ECONOMIC RESEARCH CENTRE

SIXTEENTH ROUND TABLE

(22nd-24th March, 1972)

REPORT OF THE SIXTEENTH ROUND TABLE

ON TRANSPORT ECONOMICS

Held in Paris, on the following topic:

studies (notably from the econometric approach) of factors determining the demand for freight transport

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INTRODUCTION

The study of traffic forecasting techniques has been part of the "policy" activities of the ECMT for many years. A regular supply of information on the traffic to be catered for is indeed necessary for investment planning. Moreover, the harmonisation of statistical methods and material is a major objective of international co-operation in the transport field.

This being so, some of the scientific work of the ECMT must obviously be devoted to forecasting, and more particularly to the periodical review of methods and experience. Thus, Round Tables on forecasting methods give useful information direct to the political bodies responsible for making practical use of the forecasts. Besides this, certain special studies on specific points are undertaken at the request of political authorities.

A further Round Table on forecasting techniques to follow the one held in May 1969 was prompted by the concern to improve methods and take account of the lessons drawn from experience in the meantime. A Round Table analysing the practical results of studies on the operation of the market is being held at the end of 1972. This will provide useful information complementary to that provided in this paper.

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STUDIES (NOTABLY FROM THE ECONOMETRIC APPROACH) OF FACTORS DETERMINING THE DEMAND FOR FREIGHT TRANSPORT

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1. Purpose and structure of the study

Demand for freight transport occurs in an unusually wide range of forms.

This is due, on the one hand, to the very great heterogenity of freight traffic generated, reflecting the nature of goods required for extremely varied purposes of acquisition and consumption. To this is added the considerable geographical spread of individual enterprises, the establishments of which have to maintain complex transport links based on their mutual relationships as suppliers and distributors.

On the other hand, especially in modern, densely populated industrial states, transport demand is reflected in a varied supply of transport capacity. It uses this, in varying degrees and, very often, in combinations, according to transport sectors, mode and types of transport and, therefore, according to networks, routes, length of trip and especially cost of transport.

It will be the task of the present study to explore determinants - i.e. causes, functional dependencies, motives and conditions - for the main forms in which transport demand occurs. As far as volume and composition of total freight transport and individual freight streams are concerned, these are determined, at the outset, quite generally by the level of development of an economy and, especially, the standard of living, the level of production techniques and similar factors, as well as by the structure of the economy and the location of production and consumption.

In the long run, the rate of economic growth, changes in the structure of production and consumption, and geographical location of activities influence the development of demand for freight transport. In the short term, cyclical fluctuations and seasonal factors have a direct and important impact on transport demand.

The factors determining transport demand derive from the particular objectives and soci-economic characteristics of the individual enterprises which generate demand for transport services, and on the special characteristics of the supply of these services. Demand for and supply of transport facilities are subject to reciprocal relationships, especially in the sense of a continuous process of mutual adjustment.

This adjustment is insofar (in the broadest sense) of a transport-technical kind, as constant impulses upon the supply of transport facilities are exerted through the necessity, resulting from the overall economic process, of transporting certain goods between specified locations and under specified technical and economic conditions. Furthermore, the supply of new or improved transport facilities by the forwarding industry provides incentives for dispatch or reception of goods in these new or improved conditions.

Adjustment of demand and supply in the market economy sense is expressed most directly and essentially in price formation. In the transport sector, however, the majority of transport remunerations are adjusted to changes in the relation of demand and supply affecting price only with a delay of longer or shorter duration, due to more or less rigid legal or voluntary intra-market obligations.

Transport prices in their significance as explanatory variables for the transport of goods shall be treated in a separate chapter between the presentation of determinants of transport demand related to demand and those related to supply. This approach takes account of the dependence of transport price formation on both demand for transport and supply of transport facilities.

At the outset, delimitation of the field covered by the study is discussed. This delimitation relfects both the concepts used, the data and methodology available for the study.

2. Conceptual, statistical and subjective definitions

The nature of the subject implies the necessity, at the outset, of elucidating the concept of demand for goods transport and examining the extent to which this demand can be statistically described and analysed according to the objective of the study. Then, the conceptual and statistical problems of their determinants are to be discussed.

2.1 Demand for freight transport

2.1.1 General remarks

Demand for freight transport arises in all cases where goods which are needed for production, investment, consumption or distribution purposes or the creation of services are not immediately available and must, therefore, be brought in over longer or shorter distances.

Demand for freight transport may be classified according to a variety of criteria. For purposes of the present study, it is appropriate to use as a basis the following classification according to macro-economic concepts.

I. Concepts relating to total demand in the economy and its sub-division into sectors and regions.

(1) Overall demand for freight transport in the economy

In this case, freight transport can be considered as a totality and defined according to type of goods, dispatch and reception etc.

(2) Sectoral demand for freight transport

In the sectoral analysis, the main activities in the economy can be taken into account as also individual branches of activity or given categories of firms (based, for example, on the organisation of the production or the distribution of their goods), and other systems of definition such as trade and industry, the public sector and private households, or delimitations within industry as, for example, raw materials and intermediate goods industries, investment goods industries and consumption goods industries and other divisions of this type.

From the sectoral point of view, classification according to commodity is necessary for reasons of methodology. As classification according to dispatch and reception is appropriate here, one can speak of input-related and output-related transport demand.

(3) Regional demand for freight transport

In this case, too, it is pertinent to define according to dispatch and reception and mostly according to type of goods since because of the return-load problem, this classification is often of direct relevance to transport policy for the regional economy.

In the regional analysis, the criterion adopted rapidly becomes much broader as soon as, apart from the overall magnitude of transport demand of the region, one takes into account dispatch and reception relationships, that is, transport interrelations in the form of intraregional or interregional streams of freight traffic of the region, and possibly also transit through the region.

Every explanation of transport demand which depends on the concept described under I can be combined with questions which have freight transport itself as their content. It is a question here of

II. Concepts which relate to the type and execution of freight transport

Type and execution of freight transport are characterised by factors which are explained by the differing efficiency of the various forms of transport supply and, therefore, in the final analysis, represent determinants of transport demand. These are to be examined in the present study, then, along with determinants of other types.

For the time being, however, we are concerned rather with the fact that transport demand is reflected in varying degrees of utilisation of the different forms of transport. The need arises, then, to classify from this viewpoint, too, those concepts which can be derived from the forms of expression of transport demand.

Here, there arises the difficulty of distinguishing these forms of expression within a general framework and without significant overlap. Since it is not decisive for the execution of the present study that a unified system of this kind for the analysis of the concept of transport demand is not available, one can be satisfied with the summary catalogue of the most important elements which is described below.

If one takes as a basis the fact that for the execution of a given transport operation there are alternatives, at least from the technical point of view, these forms of expression can be determined in their totality from the answers to the question "which means of transport or transport branch attracts the demand for a given shipment?" - notwithstanding, at this point, the reason for which this decision occurs in a particular case. If the decision of the shipper favours a given transport branch (railway, inland waterway etc.) - or several transport branches, if it is a question of a combined transport operation - the transport network to be used is automatically implied as is also very frequently the actual transport route to be used. Special questions arise as to whether execution is delegated to transport operators or whether own vehicles and possibly also own track is issued, whether a combined form of transport is chosen and so on.

In the case of transport concepts to be derived from transport demand, which are related to type and execution of transport (para. II), the problem is mainly how to explain demand for:

(1) transport by specified transport branches and combinations of transport branches, classified according to:

(a) transport in specified transport networks and via specified transport routes;

(b) transport by way of specified means of transport (vehicles, transport units), for example railway transport using ordinary or specialised wagons as wagon loads or whole train loads, on inland waterways with barges, motor-barges or lighters.

(2) specified transport in the sense of:

(a) own-account transport or transport through commercial transport entrepreneurs;

(b) direct and broken shipments in non-combined transport;

(c) shipments in combined transport with pallets, receptacles, containers; pick-a-brick transport;

(d) transport of specified quality, especially as far as speed and security are concerned.

It would be going far beyond the purposes of the present study to try to estimate the type and strength of various influences upon all categories of transport demand as listed above. Only the most important causal relationships can be examined with the help of examples. However, even then, the reservation has to be made that the choice of examples is narrowly limited in a whole range of cases worth examining, due to insufficient statistical information. This is especially so in the case of investigations of transport demand by sector.

2.1.2 Statistical data

Demand for freight transport is reflected directly in orders for transport services, placed by entrepreneurs, the public sector and private households with transport enterprises. Statistics for these transport orders and their composition are as meagre - with very few exceptions - as those concerning size and type of individual incoming orders of carriers, forwarding agents, brokers etc.

In general, railway companies provide statistics of transport orders and their execution in the form of tables showing the daily demand and supply of freight wagons. As, however, the breakdown of this data is crude, and fails especially to provide information concerning the behaviour of shippers in the event of delay in the supply of freight wagons, these data cannot be analysed further in the framework of the present study.

If a shipper of goods has his own means of transport at his disposal, it has to be considered that for the bringing about of a transport service there occurs an order which he, so to speak, gives to himself or, in other words, that he places an order for own account transport. Dealings of this kind are, as in the case of transport orders to third parties mentioned before, statistically not recorded as such.

Demand for transport services can be recorded in statistics only indirectly, i.e. in the form of records about specified transport services and transport data.

Transport statistics provide, above all, data about volume phenomena and physical stocks and only to a small extent information about operations and magnitudes concerning the value, i.e. the financial side of freight transport.

Stock magnitudes (such as number of vehicles, length of transport routes etc.) are of little use as indicators of transport demand. One knows little about the extent of utilisation of transport capacities. This implies that any coefficient relating the two magnitudes would be subject to a considerable margin of error.

2.1.2.1 Quantity data

Among the quantitative measures of transport demand available, ton-kilometers (tkm) is the general expression for the volume of transport demand. Data about tkm are generally available for transport by mode (railway, inland waterway, shipping etc.), sometimes also broken down by method of transport and type of transport (in road transport, for example, contract road-haulage and own-account haulage, long-distance haulage and short-distance haulage).

Unfortunately - as far as statistics for the German Federal Republic are concerned - information about ton-kilometers for transport of certain types of freight are still, to a large extent, lacking, especially as far as freight-streams are concerned. This means that a number of important relationships, such as the influence of distances and freight cost upon reception and sale relationships can be examined only incompletely or not at all. Transport distances, shipping distances, tariff bands - except for long-distance road haulage - can generally be derived from statistics only for broad aggregates of types of goods.

Transport statistics yield more information on quantities of goods in tons shipped. These are classified by a large number of commodity groups. Due to various changes in classification and territorial coverage in official statistics over a period of time, long time series are in many cases subject to reservations.

From the distinction of transport generation by dispatch and reception quantities, there arises the question of origin and destination of transport, for the analysis of which the statistics of the German Federal Republic have since recently provided data for 76 regional transport areas, for the different modes of transport, and classified by 52 main commodity groups with further commodity sub-divisions.

As far as the development of transport demand over time is concerned, published statistics provide data only for a few important benchmarks related to intervals shorter than a year. This is quite understandable in view of cost and time needed for preparing and publishing data. The reasons for seasonal fluctuations in transport demand are, in the majority of cases, only of general interest if seasonal peak use of certain means of transport - as for example the railway during Autumn - give rise to serious capacity difficulties. The seasonal determinants shall, therefore, not be examined within the framework of this study, all the more since a well-informed interpretation would require data, mainly concerning stock-movements, which are either not collected or are not available.

