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Bruinsma, F.

1995

Faculteit der Economische Wetenschappen en Econometrie

Serie Research Memoranda

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Research Memorandum 1995-12

vrije Universiteit amsterdam

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THE IMPACT OF NEW INFRASTRUCTURE ON THE SPATIAL PATTERNS OF ECONOMIC ACTIVITIES

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The article is based on the authors Phd. thesis: 'De invloed van transportinfrastructuur op ruimtelijke patronen van economische activiteiten' (Bruinsma 1994).
The author thanks Piet Rietveld and Sytze Rienstra for their comments on a draft version.

Abstract

*This **article attempts** to present a **systematic** owerview of **the** impact of transport infrastructure on **spatial** patterns of **economic** acfivifies.*

*The **central** element is that an improvement in **the** transport infrastructure **leads to lower interaction costs**. This has three major **effects. First,** an increase in fhe **access** of actors and the **accessibility** of **locations. Second** an increase in **the** producfivity of **firms** and households. Third, **a** change in fhe volume and location of activifies of **firms** and households. There **also** exist feed backs and **intermediate** facfors which have an important impact on **the** sfrength and **time** period in which transport infrastructure affecfs **economic development**.*

*The ovetview of approaches show that major steps forward **can** be made by linking modelling and non-modelling approaches.*

Introduction

The impact of transport infrastructure on spatial patterns of economic activities is receiving increasing attention from scientists and politicians. From a politica1 viewpoint the theme is of particular interest because of the tension between decreasing government expenditures and the rising demand for transport infrastructure. Three scientific disciplines are active in the field of the impact of transport infrastructure and the spatial pattern of economic activities: geography, economy and traffic engineering. However within none of these disciplines the theme has become a major subject of research. There has been little exchange of ideas between the disciplines and as a consequence the theory in this field is rather fragmented.

Observing the enormous rise in the number of - policy initiated - empirical studies in this field and considering the fragmented theoretical background, there is a need for a theoretical framework on the relation between transport infrastructure and the spatial patterns of economic activities. This article presents such a theoretical framework and an overview of methodologies involved.

It is inevitable that an adjustment in the transport infrastructure network will lead to a restructuring of traffic flows. Most important in this restructuring process is to which extent these changes in transport infrastructure networks result in changes in the total number of movements each zone generates or attracts. Improvements in the transport infrastructure networks lead to shifts in the relative accessibility of zones and by that to potential shifts in the number of movements from and to these zones. Those shifts in movements will partly occur at a short term. For instance the increased accessibility of a shopping centre leads to a higher number of customers. But most of these shifts in the number of movements will occur after the pattern of activities has stabilised and adjusted to the new situation. Those shifts in movements will settle after a long period of time. For instance in a zone of which the relative accessibility is increased it will take quite some time before the housing stock is enlarged, new shopping centres are realised and employment figures rise.

As shown, infrastructure improvements do not only lead to direct shifts in traffic flows but also to a long term spatial shift and extension of all kind of economic activities which generate or attract movements. The impact of a new link in a transport infrastructure network is not restricted to only traffic flows but it restructures the whole spatial pattern of economic activities.

The structuring impact of transport infrastructure received quite some attention recently among researchers and policy makers. The impacts can be measured at several spatial levels. At the local level one might study the impact on the inner city versus the urban fringe. At the regional level the impact on central versus peripheral regions. Of major interest at the international level are the impacts of connections on international - Trans European - transport infrastructure networks, like the high speed rail network. However, one has to state that the often heard positiveness of the size of the impacts of new infrastructure are not justified by thorough research. The results of research in this field are rather diffuse (Offner 1992). This article tries to formulate a solid theoretical framework and provides an overview of methodologies involved, on which further empirical research might be initiated.

A theoretical framework

Transport infrastructure has a long history in economic theory. Classic location theory and interregional trade theory are partly based on the impact of transport infrastructure. In those theories the choice of location or the interregional trade patterns mainly depends on distance between producers and customers. In those theories distance and/or transport infrastructure has been put in operation by transport costs.

An explicit theoretical approach towards the link between transport infrastructure and economic development is given by Voigt (1973). Voigt used components of several general growth theories to construct a development theory based on fundamental relations between the development of traffic systems and economic development. Improvements in traffic systems lead to hardly irreversible spatial differentiative impacts. This will lead to three types of regions: growth regions, underutilised regions and indifferent regions. Voigt assumes a rather mono causal relation between infrastructure development and economic development.

