain guidelines or "brightlines" in line with the approach adopted towards restrictive practices (see also Dodgson, 1991). All of the following could enhance market contestability:

-- Requiring that bus companies above a certain size publish revenue and cost accounts in a prescribed manner;
-- Administering access to terminals and possibly network ticketing and information, through a third-party public authority;
-- Declaring "spoiling" commercial registrations against tenders won by small firms to be *per se* anti-competitive;
-- Requiring that fare cuts or service enhancements made during competitive battles be maintained for a defined period of time (say, one year). This would be an application of earlier proposals to limit incumbent response;
-- Introducing *ex post* punitive measures such as triple damages against offenders so as to attach a higher penalty to anti-competitive behaviour;
-- Creating a rapid reaction squad, capable of taking immediate action against *per se* anti-competitive behaviour and act as an *ex ante* warning to others;
-- Examining the behaviour of some of the largest and most dominant firms through monopoly references to MMC. This might involve using economic models to determine whether price : output configurations were leading to serious resource misallocations.

If the Government wishes to pursue its declared policy of promoting competition in the local bus industry, then it probably needs to adopt a more interventionist stance than hitherto. Given the industry's history of public service and its high visibility, we foresee a continuing requirement for a disproportionate amount of regulatory activity to be devoted to this industry.

However, the foregoing analysis is based on the assumption that the market characteristics are defined solely by producer cost conditions. Suppose that, as we have argued, the market is also characterised by user cost economies and external benefits associated with coherent networks, stability and information. Then it is far from clear that a strategy of encouraging entry and forcing the market to behave competitively against its natural tendencies is either feasible or in the public interest.

If our economic model of the bus market is correct, there are then two possible regulatory strategies. The first is to recognise that the natural form of organisation should involve a significant degree of local monopoly power and market dominance. The regulatory problem is then to achieve a good pattern of prices and service for the public while maintaining competitive discipline on the dominant firm and controlling anti-competitive behaviour. The problems of identifying X-inefficiency, cross-subsidisation and predatory behaviour, together with the sheer scale of regulatory resources devoted to this industry suggest the need for a specialist regulatory agency (OFBUS) along the lines of the privatised utility regulators. However, it may be difficult to justify the cost-effectiveness of such a hands-on approach to an industry which, compared to the privatised utilities, exhibits very low levels of profitability.

The alternative strategy is to abandon the regime of "commercial" competition in favour of one based on competition tender or franchise. The intellectual attraction of this is that the external benefits from planning and marketing the network can be preserved by a well-organised franchiser, while competitive market forces can be brought to bear in the period tender or franchise competitions. This is exactly the solution the Government has arrived at for London, having initially proposed full-scale deregulation. However, it is not easy to see how this solution could be implemented in the rest of the country from the starting point of full deregulation; this is the irreversibility problem referred to earlier.

8. CASE STUDY 4 -- TENDER AND FRANCHISE BIDDING IN PUBLIC TRANSPORT

It is widely recognised in the economics literature, following Demsetz (1968) and Williamson (1976), that a category of goods and services exists for which a market does not exist or competition is unsustainable or subject to externalities which fall on consumers. If such goods are simply subject to public regulation or ownership of a monopoly form then various forms of inefficiency are very likely to exist. An alternative model is, therefore, to separate out regulatory control over the service to be provided and introduce supply-side competition for the right to provide the service, subject to the specification of the planners. This model, it is argued, frees production of the service to be efficient while maintaining public control over the quality and stability of delivery. Sectors in the UK which have been subjected to compulsory competitive tendering include ancillary health services (meals, laundry, cleaning), refuse collection and many other local government activities.

It is possible to write down a list of desirable features if sectors are to be competitively tendered. These are:

1. Service requirements should be easy to define and reasonably stable;
2. The technology should be well understood;
3. Sunk costs should not be too high;
4. Initial costs of defining and letting the contract should be low;
5. Monitoring of service delivery/quality should be feasible.

The combination of these five characteristics is propitious for competitive tendering. The first condition ensures that the market should not be subject to dynamic inefficiency as the service level to be provided and the technology used are clearly defined. The second and third conditions should ensure a reasonable number of bidders, so that the outcome might be quasi-competitive. Moreover, if sunk costs are low, it should be feasible to replace one contractor by another at the end of the contract term, or earlier if a failure occurs. The fourth and fifth conditions ensure that set-up and monitoring costs are not excessive. If these conditions are met, then competitive tendering should operate by mimicking contestable market conditions. In particular, once the contract is won, the winner is protected for the period of the tender, provided he delivers to contract. In such a market, a newcomer really can enter and produce before other firms are allowed to react.

How has tendering worked out in public transport? We consider the cases of local buses and rail passenger service franchises.

8.1. Local buses

The local bus sector provides a very interesting case study. Outside London, the 1985 Transport Act created a system in which operators determine the services and fares which they wish to offer commercially and local authorities then decide what additional social services they wish to secure to fill the gaps. These secured services -- some 15 per cent of total vehicle mileage -- are subject to competitive tendering. In London, a different regime is in place in which, progressively, the whole network has been put out to tender under the control of London Transport. There is therefore an opportunity to compare full deregulation outside London with controlled tendering in the capital (see Table 2 in the previous section).

We believe the evidence is that a controlled tender regime is a better environment for local bus operation than open competition, in that it:

a) permits appropriate determination of service levels in relation to demand, rather than as response to potential or actual competition;

b) therefore enables the fares/service mix to be balanced in a socially beneficial way;

c) prevents instability which imposes real costs on consumers and reduces long-run consumer confidence;

d) permits network-wide ticketing and marketing initiatives, including Travelcard;

e) promotes real competition for the market through tendering, while monitoring output, thereby exerting downward pressure on real operating costs;

f) is flexible enough to respond to government policy changes, for example, on subsidy levels, accessible vehicles and so on.

Although tendering has worked best within a comprehensively planned framework, as in London, it has also been the most successful element of the deregulation package outside London. The very real competition injected by the tender process has been a major factor, possibly even the dominant factor in reducing bus operating costs. There are some problems with the overlap with the commercial network: incumbents can register commercial services in such a way that, if the tendering authority fills in the gaps, the incumbent is best placed to win the tender. Should an incumbent lose a tender, the service can always be operated commercially. Also, certain well-known features of tender auctions, such as the winner's curse and block-bidding by large incumbents, do occur and do reduce contestability. However, overall, the criteria for success listed above are met in the local bus industry.

8.2. Rail passenger franchises

Franchising for passenger rail services was introduced as a result of the 1995 Railways Act. British Rail's passenger business was split into 25 train operating units that have been gradually put out to franchise by the Office of Passenger Rail Franchising (OPRAF). At the time of writing, thirteen train operating companies have been transferred to the private sector. Franchising differs from tendering in two respects. Firstly, there may be the possibility of a negative subsidy bid. In other words, the bidder may pay OPRAF to operate the service, although this is only expected to occur in a handful of cases. Secondly, the bidder may have greater leeway to specify service levels and set fares. In the event, contracts are tightly specified by OPRAF. Minimum service levels (the passenger service requirement) are set which, following judicial review, continue to be set at around 75 per cent to 95 per cent of the 1994-95 timetable. Standard fares for journeys under 50 miles, saver fares for journeys greater than 50 miles and season tickets in London, Cardiff and Edinburgh will be controlled through an RPI-X formula. The PTEs control the fares in seven other urban areas. The contracts are operating contracts in that the infrastructure and signalling is supplied by Railtrack and the rolling stock is supplied by three Rolling Stock leasing Companies (ROSCOs). Both Railtrack and the ROSCOs have been privatised, raising some £4 billion for the Exchequer. Train operating companies only directly control 40 per cent of their costs.

It is too early to assess the impact of franchising but a number of features can be noted:

1. Subsidy increased from £692m in 1989-90 to £1 960m in 1994-95 (both at 1994-95 prices). £755m of this increase may be attributed to the profits posted by Railtrack and the ROSCOs in 1994-95. Gross subsidy has thus increased more than threefold over a five-year period.
2. Subsidy for the first seven franchises let (see Table 4) is expected to decrease from around £299 million in the first year to around £92 million in the final year. Gross subsidy may thus be expected to reduce by over two-thirds, so that there is a possibility that in the long-run subsidy will fall below its 1989-90 levels. Much of this reduction may be attributed to the reduced track charges enforced on Railtrack by the Office of the Rail Regulator.

3. Competition for franchises has been relatively intense so far. There were an average of 20 registrations of interest for each of the first eight franchises, with around four serious bids per franchise.

4. Incumbents do not appear to have an advantage, at least in the first round. Only three of the thirteen franchises so far let have gone to management buy-outs. Large consortia, often led by publicly listed companies, seem to have cheaper access to the substantial finance which is required as a performance bond.

5. Compared to the bus industry norm of three years, franchises are relatively long. OPRAF has attempted to enforce a seven-year length, but four of the first seven contracts will be longer than this, providing new rolling stock is provided.

6. Nine of the first thirteen franchises have been won by four consortia. It is widely expected in the industry that the market will rapidly shake down to three or four major players, although there may be scope for niche operators (micro franchises).

7. Up to the year 2002, franchises are protected from open access competition. After that date (assuming present policies continue), a dual system of commercial and tendered services might be expected to emerge, as in the bus industry.

Table 4. **The first seven franchise awards**

Franchise	TOC	Franchise length (years)	Subsidy Year One	Subsidy Final Year	Average rate of subsidy cut per annum
South West Trains	Stagecoach	7	£54.7m	£40.3m	£2.0m
Great Western	MBO	10	£53.2m	£38.2m	£2.1m
Inter City East Coach	Sea Containers	7	£64.6m	£0m	£9.2m
Gatwick Express	National Express	15	-£4.6m	-£22.6m	n.a
Network South Central	CGEA	7	£85.3m	£34.6m	£7.2m
Midland Main Line	National Express	10	£16.5m	-£10.0m	n.a
London, Tilbury and Southend	Prism	15	£29.5m	£11.2m	£1.2m

n.a. Not applicable.
Source: Local Transport Today, 23 May 1996, Issue 186, p. 14.