There are, in general, no transport performance statistics available about movements within enterprises or households. Therefore, they cannot be considered as belonging to the subject of the present study. Transport between individual works, factories or operating-units of public-sector enterprises is, however, recorded and will be considered in what follows. However, freight-transport within seaports and inland-waterway harbours will be ignored, even though it is recorded by the port authorities.

2.1.2.2 Value data

Monetary data and financial results of freight transport, which can be considered as a quantitative expression of demand for transport services, are only insufficiently represented in the statistics. Even if one consults besides official transport statistics, turnover, size and breakdown of national product etc. the annual reports of transport enterprises and similar bodies, one cannot obtain even a relatively complete and accurate picture on the basis of correct definitions of time, period and subject matter of, for example, transport enterprises' profits from freight transport as recorded in statistics, or what the economy spends on transport. Only additional special surveys and their interpretatation, including the cost structure of the economy, as well as numerous estimates and separate analyses, make possible the emergence of a rough idea of the financial value of transport demand.

In general, only sufficiently disaggregated input-output tables supply suitable information. Some information concerning this subject will be supplied in a later section. However, the treatment of a question orientated on financial values of transport demand would go beyond the framework of this study.

2.2 Determinants of transport demand

2.2.1 General remarks

The occasion for a transport order may seem to be simple and matter-of-fact, and the considerations leading to it uncomplicated. On close examination, however, the coming about of transport demand is seen to be a thoroughly complex event. Even though, in the individual case, a determining factor may have such a predominance that it can be called the cause of a certain transport demand, at the macro-economic level, research into causality shows a multiplicity of causes and conditions whose influence upon transport demand interacts and overlaps. Furthermore, they in turn act upon each other in an interdependent relationship of cause and effect.

Therefore, in the quantitative analysis, the line between effects of individual influence-factors upon transport demand can rarely be drawn in an exact manner, and one is generally only able to speak of a stronger or weaker probability of influences.

The interdependence of different influences and their relationship through pre-existing factors makes it possible to introduce as a determinant of transport demand an aggregation of influences instead of one or a few more immediate determinants; one could even introduce as an explanatory variable a broad economic aggregate covering a complex of direct and indirect determinants. In progressively establishing analogous relations for ever broader economic aggregates in many cases, one is able to explain a transport demand sufficiently not only with the help of factors immediately or directly causing this demand - as far as this is at all possible - but equally by means of a functionally superior economic magnitude. A functional explanation of this kind also eliminates distortions resulting, from the point of view of probability theory, from the multicollinearity of several variables operating simultaneously. This effect generally occurs when - for example in the analysis of multiple regression - several variables, all dependent upon a common magnitude, are used simultaneously in an explicit manner in order to explain transport demand.

The same conclusion is reached, moreover, if one proceeds in the opposite sense, and if one considers that transport demand (or, in other words, the production of transport services) depends upon all the other sectors of the national economy defined by demand (or production) and, therefore, in the last analysis upon global economic demand (or global production).

On the basis of this theoretical concept, a vertical analysis with the objective of explaining, for example, total demand for cereal transport could use - either through separate or joint analyses - the consumption of wheat for bread production (or flour and flour products) and the production of fodder (cereal-based and, maybe, in total) as main determinants. Furthermore, one could consider the consumption of foodstuffs as well as total private consumption - and, finally, the national product - to be determinants of the volume of cereal transport. It goes without saying that, in order to define concepts and method, it would be necessary, in all cases, to examine and consider accordingly the particular significance of cereal transport to and from foreign countries, and transit transport.

In a horizontal analysis, demand for transport of cereals could be explained as functionally dependent on all transport within the agricultural sector or all freight transport or, again, of total demand for transport services. As total demand for transport services can, again, be considered as the function of all components of overall economic productivity and, therefore, of overall economic production, the conclusions to be drawn when considering interdependence of large economic sectors of demand and production indicate also that the gross national product is the final determinant of demand for cereal transport. Coefficients of correlation and tests of significance must be used to judge the degree of usability of the possible quantitative relations.

Only if they were available in great number would specific examples of such quasi-experimental analyses of possible determinants of a given transport demand produce generalised information about the influence of the method adopted, especially the appropriate degree of aggregation of determinants of transport demand. Such examples will have, therefore, to be omitted from the present study as far as possible.

As far as relations between transport demand and its determinants were examined with the aid of econometric methods, the mathematical form in the presentation of analyses and results has been avoided as far as possible in this study. Therefore, the more components are drawn into an analysis, the clearer and easier to understand the description should become.

2.2.2 Determinants in detail

The classification of factors determining transport demand derive necessarily from the system of macro-economic criteria of transport demand, as mentioned in para. 2.1.1, according to which determinants will have to be considered that result from the socio-economic function and situation as well as the location of enterprises (production units) and households using transport services. These factors reflect the stage of development within an economy as well as the influence of the general market situation and market interrelations and should be defined as demand-induced determinants.

Furthermore, deriving from transport supply, there are limited determinants comprising, besides quantitative criteria to be determined, in particular qualitative criteria, for which statistics can be given only with difficulty or not at all and which, therefore, can be used for an econometric analysis only with restrictions if at all.

2.2.2.1 Demand-related determinants

Macro-economic production in the form of real gross national product can be considered to be the most complete and general demand-induced determinant of freight transport. Depending on the definition of transport demand, the real volume of gross domestic product can also be used. In many cases, population size should be used as the relevant explanatory variable, and also national product per inhabitant.

The volume of foreign trade as well as actual physical quantities of exports and imports are used to explain freight streams across borders.

From amongst the components of national product, volume consumption and investment variables can also be used to explain important aspects of freight transport.

Net value added, considered as the real contribution of economic sectors can, too, be taken as a determinant of transport demand in these sectors. As far as demand variables specific to individual branches are concerned, one will have to refer to production figures, classified according to various commodities, to net- and gross-production figures, and input-output data.

Consumption variables are demand determinants for many sectors of freight transport.

In order to explain regional differentiation of transport demand, one needs, on principle, the corresponding regional subdivisions of the above-mentioned determinants. Unfortunately, statistics provide them only to a small extent in the desired detail, so that one is very often forced to use estimates. Furthermore, it must not be forgotten that transport generation and transport interdependence of a region is, to a great extent, determined by economic activity in other regions, which places further demands on the statistics and often as well the structure of the analysis.

Finally, there needs to be mentioned stock levels and stock changes, if possible classified by raw materials, semi-finished and finished goods. These - besides other variables - have to be considered as determinants mainly of short-term fluctuations in transport demand.

2.2.2.2 Supply-related determinants

The most important component of every transport supply is the price expected for the transport service to be rendered. Although there are numerous fixed prices in the transport industry, formation of prices for transport develops not only under the pressure of competing services, but also under the influence of demand for transport services. This happens, however, often with considerable time-lag. The price of transport is, therefore, strictly speaking to be considered as a demand and supply dependent determinant of transport demand. At this point of the study, however, this conclusion shall not be allowed to influence the classification used in representation of determinants.

In spite of its essential significance, the price of transport plays, in the analysis, only a limited role as determinant of transport demand. As far as transport prices are concerned, statistics and other official publications and information provide mainly tariff rates, calculated distance-rates for certain selected transport relations, general freight indices, charges for services ancillary to transport etc. Hardly any information is available about total cost of individual transport, which is borne, according to the individual case, by the receiver or shipper of the goods. Therefore, certain elements of transport cost cannot be taken into consideration in the macro-economic transport cost analyses. Furthermore, the question has to remain open whether the transport prices available (i.e. tariffs etc.) precisely reflect the market situation, and whether they are not distorted through subsidies, insufficient contribution to track costs and so on.

On can add, too, that considerable differences in the characteristics of supply of transport services are to be found behind transport prices. This means that transport prices can be used only within limits for the explanation of transport demand. In principle it is true to say that every supply allows the shipper of goods the choice between different kinds and conditions of transport; however, he does not always have a real supply-alternative when giving the transport order.

It seems, therefore, necessary to include in the analysis further elements of transport supply. Immediately there arises the difficulty of finding for these elements a satisfactory statistical measure and to delimit and select them according to comparability so that they can be used in the empirical analysis.

From the macro-economic point of view, and this is valid for the overall-economy as well as for partial aggregates such as traffic branches, sectors and regions, it is almost or entirely impossible to represent elements of supply within a statistic. They are, in part, of a qualitative nature as, for example, the handling of goods and security during shipment and, therefore, they are to a great extent impossible to include in statistical records. In part, such as for example route and duration of a transport, they can be quantified and statistically recorded only at great expense, which obviously presents an obstacle to their inclusion in regular statistics. In general, only big transport enterprises, such as railway companies, collect such data, mostly for internal purposes and, as a rule, they do not allow their use for other than their own purposes. As far as public transport statistics supply information about individual elements of transport supply, such as kilometrage and density of road networks, they are presented in such a way that one cannot answer the question other than in a very general way.

In the micro-economic field, i.e. in the view of those persons giving transport orders, different elements of transport supply, which play a role as determinants of demand for transport services, can be analysed in a much more detailed manner than if one had to rely on official statistics. In any case, if the necessary statistical investigations are not conducted, from the beginning, in such a manner that their results can be considered as representative for the basic magnitudes by branches, sectors or regions etc., the predictive value and analytical usefulness of their results concerning the influence of supply-determinants will remain correspondingly limited.

3. Transport demand explained by determinants based on quantitative analyses

The discussion which follows is based, to a great extent, on research carried out by the Ifo-Institute for Economic Research, Munich. This research concerned the question of explaining total and sector freight transport variables through macro-economic determinants. Furthermore, a survey of the Ifo-Institute concerned with transport conditions in industry and wholesale trade produced useful information.

3.1 The influence of demand-related freight transport determinants

On the basis of the results of analyses carried out according to para. 2.2 concerning the definition of transport demand and its determinants, we shall now examine to what extent volume and development of transport demand on total, sectoral and regional definitions can be explained stochastically by determinants reflecting the stage of development of the economy, as well as its structure and related characteristics.

3.1.1 Overall relationships

Amongst the overall relationships, those quantitative relationships are of greatest interest for transport demand which reflect the volume and composition of total production within an economy, as well as its development over time.

All changes in magnitude (direction and intensity) as well as in structure are time-related and closely linked to the reality of the passage of time. For purposes of this study, however, the division between structural effects and growth effects is justified.

3.1.1.1 Structural relationships

The structure of an economy reveals itself in extremely varied characteristics as, for example, in labour-intensity and capital-intensity of production, in productivity of labour and capital, prices for utilisation of land and other production factors, contributions of different sectors of production to the creation of wealth, consumption of energy per unit of national product, the national product or private consumption per inhabitant etc.

The development of transport demand is closely linked with changes in these structural data. Economies dominated by agricultural production generate only moderate transport requirements per head of population. In the early stages of industrialisation, transport demand increases more than proportionately. In the former German Reich, freight transport on railway and inland waterways, for example, rose between 1886 and 1913 on average hardly less than pig iron production which, before the First World War, was used as a measure of economic development in the absence of National Accounts; it rose much more strongly than coal production.

With further industrialisation and the start of mechanisation of production and services so far exercised manually or by craftsmen, the increase in freight transport measured in volume slows down in comparison with the expansion of total production. It slows down the more the importance of the basic materials and producer goods sector within an economy recedes in favour of the production of non-durable and durable consumer goods and services, the total production and distribution process becomes rationalised, and the more location of industry reflects favourable transport location.