In less mono causal theories, transport costs are included as one of the explanatory variables of for instance location patterns or trade flows. However, the relation between transport infrastructure and the regional structure or economic development never became a main subject of scientific research. The theme is used for different purposes by several scientific disciplines. Geographers use transport infrastructure as far as it can explain activities over the surface. Economists use transport infrastructure as far as it can help explain the functioning of markets. Traffic engineers use it as far as it gives information on the size and direction of traffic flows.

The attempts to create a broader conceptual framework are limited. Most attempts are partial approaches in which the complexity of the relation is not fully expressed. In the next section an economic and geographical approach is used in order to construct a conceptual model on the relation between transport infrastructure and the spatial pattern of economic activities.

A conceptual model - In Figure 1 the complex relation between transport infrastructure and regional economic development is presented. The construction of transport infrastructure effects the transport costs by means of

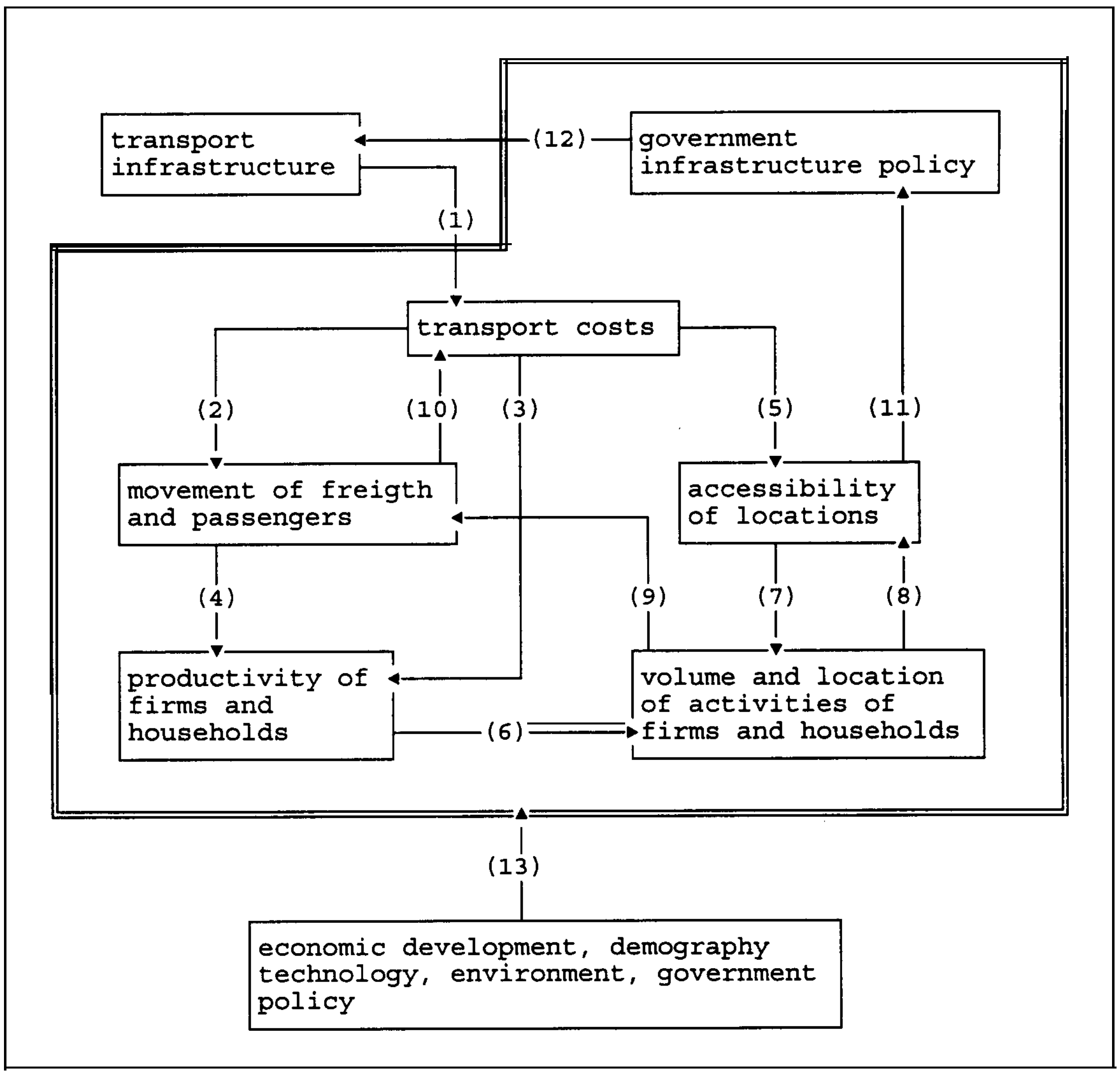

Figure 1 Conceptual model on the relation between transport infrastructure and the spatial pattem of economic activities