Given the above, it may be questioned whether passenger railways possess the desirable features for franchising. Firstly, although service requirement can be based on the initial timetable - and even here there will be disputes (e.g. the Fort William Sleeper) - these requirements may be expected to change over time, whilst the benefits of operating a network of services are not well understood. Secondly, the technology may not always be well understood -- should a service be operated by diesel or electric traction, or by frequent, low-quality trains or less frequent, higher-quality trains? There may be scope for dynamic inefficiency in the new regime. Thirdly, sunk costs may not be substantial, given the creation of Railtrack and the ROSCOs (although it is interesting to note that one of the successful franchise consortia is bidding for one of the ROSCOs), but the human capital costs (particularly concerning experienced managers and drivers) are not negligible. Franchise hand-over has been a problem with one urban rail operation in America. Incumbents may be successful in renegotiating contracts given the costs involved in replacing them. There are also concerns that bidding may not be competitive in the long run, when the industry has shaken down to four major players. Equally, there are concerns that, in an industry with high fixed costs (related to track access charges), bids will not be efficient, being based on average rather than marginal cost pricing. Fourthly, initial costs of defining and letting the contracts have been substantial. OPRAF has a budget of £181m net of subsidy to train operating companies in 1994-95 and the cost of one of the initial franchises being let was over £6m in external fees alone. Fifthly, monitoring of service delivery will require twice-yearly passenger surveys (undertaken by the train operating companies) and detailed performance monitoring of reliability, punctuality, overcrowding and cleanliness, based mainly on self-reporting. Although it is early days, the expectation is therefore that rail franchising will be less successful than bus tendering.

9. CONCLUSIONS

The obvious conclusion of this paper is that the question:- regulation or competition -- poses a false choice. The answer may be either, both or neither, depending on the economic circumstances of the sector. It is essential to remember at all times that policy instruments such as regulation are means to the end of producing a good result for society and have no intrinsic merit or value for their own sake. Regulatory bodies often need to be reminded of this.

Broadly speaking, it is possible to divide the old public sector into a number of different economic categories. First, there are the genuine public utilities with clear natural monopoly characteristics. If these are privatised, they will require public regulation of a price-cap or rate-of-return kind. If they are vertically integrated production and distribution industries, then structural questions of vertical separation, access to the monopoly resource and interconnection rules have to be resolved. In the case of the railways, how this will happen for passenger services is an interesting question. Secondly, there are sectors such as road haulage and express coaches which are workably competitive. Here, quality licensing is required to protect public safety and environment and to provide a level playing field for competition. Beyond that, particularly if there are opportunities for innovation and dynamism, I would argue that minimal regulation is required and that more attention should be paid to market performance than to market structure when considering these sectors. Here, the *laissez-faire* approach of the British has been relatively successful. Thirdly, there are sectors which are neither workably competitive nor obvious natural monopolies. These imperfectly competitive sectors, among which the author would include the local bus market, are particularly difficult to deal with and the balance between competition and regulation is by no means clear. In the case of the local bus industry, the performance outturn from deregulation has been disappointing and the losses of a coherent network, of consumer confidence, of stability and of the ability to use the level of quality of bus service as a tool of city transport policy, have been too great. For that type of market, the competitive tender or franchise option seems very relevant. The overall conclusion, therefore, is that an eclectic approach is required, depending on a clear analysis of the economic characteristics of the sectors. Political dogma is the enemy of sensible policymaking in a sector as varied as transport.

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WHICH GOVERNMENT POLICIES FOR WHICH SUSTAINABLE MOBILITY (SAFETY, ENVIRONMENT)?

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SUMMARY

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1. INTRODUCTION

In the title of this paper there is a term containing two words which tend to be flogged to death these days, veritable buzz-words: "sustainable" and "mobility". Since it is the aim of this report to identify measures and actions that governments can initiate to lead to a sustainable mobility, this sustainable mobility seems to describe a desirable target situation. A number of questions arise here:

– How is "sustainable mobility" to be defined?;
– Are there any quantitatively measurable values or observation data, and corresponding limit values, that precisely describe "sustainable mobility"?;
– Is "sustainable mobility" capable of obtaining a consensus as a social and national policy goal or is it simply the goal of a few Green ideologists?;
– To what extent does present and expected future mobility rate as "sustainable"?;
– Which measures lead to "sustainable mobility"?

Initial consideration indicates that "sustainable mobility" certainly has a high degree of acceptance among both the general public and the decisionmakers as a somewhat vague slogan, but experience shows that when it is defined more precisely people are reluctant to draw the obvious conclusions and take the necessary action. There is reason to suspect that the concept of "sustainable mobility" is very often used to salve the public's conscience by setting goals that sound very laudable and then going on exactly as before. Analysis of the measures implemented in pursuit of transport policy goals and concepts confirms this to a large extent.

2. SUSTAINABLE MOBILITY

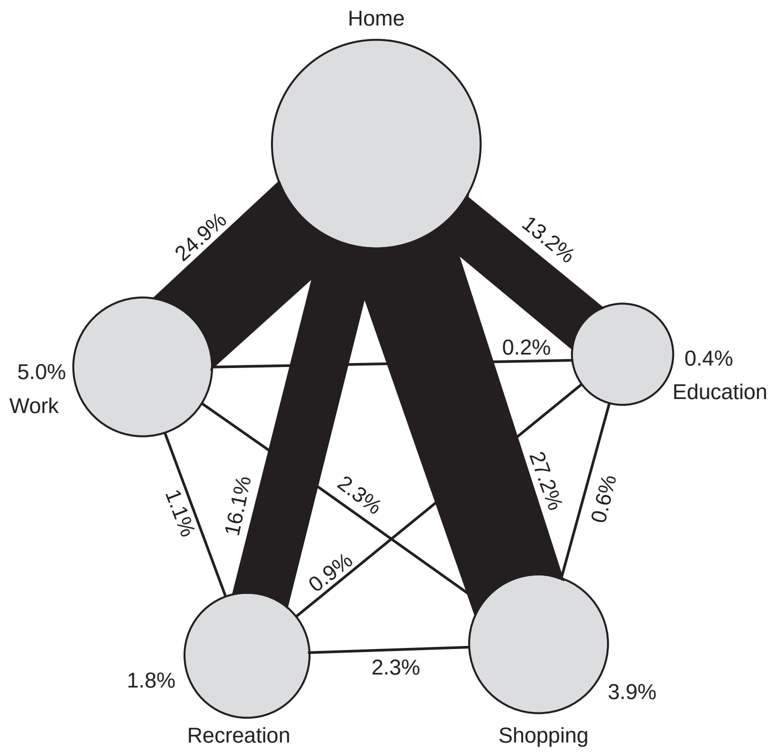
2.1. Mobility

Mobility in transport studies is understood as the spatial movement of people and goods. In passenger transport, a distinction is made between utility mobility and fun mobility.

– **Utility mobility**

  From the standpoint of the "activity concept", movement is for the purpose of carrying out different activities at different places. These activities can be divided, for example, into five basic functional areas of human existence: home, work, education, shopping and recreation (Figure 1). In this sense, transport and mobility are therefore "means to an end". If we disregard leisure traffic whose real aim is "movement for movement's sake", as in the case of simply going for a walk or cycling for exercise, then utility mobility on workdays accounts for well over 90 per cent of all trips.

Figure 1. **Workday mobility between the five basic functional areas Weekday travel by the inhabitants of Graz, 1982**



Source: Köstenberger, Fallast, Sammer *et al.*, 1983.

– **Fun mobility**

When the aim of a trip is not an activity at the destination, but rather the trip itself, we speak of fun mobility. Generally speaking, its quantitative importance is overestimated but there is no doubt that at weekends and holiday periods it is more important than in normal weekday traffic.

There are two different trends influencing future fun mobility:

1. Increasing leisure and hence recreational mobility; but also the growing number of pensioners, who refuse to give up the car in their retirement, are having an increasing influence on fun mobility;
2. Capacity bottlenecks in transport infrastructures and environmental problems are putting a brake on fun mobility using motorised transport in particular. This is leading to disenchantment with mobility: congestion, difficult traffic conditions and strain lead to stress situations, which people would rather avoid because they reduce the pleasure of travelling.

In freight transport, only the concept of utility mobility applies: the transport of goods between the different places in which they are produced, sold and consumed. The economy based on the division of labour, which divides production processes between different places in order to minimise the total cost of production, leads to a considerable increase in freight traffic flows.

Mobility thus constitutes a basic need and is also a symbol of democracy, freedom and a functioning economy. For individuals, it represents the potential freedom to choose different places for activities, connected with work, school, shopping or whatever. To this extent, an expansion of the transport supply increases the freedom of mobility of the individual. It must be taken into account, however, that any such expansion creates new traffic, because supply stimulates demand in the transport system as elsewhere: and new traffic has consequences that can certainly restrict the freedom of other people (see forced mobility).

Mobility also has negative effects, however, such as traffic noise, solid and fluid emissions, land use, accidents and energy consumption, and thus causes enormous costs. Mobility can also become a necessity (forced mobility) as, for example, when the car has to be used because the corner shop which could be reached on foot has disappeared as the result of competition from supermarkets. The same naturally applies with the concentration of central facilities which greatly affect the provision of local schools and public services. Another kind of forced mobility also appears when, for example, parents take their children to school by car because they are afraid they might be run over, or when people have to commute over long distances because there are no local employment opportunities. Forced mobility is, however, frequently a result of present land-use and transport policy and concerns certain groups above all: children and young people, women and pensioners.

Sustainable mobility thus lies somewhere between the free exercise of mobility with no restrictions and the aim of minimising the negative consequences.

2.2. Sustainability in transport

"Sustainability" describes the operation of a system in such a way that it can continue to operate in the long term (for a long while as compared with a human life). The transport system will thus be sustainable if it corresponds to a cyclical system. In concrete terms, this means:

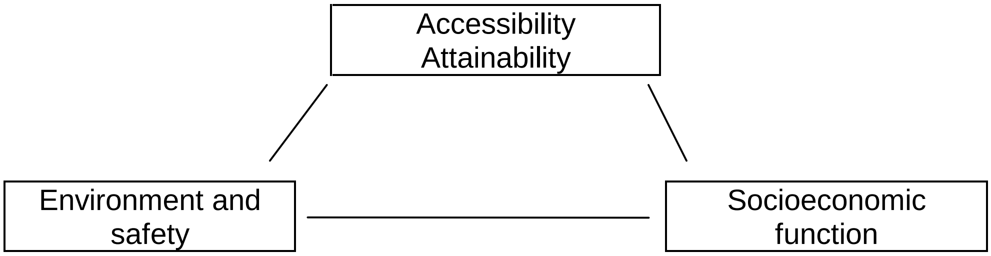
1. Only such and so much natural resources must be taken from nature as can be replaced;
2. Only such and so much waste must be returned to nature as is compatible with regeneration;
3. There must be no effects on people, fauna and flora which cannot be controlled.