Between the wars, this development was clearly apparent in Germany in both the periods of upswing in the economy of 1924 - 1929 and 1933 - 1938 as well as during the world economy crisis of 1930 - 1932. Freight transport increased less or decreased more rapidly than important indicators of general economic activity. This development continued after the Second World War.

It is to be seen, therefore, that the transport intensity of macro-economic production differs under structural conditions when these differ from each other fundamentally or by degree. This transport intensity is relatively high at the beginning of industrialisation, while it is relatively moderate in the case of advanced industrialisation and a high standard of living of the population.

Changing statistical definitions and territorial changes are a difficulty. They permit neither the representation of the various structure phases of the German economy since 1886 to the present on a homogeneous basis nor their analysis in respect of their influence upon transport intensity. Comparison of information gained through interval analyses leads to the conclusion, however, - and this is confirmed by long-term research for the United States since 1890 - that the dependence of transport intensity of macro-economic production on structural changes, as they occur during the gradual progression from agricultural to highly developed industrial state, follows a pattern which can be interpreted best by a non-linear function of the form

$$y = a \cdot x^b \qquad (1).$$

From the econometric point of view, this pattern can be confirmed with the aid of a cross-cut comparison of more than 20 economies from four continents with varied stages of development. To begin with, there is calculated - if possible for the same period of reference - the present degree of elasticity of transport demand in relation to the real gross domestic product. If the elasticities in relation to gross domestic product per head of population are established, the countries under investigation are approximately grouped around a regression line of the above-mentioned type of function.

In short, this functional relationship shows that elasticity of transport demand in relation to the national product decreases with rising standard of living, rapidly at first, more slowly later on. As the stage of development within an economy can very appropriately be characterised when looking at the energy consumption per head of population, and when those sectors of the economy which use a great deal of energy are generally the ones with the greatest transport activity, it comes as no surprise that the functional connection of the earlier mentioned type of exponential equation is equally valid for the stochastic relationship between transport elasticity in relation to real gross national product, and energy consumption per inhabitant, and that this is statistically significant.

Transport elasticity figures of 2 or 3 and even higher are to be found regularly in countries with very low national product per inhabitant, such as Thailand, India and similarly structured countries, while transport elasticity in most Western-European economies and the United States, is smaller than 1. In these last mentioned economies the tendency to further reduction of the relative transport requirement quantitatively measured, is currently rather weak. Short-term fluctuations, in particular those in an upward direction, require further research in order to be explained. A further considerable reduction of transport elasticity in highly industrialised countries can only be expected if the use of new technologies, for example an extensive use of atomic energy, were to lead to a pronounced reduction of specific transport generation within an economy.

3.1.1.2 <u>Development effects</u>

The analysis of transport intensity of macro-economic production and of the elasticity of transport demand in relation to the level of and changes in real gross national product has already shown that there are close links between the development of transport demand and general economic activity. These links have already been studied in detail for numerous economies. Analyses in similar detail are, however, lacking for shorter and medium-term periods.

3.1.1.2.1 <u>Growth effects</u>

In the long-term analysis there exists a stochastic relationship between development of overall transport demand - expressed in tons shipped or ton-kilometers performed - and the growth of real gross national product. This relationship can be called approximately linear only in periods of steady economic development in which the economic process is not disturbed by simultaneous multiple changes in structure or by pauses in development.

However, very often influences are brought to bear whose importance increases or decreases over a certain period to the extent that it becomes impossible to explain this relation satisfactorily by means of a linear function of the simple type

$$y = a + bx \quad (2).$$

It needs to be investigated to what extent in such cases freight transport can be explained more clearly by introducing the time factor (t) into the equation. The equation would, then, read

$$y' = a + bx + ct \quad (3)$$

where
- y' = freight transport
- x = real gross national product
- t = time
- a, b and c are constants.

When, in the long-term period studied, the general intensity of econmic growth and that of freight transport increases or decreases significantly - the two variables in similar or opposite directions - or if one has to combine periods with differentiated structures (for example pre- and post-war conditions), the interpretation of functional correlations of both variables through non-linear functions has proved successful.

Here one can use functions of the type already mentioned

$$y = a \cdot x^b \quad (1)$$

or also equations such as

$$y' = c \cdot x^h \cdot e^{gt} \quad (4)$$

where
- y' = calculated values of freight transport for the period (t), x varying
- c = constants
- x = real gross national product
- h = elasticity of freight transport in relation to the real gross national product
- e = natural logarithm base
- gt = time effect (t) with national product constant

The exponent b of the function (1), which represents the elasticity coefficient, reflects all determinants of the development of national product, structural changes, particularly of a technical character, as well as the direct impulses caused by the market, changes in population and labour volume as well as those of labour productivity and all other factors determining the strength and direction of economic growth.

In function (4), where these influences are analysed, the elasticity coefficient h expresses the way in which transport demand reacts to the expansion of overall economic activity without being influenced by basic structural changes. This is modified through factor e^{gt} insofar as the coefficient g reflects explicitly the influence of all determinants which change the structure of national product over time, i.e. due to technical progress. It is important to consider how closely the national product correlates with time, since the coefficients could be distorted in the case of marked multicollinearity, and the correlation between national product and transport demand through function (4) would, then, not be characterised by the required degree of statistical confidence.

Other macro-economic variables as well as the real volume of total economic production can possibly be used to explain transport demand. The suitability of these variables depends upon the fact whether, from the economic point of view, they cover sufficiently the sector of transport demand which has to be explained, and how far the stochastic relation between these two variables is free from random disturbances. For the Federal Republic of Germany, the gross domestic product can be considered - amongst the components of national product - as useful determinant of transport demand. The correlation with private consumption is less close. For certain questions it is possibly advisable to combine different aggregates.

In this way, it can be tested to what extent a function comprising real private consumption and fixed investment variables, as well as possibly a time factor, can explain long-term transport demand, on the condition that transport demand can be defined as the sum of inland transport operations and reception of goods from abroad.

It is not possible to give a generalised answer to the question how far partial economic variables, playing a decisive role for the realisation of total economic production, can be considered as determinants of transport demand. On principle, one can say that partial economic variables whose long-term development - economically and statistically reliable - correlates closely with growth of national product, very possibly show in the same period a close stochastic relation with the development of the total transport demand variable and, therefore, can be described as determinants of transport demand, as far as there exists a reasonable economic relation between these two variables. Examples can be found mainly in the field of demand for transport of economic sectors and shall, therefore, be treated in the chapter concerned with this question.

No firm conclusion appears possible concerning the determination of total transport demand through a sectoral economic variable. This is because each significant relation of growth between an economic variable and total transport demand is very probably applicable - in the same or a modified form - between this economic variable and each sector variable of transport demand closely correlated with development of total freight transport. A relationship of this kind becomes predictive in the sense of this analysis only when it is also economically plausible.

A particularly striking example in the Federal Republic of Germany is given by the development of long-distance road haulage, which is closely correlated with overall economic activity. When treating modal split, this point will have to be re-examined.

The general development of gross national product and some of its components, such as private consumption and construction investment is, as well, suitable for the explanation of certain classification of transport demand according to type of goods. This question will be treated in the section concerned with relationships between sectors.

3.1.1.2.2 Cyclical effects

Since the economic process forms a unity, factors contributing to long-term growth of freight transport can also be recognised as determinants of short- or medium-term transport changes reflecting economic trends. This is the more valid if those factors themselves are exposed to economic fluctuation. Furthermore, one has to take into consideration factors which - without belonging to the regular seasonal movements - repeatedly influence the economic process temporarily as, for example, stock fluctuations in industry.

The econometric analysis of determinants of short- and medium-term fluctuations of transport demand has so far, contrary to research into long-term growth relations, generally been neglected and needs to be intensified.

A summary view was given for the Federal Republic of Germany in a linear growth-rate function, which established a link between annual changes of transport demand in per cent and the corresponding changes in real gross national product. The function is as follows.

$$\frac{y_t - y_{t-1}}{y_{t-1}} = b \frac{x_t - x_{t-1}}{x_{t-1}} + a \qquad (5),$$

where the quotients on the two sides of the equation represent the rates of growth of x and y in period t compared to period t-1.

Inverval analyses, particularly in the way of moving periods, show that this function (which is basically reliable only for long periods) can yield statistical estimates of adequate reliability for growth rate of transport demand for shorter periods, when these periods are characterised by undisturbed growth at a fairly regular rate. This, however, cannot be considered to be the general rule. Elasticity of transport demand in relation to the overall economic activity in the short term often produces considerable fluctuations. It is not rare even that transport demand diminishes from one year to another while real national product is still rising vigorously.

The marked and often seemingly random way in which short-term fluctuations of the two global variables can move in relation to each other is illustrated particularly well if one shows geographically, for example, the deviations from growth rates for both variables in Germany over the 1950 - 1970 period. In spite of numerous irregularities, however, it is apparent that the elasticity of transport demand in relation to overall economic activity is high in periods of expansion, and low in periods of recession.

The quantitative analysis confirms the stochastic character of this relationship, which corresponds to the following form:

$$(y_{w(t)} - \bar{y}_w) = b\ (x_{w(t)} - \bar{x}_w) \qquad (6),$$

where $y_{w(t)}$ and $x_{w(t)}$ represent the rates of change of the two variables transport demand ($\underline{y}$) and real gross national product (x) in the years (t) and where ($\bar{y}_w$) and ($\bar{x}_w$) represent their trend values during the total period under consideration. This method does not explain a divergence in direction between growth of transport demand and national product as observed at three points within the period studied.

Uncertainty in specifying trends can even then not be eliminated to a satisfactory extent when - as is economically plausible - one or two further explanatory variables illustrating the influence of stock movements are introduced into the function (5) in order to explain increase of transport demand. For this one has to take into consideration the rates of change in industrial stocks of raw materials and/or semi-finished goods or final products, which are of great importance for each specific type of transport demand.

Attempts at the better explanation of divergencies in the direction of growth rates show that for short and medium-term changes in transport demand in the given observation period, fluctuations in the production of basic materials and production goods are to be considered as the decisive macro-economic determinant in the context of function type (5). This seems to indicate that further information could most probably be gained from the study of sectoral determinants of transport demand. These could be used in order to improve the analysis of the influence of cyclical factors on transport demand.

3.1.2 Sectoral relationships

3.1.2.1 Problems of classification

Statistics of demand for transport services by sector, i.e. categories of economic activity, branches and particularly defined fields of production are meagre.

As far as input-output-tables contain information about services rendered by the transport sector for various sectors of the economy, this information is derived from value variables. In spite of price deflation, the information required for studies concerned with tons, distances and performance in ton-kilometres can be derived only with considerable uncertainty or not at all.

In some cases, the classification of transport statistics by commodity allows conclusions about volume of transport demand by industrial and other economic branches. In some cases, one has to employ additional information concerning technical production coefficients and the composition of sales. In an overwhelming number of cases, however, a classification of statistically available partial variables of freight transport by individual demand categories is extremely difficult, if not impossible; in some cases, classification according to nature of goods is not detailed enough, in others the same category is used as well for investment or production as for consumption, while it is often impossible to classify the given transport consignment in each case accurately according to the appropriate end-use, i.e. sectors, branches etc. To some extent information is lacking even for a merely estimated classification.