shorter distances and/or higher average speed (relation 1). These changes in the transport system lead tot reductions in fuel, capital and/or wages. On its turn these changes within the traffic system will lead to changes in the choice of transport mode, route choice, time of departure (in case of congested networks) and the generation or attraction of new movements per zone (relation 2).

The reduction in transport costs combined with the changes in the patterns of movements of households and firms will lead to an increase in the productivity of the zones involved (relation 3 and 4).

For households this impact can be explained as follows. The reduction in travel time makes it possible to reach the same level of productivity and consumption in a shorter period of time. In reality at the level of households one may observe that higher travel speeds stimulate long distance trips. The travel time elasticity of household movements seems to be rather high. So a possible outcome is that travel behaviour of households tends to adapt into the direction of more frequent visits over longer distances instead of a rise of household productivity.

For transport and transport related firms an improvement in the transport infrastructure has its impact on the number of drivers and lorries needed to reach the same level of productivity or service. Here a substitution of private capital and labour by public capital takes place. This effect on transport related private capital and labour leads to a reduction of transport costs. This allows more transport intensive productivity, for instance by increasing the frequencies of the deliveries or by an expansion of the geographical market area.

Another possible consequence of the improvement of the transport infrastructure is an increased reliability on the exact time of the delivery of goods by a decreased chance of congestion. This also has a positive effect on the productivity of firms. In the case of the deliveries of goods not only the mean travel time is important but also the variance of travel time. A higher reliability in deliveries increases the smoothness of the production process and allows producers to reduce their stocks (just in time principle).

A last effect of the improvement of the transport infrastructure is the improvement of the labour market. The geographical labour market of which labourers can be attracted without making a move of the household necessary, expands by the improvement of the infrastructure network. In reality this has led to an expansion of regional labour markets and in some cases to long distance commuting.

The decrease of transport costs also leads to an increase of the accessibility of the zones involved (relation 5). The accessibility of a zone depends on all possible efforts necessary to visit or leave this zone. Accessibility can be operationalized in several manners (see Hilbers and Verroen 1993 and Bröcker 1989). One of the most attractive methods is to use the integral costs of movements from and to each zone. Those integral costs contain for car drivers flexible costs (for instance gasoline and toll), fixed costs (for instance interest and depreciation) and time costs. For the assessment of travel time one can use value of time studies (see Kleijn and Cheung 1989). The time costs depend also on congestion. So the accessibility of zones also depends on the size of congestion within and between the zones.

The accessibility of a zone can be seen as the weighted mean of the integrated transport costs of a certain zone to all other zones. For each motive of movement the zone need to be weighted by the mass of the zone for that specific motive. For instance for the shopping movements all zones are weighted for the size of their shopping centres.

The increase in productivity and accessibility in a certain zone might lead to an expansion of the economic activities and/or population within the zone (relation 6 and 7). A relevant implication of interregional trade theory is that a positive effect on productivity, employment and/or population is not guaranteed when interregional transport costs decrease. A decrease of interregional transport costs leads to an increase of interregional competition. Firms producing for the local and regional markets can be replaced by imports from competitive regions. In other words, the decrease in interregional transport costs implicates also a decrease in the protection of regional markets. These negative impacts can only occur in the case of improvements of the interregional transport infrastructure networks. Improvements of local or regional transport infrastructure networks - like improvements in local or regional public traffic sevices - will not lead to those negative impacts.

Another subdivision with an important spatial component is the difference between generative and distributive impacts (Rietveld 1989). The generative impacts concern the total change in economic activities in all zones involved by the transport infrastructure improvement. The shifts in the economic activities will not be evenly spread over the zones. Some zones will profit above the average, others below. As a consequence of the restructuring of economic activities some zones may even be confronted with a decrease in economic activities. The difference between distributive and generative impacts is especially important at low spatial levels. In the direct surrounding of for instance a new highway one might measure a rather strong increase in employment, whereas on a higher spatial level one measures a shift of employment toward this highway from more remote zones. Here the increase of employment in the direct surroundings is compensated by a decrease of employment in more remote areas. What seems to be a generative effect at a low spatial level might be a distributive effect at a higher spatial level. The spatial level of the area under study should be chosen wide enough in order to minimize the risk of measuring generative effects instead of distributive effects.