Sustainable mobility thus lies in a field of tension or in conflict with the following goals (Figure 2):

– Ensuring the long-term attainability and accessibility of the desired places for all people and all transport users:
  Here, it is a matter of ensuring adequate mobility for each individual. This can be demonstrated by the following examples:
  - Intensive encouragement of car mobility leads, in thinly populated areas, to a reduction in public transport on cost grounds. It is people without cars who suffer (e.g. children, young people under 18, elderly people, etc.);

- Intensive car mobility leads, above all in conurbations, to congestion, which itself restricts the road-user's mobility;
- The inhabitants of underdeveloped countries should be allowed the same level of mobility as the inhabitants of highly developed countries. The inhabitants of underdeveloped countries should not have to accept low mobility without compensation just because the highly developed countries consume more than their fair share of resources (sustainability thus has a distribution effect and hence also consequences for democracy and politics).

Figure 2. **Sustainable mobility: the tensions and conflicting objectives**



– Ensuring the long-term sustainable protection of the environment and the population:

Here, all environmental policy objectives are to be related to safety:
- Avoid or reduce the quantities of harmful emissions (such as CO_2, CH, etc.);
- Avoid irreparable damage to health, as through road accidents, harmful emissions and noise;
- Avoid further land use and damage to the countryside.

– Ensuring a certain socioeconomic minimum standard:

- The exercise of the mobility necessary for normal life must be affordable for all individuals, including the economically disadvantaged strata of society (sustainability also has a social component);
- The consumption of resources as a result of mobility must also permit future generations to go on being mobile. This is compromised in the longer term by the rapid consumption of fossil fuels. Operating at the expense of future generations is not sustainable.

The above discussion leads to the conclusion that the objective of sustainable mobility cannot be considered in isolation, but is interrelated with many other socioeconomic factors, as in a networked system. Particular attention should be paid to the "protection principle" and the "provision principle": according to the protection principle, no emissions or other disbenefits which impair human health and wellbeing or cause harm to the environment will be permitted. The provision principle means that, in principle, future generations must not be restricted in the satisfaction of their needs and potential future dangers for man and the environment are to be avoided.

It is possible to make sustainability at least approximately measurable by using indicators which describe all relevant effects of mobility. These include mobility statistics, cost statistics, emission indicators, etc. In order to be able to check the extent to which sustainable mobility has been achieved, it is necessary to define quantitative targets for all these indicators (limit values, threshold values for acceptable or unacceptable effects). This condition is as yet not fulfilled for all effects.

2.3. The time dimension of sustainable mobility

An important component of sustainability is the time dimension. A sustainable "cyclical system" means that the effects of the system under consideration, "mobility", in its interaction with the system "life and nature on earth", remains stable in the long term, or remains constant in its total effect, or changes only in such a way that it leads to no critical bottlenecks or shortages with respect to the quality of life of men and animals or the continued existence of nature. Sporadic short-term variations are of no importance here. Even taking account of the fact that the earth is finite, the period considered is to be extended until the total effects remain stable.

Long-term studies of mobility trends do not indicate any likelihood of saturation in the coming decades (Pischinger *et al.*, 1996-97). From this standpoint, the period considered should be extended further, but in practice this period has to be limited enough to permit at least a halfway reasonable forecast of the effects. Thus, for example, it makes little sense to make a quantitative estimate of the effects of energy supply for transport in fifty years' time when we have no idea of what the main energy technology will be by then. From the standpoint of the sense of responsibility for future generations, it is therefore necessary to require that sustainability should be achieved in more manageable periods of, say, 20 to 30 years.

2.4. An attempt to define sustainable mobility

In what follows, an attempt is made to define a sustainable mobility according to the present state of knowledge and using the available indicators. This represents a judgement and is thus subjective.

- Fuel consumption:
  Strictly speaking, the mobility trend is sustainable if no non-renewable forms of energy are consumed. This means that the path to sustainability can be reached only if there is a significant reduction in the consumption of petroleum-based fuels.

- Exhaust emissions:
  Sustainability requires the exclusion of any potential danger to man and nature, which means that all harmful exhaust emissions must respect limit values which preclude damage.

- Greenhouse gas emissions:
  Sustainability requires a reduction in all greenhouse gas emissions to an extent that ensures that they do not disturb the "natural" equilibrium of the CO_2 content of the atmosphere. This means that the achievement of the Toronto target (reduction to 80 per cent of the quantity of greenhouse gases emitted in 1988 by 2005) or the target set by the Climate Convention, was only a step in the right direction. The long-term goal must be "zero CO_2 emissions".

– Safety:
  Sustainability with respect to safety means, strictly speaking, no fatal accidents and the minimisation of other accidents.

– Economic efficiency:
  A sustainable transport system should satisfy the principle that the originator of costs must pay. This means that the degree of cost coverage for the use of infrastructures for all transport modes should be 100 per cent, and all external costs must be internalised.

– Land use by transport:
  Sustainability with respect to land use requires limits on the area of land occupied by transport infrastructures, so that sufficient living space remains for men, animals and plants. Limit values should therefore be set according to the type of region.

– Noise emission:
  Sustainability means respecting the noise emission limits set according to the purpose for which the surrounding area is used.

– Principles and methods on the path to sustainable mobility:
  - minimisation of ecological and health risks;
  - avoidance and prevention before repair;
  - use of the most resource-conserving/environment-friendly transport technology and mode;
  - economic efficiency aimed at achieving the greatest possible benefit to the economy as a whole at the least possible cost;
  - permit balanced mobility opportunities -- in the sense of making it possible for all people to reach their places of work or education, the facilities they need, etc.;
  - promotion of the transport modes which best correspond to the named principles, i.e. those which are most environment-friendly, energy-efficient and resource-saving.

3. TRENDS

The question arises of whether the present situation and future development of transport, taking into account measures which have already been planned or decided upon, satisfy the principles of sustainability or not. To try to answer this, we analyse past and future traffic trends using two examples:

1. The findings of a survey for Austria, with traffic trend estimates to 2020 (Pischinger *et al.*, 1996);
2. Findings for Europe and the whole world for 2020 and 2050 (Pischinger *et al.*, 1996-97).

3.1. Trends in Austria

The framework conditions for the trend scenario discussed are as follows:

- The past transport demand trend continues until saturation of the car ownership rate at about 650 cars per 1 000 population and does not reach saturation until after 2020;
- Fairly linear growth is expected in freight traffic, which remains closely linked with the Gross Domestic Product despite changes in the breakdown of the goods carried;
- Gross Domestic Product growth is almost linear;
- The tax burden on transport remains roughly the same in real terms;
- Progress in automobile technology leads to an annual reduction of some 1.5 per cent in fuel consumption, despite the increased vehicle weight and engine performance of new cars. The exhaust gas limits are set by EURO II and the present proposals of the German environment agency developed for EURO III;
- In truck traffic a reduction in fuel consumption of 5 per cent by about 2020 and about 0.1 per cent a year in vehicle weight is expected;
- In air transport, technological improvements in the renewed fleet are expected to reduce fuel consumption by 36 per cent, while the occupancy rate will increase from 72 to 85 per cent;
- No significant changes in the energy consumption of rail or waterway transport are to be expected;
- As regards infrastructure extension measures, no great changes are assumed in either road or rail transport, apart from the already decided and fundable measures. This corresponds to a "*status quo* prognosis" for infrastructures.

3.1.1 Methodology

The following results were obtained concerning the vehicle stock for the different categories of vehicle, the specific annual traffic volumes and transport outputs, the specific fuel and energy consumption and the specific emission figures. Since the individual figures, in particular for annual vehicle distances and transport outputs, are known only approximately and for a few reference years, the annual fuel consumption figures were used for calibration. We thus have relatively precise values for the traffic volumes and transport outputs for the years analysed, 1971 to 1995.

3.1.2 Transport demand trend

The trend in passenger transport demand to 2020 does not indicate any saturation in the next 25 years (Figure 3). Between 1995 and 2020, an increase of about 58 per cent in total passenger traffic is expected. The strongest growth is in car traffic with an increase of 67 per cent between 1995 and 2020. The main reasons for this are:

- Further increasing car ownership; consumer behaviour surveys do not permit any concrete saturation value to be determined. The number of people of driving age will continue to increase in the future;
- Urban sprawl continues, with housing estates becoming increasingly car oriented. Not least, the environmental situation in the conurbations leads many people to seek a new home in the green belts outside the towns;
- Falling daily and weekly working hours leave more time for physical mobility. Part of the growing leisure time is converted into traffic (about five minutes of every hour's reduction in daily working time is used for mobility; Sammer *et al.*, 1990).

Traffic for different purposes grows at different rates. The strongest growth is in traffic for economic, leisure and personal business purposes. The transport output of public passenger transport (train and bus traffic) shows a significantly smaller increase of between 34 and 40 per cent over the same period. This means that the public transport share of total passenger transport has a falling trend (1995 share: 25 per cent, 2020 share: 22 per cent). The greatest increase is in air transport, 136 per cent. Over the next 15 years air traffic will just about double. Walking and cycling transport output will remain roughly the same, though the population will increase by about 4 per cent over the period.

Figure 3. **Passenger transport output trends in Austria to 2020**

Source: Pischinger *et al.*, 1996.

These changes are not distributed evenly throughout Austria but differ greatly according to the settlement structure and type of trip:

- The increases in private, motorised traffic are above all in the thinly populated regions and in the catchment areas for the conurbations and concern mainly shopping and leisure traffic;
- The increases in public transport are restricted to the centres of the conurbations and commuter traffic to and from the conurbations (as the result of capacity bottlenecks) and intercity traffic;
- The increases in air traffic are mainly in medium- and long-distance traffic, above all for business and holiday travel.

Table 1 shows the forecast trend in annual specific passenger transport output. The main features are:

- In motorised private transport, an increase in the annual distance covered per person from 8 437 km in 1995 to over 13 000 km in 2020 is to be expected;
- An increase in public transport is also expected, but only about half as big. In the year 2020, the average total distance covered will be over 4 000 km;
- The biggest relative growth is expected in air transport, from 670 km in 1995 to over 1 500 km per person in 2020.