If possible, one should distinguish between dispatch and reception, and the nature of goods dispatched should be classified by production branches, the nature of goods received by sectors of processing and consumption. On the basis of the commodity classification as generally used in transport statistics, dispatch of approximately 15 types of goods can be related approximately to the output of certain industrial and agricultural sectors. These are:

production sector	dispatch of goods (main group of goods)(1)
agriculture	agricultural products, food, beverages and tobacco, animal feedingstuffs
coal mining	coal, lignite, patent fuels and coke
crude oil production	crude oil
mining of metallic ores	iron ore, non-ferrous ore and waste-products thereof
salt mining	rock salt and pit salt
non-metallic minerals	sand, gravel, pumice, clay and dross; other non-metallic minerals and related raw minerals; chalk and cement, glass, building materials and similar mineral semi-finished and finished goods
iron and steel industry including iron, steel and malleable casting, drawing and rolling mills	pig-iron, ferrous-alloys, raw steel, products of rolling-mills, drawing works and foundries, iron and steel forgings
non-ferrous metals	non-ferrous metals and semi-finished products
chemicals	basic chemicals and other chemical products (including starch) and fertilizers
oil refining	power and lighting fuels, heating oil; other petroleum products and gases; benzol, tar and similar distillation products
sawmills and woodworking wood-pulp, cellulose, paper- and board-production	wood (including pit-props) and cork, cellulose and waste paper

(1) Classification according to the nomenclature of the Commodity Classification for Freight Movement Statistics valid in Germany until 1962. The groups shown are, with a few exceptions, satisfactorily comparable with these of the Commodity Classification in force since that time.

food, beverages and tobacco	cereal, fruit- and vegetable-products, hops, sugar, meat, fish, meat and fish-products, eggs, milk and milk-products including edible fats, tobacco, drinks and other foods and beverages
vehicle building industry	vehicles
all consumption and investment goods industries	all other goods

The potential for classifying the goods received according to individual economic branches, is much more limited. Here, only the following categories can be used in econometric relationships:

economic sector	reception of goods
size of population	agricultural goods
energy consumption	energy materials
construction industry	building materials
real gross domestic product(1)	other goods

Although the transport of all goods can be traced back to a requirement in an enterprise or household and is, therefore, part of transport demand within a certain economic sector, the question of the economic determinant of demand expressed in such transport can, in the overwhelming majority of cases where goods and groups of goods are shipped, not be answered in an econometrically satisfactory way. Although this mostly consists of goods playing only a secondary role in total freight transport, their importance when dealing with numerous sectoral and even more so regional analyses cannot be overlooked.

It appears to be useful in the framework of the present study to examine, above all, the relationship between transport of economically important goods and development of transport of superior groups and all goods as well as with the development of general macro-economic determinants; it will need also to be studied, whether through aggregation of freight transport it would be possible to develop summary figures whose development can be better explained through sectoral variables than that of a certain individual freight transport.

3.1.2.2 Demand shifts within freight transport

The commodity structure of freight transport demand only rarely changes abruptly. Sharp changes in trend, random flucuations and special influences are less and less noticeable with time, mainly because of increasing aggregation of types of goods into, for example, commodity sub-groups, commodity-groups and

(1) Adjusted according to the share in total turnover of the most transport-intensive industries.

NST-headings of the transport nomenclature as used at present. It seems, therefore, possible - and justified, as more detailed econometric explanation through immediate economic variables is lacking - to regard and determine the development of sector variables of transport demand as function of the total demand for freight transport.

The functional relationships established in this way are, at least for the Federal Republic of Germany between 1950 and 1970, mainly linear in the sense of the functional type (2), where the slope parameter (b) is by definition smaller than one and the level factor (a) should ideally approach zero. Examples of linear dependence on growth of total demand for freight transport (via rail, inland waterways, long-distance road haulage and pipelines) are supplied by the development of transport of agricultural and forestry products, food, beverages and tobacco, feedingstuffs, fertilizers, chemical products, furthermore of coal and most raw materials, semi-finished goods and finished products of the iron- and steel-sector, as well as finished industrial goods and other goods. The most striking example of a non-linear relationship between growth and the total transport demand in the sense of functional type (1) is to be seen in transport of crude oil and petroleum products, which increased in the second half of the observation period at a more rapid rate than before and at a rate higher in relation to total freight transport demand.

The development of share in total freight transport by individual commodity and groups of goods is shown in a "mirror image" of functional relationships between individual types of freight and their grouping within total transport demand - in whatever way this is done, either in the framework of the official statistics or ad hoc. The more reliable are these functional relationships statistically, i.e. according to the probability criteria of correlation analysis - the steadier is the development of the share of the freight concerned within total demand for freight transport. Over time, these shares cluster about trend-lines, which are determined, in the Federal Republic of Germany and within the observation period, by linear functions for almost all main groups of freight. Again, an exception has to be made for the transport share of crude oil and petroleum products, which follows a second or even higher degree trend, reflecting different growth rates in the periods already mentioned and through signs of saturation in private motorisation towards the end of the observation period.

Growth trends of shares of important commodities and groups of goods in total demand for transport as established for the period after the Second World War, apply to some extent to the more remote past. Some commodities and commodity groups labelled as bulk goods by reason of the quantity to be shipped as well as in view of the relatively moderate care required in their shipment and transhipment, these roots may be traced back into the first decade of this century - this within the German territorial area at given periods and, therefore, with the necessary reservations as far as comparability of share from one period to another is concerned.

Only transport of crude oil and petroleum products have since strongly gained in importance within the framework of total transport demand. Their share, represented as time function (x), follows roughly a wide-stretched growth curve with the form of a logistic function of the basic type

$$y = \frac{k}{1+e^{a-bx}} \qquad (7),$$

the direction of which has tended only in the recent past towards a saturation value (k), which is understandably only an estimate.

Transport shares of ore and iron and steel show, since the First World War, a weaker upward trend of approximately linear form. Due to the rapid growth of plastics in the last ten/fifteen years, which has relatively dampened the significance of the iron and steel sector for transport demand, a linear equation, however, describes probably less and less adequately the trend of these transport shares over the whole period of time.

Over a long period, the transport of coal and lignite, wood and long-distance transport of building materials (including non-metallic minerals) and cereals has tended to become less important. For the shares of cereals and wood, the trend is linear over six decades, for coal and building materials in long-distance transport the shares over time tend to higher degree trend functions. It would have to be examined which functions are most reliable and economically plausible. In this context, it would be interesting to answer the question whether the ups and downs in transport shares of some commodities do not follow - as diagrams seem to suggest at first sight - long-phase cycles as, for example, ten to fifteen years for building materials and iron and steel, 20 to 25 years for fertilizers and cereals and probably even longer for other goods.

If the above-mentioned bulk goods are included in one group, it can be seen that their share in total demand for transport has decreased since before the First World War slowly but continuously. Comprising about 85 per cent of total transport at the time, it stands at present at 75 per cent. The relationship between the development of bulk freight transport and the growth of total demand for transport as explanatory variable is approximated by a non-linear function of the type (1).

Economic determinants of the decreasing importance of bulk transport are varied and are to be found mainly in changes in production techniques and of consumption patterns; both, shifts in industrial location and creation of new sites with the aim of minimising the cost of transporting raw materials or investment goods, have also to be considered.

With the relative decrease in demand for bulk-freight transport the share of the rest of the freight sector increases automatically. The increasing importance of transport of finished goods and other non-bulk goods, on the other hand, has an obvious economic basis in the rapid growth and changing pattern of private consumption.

3.1.2.3 Relationships with economic variables

Economic variables of significance for sectoral transport demand have already been mentioned in the paragraph concerned with problems of classification (3.1.2.1). In what follows, it shall be shown how far it is possible to explain parts or even the whole of transport demand through single and aggregated sectoral economic variables or - as in the case of the so-called transport coefficients - related to the corresponding transport variables, how they can be used in the analysis of transport development.

3.1.2.3.1 Transport coefficients

Those transport coefficients represent an important analytical instrument for the assessment of sectoral variables, which express the relation of quantity transported of a commodity or a group of commodities for production and possibly for production and importation of these goods. When the statistics are available, the relation of quantity transported of production inputs to production (and possibly to production and imports) of a certain product can be enlightening, in that it can indicate the transport intensity of a production process.

In this context, the quantity transported can either be recorded for all branches of transport together or only for individual transport branches. In the same way and to a certain degree, regional sub-divisions of such quantities transported are feasible; a reservation has to be seen in the fact that some comparisons will have to be excluded at the outset as they seem economically meaningless or because one would have to compare magnitudes of too extreme a character with each other.

Most transport coefficients which can be formed are subject to changes over time. These will have to be examined carefully as they could be caused through changes in the numerator and/or denominator of the quotients.

Production technique and its changes have a determining influence on the relationship between the quantity of certain goods produced and transported. Because of improvements in production techniques, particularly those resulting from rationalisation measures, the production of many goods requires less or different, lighter basic materials. With the decrease in consumption of certain products, the quantities transported and, therefore, the corresponding transport coefficients decreased automatically. This was influenced, too, by general changes in demand, such as the increasing use of plastics as well as changes in supply and sales-interrelations in numerous sectors, amongst other things due to decisions about location of production made by entrepreneurs which were, for example, more orientated to raw materials required, energy, labour force, sales outlets or contracts with firms or the administration.

An influence on level and direction of change of transport coefficients is also exercised by definitions in and alterations of the basic statistics, for example the statistical treatment of double-counts when analysing quantities of transport of all branches of transport, as well as conditions of competition between transport branches in the case that transport coefficients are analysed only for some of them.

Due to the complexity of determinants of transport coefficients, their changes can be econometrically explained only with difficulty. As transport coefficients represent mainly an instrument for forecasting and planning, knowledge about the trend of their development is, besides the results of mainly deterministically orientated research into causes of changes in these coefficients, of a certain value.

Crude oil transport represents an example of rising transport demand in relation to the development of production and imports. While, at the beginning of the fifties, most imported crude oil was processed in refineries near the coast and did, therefore, not require inland transportation, the increased setting up of consumption-orientated refineries further inland was responsible for the fact that crude oil transportation rose more rapidly in ton-kilometres than the consumption of products. Dependent on time, the transport coefficient has followed in the last 15 years a steeply rising linear trend.

In contrast to this the development of the transport coefficient for petroleum products showed a downward trend. Here, since local transport of goods is not, in Germany, regularly recorded in statistics, the increasing importance of this transport in delivery of petroleum products to the consumer is missed.

Further examples of a trend of falling transport coefficients can be found in transport of ore, as well as iron and steel. For some other commodities, such as coal and building materials, the development of the transport coefficient shows no definite trend.

3.1.2.3.2 Economic functional relationships

As sectoral determinants, which explain stochastically basic sector variables or total transport demand, there can be considered individual components of macro-economic production and sector variables, in particular of the goods-producing industry, as well as aggregates of such components and sector variables.

Among the unique determinants of a sectoral type, there are above all production and consumption volume - or as a proxy the corresponding turnover - and the size of population. These have been cited as determinants of certain sectoral transport demand variables in the paragraph concerning classification problems (3.1.2.1). The relationships existing between these economic variables and categories of transport classified according to shipment and reception, can - for the post-war period in Germany - in most cases be explained by the non-linear functions of type (1), to some extent of type (4) and to a lesser degree also to the linear function (2) - given sufficient statistical provision against random influences.

Since, apart from the individual categories of goods described above, the residual group both on the dispatch and reception side is also explained - other goods dispatched through production of consumption and investment goods, other goods received through real GDP (adjusted as above) - the sectoral explanation of the various transport categories described provides, through appropriate summation of the individual results, values for the total of freight dispatched and received.