It is important to state that both generative and distributive effects are of main importance in research on the impact of new transport infrastructure on spatial patterns of economic activities. The target in most studies is the size of the generative effects, especially employment growth. However, from the viewpoint of for instance physical planning, distributive effects are as important as generative effects. There might be a need to relocate certain economic activities from unsuitable locations, or to steer autonomous developments, towards locations suitable for those activities. Transport infrastructure might be - especially at a low spatial level - an important instrument for steering those developments.

Until now only direct links between the construction of transport infrastructure and the spatial pattern of economic activities are given. However, there are a number of indirect - feedback - relations which are important.

A first feedback concerns the relocation of economic activities. This relocation implies changes in the masses of the zones involved. Those changes in the masses of the zones has its feedback on the accessibility of the zones (relation 8).

In a similar way, the changes in the location of economic activities effect the number of movements of freight and passengers (relation 9). In case of congestion this shift in the number of movements of freight and passengers implies changes in transport costs (relation 10).

Transport infrastructure cannot be seen as completely exogenous since it is developed by the government. The government reacts on changes in the transport system. The main target of government infrastructure policy might be to secure an acceptable level of accessibility for each zone (relation 11 and 12). On the other hand, the governmental economic policy might be oriented towards the development of additional transport infrastructure in zones with a fast economic development, for instance to overcome congestion. Those two targets of government policy make clear that from a government perspective the construction of transport infrastructure can been seen as a cause as well as a consequence of economic development in certain regions.

A last remark concerns the fact that new transport infrastructure is not the only factor that has an important impact on the development of traffic flows and the spatial patterns of economic activities. In general factors like technology, demography, economy, environmental policy and general government policy may be mentioned (relation 13). Those factors shape a wider context in which the relation between transport infrastructure and the spatial pattern of economic activities has to be analyzed. Above this, it is important to understand that those factors have a major impact on the strength and time period in which transport infrastructure has an impact on spatial patterns of economic activities. This means essentially that a multivariate approach is called for.

Research methods

In this paragraph an overview is presented of approaches which are in common use in empirical research to trace the impact of new infrastructure on spatial patterns of economic activities (see for a more extended overview Bruinsma and Rietveld 1992). An overview of approaches is given in Figure *2.*

	Models	Other approaches
Aggregate data	- transport land use models - production function models - location models - interregional trade models - genera1 equilibrium models	- quasi experimental
Desaggregate data	- stated preference models - revealed preference models	- quasi experimental - entrepreneur survey - expert judgement - calculation of the impact of infrastructure on transport costs

Figure 2 Research methods

In Figure 2 a twofold subdivision is used. First there is a subdivision between models and other approaches. Second there is a subdivision based on the spatial level of the data input. Behind this double subdivision lay two arguments. In recent research activities a sharp division exists between models and other approaches. In my opinion linking those two approaches will result in major steps forward from a methodological point of view. Even more it might lead to new empirical results and give new evidence in the complex relation between transport infrastructure and the spatial pattern of economic activities. So far only a few attempts in this direction are known (for instance Spiekermann and Wegener 1992). The second argument is that the availability of data is still a serious bottleneck in research in this field. A number of approaches get stuck in their further development and/or empirical elaboration because of shortcomings of data sets. Data are not available at the correct spatial level and/or the desired subdivision into infrastructure components etcetera.

Another possible division might have been a division of approaches in infrastructure components (road, rail, air, etc.). This division has some close links with the spatial aggregation level of research. At the urban level quite some research is oriented towards specific urban infrastructure networks like city rail (Berechman and Paaswell 1983, Bajic 1983, Cervero 1984, Hall and Hass-Klau 1985), orbital motorways (Bayliss 1990, Bruinsma et al. 1993), sight locations (BCI 1990, Jansen and Heijs 1992, Korteweg 1992) and railway station locations (Sprangh and Van Tongeren 1983, Jansen and Van der Sterre 1986, Bongenaar and Olden 1992 and NEI 1994). Another type of infrastructure which is receiving special attention at the interregional level is the high speed rail line (Bonnafous 1987, Ter Brugge and Pellenbarg 1988 and Plassard 1991).