Table 1. **Trends in annual specific passenger transport output in kilometres per person in Austria to 2020**

Year	**MPT (1)**	**PT (2)**	**Air**	**Foot+cycle**	**Total**
1995	8 437	3 375	670	881	13 364
2020	13 513	4 377	1 521	881	20 258
Change in %	+60 %	30 %	+127 %	±0 %	+52 %

(1) Motorised private transport.
(2) Public transport.

In freight transport, an increase in transport output, measured in tonne-kilometres, of over 40 per cent between 1995 and 2020 is expected in Austria (Figure 4). There are great differences between individual transport modes:

- The biggest increase is in air freight: up more than 90 per cent between 1995 and 2020 and with the market share growing from 5 to 8 per cent;
- Road haulage is expected to increase by over 50 per cent, with the market share growing from 54 to 58 per cent;
- Rail and waterway transport shows the smallest increase and the market share falls from 44 to 39 per cent.

Figure 4. **Estimated trend in freight transport output in Austria to 2020**

Source: Pischinger *et al.*, 1996.

Table 2. **Trend in annual specific freight transport output in tonne-km per person in Austria to 2020**

Year	Road	Rail	Waterway	Air	Total
1995	2 221	1 628	218	81	4 148
2020	3 282	1 941	271	156	5 864
Change in %	+48 %	+19 %	+24 %	+93 %	+41 %

3.1.3 Consequences of traffic trends in Austria

The vital question arises of what quantitative environmental effects of the expected traffic trends can be estimated and whether this development can be considered sustainable. The quantitative effects with respect to energy consumption and exhaust emissions are taken from the 1996 study already cited in chapter 3 on the economic cost of measures to reduce CO_2 emissions from traffic in Austria (Pischinger *et al.*,.1996).

– Energy consumption in transport:

  In the next 25 years, energy consumption in the transport sector (Figure 5) will increase by about 15 per cent, i.e. considerably less than the growth in passenger transport volume and transport output. The reason for the flattening of the energy consumption growth curve lies in the technological improvement of the vehicle stock. However, growth varies greatly between transport modes: the greatest increase is in the electricity consumption of rail transport, up 28 per cent and in aviation spirit, up 22 per cent. Rail and waterway diesel consumption is expected to fall by 2 per cent.

Figure 5. **Trend in transport sector energy consumption in Austria to 2020**

Source: Pischinger *et al.*, 1996.

A very striking fact is that, while the per capita transport energy consumption of the Austrian population in 1995 was 8.42 MWh or 699 kg of fuel, this figure is expected to rise in the next 25 years to 9.66 MWh or 794 kg fuel.

Table 3. **Trend in annual specific energy consumption in MWh/person and fuel consumption in kg/person**

Year	Gas.+Diesel Road	Diesel Rail+ Waterway	Aviation spirit	Electricity Rail	Total
1995	7.93 MWh 639 kg	0.996 MWh 8 kg	0.618 MWh 52 kg	0.314 MWh	8.42 MWh 699 kg
2020	8.41 MWh 722 kg	0.0985 MWh 8 kg	0.752 MWh 64 kg	0.402 MWh	9.66 MWh 794 kg
Change in %	+14 %	-2 %	+22 %	+28 %	+15 %

– Carbon dioxide exhaust emissions:

According to the trend, transport induced CO_2 emissions will increase by about 18 per cent in the next 25 years. The Toronto target will be missed by a long way (Figure 6). About half of the CO_2 emissions come from motorised private transport and 35 per cent from trucks and agricultural implements.

Figure 6. **Trend in transport-induced CO_2 emissions in Austria to 2020**

Source: Pischinger *et al.*, 1996.

In road transport (passenger and freight transport), per capita CO_2 emissions at present amount to about 2.01 t per year out of a total for all sources of 2.28 t per year. This figure is expected to rise to 2.58 t/person by 2020 (Table 4).

Table 4. **Trend in annual per capita CO_2 exhaust emissions in Austria to 2020 in tonnes**

Year	Road	Rail	Waterway	Air	Total
1995	2.01	0.84	0.053	0.10	2.11
2020	2.28	0.82	0.062	0.12	2.38
Change in %	+13 %	-2 %	+17 %	+19 %	+13 %

– Carbon monoxide exhaust emissions:

About 88 per cent of the CO exhaust emissions in Austria come from private transport. Through reducing the exhaust gas limit values in connection with enhanced engine technology, it should be possible to reduce CO emissions from the present 347 000 t/year to 133 000 t/year, or a reduction of over 60 per cent (Figure 7). Per capita CO exhaust emissions at present amount to 43 kg/year, but this figure should be reduced to 16 kg by 2020 (Table 5).

Figure 7. **Trend in CO exhaust emissions in Austria**

Source: Pischinger *et al.*, 1996.

Table 5. **Trend in annual per capita CO exhaust emissions in Austria to 2020 in kg**

Year	Road	Rail	Waterway	Air	Total
1995	42.9	0.05	0.01	0.1	43.1
2020	15.7	0.04	0.01	0.1	15.9
Change in %	-63 %	-28 %	-4 %	+15 %	-63 %

– Nitrogen oxide exhaust emissions:

Thanks to progress in engine technologies and NO_x exhaust gas limit values, a reduction of 30 per cent in NO_x exhaust emissions is expected in the next 25 years (Figure 8). At present, around 95 per cent of total NO_x emissions are caused by road transport. Per capita NO_x emissions in Austria in 1995 amounted to 13.8 kg. This figure is expected to fall to 9.3 kg/person per year by 2010 (Table 6).

Figure 8. **Trend in NO_X exhaust emissions in Austria**

Source: Pischinger *et al.*, 1996.

Table 6. **Trend in annual per capita NO_X exhaust emissions in Austria to 2020 in kg**

Year	Road	Rail	Waterway	Air	Total
1995	12.9	0.3	0.1	0.6	13.8
2020	8.3	0.2	0.1	0.7	9.3
Change in %	-36 %	-16 %	+15 %	+23 %	-33 %

– Hydrocarbon exhaust emissions:

HC emissions are expected to fall by 70 per cent. At present road transport accounts for 99 per cent of the total: motorised private transport 72 per cent and road haulage 27 per cent (Figure 9). Annual per capita HC emissions from road transport amount to 5.8 kg. This figure is expected to fall to 1.6 kg by 2020.

Figure 9. **Trend in HC exhaust emissions in Austria**

Source: Pischinger *et al.*, 1996.

Table 7. **Trend in annual per capita HC exhaust emissions in Austria to 2020 in kg**

Year	Road	Rail	Waterway	Air	Total
1995	5.8	0.020	0.005	0.051	5.9
2020	1.6	0.020	0.005	0.055	1.7
Change in %	-72 %	0 %	0 %	+8 %	-71 %

– Particulate exhaust emissions:

At present, 19 per cent of particulate exhaust emissions originate in motorised private transport, 41 per cent in road haulage and 34 per cent in agricultural implements. A total reduction of 38 per cent is expected over the next 25 years (Figure 10). The per capita particulate exhaust emissions amount at present to almost 1 kg/year and are expected to fall by almost half (Table 8).

Figure 10. **Trend in particulate exhaust emissions in Austria**

Source: Pischinger *et al.*, 1996.

Table 8. **Trend in annual per capita particulate exhaust emissions in Austria to 2020 in kg**

Year	**Road**	**Rail**	**Waterway**	**Air**	**Total**
1995	0.938	0.009	0.001	0.001	0.950
2020	0.555	0.007	0.001	0.001	0.564
Change in %	-41 %	-18 %	-4 %	+12 %	-41 %

– Sulphur dioxide exhaust emissions:

The trend in sulphur dioxide exhaust emissions reflects the desulphurisation of motor fuels (Figure 11). Road transport accounts for 84 per cent of total SO_2 exhaust emissions, road passenger transport 33 per cent. The expected reduction to 2020 amounts to 35 per cent. The annual per capita emission is about 1.2 kg and this will fall to about three-quarters of a kilogramme (Table 9).

Figure 11. **Trend in SO_2 exhaust emissions in Austria**

Source: Pischinger *et al.*, 1996.

Table 9. **Trend in annual per capita SO_2 exhaust emissions in Austria to 2020 in kg**

Year	Road	Rail	Waterway	Air	Total
1995	1.031	0.047	0.004	0.145	1.223
2020	0.607	0.046	0.004	0.106	0.763
Change in %	-41 %	-1 %	-4 %	-27 %	-38 %

3.1.4 Road safety trends in Austria

The road safety trend, as represented by the number of killed and injured road users, is tending to fall (Figures 12 and 13). This is due to the following factors:

- constant road safety efforts through legal, constructional and educational measures;
- the increasing experience of car drivers;
- increasing traffic, which reduces driving speeds.

Figure 12. **Trend in the number of injury accidents per year in Austria broken down by transport mode**

Source: Pischinger *et al.*, 1996.

Figure 13. **Trend in the number of fatal accidents per year in Austria broken down by transport mode**

The number of injuries and deaths per year per million population is tending to fall, though there are very considerable differences between modes (Tables 10 and 11).

Table 10. **Trend in injury accidents in Austria to 2020 in injuries per million population per year**

Year	MPT	PT	Foot+Cycle	Truck+Other	Total
1995	4 794	86	1 201	230	6 312
2020	3 950	53	1 089	141	5 233
Change in %	-18 %	-38 %	-9 %	-39 %	-17 %

Table 11. **Trend in fatal accidents in Austria to 2020 in deaths per million population per year**

Year	MPT	PT	Foot+Cycle	Truck+Other	Total
1995	107	3.4	34	7.	152
2020	66	2.1	13	4.9	87
Change in %	-38 %	-36 %	-60 %	-35 %	-45 %

In a comparison of specific road safety in the EU countries, measured in deaths per billion passenger-kilometres in road transport, Austria, with about 75 in the years 1988-92, is way over the average figure of 13 (European Commission, 1995).

3.1.5 Noise emissions

Traffic noise is a form of environmental pollution which is directly perceived by the population affected and therefore arouses strong reactions. According to the 1991 microcensus, 26 per cent of households are subjectively seriously affected by traffic noise and 15 per cent very seriously affected (*Mikrozensus,* 1991). This subjective disturbance is tending to decline slightly (between 0.4 and 0.9 per cent per year). This is partly due to getting used to the noise, but also due to measures taken in both vehicles and infrastructures.