Overall transport demand, defined as total amount of goods transported, can, furthermore, be obtained by dividing freight transport into five branches of goods, and its explanation through sector parameters with following addition of sector variables. These sectors are: energy resources (i.e. oil and coal), iron and steel, building materials, food, beverages and tobacco, and other goods.

In order to explain the overall transport of energy materials, primary energy consumption (expressed, for example, in term of coal equivalent) can be used. The functional relationship is best expressed with equation type (1). Due to the great influence exercised in the coal sector by stock changes upon the volume of coal transport and because of the importance of statistical double counts in coal traffic, it seems necessary to exclude coal from the energy sector and to explain its transport demand separately through the transport-relevant consumption of coal. The relationship is linear, as is the relationship between oil transport and petroleum product consumption.

The explanation of demand for food, beverages and tobacco transport through real private consumption is non-linear in the sense of the function (1).

Linear functional relations exist between transport of the remaining freight sectors and their determinants, i.e. iron and steel transport and the production of rolled-steel finished products, building material transport and the real building production(1), other goods and the real gross national product.

A series of aggregated macro-economic sector variables permit total transport demand to be determined directly and without previous interpretation of individual sub-components. According to structural characteristics of an economy and trends over certain time periods, such aggregates require special selection and composition. Their statistical presentation - for example as a sum of absolute figures or as an index with an appropriate or inappropriate weighting from the transport demand viewpoint - could alone possibly provide a criterion of their suitability.

As long, for example, as distribution of coal in Germany had not been significantly influenced by the structural change in energy supplies, the long-term correlation between freight transport with its high coal shipment share and the index of net industrial production was weak. This was so because the index took only small account of the main transport-intensive industries due to its weighting with net production values. With the considerable decrease in coal transport since 1958, and other shifts in bulk freight transport, the index of net industrial production is now more reliable as an explanatory variable of transport.

Total transport demand can, in particular, be determined through aggregates of production and import variables, which are chosen with the aim of being representative of the composition of the major part of freight transport demand by commodity. In this context, the Ifo-Institute has carried out tests with 43, 38, 17, 12, 9 and 6 commodity groups; these showed that the correlation of aggregates with total transport demand does not necessarily become closer with increasing number of commodity groups. For the Federal Republic of Germany, an aggregate of nine components proved very useful. This was composed of:

6 kinds of domestically produced goods

- coal
- crude oil and petroleum products
- raw steel
- pig-iron

(1) If one explains building material transport through real gross investment in building, the non-linear relation according to form (1) proves more suitable.

rolled steel finished products
cement

3 kinds of imported goods, i.e.

coal including briquettes
crude oil and petroleum products
iron ore

The stochastic correlation of this production and import aggregate with transport demand is represented by a linear function of the type (2). If the analysis includes time periods with considerable differences in economic structure, i.e. pre- and post-war periods, it is preferable to approximate the relationship through the functional type (3), which takes time into consideration as a second explanatory variable.

3.1.3 Regional relationships

It is particularly important for regional analyses of transport demand to distinguish between shipped and received goods. For some problems, i.e. questions concerning capacity of certain transport routes and transport equipment, the transit of freight through a region is also of interest, but can be excluded from the present study. The regional comparison includes necessarily the determination of trips according to origin and destination, i.e. interregional transport relationships.

The volume and composition of freight shipment and freight reception depend, in every region, on whether and to what extent goods-producing sectors (producers of raw materials and production goods, capital goods and finished products) as well as goods-consuming sectors (producers, investors, public and private consumers) are available and become active. In general, trading enterprises act as mediators; the goods transport sector, equally to be seen as mediator, drops out as determinant of transport demand at this point of study.

In principle, the same analytical methodology, based on relevant determinants, can be used to determine transport demand of an individual region, as is used in the case of the overall economy. Differences result only from the structure and dynamics of the economic area under study, which underlines, above all, the significance that has to be attributed, as a rule, to the size of a region for the choice of methodology.

Very small regions are, as a rule, unilaterally orientated; their economic activity is often basically determined by only one or a few larger enterprises. As the development of individual enterprises does not, in general, continue so steadily that it could be functionally derived from the development of the corresponding total economic sector, the analysis of shipment and reception of goods within a small region can, as a rule, not be carried out in a stochastic manner, but merely on the basis of a deterministic approach, which takes into consideration only those factors particularly relevant to the region under study and for a specific period (one year for example).

In the same way it is only rarely possible to determine through an analysis of its development the transport demand in small regions with strong economic dynamics through estimated values lying in an acceptable confidence region.

As experience shows, this is almost always the case when the structure of determinants in the small region has changed considerably; i.e. when previous determining factors have altered considerably in their significance and new ones have become relevant.

With regions of larger size, the influence of economic activities dominating in the smaller territory, as a rule lose their weight because other sectors of production and consumption are in evidence. Thus, conditions for the use of analytical methods based on probability theory are considerably improved. If, with the aid of stochastic methods, information about transport demand in several regions has to be gathered, one has to realise in the first place that the variables of shipment and reception often show from one region to another considerable (absolute and) relative differences, as can be seen when transport variables are related to the general economic variables of the same region as, for example, the gross domestic product, the size of population or even merely the geographical area.

If, therefore, for the analyses of transport demand in a number of regions through sector and overall economic determinants from these regions, one requires to make assertions which are not valid for the sum of all regions or the (statistical) average of any x regions, but which are based on approximation values for the specific conditions in the individual regions, only similarly structured, comparable regions can be included in the study. Amongst a substantial number of regions, one can, as a rule, find some which, from the outset, are comparable with each other in this way. In some cases, relatively homogeneous regions can be created through the gathering of suitably structured smaller subregions into regions (perhaps geographically fictional) useful for the analyses in question.

For the study of the influence of sector and overall economic determinants on transport demand in several regions, comparable as described above or rendered comparable, the same principles and - as far as necessary - reservations can be applied as those for the corresponding analyses, which from the outset relate to one region or one economic area only.

A further task is the explanation of dispatch and reception in all regions of an economy through their determinants operating in those regions. To consider a solution with the aid of a multiregional model which - in order to take account of marked differences in structure and growth - is also equipped with several explanatory variables, would be asking too much of empirical economic research at the present level of its analytical potential. One only has to consider how great are the gaps in statistics concerning important regional data, and how meagre knowledge about determinants of many economic decisions and elasticities of behaviour patterns. Many carefully constructed models for the explanation of regional transport demand - and this is the case, too, where variables of dispatch and reception, and transport interdependence are concerned - cannot be verified and are, therefore, (at least for the time being) of only theoretical interest. Some may be of interest for special, more restricted, local analyses. It is apparent, however, that empirical results in the field of econometric explanation of regional transport demand remain sparse.

When making first studies as those described, the Ifo-Institute did not develop a complicated model, which would try to take into consideration various causal or functional relations, time-lags, feedback effects, etc.; it operated consciously with an extremely simplified explanatory statement yielding at this stage merely relatively rough approximation values.

These approximation values were statistically ascertained in regional cross-section analyses for individual years. The comparison - and if possible the functional determination - of the regression-coefficients calculated for the individual years, yielded evidence on possible structural changes which, then, could be followed up in individual analyses.

The basic-explanatory statement, which has proved to be linear, reads:

$$y = a + b(\frac{u_s}{U} x) \qquad (8)$$

Here, (y) represents alternatively dispatch, reception or the sum of dispatch and reception of a region with the total surface traffic networks, railway, inland water-transport and long-distance road haulage. (x) represents the gross domestic product (at constant prices). The quotient modifying the explanatory variable indicates, in the case of the sum of dispatch and reception, the share in total industrial turnover of the sectors mining and raw materials industry and the producer goods industry. In order to explain dispatch, the same sectoral turnover-relations can be used as a basis. In the case of reception, turnover-shares of the final-goods-industry as well as branches of the chemical industry, steel and vehicle industry, can be used. These, to a great extent, also receive goods from the remaining industrial sectors.

The first rough approximation can be improved by breaking down the total analysis into sectoral analyses. This can be done by selecting the results of the cross-section analysis carried out for all regions, those regions deviating significantly from the average and in examining how - together or divided into further sub-groups - their transport variables can be better explained through the use of more relevant factors for the modification of gross domestic product. Such factors can be derived from turnover-proportions of specifically chosen industrial sectors.

As the uncertainty of the stochastic explanation increases, the smaller the regions to be examined and the more heterogeneous their structures, it is advisable to reduce the probability of error in another way. One should derive the required transport variables, at the outset, for the larger regional units and only then, on the basis of these, for the nearest smaller regional subdivision. In Germany, for example, the order to be used is: entire area of the Federal Republic, Federal Länder, transport regions. Transport variables available in the statistics or functionally calculable for the individual larger units can be used as basic values. Of these, partial variables of a sectoral kind can be used as sums or as individual values of row or column matrices of the regional distribution of transport demand, within which the consistency of all values can be assured.

Definitions of transport demand as used mainly in regional analyses, e.g. local, intraregional, border crossing etc., can be determined either through additional variables or modification factors including, above all, population size and density (for example for local transport), export share etc., or through definitional relationships.

From the results of surveys in the Federal Republic of Germany based on the method described above, it should be mentioned that structure parameters expressing relations between general economic activity and transport demand, when analysed on the basis of reasonably sized geographical sub-divisions and over a certain period of time, are in most cases not as unstable as initially one might have presumed on the basis of theoretical causality. As far as these parameters are subject to change, they proceed, moreover, in relative continuity. The analyses described provide, therefore, good formulations for forecasts of regional distribution of transport demand.

As far as transport interdependence of regions is concerned, a realistic explanation should ideally depart from a representation of input-output relations of economic sectors, with a carefully detailed classification by products. But even where such a representation is available and could be used, a model is lacking, which - on the basis of multi-sectorally and multi-regionally linked economic activities - could explain in a sensible, statistically sound and practicable way, freight streams between regions of an economy and across foreign borders.

The dependence functions which have come to be known as gravity models, often successfully used for analoguous passenger transport analyses, can only be used rarely and to a limited extent for the explanation of freight transport streams. Such functions have the basic logarithmic form

$$\log T_{ij} = a \log Q_i + b \log Z_j - c \log W_{ij} + \log k \quad (9)$$

where, related to freight transport,

T_{ij} = freight stream from region (i) to region (j)

Q_i = determinant of total freight dispatch (origin transport) from (i)

Z_j = determinant of total freight reception (destination transport) in (j)

W_{ij} = resistance to be overcome by transport from (i) to (j)

a, b, c are parameters, k is a constant.

There are numerous disadvantages to the application of this functional relation to freight transport. One of the most important lies in the fact that origin and destination transport determined by Q_i and Z_j can differ so basically from each other that the two variables influence each other only to a minute degree, if at all. Even if one were to determine total freight dispatch from (i) and total freight reception of (j) in a very exact exogenous manner, the problem would not be solved. This is so because the case is feasible where (i) dispatches certain goods which, although required in (j) and obtained outside that region, do not originate from (i). Furthermore, the formulation of resistance variables causes difficulties as the relevant factors are partly insignificant for transport demand (as, for example, length of trip for goods of a certain type and quality), and in part they are of predictive value only in connection with other variables which are difficult to quantify (as often, for example, freight tariffs).

One has to find, therefore, refinements to the model. To achieve this it is advisable to depart from the analysis of purely transport relationships and to include in the analysis, notably, prices and quality of goods; i.e. in order to explain freight streams, the total complex of reception and distribution relationships, including transport costs and transport conditions, would have to be considered.