Such a division in infrastructure components will give a rather diffuse overview of approaches while most approaches are used for several infrastructure components. Here the approaches will be dealt with conform the double subdivision of Figure 2.

Models based on aggregafe data - Active it this type of research are traffic engineers and economists. The models developed by traffic engineers are based on the traditional transport models. Those traditional models are not capable to analyze the impact of transport infrastructure on spatial patterns of economic activities, however. In those models the locations of activities like work places and houses are given. In the integrated transport land use

models this static situation is left. Those models try to incorporate the generation of new movements in the analysis. The transport land use models are developed for the urban areas. An overview of those models is given in Webster et al. (1992). Some Dutch attempts to develop an integrated transport land use model are given by Hamerslag (1975), Hamerslag and Immers (1991) and Hamerslag, Van Berkum and Repogle (1992).
An important element in most integrated transport land use models is that the total size of population and employment of the urban area is given. This means that the model outcomes only give information about the spatial spread of activities over the city surface and nothing about the total size of the activities. The models analyze distributive effects of infrastructure improvements instead of generative ones. Therefore, if one still wants to deal with generative aspects one has to feed a transport land use model with information of a multi-regional model, like for instance an interregional trade model. Nevertheless, even with only the use of a transport land use model at least some expectations about generative effects can be given. Generative effects of an infrastructure improvement are expected if one observes an increase in productivity in a city. This increase in productivity will be realised by a decrease in transport costs caused by a decrease in distance and/or higher speed. In which matter this decrease in transport costs contributes to a more attractive urban production environment depends of course on the infrastructure improvements in competing cities, which are beyond the reach of the model.

The economic models analyze how transport infrastructure effects the regional production structure. The production function approach, the location approach and the interregional trade models are all focused on this regional level. The lower transport costs caused by the improvement of the interregional transport infrastructure networks result in an increase in the accessibility of regions. As a consequence the geographical market area will expand. A rise in productivity occurs via the higher returns to scale caused by this expanded market.

In the production function approach the level of production depends on the classic private production factors - capital and labour - and transport infrastructure. The public sector provides the transport infrastructure in moste cases free of charge. Improvement of the transport infrastructure has a positive impact on the level of productivity of the private production factors.

This rise in productivity may result in higher wages for the employees, higher profits for the producers, lower prices for the consumers or a combination of those effects.
Production functions are applied to estimate the impact of an improvement of a certain type of transport infrastructure on the productivity of labour and capital (see for an overview Rietveld 1989). A common problem researchers are confronted with is the poor availability of data concerning private production factors at the desired sectoral and/or regional subdivision. As a consequence in most studies incomplete quasi production functions are used (see for instance Blum 1982 and Nijkamp 1986). Another complication is that the impacts of transport infrastructure might cross regional borders. For instance the impact of a national airport will also be measured outside the region where this airport is located. Aschauer (1993) tries to solve these shortcomings by applying the production function at the national level. However, desaggregation of results to the regional level is then impossible (Munell 1993).
One of the lessons that can be learned from the production function approach is that ongoing improvements of transport infrastructure will result in a lower growth of the regional value added (law of decreasing returns to scale). However, if the other production factors - capital and labour - show a growing tendency there might occur a bottleneck if the level of the transport infrastructure remains constant. This bottleneck may have a negative impact on the productivity of labour and capital.

Improvement of transport infrastructure in a region leads to an increase in the productivity of private production factors as ascribed above. In its turn this may lead to an expansion and/or relocation of those production factors in and between regions. This effect is analyzed by location models. In those models the impact of transport infrastructure is analyzed together with other factors that might influence the location of firms like the price of labour, investment subsidies, sectoral structure, accessibility of markets etcetera. The main target in a location model is to explain the changes in private investments and/or employment by those location factors (see for instance Evers et al. 1987).
The results of location factor models are rather diffuse (compare Botham 1983, Dodgson 1974 and Kau 1976). This is mainly caused by the difficulties to define some of the essential parameters and the poor availability of desaggregated investment data.

The interregional trade models are more sophisticated and detailed if one wants to analyze the impact of changes in interregional transport infrastructure networks on regional economic development. Those models need to contain at least the next three elements (Amano and Fujita 1970):

- a link between transport infrastructure and transport costs,
- a link between transport costs and traffic flows,
- a link between traffic flows and regional development.