The noise level will increase by about 1 dB by 2020 due to the increased traffic volume, and the number of dwellings affected by about 2 per cent, if no further noise reduction measures are taken. It is known that, in the case of buildings alongside main roads, the maximum permissible noise level for dwellings, 55 dB, is exceeded by up to 25 dB.

3.1.6 Infrastructure costs in Austria

In order to assess the sustainability of mobility, infrastructure costs are also of importance. Estimation of the system costs of infrastructures and the costs to the economy as a whole, and their respective degrees of coverage, was carried out for road transport in Austria for 1993 (Table 12). The degree of system cost coverage is to be understood as the ratio between system income and expenditure (e.g. the mineral oil tax, vehicle tax, etc. and the construction, maintenance and capital costs and also the administrative costs). The degree of coverage of the cost to the economy as a whole includes, in addition to the system full cost, the cost of accidents and the consumption of resources (e.g. the external accident and environmental costs). Not included are the costs to third parties of the overloading of transport infrastructures (e.g. costs resulting from the late delivery of goods or the time wasted by passengers, etc.). While the degree of coverage of the system infrastructure costs for car traffic is 191 per cent, the degree of coverage of the costs to the economy as a whole for all vehicles is under or barely 60 per cent.

Table 12. **Coverage of the system costs of infrastructures and the costs to the economy as a whole of different modes (3 per cent interest rate, not taking account of the external benefits or the external costs caused by the overloading of infrastructures)**

Transport mode (source)	System	Economy as a whole
MPT Vienna (Herry *et al.*, 1992)	109 %	34 %
PT Vienna (Herry *et al.*, 1992)	33 %	29 %
Truck traffic in Austria (Herry *et al.*, 1993)	84 %	44 %
Car traffic in Austria (Herry *et al.*, 1993)	191 %	43 %
Rail traffic (ÖBB)	71 %[(1)]	60 %[(2)]

(1) Proportional operating cost coverage including payments, i.e. the income is divided equally between covering operating costs and infrastructure costs (Herry *et al.*, 1991).

(2) *Source:* Tichy, 1988.

Basically, it should be considered whether the additional infrastructural and other costs caused by urban sprawl (e.g. environmental costs due to additional car use) should not be partly imputed to motorised private transport, this being a necessary precondition for a dispersed residential structure. In this case, the degree of cost coverage would be significantly lower.

3.2. Traffic trends in the European OECD countries and in the whole world

Consideration of sustainable mobility can by no means remain restricted to the national level. Because it has global effects, such as the consumption of limited oil resources and the climatic effects of CO_2 emissions as well as the problem of uneven distribution (distribution of resources, consumption of resources, sensitivity to climate change, etc.), it has an international or worldwide dimension. The findings presented here stem from a study of forecast worldwide transport demand and CO_2 emissions (Pischinger *et al.*, 1996-97). The framework conditions for the forecast trends are:

- Worldwide positive economic development with moderate growth;
- No major supply bottlenecks or real price increases in oil-based fuels;
- Population growth in line with UN forecasts: European OECD countries up 3.7 per cent to 488 million between 1995 and 2050, world population up 74 per cent to 10 019 million (United Nations, 1995).
- Car ownership in the industrialised countries heads towards saturation at 760 cars per 1 000 population. In the developing countries, the growth rate is taken to be half that in the industrialised countries (saturation 380 cars/1 000 pop.).

3.2.1 Trends in the European OECD countries

- Passenger transport:

  Passenger transport output will significantly increase: up 46 per cent to 2020 and 72 per cent to 2050. These increases probably represent a minimum. The biggest increases are in air traffic: up 138 per cent to 2020 and 279 per cent to 2050 (Table 13). The specific per capita transport outputs have a somewhat lower growth rate (Table 14).

Table 13. **Trend in passenger transport output in the European OECD countries (excluding non-motorised traffic)**

Year		**MPT**	**PT**	**Air**	**Total**
1995	Billion pass-km/year	3 727	925	602	5 254
2020	Billion pass-km/year	5 143	1 098	1 433	7 674
	Change from 1995	+38 %	+19 %	+138 %	+46 %
2050	Billion pass-km/year	5 627	1 143	2 281	9 051
	Change from 1995	+51 %	+24 %	+279 %	+72 %

Table 14. **Trend in annual per capita passenger transport output in the European OECD countries (excluding non-motorised traffic)**

Year		MPT	PT	Air	Total
1995	km/person/year	7 920	1 965	1 280	11 165
2020	km/person/year Change from 1995	10 338 +31%	2 208 +12 %	2 880 +125 %	15 426 +38 %
2050	km/person/year Change from 1995	11 535 +46 %	2 343 +19 %	4 676 +265 %	18 554 +66 %

– Freight transport:

The increases in freight transport are significantly greater than in passenger transport: up 86 per cent to 2020 and 175 per cent to 2050 (Table 15). The biggest increases are in air and road transport. The specific increases in freight transport output are somewhat lower (Table 16).

Table 15. **Trend in freight transport output in the European OECD countries**

Year		Road	Rail	Waterway	Air	Total
1995	T-km/year	1 099	289	523	58	1 969
2020	T-km/year Change from 1995	2 132 +94 %	476 +65 %	944 +80 %	115 +98 %	3 668 +86 %
2050	T-km/year Change from 1995	3 298 +200 %	599 +107 %	1 345 +157 %	183 +216 %	5 424 +175 %

Table 16. **Trend in annual per capita freight transport output in the European OECD countries**

Year		Road	Rail	Waterway	Air	Total
1995	T-km/person/year	2 335	614	1 111	127	4 183
2020	T-km/person/year Change from 1995	4 285 +84%	957 +56%	1 897 +70%	231 +82%	7 370 +76%
2050	T-km/person/year Change from 1995	6 761 +190%	1 228 +100%	2 757 +148%	375 +195%	11 121 +166%

3.2.2 Trend in world traffic

– Passenger transport:

As compared with the trend in Europe, significantly greater increases are expected in worldwide passenger transport output (Table 17): up 87 per cent to 2020 (as against 46 per cent for OECD Europe) and 190 per cent to 2050 (72 per cent for OECD Europe). The reason lies in the fact that the world population growth rate is much higher and the saturation limits for transport demand lie in the very distant future. The highest growth rate is in air transport, followed by road transport.

Table 17. **Trend in worldwide passenger transport output (excluding non-motorised traffic)**

Year		MPT	PT	Air	Total
1995	Billion pass-km/year	12 297	12 601	2 926	27 824
2020	Billion pass-km/year Change from 1995	23 478 +91 %	21 622 +72 %	6 917 +136%	52 017 +87%
2050	Billion pass-km/year Change from 1995	40 199 +227%	27 633 +119%	12 824 +338%	80 656 +190%

Per capita transport demand shows much smaller increases: 35 per cent to 2020 and 67 per cent to 2050 (Table 18). The far lower per capita worldwide transport output can clearly be seen: 4 829 km/person and year as against 11 165 km/person in 1995 for the European OECD countries. This gap will not narrow significantly in the future.

Table 18. **Trend in annual worldwide per capita passenger transport output (excluding non-motorised traffic)**

Year		MPT	PT	Air	Total
1995	km/person/year	2 134	2 187	508	4 829
2020	km/person/year Change from 1995	2 953 +38 %	2 720 +24 %	870 +71 %	6 543 +35 %
2050	km/person/year Change from 1995	4 013 +88 %	2 758 +26 %	1 280 +152 %	8 051 +67 %

– Freight transport:

The growth trend in freight transport output is considerably higher than that in passenger transport: up 136 per cent to 2020 and 311 per cent to 2050. The biggest growth is in air transport, followed by road transport (Table 19). Considerably lower is the growth in per capita freight transport output: up 71 per cent to 2020 and 136 per cent to 2050. In 1995 the per capita worldwide transport output was roughly half that in the European OECD countries. This gap will be reduced in the future (Table 20).

Table 19. **Trend in worldwide freight transport output**

Year		Road	Rail	Waterway	Air	Total
1995	T-km/year	5 083	5 618	2 356	278	13 335
2020	T-km/year Change from 1995	12 714 +150 %	12 793 +128 %	5 216 +121 %	795 +173 %	31 483 +136 %
2050	T-km/year Change from 1995	23 974 +371 %	21 051 +275 %	8 297 +252 %	1 516 +445 %	54 843 +311 %

Table 20. **Trend in annual per capita freight transport output in the European OECD countries**

Year		Rail	Waterway	Air	Total
1995	T-km/person/year	975	409	48	2 315
2020	T-km/person/year Change from 1995	1 609 +65 %	656 +60 %	95 +98 %	3 959 +71 %
2050	T-km/person/year Change from 1995	2 101 +115 %	828 +102 %	151 +215 %	5 474 +136 %

3.3. Assessment of the trend with respect to sustainability

In order to be able to plan appropriate measures in the direction of sustainable mobility, it is necessary to assess the present situation and trend with respect to its sustainability:

– Fuel consumption:

The Austrian trend in the consumption of non-renewable fuels (petroleum based) shows an increase of 18 per cent in the forecast period. Worldwide, due to the significantly stronger growth in traffic and transport output, a greater increase in fuel consumption is to be expected. In a study of worldwide CO_2 emissions (Pischinger *et al.*, 1993), over the period 1988 to 2005 an increase in annual consumption of 58 per cent was forecast. This corresponds to a very plausible assumption of an annual growth of about 3.4 per cent in fuel consumption. Under this assumption, the worldwide petroleum deposits known in 1994 would last 29 years and with the assumption of constant consumption, 43 years (*Institut der Deutschen Wirtschaft*, 1996). According to a Shell study, the exploitable world oil reserves should last another 300 years. It should be pointed out that by the middle of the 21st century an alternative and economically acceptable form of energy can be reasonable expected *(Chua, 1995)*. Nothing is known about the sustainability of this alternative energy.

From the standpoint of sustainability, it is irrelevant whether the oil reserves will last 29, 43 or 300 years: any consumption of non-renewable resources is counter to sustainability. Therefore, the present trend with respect to fuel consumption cannot be considered sustainable or anywhere near sustainability.