It has to be stated, however, that the transport interrelationship of regions in long-distance road haulage can be determined quite satisfactorily in a gravitation model, which contains as explanatory variables the gross domestic product of the regions of dispatch and reception and as a resistance variable the average distances between regions. Two reasons are decisive in this context. For one, as analysis has shown, gross domestic product represents in its totality a reliable indicator of long-distance road haulage generation. On the other hand, due to the small share of bulk freight in long-distance road haulage, goods transported by road over long distances are distributed more evenly by type of goods in the various dispatch-reception relations than rail and inland waterway transport. Furthermore, transport via long-distance road haulage is, in spite of the concentration of goods-streams in urban and industrial agglomerations, spread regionally much more evenly than freight transport by rail, inland waterway or air; in particular bulk freight transport on rail and inland waterway shows strong axial concentration.

3.2 The influence of demand and supply determinants of freight transport, in particular of cost, and the explanation of modal split

The decisive role which, for a long time, economic science had attributed to costs and prices of transport when planning industrial location and choosing means of transport, has been reduced considerably in the recent past. This has mainly two reasons. On the one hand, technical progress in production techniques, the transport industry itself, and certain demand changes in many economic sectors have led to a reduction of specific transport cost; on the other hand and as a result of full and even excess utilisation of capacities in the economy with simultaneous and lagged effects, with delay in delivery dates, depreciation of quality of goods, deterioration of services etc., transport cost as the decisive criterion for the ordering of goods, the choice of route and mode of transport has been reduced in importance or even replaced by other criteria. Amongst these criteria one can note, above all, speed of transport; in many cases, security of transport as well as correct handling of goods shipped.

Micro-economically, this can be easily shown with the help of results of recent surveys, even though there remain enough enterprises and branches where transport cost s remain proportionately high and are still important, possibly even decisive factors for the transport decisions of entrepreneurs.

Macro-economically - mainly due to the available and, even more, the lacking statistical material - the importance of transport cost as a determinant of transport demand, in spite of its central position in the system of determinants can

(a) be shown satisfactorily only in a relatively small number of cases and

(b) hardly be distinguished from the complementary or competing influence of other determinants to be mentioned in this context, in particular supply-related determinants.

For these reasons, analyses of demand-elasticities in freight transport are generally lacking. Available results of analyses concerning the influence of transport cost or transport prices on the choice of means of transport can, therefore, only moderately illuminate the question of the determinants of modal split, which should be considered in this section for methodoligical reasons.

3.2.1 Transport cost, proxy variables and additional determinants

There are, as was mentioned earlier, a series of production branches whose inputs carry high direct and indirect transport costs in relation to the gross production value of their products. Included in this group are most branches of raw material production and oil refining, both with transport cost shares exceeding 10 per cent. In the great majority of sectors included in the input-output tables of the Ifo-Institute, however, these cost shares are lower and often much lower than 5 per cent. This does not exclude the possibility, of course, that even in those sectors where transport costs are very low, these costs represent a significant element in transport planning.

An Ifo-Institute survey which was carried out in 1968 covered almost 80 branches of industry and the wholesale trade. This survey showed the important role which was played by speed, reliability and transport risk as well as the nature of fragility of the goods. It is often the individual situation of the shipper or the wishes or location of the customer which decide choice of transport. Other factors which may play a role are the location of the producer or wholesaler or lack of choice of transport for a specified commodity. It is significant that in the majority of branches both of industry and of wholesale trade, firms more frequently reported speed of transport as the reason for their choice of mode of transport than transport price and conditions. This applied for all commodities included in the study.

In the present state of our knowledge, the determinants of transport demand in Germany described above, which are in addition to the tariff component, can be quantified neither in a sectoral or regional definition to a sufficient extent that one could consider an econometric study of their effects. Since there are also insufficient statistics on transport cost, one has to fall back on proxy variables. Here one may consider freight rates for public transport as, for example, if one is an expert one can work out rail tariffs for different goods, distances, types of transport and weight classes. One can also take totals of transport costs as these are reported in statistics and company reports concerning the transport of the goods in given circumstances from a place of dispatch to a place of reception. Other material which can be used includes official and other freight indices and average income of transport undertakings per ton/kilometre.

It would be going too far to discuss in detail the problems and limitations of the use of these proxy variables. Insofar as one is not referring to the general characterisation of tariff variables under 2.2.2.2, it should be pointed out here, that econometric experiments with tariff variables are often unsatisfactory only because there is no satisfactory or representative tariff variable for the transport demand to be explained and none can be produced. The problem becomes more difficult still, when one attempts to explain alternative demand possibilities. All too frequently the comparability of tariff variables to be used is distorted and one must in the analysis abstract not only from related cost and surcharges, but also rebates, especially on the basis of private agreements between freight forwarders and shippers or receivers. These factors become more important, the more transport demand is specific from the sectoral or regional point of view.

3.2.2 Modal-split

If one wished to explain the split of transport demand on all inland transport branches with the help of tariff variables, one would need, according to what has been said above, first of all to break down the overall variables for demand accruing to the railways, inland waterways, road haulage and pipelines into comparable sector variables.

For modal split between railways and inland waterways one can, as studies have shown, ignore differences in freight accrual if bulk transport predominates in the case of both types of transport and if no decisive changes have taken place in the relationship between railway and long-distance road haulage in the period under study. It is necessary either for railways alone or also for inland waterways to develop a tariff index which reflects the predominance of bulk freight transport in the main transport relations. At the Ifo-Institute, more than 30 commodity groups were used. The tariff index derived was weighted with appropriate quantities of freight. This index was then used to explain the amount of freight accruing to the railways on the basis of total traffic accruing to railways and inland waterways, according to the function

$$y = ax^{b}z^{-c} \qquad (10)$$

where

x = rail and inland waterway freight traffic

z = railway tariff index.

Freight transport on inland waterways results as the difference (x-y). It can, however, also be determined according to formula (10) as (y) if one applies (z) as the tariff index for inland waterway transport. Reciprocal application of the tariff index for the other transport branch, of a coefficient explaining the freight level relations of both transport sectors to each other, is also possible.

How far such an analysis provides reliable figures, or whether it can be considered as a first rough attempt only, depends on the specific circumstances and remains to be examined. The use of a freight index becomes problematical when it reflects the real world inaccurately as a result of structural changes.

It does not seem sensible to use a similar process to compare total long-distance road haulage with rail freight transport using a tariff variable; compared with the railway, long-distance road haulage has only a very small share in the transport of bulk freight, its freight streams, too, are different and represent mostly door-to-door transport. To clear this mass of distorting factors - possibly considering also transport where no substitute is possible - would require a great deal of research and could even introduce new elements of uncertainty into the basis of the analysis. As long as such analyses do not provide reliable results, demand for long-distance road haulage performance is described by its close functional relationship, over a period of time, with the development of real gross national product or with gross domestic product. This relationship is expressed by functional type (1).

Construction and use of pipelines must be considered in relation to location and capacity of oil refineries and other plants requiring transport of products via the pipelines. In present circumstances demand elasticity of alternative transport possibilities is low. In practise, there is virtually no substitute for pipeline transport.

Explanation of modal-split should, however, be carried out not only on the basis of the already mentioned global equations but should also always aim at confirmation via the analysis of the development of the commodity pattern over time. Experience has shown that transport demand for important commodities in various transport branches - at least according to the ten NST-headings of transport statistics - showed a relatively steady development, which could be used to explain modal-split via functional relationships to the appropriate total transport, transport coefficients etc.

Results of such detailed analyses can be used, in particular, in models which attempt to describe modal-split in sectors of the economy. Such a model can be constructed only on the basis of a general analysis of economic structure and dynamic and of transport in the appropriate region. It has to be pointed out, as has been mentioned before, that the close long-term relationship between real gross domestic product and transport demand for long-distance road haulage can, as a rule, be very useful for the corresponding regional analyses.

An analysis of the short-term development of transport demand as far as modal-split is concerned shows, in the case of rail, inland waterway transport and long-distance road haulage that the deviations from trend shown in their share in global transport are related rather closely to overall economic trends. Analyses carried out so far show that, in relation to trend, the share of the railways in total transport rises in upswing phases and falls during the downswing. Inland waterways and road freight shares move in the opposite direction. The relationships need more thorough study, especially as far as their causality is concerned. The results of transport policy measures, which do not usually produce their full impact immediately, need especial attention.

4. Supply-related determinants of freight transport

In keeping with the structure of the present study, some important factors related to the supply of transport services and which have an influence on transport demand have already been discussed in part 3. These are, if one excludes transport price since it is a variable significantly influenced by transport demand in a market economy, time and reliability of transport, degree of risk during transport and method of goods handling. All these determinants are at present practically unquantifiable in the macro-economic sense, especially for purposes of comparative studies, and therefore, they have to be omitted from an econometric study for the time being.

As far as time is concerned, one must judge according to the case whether and to what extent this determinant can be sensibly replaced by distance. This would hardly be the case for road haulage but could be feasible in the case of rail, inland waterway and air transport. Moreover, information can be derived about the suitability of the other determinants listed from statistics of traffic accidents and cases of transport damage handled by insurance companies.

The transport infrastructure has a basic significance as a supply-related determinant of transport demand. By infrastructure is meant the type and geographical location of route networks, their length, capacity, and interchange points with their special features. Furthermore, the way in which demand is satisfied by vehicles of a given type and capacity and their use according to number and, if applicable, timetable, trip time, turnaround time, etc.

Just those among these determinants which, on account of important qualitative characteristics or capacity limits have a special influence on demand, are as far as these very characteristics are concerned to a large extent not available in statistical form or cannot even be translated into such form and cannot, therefore, be taken into account. There remains, then, practically only route length. This factor alone determines transport demand only as an extreme constraint, although in individual cases the availability or non-availability of routes doubtless influences the development of a region significantly and, therefore, exerts an impact on economic activity.

In an assessment of route length as a determinant of transport demand, a distinction has to be made according to whether one is dealing with an economy at an early or late stage of its development.

In economies which are only in early stages of industrialisation and show only low densities for the length of route networks per unit of area, a new railway or road will normally produce powerful impulses on economic activity which are clearly expressed in the growth of transport services and total sales in the economy. This relationship can be shown, for example, for the former German Reich for the period from 1850 to 1910. In this case, certain reservations have to be made with respect to statistical completeness and the availability of macro-economic variables.

In highly developed modern economies, on the other hand, where dense route networks are already available, the impact of the completion of a new route is small or negligible from the macro-economic point of view.

Seen overall, the length of route is so little representative of the supply of freight transport facilities, that it can hardly make a contribution either in cross-cut or time series studies to explain with any confidence the relationships between transport potential and transport demand, doubtless present, or otherwise expressed, between transport supply and the level of development of the economy.

For individual studies about a given transport route or route project, additional information can mostly be supplied, although as a rule only by separate surveys and questionnaires. These make it possible to estimate the influence of the relevant supply-related determinants of transport demand. Such information is needed, as far as supply is concerned, above all with respect to the technical and economic efficiency of the route and of competing routes and transport enterprises. Information is needed to no lesser degree about joint use of the route by passenger traffic. So far as the questions which are used in special surveys and are relevant to assessment of the route construction projects are concerned, one needs mainly investigations which overlap with the field of cost benefit analyses and are not treated in the present study.