Those models need a very detailed input of data. As might be expected the researchers fail in feeding the model properly in most cases, therefore.

There are also general equilibrium models available in which transport components are incorporated. Those models show two weak spots concerning the pricing of transport costs (Van den Bergh 1992). First, those models suppose that the markets of transport services are flexible. This means that demand is always equal to supply. The supply of transport modes is supposed to be elastic. In reality there is no such supply elasticity, however. Investments in infrastructure - as well in the physical network as in rolling stock - are rather time consuming. It takes a relative long period of time before transport infrastructure is adjusted to changes in demand. Second, the general equilibrium models are based on the functioning of perfect markets. However, the transport sector can be characterized as an imperfect market. There exist monopolies (national railway companies), public goods and externalities (for instance congestion).

Models based on desaggregate data - Revealed and stated preference approaches are most common in attempts to study the impact of transport infrastructure on spatial patterns of economic activities with models using data on a desaggregate level.

These approaches are implemented at different spatial levels. Both approaches are based on individual utility functions. In the case of revealed preference models the utility function is fed with data concerning choice behaviour in actual situations. In case of stated preference the data concerns preferred behaviour of respondents who made a choice in a laboratory situation.

The revealed preference models show four weaknesses (Kroes and Sheldon 1988). First, it is hard to get enough variation in the data set in order to allow an analysis of all factors. Second, there often appear to be strong correlations between some of the independent variables. For instance travel time and travel costs are correlated rather close. For each transport mode holds that the longer the trip takes the more expensive it will be. It is difficult to estimate the utility of those closely correlated factors. Third, revealed preference data only can be collected after the improvement in the transport infrastructure network is realized. It is not possible to make predictions in an early stage of development. Especially for transport infrastructure it is already in the phase of decision making of great interest to have information about the trafftc flows after the realisation of the network improvement. Fourth, revealed preference models allow only the use of direct variables like travel time and travel costs. The models are less capable to deal with indirect variables like travel comfort or the quality of railway station facilities.

Since the stated preference models use hypothetical assumptions in a laboratory situation they can cope with most of the weaknesses of the revealed preference models. The main weakness of this type of models is that the actual behaviour does not necessarily correspond with the preferences given. For instance, people might say - for a number of reasons - to expect to make use of a new highway but after the realisation this expectation might not be translated in actual behaviour.

The need for information on expected traffic flows before the decision is taken to construct a new link in an infrastructure network has led to attempts to combine both methods. Revealed and stated preference models have to be seen as complementary instead of opposite, therefore.

***Other approaches** based on aggregafe data* - The quasi experimental approach is the most common used non-model approach based on aggregate data. In this approach the development in a region is analyzed after an improvement of the internal structure. This development is compared with the development before the improvement and/or a group of reference regions. The traditional quasi experimental approach contains four applications (Isserman 1990).

- the situation after the improvement is compared with the situation before,
- the situation after the improvement is compared with the situation in reference regions where such an improvement did not take place,
- both the before as the after situation are compared with reference regions
- regions where improvements have taken place are linked to reference regions on basis of a similar development in the before period, then after development is compared.

The main objection of Isserman (1990) is that those methods are focused on differences between two groups of regions (regions with improvements versus regions without improvements) and the general tendencies between those groups. The individual regional variance is neglected. This individual regional information is lost by analyzing average developments. Another problem of the quasi experimental approach is the need for a large numbers of observation (regions). The approach is of little use in a small country with a limited number of regions like the Netherlands (Bruinsma et al. 1995a).

Other approaches based** on **desaggregate data **-** Approaches in which desaggregate data are used, are implemented at all spatial levels. Especially international oriented empirical studies apply these rather qualitative approaches. On this spatial level modelling is still limited.
The quasi experimental approach use the same technic as ascribed above. The only difference is the spatial level at which data are collected. Here data are collected at the level of individuals instead of regions.