– CO_2 emissions:

The trend in transport sector CO_2 emissions in Austria, according to Figure 3.1.4-2, shows an increase of 18 per cent between 1995 and 2020. A similar increase is expected for Europe as a whole. Worldwide, an increase in CO_2 emissions of some 65 per cent can be expected.

Sustainable development with respect to CO_2 emissions is characterised by no or only very low emissions, which do not disturb the delicate balance of the CO_2 concentration in the atmosphere. The Toronto target is to be seen as a short-term target on the difficult road to sustainability (for Austria, this requires a reduction in CO_2 emissions of 33 per cent between 1995 and 2005). What is more, the Climate Convention goal of halving CO_2

emissions by 2010 is also to be seen simply as a milestone on the road to sustainability. The trend in transport-induced CO_2 emissions is thus getting further away from sustainability conditions rather than approaching them.

– Other exhaust emissions:

As far as individual exhaust gas components are concerned, thanks to the EURO II and EURO III exhaust gas limit values and technological improvements in vehicles and fuels, a significant improvement in the trend has been or will be achieved. This is the case in particular with CO, HC, SO_2 (Figures 7, 8 and 9). Nevertheless, the limit values set by the environmental protection regulations in force in Austria and Europe will frequently be exceeded. The situation with the precursor substances for ozone, NO_x emissions, also looks critical: according to the Austrian Ozone Act, NO_x emissions should be reduced by 40 per cent between 1995 and 2001, but trend forecasts indicate that a reduction of only 18 per cent will be achieved and, as from 2013, a further increase is to be expected unless additional measures are introduced.

The trend in individual exhaust gas components in Austria and Europe is heading in the direction of sustainability, but true sustainability will not be achieved without further measures.

– Noise:

The present trend in all countries is for noise emissions to remain at about the same level or increase. Since on virtually all main roads the noise limit values for residential buildings are exceeded by up to 20 dB, no move in the direction of sustainability will be possible without more intensive measures.

– Infrastructure costs:

Sustainability requires that all costs be properly imputed to users. Since the degree of coverage of the costs to the economy as a whole in all European countries is well under 100 per cent, this situation cannot be considered sustainable. At present, there are certainly declarations of intent and targets have been set (e.g. European Commission 1995), but there are no signs of political implementation.

– Safety:

Strictly speaking, sustainable mobility means that no accident victim should be killed or suffer lasting damage. The goal is unrealistic. In virtually all European countries the trend in the number of people killed or injured in traffic accidents is falling despite rising transport output. This trend goes in the direction of sustainability. Very striking, and far from being sustainable, are the great differences in road safety standards in European countries. Thus, for example in Austria, the accident rate (deaths/million pop.) is about twice as high as in European countries with a high level of road safety. Therefore, in order to progress along the path to sustainability with respect to road safety, a target should be set, such as endeavouring to halve the number of killed and injured within ten years.

– Minimum guaranteed accessibility:

  The present trend in many European countries is aggravating the situation whereby in country areas, and also on Sundays and holidays, only a minimal public transport supply is available, for cost reasons. This development is thus excluding particular sections of the population from mobility. The reasons for this lie, on the one hand, in the unfavourable cost situation of public transport (the rationalisation potential is still by no means exhausted, because there is no "market") and, on the other hand, in the lack of appropriate organisation and financing structures in many countries.

In addition to the sustainability indicators discussed above, a number of other effects are of importance for the sustainability of mobility, such as land use, soil and water pollution, division and severance effects caused by transport infrastructures, impairment of the landscape, etc.

Summarising, it must be said that the observable transport trend in Austria, Europe and the whole world is tending to move away from a situation of sustainability, except in a very few respects. It is therefore urgently necessary to implement **additional** measures over and above those already decided and planned. Here, appropriate national policy and initiative is of vital importance if the formally accepted policy goal of sustainability is to be taken seriously. In Austria, this was decided in the Federal Government's National Environment Plan of 1996 *(Bundesministerium für Umwelt, Jugend und Familie*, 1996). The European Commission is also pursuing this goal (EU Commission, 1993).

4. MEASURES FOR SUSTAINABLE MOBILITY

The above arguments have shown that sustainable mobility is not possible without drastic and consistent additional measures. Here, national governments have the vital role of creating the political, legal and economic framework conditions necessary for the inherent dynamism of the social forces and the market to be harnessed to work in this direction.

4.1. Transport policy targets for sustainable mobility

1. Traffic avoidance
   Creation of framework conditions in the fields of land use planning, finance policy, economic policy, social policy, etc., which can reduce existing transport demand and avoid additional future demand.

2. Ensuring mobility
   Creation of framework conditions which will ensure a yet to be defined necessary minimum degree of mobility for all.

3. Modal shifts
   Creation of framework conditions which promote the intermodal use of transport to achieve the optimal ecological and economic cost in each case (including all external costs).

4. Transport system improvement
   Creation of framework conditions which promote the following:
   - improvement in vehicle and fuel technologies to minimise emissions and fuel consumption;
   - improvement in infrastructures to achieve more environment-friendly transport operations;
   - ecological optimisation of transport operations.

The task of the State should be concentrated on creating and maintaining the overall framework conditions. These framework conditions include finance, land-use planning, economic and social policy, attribution of responsibilities, etc. The most important measures required for these framework conditions are listed in section 4.3.

4.2. Transport policy strategies required for sustainable mobility

- *Consistent pursuit of a sustainable transport policy*.
  Experience shows that in many countries very ambitious concepts have been worked out, but in everyday decisionmaking these concepts are taken into account very little, if at all. It is absolutely essential that all decisions, actions and measures are examined for their compatibility with transport policy goals and concepts and, where necessary, they should be rejected or modified.

- *Concentration on important measures which have high cost-effectiveness from the standpoint of the economy as a whole and synergy effects*.
  Dissipation of effort in a multitude of measures brings little chance of success.
  Experience has shown that the well-targeted deployment of human and financial resources brings the most effective results.

- *Implementation of innovative measures in the form of demonstration projects.*
  New measures for which there has been little or no practical experience should be tried out in pilot projects for a limited time in a limited area (e.g. the "cycle-friendly town" of the 80s in Germany, demonstration projects of the 4th Framework Programmes of the EU, regional bus corridor Salzburg-Eugendorf, 1994-95). This has a number of advantages:

  - The measures can be corrected and optimised before full-scale introduction;
  - Demonstration projects cannot reasonably be refused by opponents of the measures;
  - Experience gained through demonstration facilitates full-scale implementation and increases acceptability;
  - The financial resources are used more effectively.

- *Long-term phased plans with binding limits by certain dates* (e.g. for the introduction of new noise and exhaust gas limit values for cars or for CO_2 emissions) give all those concerned a secure basis for their planning and in particular make it possible for industry to adjust to the changed framework conditions in an orderly fashion.

- *Limitation of state involvement to the highest level tasks*: Transfer of the implementation of suitable tasks to the private market (as with the implementation of the "Energie 2000" programme for the transport sector in Switzerland). Government structures are not suitable for the implementation of many types of measure. The transfer to private organisations for a limited period by means of contracting out generally has the following advantages:

- Enhanced cost effectiveness through the use of market mechanisms;
- More flexibility than with state structures;
- Correction in the case of unsuccessful implementation is more feasible;
- Separation of the implementation and control functions, etc.

– *Budgetary and financial planning must make the necessary resources available for implementation*. Basically, financing out of earmarked funds giving a clear signal (charges) is to be preferred to general tax revenue, especially for the internalisation of external transport costs. The amount of the charge should be based on the underlying costs. Earmarking means that the revenue should flow to the area where the costs are incurred (territoriality and objectivity principle, Commission of the EU, 1995).

  The following advantages should be mentioned:
  - Application of the “originator pays” principle;
  - More transparency, hence greater acceptance.

– *Drawing up and implementation of a co-ordinated national transport research programme with an accompanying effectiveness monitoring system*.
  To achieve the goal of sustainable mobility there are still unresolved problems which call for scientific study, as does the implementation of measures. This can only be done through a co-ordinated research programme focusing on the essentials according to the degree of urgency. In many countries, as in Austria, there are many entities which finance transport research, but there is no overall research concept, only seldom any quality control and no systematic publication of findings. This leads to great inefficiencies in national transport research.

– *On-going information and awareness-raising work for sustainable mobility*. The acceptance of what are frequently unpopular measures can be achieved only through ensuring that all concerned (decisionmakers, transport operators and users, experts, representatives of the media, industrialists, the public at large) have a high level of information and awareness.

4.3. Transport policy measures for sustainable mobility

The measures discussed below are limited to the field of activity of governments and the administration. They are naturally not exhaustive, but constitute a representative list. Where results are available, the effectiveness of the measures is presented.

4.3.1 Financial/fiscal measures

– Introduction of nationwide road pricing with an onboard automatic debiting system, increasing the charge in each year by, for example, ATS 0.10/kilometre for cars and between ATS 0.10 and 0.40 for trucks, depending on the all-up weight, until full cost coverage is achieved for the infrastructure costs, including the external costs. Double charge for peak periods and in particularly environmentally sensitive areas; use of the extra revenue for ecologically oriented infrastructure work and, for example, to reduce non-wage labour costs;

Note: The advantage of an onboard system over the toll systems planned or already in place in individual European countries is that it is possible to have the charging system cover the whole country. This avoids traffic diversion to roads which are less safe than motorways and to environmentally sensitive local roads. The onboard system works with a credit card and consists of a sealed onboard computer. A harmonized European charging system needs to be developed. For competition reasons, co-ordinated introduction throughout Europe should be aimed at. Compensation for socially disadvantaged user groups is to be recommended.

Effects:

- Progress towards cost-covering and fair transport pricing;
- Inhibition of transport demand, in particular in peak periods;
- Shift to public transport;
- Reduction of the emissions caused by cars;
- Positive cost/benefit balance for the economy as a whole (Pischinger *et al.,* 1996).

– Introduction of fuel consumption-dependent takeoff and landing fees for aircraft.
The amount of the fees should be calculated on the basis of the specific consumption of the engines and the number of seats in such a way that, on average, the price increase per passenger-kilometre is similar to that resulting from the road-use charge. These fees should be increased in stages. The revenue should be used for ecological infrastructure improvements and to reduce non-wage labour costs. Short-distance flights would thus have to bear higher charges, so that over these distances a switch to rail transport is to be expected.