If one needs to ask how far a new route or a route with increased capacity will attract transport demand and affect existing traffic streams, a question which a study of the viability of a route cannot overlook, stochastic relationships can be used which have been derived from similar analyses of comparable routes in other regions with similar conditions. As was shown above, it is almost impossible to use the length and capacity of a route as variables, either dependent or explanatory, in such stochastic analyses. First, therefore, one takes as a proxy for the route as a determinant of transport supply freight traffic using the route. Then one reverses the question so that one is studying the level of transport demand which would apply to this route if similar relationships held good as for other similar routes in regions with structural data of a statistically reliable nature. The essential information about determinants, methodology and typical functional relationships has been described in previous sections on sectoral and regional relationships and modal-split. The usefulness of the procedure depends on the possibility of a basic analysis of a sufficiently large number of similarly structured regions and on the reliability of the hypothesis that the result derived can be used for the region under study and the route to be assessed.

5. Prospects

As a study of the determinants of transport demand has shown, many conditions necessary for a more adequate explanation of freight transport remain unfulfilled. This is certainly the case for macro-economic explanations with the help of mathematical models based on stochastic relationships of a functional or causal nature. But individual variables, taken out of the total population and time series, are often insufficiently reliable for their determinants to be quantified.

This results to a large extent from gaps and deficiencies in statistics concerning sectoral and regional economic activity.

In the case of freight transport itself it reflects also insufficient information, especially that of a quantitative nature, on behaviour of persons and firms when confronted with transport decisions.

Moreover, the methods used themselves often set limits. It is not always the case that a single determinant can explain transport demand variables satisfactorily in a stochastic equation. The use of several explanatory variables is often limited by the presence of multi-collinearity. One can only advise caution, too, in the face of giant models which try to explain transport variables through interrelated multi-regional determinants. Although the interdependencies which lead to the formation of transport demand are very complex, the precision of the explanation of a global variable does not necessarily rise with the use of interrelated detailed explanations. With every specification of detailed variables, further uncertainties or even mistakes can arise in the explanation of the global variable. This is the case with respect to the conditions which have to be assumed (causal relationships and hypotheses), inexactitudes in the estimation of components which are not statistically available, and increased error probabilities in the stochastic relationship.

Even so, detailed analyses for the explanation of transport demand should be encouraged which emphasize the disaggregation of total traffic of the various transport modes according to sectoral and regional components. This appears to be especially important because present and ex-post analyses concerning the determinants of transport demand provide the necessary basis for the forecasts of freight transport which have continuously to be renewed. It is unsatisfactory if, on account of insufficient statistical evidence and, therefore, lacking knowledge about detailed relationships, forecasts of certain sector variables of transport demand have to be built on the assumption of constant structural parameters, the invariance of demand elasticities, and the assumption of unchanged transport policies.

The greater degree of disaggregation should especially have the effect of providing information on the influence of important transport intensive industries on transport demand over a business cycle as well as over the medium and long term. The disaggregation becomes questionable if the ex-post relationships become clearer, but cannot be used for forecasting because the forecast of the determinants cannot be verified or leads to too great difficulties.

In some cases the forecasting of determinants can be omitted, for example, where the ex-post development of the sector variables of transport demand to be explained is very smooth and the assumption appears to be justified that the trend will continue in the future.

Moreover, Ifo-Institute checks on certain long-term projections for the year 1970 showed that in a series of cases projection values derived through extrapolation of trend were closer to the actual (or comparable) values for the year 1970 than estimated values derived by more sophisticated methods.

This should not, however, lead to the conclusion that extrapolation of trend is basically and always the "incorrect" or in comparison to others the "best" method of long-term forecasting. Every forecasting task requires a method which is adequate to the question. Choice of method depends also on knowledge about the dominant causal relationships, type, the quality of the statistics and the human and technical resources available for carrying out the forecast. Often a whole system of estimation processes is necessary in which extrapolation of trend can in some circumstances play an important role.

One must, however, take account of the fact that the relatively greater forecasting "accuracy" of extrapolations of trend applied to a projection period in which overall economic growth was subject to few and only small distortions. One can hardly expect that an extrapolation of trend for a future period which turns out, in contrast to the base-period, to be a period of disturbed and uneven development, would bring projection values of comparable accuracy to those which were derived in the framework of the above mentioned check carried out for the period until 1970.

It is impossible, of course, for one to say a priori that "better" results might be obtained with another method and describe what this other method might be. As long as one places the emphasis in forecasting on the use of ceterisparibus-functions, one has to ask oneself whether it is worthwhile, insofar as one is concerned only with "accuracy", to work with a forecasting or projection model based on them, when this model cannot yield better results than an extrapolation of trend.

The trend does, of course, not take account of economic relationships. On the other hand, one may use extrapolations of trend even if they are not considered appropriate for this reason, in order to get an idea of orders of magnitude which can be used for the checking of projection results derived by other methods.

At this point a word needs to be said about the basic problem of checking long-term forecasts. The projected value, which is derived functionally by the use of stochastic relationships or through the extrapolation of the underlying trend in the past in relation to time, has the characteristic of a trend value. The value which actually occurs in the projection year is, on the other hand, not only subject to the influence of the general trend of economic growth but also to cyclical movements and also, in some cases, to the once for all effect of special factors.

One can try to calculate a trend value corresponding to this actual value. One will, however, immediately discover that for one and the same statistical series a variety of completely different trend functions appear to be acceptable and can be justified on the basis of the usual test values. If one compares the trend values derived from the various methods of calculation to the forecast value, one can show quite astonishing deviations in relation to the accuracy of the projection.

Every attempt to transform the actual value to a trend value corresponding to the value projected, brings uncertainty and inaccuracy into the process of checking. This uncertainty and inaccuracy necessarily casts doubt on the results of the check.

Furthermore, it is in the nature of the economic process that an exactly quantifiable forecast of future economic values and phenomena is simply not possible. It is also a fact that every published forecast results in reactions which can either make the forecast self-fulfilling or can have the opposite effect. Of their nature, these reactions cannot be taken into account in the forecasting process. The limitations which result for even the most "well tested" method with respect to its accuracy, can be defined neither in any general way nor with finality since one has far too few forecasts which are comparable one with the other. These limitations are, however, obvious and they considerably limit the results which may be expected from a check on the accuracy of forecasts.

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SUMMARY OF THE DISCUSSIONS

FOREWORD

By definition, demand forecasting covers a very wide range of factors inherent to transport itself and a good many others that are extraneous to it. This makes it most difficult to fit this summary into a carefully systematic framework, and as more or less conflicting views were expressed by participants, the opinions set out in this account of the proceedings do not necessarily coincide.

A. GENERAL

It was noted from the start that, all in all, forecasts seldom produced successful results and, hence, those who had to make investment decisions might judge them to be of little use. A proper use of forecasts above all implies a clearer definition of objectives.

In practice, the investment programmes referred to involve distinctly larger requirements from year to year. Investment policy must fit in with the economy as a whole and transport trends must accordingly be traced within the context of the general economy. Here, "the economy" must be construed in the broadest sense, that is, by reference to a knowledge of human needs, this because a growing number of diversified transport requirements no longer fall within the concept of the economy in its narrow sense whilst still having some aspects which, without question, have an economic impact in the true meaning of the term.

On the political side, little use has so far been made of the multi-modal approach. Furthermore, regional economic requirements also have a bearing on the policy maker's prospection of future needs.

Clearly, the magnitude of the needs expressed by different interested groups and from different quarters is such that they cannot all be met. That is why selective criteria must be introduced, mainly by means of intermodal cost/benefit analysis. The needs to be met are also conditioned by certain regional development and environment objectives. Forecasting cannot be effective without a prior knowledge of major political options as, failing this, it will be wrongly focussed from the start. To deal with this, planning models providing for evaluation of objectives or simulation models comprising variable parameters might be envisaged.

It is apparent that users of forecasts show most interest in those at fairly short range; this applies both to transport operators and to makers of transport equipment.

The usefulness of forecasting can be seen in two ways:

1. From a theoretical angle, forecasts have a limited usefulness in that they pave the way for general policy guidelines; they describe a problem but without providing the solution of it and do not therefore provide the means of making decisions on specific points. The important thing is that the problem should be clearly stated from the start.

2. From a practical angle, a decision cannot wait for the forecasts; synchronisation is often necessary. A relationship can be established between research and decisions on specific points, at least for other than major decisions. Ultimately, the cumulative effect of short-term decisions conditions the long-term prospect.

Some participants did however consider that a long-term outlook could also be of interest to forecast users, both political decision-makers and suppliers of equipment.

The problem may have substantially different aspects depending on the level of development of the country concerned. In countries where industrialisation is at a less advanced stage, development options are plainer and simpler, but there still remains the problem whether the time-range of forecasts should be same for political decision-makers and for industry.

An important distinction must be made between global and sectoral forecasts. Global forecasts can provide useful data for planning infrastructure capacity, provided however that the units and criteria they refer to are strictly relevant, (e.g. vehicle-km, not tons). Similarly, closer analysis of sensitivity relationships (higher taxation and subsidies) seems desirable. As regards sectoral forecasts, it seems that this type of information is not yet sufficiently developed.

As to the ultimate purpose of the forecasts, it was pointed out that the main interest lay in the analysis and not so much in the quantitative results, especially bearing in mind that it soon becomes apparent at the start that the information essential for arriving at a correct result is lacking. Thus, there is often a scarcity of means for developing in actual practice methods that, in theory, are recognised as useful.

On the other hand, the lessons drawn from previous mistakes and shortcomings can help to straighten the course of future research provided that the reasons for such mistakes are sufficiently clearly traced. More attention should therefore be given to the study of previous forecasts. This retrospective process should be backed by sound information obtained by adequate contact between theory and practice. The forecasting process itself helps to improve information. It is this constant inter-action which leads to gradually better forecasts.

The development of forecasting technique at research level itself gave rise to a fairly wide exchange of views. Some participants considered that, given the constantly expanding volume of research, its rationale should be more carefully considered to save it from deteriorating into a loose and aimless persuit.

First, it was time to treat some knowledge as definitely established and not go on using it over again as a research topic. The practice which consisted in everlastingly starting back from stratch - an unfortunately too frequent tendency nowadays - should stop. This defect was due to lack of information and also insufficient effective guidance for young research workers.

Though duplication must be avoided, it would be a bad thing to accept the institution of research monopolies. This raises the issue of the function of government departments as regards research. For several reasons, it is not desirable that the administration should monopolise research. First, there is the obvious risk of its claiming to be the only custodian of the truth if it is never challenged by qualified spokesmen. Secondly, politics could have too much influence on research projects. Yet another reason is that government bodies are not aware of every requirement: many pieces of information (especially of a confidential kind) escape their notice.

Most government intervention in research is concerned with planning, co-ordination and control and with the organisation of essential contacts between research workers on the one side and political decision-makers and other users on the other.

There is an obvious need for a comprehensive programme of research. To start with, it would be a good thing to know exactly what research is expected to achieve. Other points to be settled are co-operation at various levels and continuing links between research projects.

Some relationship should be established between basic research and applied research and between government-sponsored research and industrial research. Research should have frequent contacts with political authorities and with industry as, failing this, it soon becomes meaningless. It must also be borne in mind that from the forecast users' angle, the essential point is to be provided with alternative solutions.