Surveys among entrepreneurs are quite popular among researchers. Those surveys might be postal questionnaires, telephone interviews or face to face interviews. There are two main targets to distinguish. The first one is to trace the impact of transport infrastructure on locational decisions of firms. The second target is to measure the impact of the construction of new transport infrastructure in case of bottlenecks in the existing network (see Diamond and Spence 1989 and Bruinsma et al. 1995b).
The information obtained from these surveys may not be free from subjective judgements. Those subjective judgements are not always unconsciously given due to a lack of information. In the case of a study on the impact of transport infrastructure on locational decisions an entrepreneur who has taken the wrong locational decision may try to disguise his mistake by giving an overly optimistic view of his present location. The entrepreneurs might also give an overly optimistic view of the impact of a future transport infrastructure improvement because he expects that this might accelerate the decision process.
However, one has to realize that it is extremely difficult for a entrepreneur to indicate the impact of transport infrastructure on his firm. In case of the locational decision there are many internal and external factors combined in the final decision. Transport infrastructure is one of them just like the preferences of his wife c.q. husband. The researcher has to create a broad context of impact factors to prevent that the entrepreneur overestimates the

importance of transport infrastructure.
Nevertheless this type of research is very important. In reality an entrepreneur takes a decision to (re-)locate his firm based on imperfect information. The perception of the entrepreneur of the potential location and some alternatives is of main importance. Only with surveys of this type the process leading to the final location decision can be reconstructed.

The difference between a survey among entrapreneurs and expert judgement is rather small. Here, we consider an approach as an expert judgement instead of survey if the information requested concerns not only the - spatial location - of the own firm, but a more general view of the impact of transport infrastructure on economic development (for instance Healey & Baker 1990-1993).
In a number of research projects on the impact of transport infrastructure and spatial patterns of economic activities, experts have to weigh the independent variables. The phase of research in which weights are given varies across these studies. Also the weighting procedure can refer to different elements of the research project (compare NEI 1987 and Cheshire et al. 1986).
A last form of expert judgement concerns Delphi-like research approaches in which consensus among experts is aimed at via iterative procedures.

A completely different approach for achieving knowledge on the impact of transport infrastructure on the spatial pattern of economic activities is by calculating the gains in transport costs of potential users as a result of an improvement in the network. The impact is measured in reduced travel times, which are evaluated in a monetary way for each travel motive. Important travel motives are: freight traffic, business travel and non-business travel. Non-business travel is often subdivided in commuting and leisure time trips. The crux in this type of research is the monetary evaluation of those travel motives (De Jong et al. 1991). In the Netherlands freight traffic is evaluated by wages of drivers, fixed costs of car use and/or general company overhead costs. The business trips are evaluated by a percentage of the gross wages in which National insurance contributions are included. Those monetary evaluations are widely accepted (only the levels of the percentage of the gross wages is disputable). Less consensus exists on the monetary evaluation of non-business trips, which are often evaluated by a percentage of the wage level.

Conclusion

The impact of transport infrastructure on spatial patterns of economic activities has received - from at least a theoretic point of view - little systematic attention until now. This article attempts to give such a systematic approach.

The central element in this approach is that an improvement in the transport infrastructure leads to lower interaction costs, which may have three major effects. First, the access of actors increases and by that the accessibility of locations increases. In the second place the productivity of firms and households increases because of the decrease in interaction costs. Third, this increase in productivity of firms and households and the increased accessibility of locations have an impact on the volume and location of activities of firms and households; the spatial pattern of economic activities.

Above those direct impacts it is important to notice a number of feed backs and intermediate factors. The intermediate factors have an important impact on the strength and time period in which improvements of transport infrastructure affects the spatial pattern of economic activities. It is of major importance to make an inventory of the whole regional context in which the improvement of a transport infrastructure network takes place. The research should cover all the elements of this inventory list.

The impact of a transport infrastructure improvement has to be seen in the light of the general - regional, national and international - economic development and the prevailing government policies on areas like for instance investment subsidies, environmental issues and technological development.

The overview of approaches in this field shows that in particular models are commonly accepted. Nevertheless those models are sometimes stuck in their further development by poor availability of data. The research on the impact of improvements of transport infrastructure on the spatial patterns of economic activities has flourished on the urban and regional level. At those levels of spatial aggregation a number of different models are available. At the international level the number of models is limited and the research is more based on qualitative approaches. To my opinion by combining different models - for instance a transport land use model with an interregional trade model - or by relating a model with a non-model approach - for instance a location model supplemented with an expert judgement approach - at different levels of spatial aggregation some major steps forward can be made in increasing the knowledge on the impact of transport infrastructure on spatial patterns of economic activities. Those mixed approaches may lead to new empirical results and new evidence in this complex relation. ,

In view of the limitations inherent to each successive approach it is advisable to apply in new empirical and/or policy oriented studies several - linked - approaches.

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