Effects:

- Increased capacity utilisation;
- Reduced demand;
- Switch to rail;
- Use of energy-efficient aircraft;
- Reduced fuel consumption and emissions;
- High cost/benefit balance for the economy as a whole (Pischinger *et al.,* 1996).

– Reduce fixed transport costs and increase variable costs to make the total effect cost-neutral.
In road transport in particular, fixed costs due to taxes (e.g. vehicle tax/year for a 38-tonne truck in the EU countries was between ATS 307 and ATS 4 100 per month in 1994; *Source:* Commission of the EU, 1995) and the insurance costs should be calculated on the basis of transport output. This should be harmonized in all European countries.

Effects:

- "Originator pays" principle ("cost justice") becomes effective;
- Reduction in car use;
- Shift to public transport;
- Reduction in negative environmental effects.

4.3.2 Land-use planning measures

The aim of these measures is to ensure compact towns with sufficient density and an optimal mix of functions so as to minimise motorised traffic and transport demand ("sustainable town planning"). The decentralised development of town structures should bring an increase in the transport output of passenger transport in the order of 30-40 per cent.

– Restriction of peripheral building land, improved access for central building land.
  In Austria in particular, there is in many municipalities a great surplus of peripheral building land, while central building land is not available. Cancellation of building land status in peripheral areas and imposing an obligation to construct on central building land, or raising the tax on undeveloped building land to the same level as that on developed land, could solve this problem.

– Levying of graduated connection charges: for residential land, depending on the distance to public transport stops and for enterprises depending on the distance to the nearest rail connection (the greater the distance, the higher the charge).

– Introduction of effective regional planning instruments.
  In Austria regional planning is relatively ineffective due to the very great autonomy of the local authorities. Better planning can best be achieved by giving increased central government grants to those local authorities which join together to form integrated development and transport associations.

  Effects:
  - More compact town structures in the longer term;
  - Maintenance of larger areas of open land for future generations;
  - Reduction of traffic and transport demand in the longer term;
  - Switch to more environment-friendly transport modes;
  - Reduction of the negative environmental effects of transport in the longer term;
  - Very good cost/benefit balance for the economy as a whole.

4.3.3 Measures to improve the organisational structures of public transport

Implementation of the following measures is a precondition for an efficient public transport system.

– Reorganisation of the organisational structure of public transport.
  The present organisational structure of public transport operators (urban transport undertakings, railway undertakings) is no longer competitive. The present trend in national railway undertakings, for example, goes in the right direction but is not consistent enough. Division into three functions should be aimed at:

  1. Planning, construction and maintenance of the infrastructures.

  2. Planning and management of the public transport supply (timetable, route network, tariff and ticketing system, marketing, etc.).
     This function should also be divided vertically into long-distance tasks (intercity traffic) and regional tasks. The transport supply should be contracted out on the basis of public

calls for tender, so that market mechanisms can come into effect. The last task includes the regional and, where appropriate, the local bus and rail services and, for areas or periods of low transport demand, alternative forms of paratransit (on-demand collective taxi, on-demand bus, etc.).

3. Operation of transport services by the transport undertakings present on the market (road and rail).

   Note: This means that the line concession at present held by transport undertakings would be handed over to the organisational levels of public transport management (area concessions). This would require a change in the law in most countries. At the same time, the financing of public transport must be adjusted to the new structures. In the medium term, full coverage of total infrastructure costs, including external costs, should be aimed at for public transport too.

   Effects:
   - Rationalisation effects for public transport;
   - Enhancement of public transport attractiveness through the integration of partly isolated undertakings into integrated public transport association systems;
   - Switch to public transport;
   - Reduction of the negative environmental effects.

4.3.4 Measures to improve infrastructures

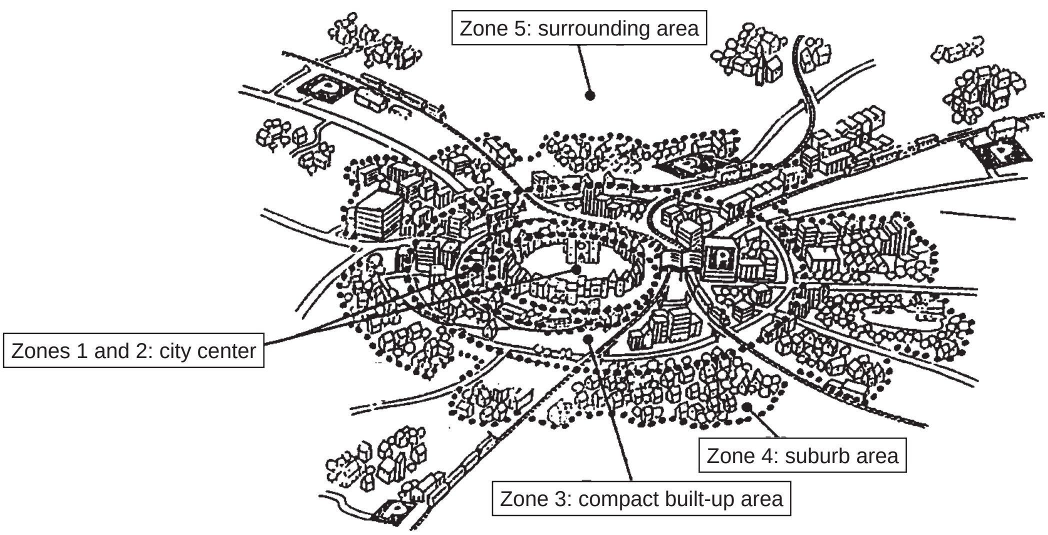
- Principles for the extension of infrastructures.
  - Any further extensions of networks should be carefully examined from the standpoints of necessity, environmental acceptability and utility to the economy as a whole.
  - Priority extension should mainly concern modes which take account of the need for rail infrastructures to catch up with respect to road infrastructures.
  - There should be some rethinking about very high speeds on new sections for land use and ecological reasons. Maximum speeds on new sections all over Europe should not exceed 100 or 110 km/h on motorways and 80 km/h on other roads. Speeds on new rail sections should, as a rule, not exceed 160 km/h.
  - Better use of existing infrastructures through organisation measures should take precedence over physical capacity extension (e.g. introduction of HOV lane, information centres) on motorways.

- Extension of infrastructures for combined transport in the freight sector.
  A nationwide network of freight terminals is a precondition for goods suitable for carriage by rail actually being switched to rail. In addition to this infrastructural measure, the intermodal logistics organisation needs to be significantly improved and freight traffic centres should be set up for conurbations.

  Effects:
  - Rationalisation effects in freight transport;
  - Shift from road to rail transport;
  - Avoidance of negative environmental effects.

– Organisation and upgrading of the transport infrastructure in conurbations on the zone principle.
  The conurbation is divided into five zones determined by the historic development of the districts of the town (Figure 14):
  - Zones 1 and 2 include the historic centre and immediately surrounding districts. Motor vehicles are excluded from zone 1, except for delivery traffic at specific times of day. Zone 2 is accessible all day for delivery traffic and residents' vehicles, with a speed limit of 30 km/h. There are parking spaces only for loading and unloading, handicapped people and residents. There is full access for public transport and cycles.
  - Zone 3 corresponds to the densely built-up areas developed in the rapid industrialisation period and generally has a grid-like road network; there is a 30 km/h speed limit throughout zone 3, except for main thoroughfares. Public transport has priority. The whole area is subject to managed parking (metered short-term parking, long-term parking for residents only for a flat-rate charge, places for delivery vehicles).
  - Zone 4 includes typical suburban and urban sprawl areas; it is divided into environmental areas with traffic calming arrangements, as a rule separated by main roads. Public transport has absolute priority. Bike-and-Ride facilities should be provided at the stops.
  - Zone 5 generally includes the green belt and is not building land. The surrounding municipalities are connected by regional public transport (train, bus). Park-and-Ride facilities should be provided at stations and stops.

Figure 14. **The zone concept of a conurbation as a traffic organisation model for towns**



The "zone model" encourages compact town structures and improves the urban habitat in existing towns through traffic restraint. This makes living near the centre more attractive. The zones should be linked with one another by pedestrian and cycle paths.

An important flanking measure for the zone model is the promotion of non-motorised and public transport and access limitation for car traffic (traffic light control on the congestion avoidance principle).

Effects:
- Switch from the car to non-motorised and public transport;
- Compact town structures, avoidance of urban sprawl migration from the city;
- Reduction of pollutant emissions;
- Promotion of cycle traffic and parking place management in particular are of high benefit for the economy as a whole (Pischinger *et al.*, 1996).

4.3.5 Measures to improve transport operations generally

- Explanation and information measures.

  The aims here are:
  - to raise awareness of the importance of environment-friendly and safe transport;
  - to increase the acceptance of necessary, but unpopular environment-friendly measures;
  - to influence transport behaviour in the direction of using more environment-friendly modes;
  - to influence driver behaviour with the aim of improving road safety and reducing negative environmental effects.

  This measure requires target group oriented publicity work which is fundamentally different from the marketing of consumer goods. This measure has high benefit for the economy as a whole (Pischinger *et al.*, 1996).

- Establishment of mobility centres.

  Mobility centres have a service function and are intended to facilitate passengers' access to environment-friendly transport behaviour. Some important tasks are, for example:
  - Information about the available transport supply;
  - Organisation of door-to-door service by means of an integrated transport chain using taxis and public transport;
  - Establishment of car pools.

- Reduction of speed limits on roads.

  The maximum permissible speeds should be set as follows, according to the function of the road:
  - 100 km/h for motorways and fast roads outside conurbations and 80 km/h in densely-populated areas;
  - 80 for all other open roads;
  - 50 for main roads with priority in built-up areas;
  - 30 for all other roads in built-up areas.

  As a flanking measure, strict surveillance is necessary.

  Effects:
  - Significant reduction in noise and exhaust emissions and in fuel consumption;
  - Significant reduction in road accidents;
  - High benefit for the economy as a whole (Pischinger *et al.*, 1996).

4.3.6 *Measures to improve vehicle technologies*

– Reduce the fuel consumption of cars.
  A very effective measure, but one politically difficult to implement, is a medium-term target for the reduction of fuel consumption: for example, as from 2005, only cars with a specific consumption of 3.5 litres/100 km should be allowed to be registered. This would mainly affect big, powerful, comfortable models. This measure requires a common international approach.