Governments can also play a part in taking stock of the weak points of research. Apart from this, government-sponsored research is often desirable to check the working of research as it would be bad thing if political authorities were unable to verify how the work has been done. Furthermore, the purpose of research being of a practical order it is most important that its results should be presented in intelligible form; here again, government departments can play a useful role by asking research workers to express their findings in terms that everyone can understand. The continuity of research could also be improved if governments issued research assignments more quickly and defined them more clearly; this would save a good deal of time that is otherwise wasted (sometimes to the extent that the information is provided after the political decision has been made).

At international level, though the usefulness of exchanges of experience needs no further proof, the participants in this Round Table did nonetheless emphasize the positive role played by the meetings organised by the ECMT on scientific topics.

B. SHORT-TERM AND LONG-TERM FORECASTING

Broadly speaking, existing scientific experience mainly applies to medium and long-term forecasting. The interest that the various parties concerned attach to different forecasting ranges has already been discussed. It was found that on the whole, business management requirements are more or less short-term. On the other hand, longer-range forecasts are a feature of forward planning whenever the investment involved is on a sizeable scale.

Research has now reached the stage where long-term forecasts can be checked ex-post facto. Adjustments in the course of the period covered by the forecasts can be made at business management level at far closer intervals (e.g. each year) than in the case of a general plan (e.g. every five years).

One of the problems of short-term forecasting lies in getting up-to-date information. In practice, the available data generally applies to situations prevailing at least a year before. This deficiency is not easily cured, a frequent approach for dealing with it is by intuition.

As to the criteria for a correct evaluation of the economic development of transport, there seems to be an unending quest for more valid criteria, especially in the case of short-term forecasts. Though reference to incomes does not give very convincing results, consumption surveys seem to provide a more accurate approach but their findings must be wisely and carefully interpreted.

It is sometimes claimed that the economic impact of transport declines as the general economy develops; this is not necessarily the case at all transport levels and, hence, the question arises whether the evaluation criteria used for this purpose are valid. Indeed, the ton-kilometre is a purely technical unit of measurement providing no information of an economic order (particularly as regards elasticity in relation to income). This raises the question whether the criteria should be tons, vehicles or costs. This point was raised on several occasions in the course of the Round Table discussions.

In the case of short-term forecasting, special attention ought to be given to psychological factors. As regards deviations due to seasonal, climatic or cyclical factors it seemed inappropriate to try to determine them exactly. It is more effective to work out a system of indicators based on observed tendencies. In this way, one can take measures towards regularisation of supply.

A system of economic indicators has been built up on the basis of suitably interpreted surveys, e.g. those showing the fairly recent trend of production and prices, and checks have also been made to trace the trend of business prospects. However, transport operators have so far claimed that indicators of this type were not of genuine use to them.

Generally speaking, there is too much segregation between transport and certain extraneous factors. In addition, such factors (e.g. town and country planning) are credited with a stability which they do not really possess. Moreover, it is essential to have planning criteria which can be expressed in values, especially for cost/benefit analysis.

At research level, it would above all be necessary to get information more promptly in order to keep in touch with events more closely, develop the psychological surveys which would provide useful data for short-term forecasting and, more generally speaking, aim towards information of a more precise and less general type in order to provide something of more interest to economic circles.

C. THE FACTORS OF DEMAND

Broadly speaking, scientific knowledge of the effects of deliberate intervention in the process of economic growth is still limited. The same applies to town and country planning: this may generate additional transport costs or bring about transfers of requirements as between geographical areas, or it may also reduce costs by braking excessive growth phenomena (e.g. growth of unduly large conurbations or of over-pressured industrial areas).

In the light of this, it may be asked whether the study of transportation as a separate topic is warranted. Some countries proceed accordingly; what is more, town and country planning policy takes practically no account of traffic forecasting models. This absence of integration may be partly due to the failure of psychological attitudes to change in step with requirements, but the reluctancy is also to some extent attributable to the ineffectiveness of the models employed. Hence, the first improvement should probably be to introduce more precise criteria.

Again with reference to town and country planning, it has to be admitted that few options stand the test of time in actual practice and, what is more, they are very seldom applied and observed. Everything considered, the procedure still consists in making plans, unmaking them and remaking them. Even nowadays, town and country planning does not always give plain guidance regarding transport. Yet another point is that overall planning has little grip on certain wellnigh independent bodies, such as the railways, which often develop their own approach.

At a broader level, models covering the economy as a whole are available. These often are highly schematic and, indeed, political decision-makers seldom take them into account. On the other hand, regional economic models are scarce. Once these "global" models are constructed, "policy" targets such as those concerning modal split or town and country planning should be set. Next there is the evaluation of more limited projects, e.g. those relating to high-density traffic corridors. Closer attention might be given to a policy for location of industry and the corresponding impact on transport.

From a more strictly budgetary angle, it seems that a closer study of overall appropriations might bring out more clearly (and in some cases expand) the share of budget resources that ought to be allocated to transport. This particularly applies to places where options relating to location of activities involve greater traffic needs; in practice, transport is often an alternative (not always an optimal one) to a land-use decision (often not the wisest).

The breakdown under "project" and "branch" headings of the overall budget allocation for transport raises the question of correlation between GNP and "economic" units of transport output. When this output is simply expressed in tons, there is a very substantial difference in correlation from country to country and from one category of traffic to another. This distortion may be due to changes in the pattern of industry, to imprecise basic data or to use of "non-economic" measurement criteria (ton-km). Consideration must therefore be given to what might serve as a more suitable unit than ton-km for economic appraisals of transport. One might envisage a financial criterion, a time criterion, or another physical criterion which is not lacking in significance (vehicle units). In some quarters, a unit based on tons related to transport time is recommended. In any event, the choice of a criterion also depends on what the forecast is intended for (i.e. what are we trying to find out?).

By differentiating between types of transport and evaluation criteria, more specific objectives can be tackled: unduly schematic models cannot really meet requirements.

Models should be carefully detailed and based on plentiful data. The information required is complex and numerous variables have to be introduced.

Time is a very important factor which often outweighs price, but there is still little knowledge of it. A fairly direct approach could be obtained by working out regional input-output tables which could give traffic flows. This would require a knowledge of tonnage by category and the weighting of transport generators.

The use of gravity models does however raise many difficulties. Trade statistics often have to be used as a basis instead of transport statistics, and this gives a distorted view. Though gravity models can help towards a better approach, the analysis of determinants must first be improved.

D. MODAL SPLIT

One of the most controversial determinants of modal choice is return load. The participants in the Round Table were divided in their opinion on this point.

Surveys give a largely satisfactory and highly complex picture of requirements, particularly as regards the time factor. It is important to bear in mind that this is a constantly changing picture as regards both the shape and content of traffic patterns.

It is important to know whether the user really has an alternative and whether the importance that one is inclined to give to location is really deserved.

Modal choice surveys should first be less tightly bound to what has now become conventional formulae and mechanisms. A more qualitative approach is called for, especially by means of direct questioning of users on their present and future needs.

A vitally important point is to know when the decision on modal choice is made as the real impact of motivational factors largely depends on this.

One allegation against forecasting is that it too often extrapolates the past and does not take sufficient account of the possibilities provided by new technologies. Apart from the fact that the outcome of the application in practice of such new technologies is difficult to foresee, it must be admitted that factors which were believed to be foreseeable with reasonable certainty have sometimes been overestimated; recent experience with containers has shown how hazardous certain inflated forecasts of technological possibilities could be.

In many cases, there is interaction between the determinants of modal choice; for instance, the importance of price varies with distance. Consideration should be given to a sufficiently homogenous make-up of commodity groupings both with a view to forecasting requirements and to guide the user's choice of mode.

Within business undertakings, there may also be requirements generating increased transport which is apparently uneconomic; this particularly applies to cases where the object is to make optimal use of production units located at different points. This factor obviously reduces the value of gravity models.

Managements do not make their decisions by successive instalments or for separate aspects but with an eye to a general scheme of things; therefore, though separate analysis of each factor is important from a methodological angle, this general scheme of things as an entity must not be lost sight of.

If the aim is to establish a relationship between transport and transport generators, the inevitable outcome is to design a model embracing all such inter-relationships and extending far beyond the transport field; in actual practice, however, such an exercise seems unfeasible at present.

However, partial approaches of this kind are conceivable e.g. for a regional development plan. This would cover, inter alia, infrastructural requirements, the effect of new infrastructures on the plan as a whole, and the plan's consistency with other assumptions as to economic development. This could be a most useful method, especially for a study of environmental factors.

E. THE DATA REQUIRED

At an earlier point in this report, reference was made to the origin-destination figures needed for forecasting models. Part of the discussions at this Round Table centred on the different types of desirable data.

Input-output tables certainly ought to be improved: here, the question arises as to what the size of the areas to be studied should be. Next, the real need is for regional production-consumption statistics rather than national accounting statistics broken down by regions. Apart from this, transport is not always discernible as such in the statistics: transport on own account is often intergrated in the activities of the firms concerned. There is also something of a vicious circle in the pattern of the data since transport serves as a basic datum for input-output tables, which means that they are partly derived from this and are at the same time expected to provide information on it.

Breakbulk hauls are also a problem as they are often counted several times over.

More generally speaking, the study of demand seems to be better than that of supply. It would be useful to have more carefully updated data, better transparency of prices and tariffs, better information on investment and also the possibility of appraising more correctly the factors which have a bearing on transport capacity.

Some statistics are mainly intended for administrative purposes and are of limited significance for a knowledge of the economics of transportation; these statistics are indeed seldom designed as transport statistics but usually as national economic data or with a view to "internal" use.

Transport-users surveys or, better still, panels interviewed at regular intervals would be likely to provide better information.

CONCLUSIONS DRAWN FROM THE DISCUSSIONS

At the end of the discussion, the Chairman summed up the main conclusions and asked each participant to supplement them. Some of these conclusions already stand out clearly from the foregoing brief summary. Others are set out below to draw attention to them but without this affecting the contents of this summary as a whole:

Decision makers for whom a knowledge of traffic forecasts is useful are:

- governments;
- transport operators;
- makers of transport equipment;
- forwarding agents.

As regards research proper, experience has shown that most errors are due to unduly self-centred attitudes (refusal to co-operate) and to a lack of scientific maturity (too many beginners everlastingly re-tackling problems from scratch). On the other hand, it is also important to beware of a perfectionist approach which sees only the ultimate goal and disregards the road ahead.

Research should above all provide the data needed for infrastructural policy, having regard to the constantly expanding scale of its financial implications, and the information provided should cover both short and long-term prospects. This should lead to more consistent planning at sufficiently long range. To this end, contacts between the three parties concerned (government-industry-transport) and research should be developed.

International research co-ordination should be stimulated not only by periodical exchanges of information but also by a more refined analysis of the contents and results (followed by critical appraisal).

A single substitute for the ton-km is not enough; several are needed in order to be able to match the purpose of the enquiry. Broadly speaking, however, one must be wary of over-simplified information. What is needed above all is a sound idea of the future trend by mode. This means that the information should cover future volume of traffic, future prices and investment in infrastructure and other transport equipment.

As regards modal split, transport cost elasticity should preferably be determined by commodity groups (according to volume and distance). Time is an important element for certain categories of traffic.

The development of better regional models is not merely a question of statistics but also depends on users' and transport operators' choice and on technical change.

The Round Table did not reach any conclusions as to deliberate intervention in so-called natural economic developments (e.g. regional economy).

Concentration of information and research in Government hands was not considered desirable, but actual practice involves important distinctions from country to country. In the last resort, this is a matter of political attitudes in the country concerned.

Lastly, the purpose of forecasting is not to predict, but to show political decision-makers the alternatives and the effects that follow from each of these alternative courses.