  Effects:
  - Considerable reductions in exhaust emissions and fuel consumption;
  - High benefit for the economy as a whole *(*Pischinger *et al.*, 1996).

– Reducing noise emissions from road and rail traffic.
  Long-term target for low rolling noise limits for car tyres and for railway wagons, reduction of other vehicle limit values according to an international timetable. In the next 20 years it would be possible to achieve a reduction of 15 dB in tyre rolling noise, for example (Sandberg, 1993).

– Further reduction of exhaust gas limit values.
  In particular, the EURO III limit values should be made binding and lower EURO IV limit values should be prepared with a fixed date for coming into force.

– International research and research funding for zero-emission vehicles should be stepped up, with testing in demonstration projects in order to gain practical experience.

5. CONCLUSIONS

5.1. Synergy effect through a comprehensive package of measures: the example of Austria

A comprehensive package of measures can trigger synergy effects. The question arises of what effects such a package will have on the economy and the central government budget. We therefore briefly present the findings of a 1996 study carried out for the case of Austria *(*Pischinger *et al.*, 1996).

– This package of measures (“Toronto scenario”) includes the following individual measures: land-use measures, nationwide road pricing, takeoff and landing fees for aircraft, parking management, 100/80/50/30 km/h speed limits, quotas for transit road haulage, targets for the reduction of car fuel consumption, promotion of cycle traffic, promotion of logistics services for freight traffic, awareness-raising campaigns, introduction of biofuels, enhancement of urban and suburban public transport, rail transport and combined transport, restriction of car access to town centres, promotion of zero emission vehicles.

– Table 21 shows the changes as compared with the effects of the trend described in section 3.1. It shows that significant improvements in the direction of sustainability are possible.

Table 21. **Changes in the transport sector as the result of the "Toronto scenario" package of measures as compared with the trend in Austria to 2020**

Factor affected	%	Factor affected	%
Passenger transport output	-9	Kerosene consumption	-33
Freight transport output	-3	CO_2 emission	-47
Car kilometres	-21	CO emission	-38
Travel time	+3	No_x emission	-25
Number of killed and injured	-23	HC emission	-23
Electricity consumption	+35	Particulate emission	-15
Gasoline consumption	-64	SO_2 emission	-44
Diesel consumption	-45	Central budget revenue	ATS 82 billion

The savings to the economy, as compared with the trend, amount to some ATS 260 billion between 1997 and 2005, and ATS 895 billion between 1997 and 2020. These savings are achieved through reduced infrastructure, administration, vehicle operation, top-down, exhaust gas, noise and accident costs (an average value is taken for the CO_2 costs).

The macroeconomic effect to the year 2006 is as follows:

- Increase in freight transport costs: +5.4 per cent;
- Cost increases in individual sectors of the economy:

Trade: +0.43 per cent
Transport and communications: +0.43 per cent
Mining: +1.47 per cent
Food, drink and tobacco: +0.49 per cent;

- Possible reduction in non-wage labour costs through using the surplus state revenue for this purpose: -3.2 per cent;
- Change in the rate of inflation with reduced non-wage labour costs: +0.28 per cent.

5.2. Summary

The transport trend as a whole is not on the way to sustainability. There are, however, a number of effective measures which can alter the trend in the direction of sustainability. For a sustainable transport policy, it will be necessary to begin with those measures which have optimal cost effectiveness. It is clear that sustainable mobility brings high benefit for the economy as a whole and the macroeconomic effects are thoroughly acceptable. Since many of the measures required for sustainable mobility have low acceptance and appear politically difficult to implement, intensive explanatory and awareness-raising efforts will be necessary.

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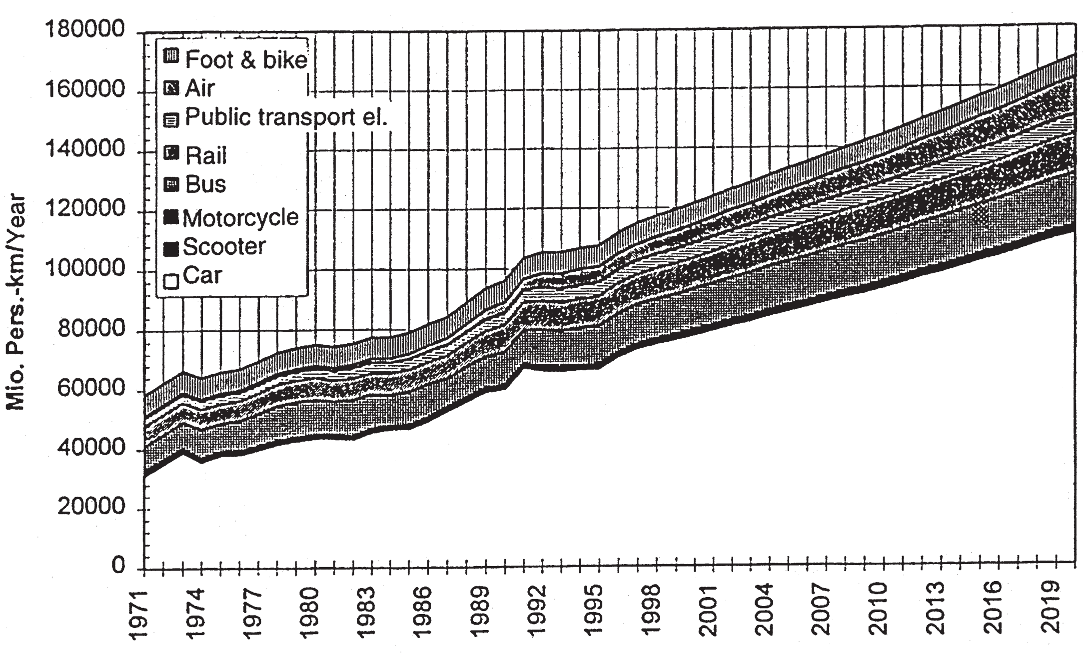
Traffic for different purposes grows at different rates. The strongest growth is in traffic for economic, leisure and personal business purposes. The transport output of public passenger transport (train and bus traffic) shows a significantly smaller increase of between 34 and 40 per cent over the same period. This means that the public transport share of total passenger transport has a falling trend (1995 share: 25 per cent, 2020 share: 22 per cent). The greatest increase is in air transport, 136 per cent. Over the next 15 years air traffic will just about double. Walking and cycling transport output will remain roughly the same, though the population will increase by about 4 per cent over the period.

Figure 3. **Passenger transport output trends in Austria to 2020**



Source: Pischinger *et al.*, 1996.

These changes are not distributed evenly throughout Austria but differ greatly according to the settlement structure and type of trip:

- The increases in private, motorised traffic are above all in the thinly populated regions and in the catchment areas for the conurbations and concern mainly shopping and leisure traffic;
- The increases in public transport are restricted to the centres of the conurbations and commuter traffic to and from the conurbations (as the result of capacity bottlenecks) and intercity traffic;
- The increases in air traffic are mainly in medium- and long-distance traffic, above all for business and holiday travel.

Table 1 shows the forecast trend in annual specific passenger transport output. The main features are:

- In motorised private transport, an increase in the annual distance covered per person from 8 437 km in 1995 to over 13 000 km in 2020 is to be expected;
- An increase in public transport is also expected, but only about half as big. In the year 2020, the average total distance covered will be over 4 000 km;
- The biggest relative growth is expected in air transport, from 670 km in 1995 to over 1 500 km per person in 2020.

Table 1. **Trends in annual specific passenger transport output in kilometres per person in Austria to 2020**

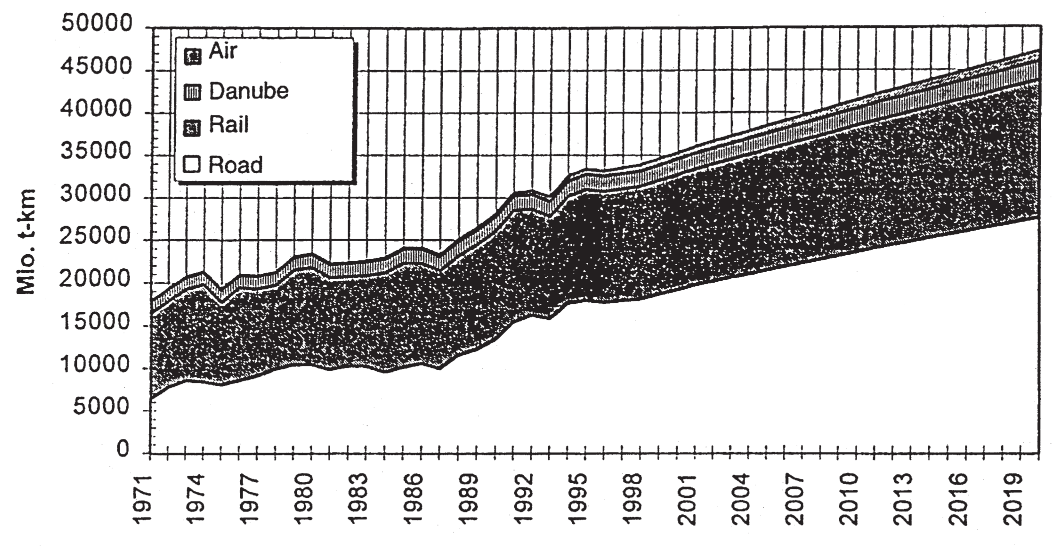
Year	MPT (1)	PT (2)	Air	Foot+cycle	Total
1995	8 437	3 375	670	881	13 364
2020	13 513	4 377	1 521	881	20 258
Change in %	+60 %	30 %	+127 %	±0 %	+52 %

(1) Motorised private transport.
(2) Public transport.

In freight transport, an increase in transport output, measured in tonne-kilometres, of over 40 per cent between 1995 and 2020 is expected in Austria (Figure 4). There are great differences between individual transport modes:

- The biggest increase is in air freight: up more than 90 per cent between 1995 and 2020 and with the market share growing from 5 to 8 per cent;
- Road haulage is expected to increase by over 50 per cent, with the market share growing from 54 to 58 per cent;
- Rail and waterway transport shows the smallest increase and the market share falls from 44 to 39 per cent.

Figure 4. **Estimated trend in freight transport output in Austria to 2020**



Source: Pischinger *et al.*, 1996.