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SERIE RESEARCH MEMORANDA

EMPLOYMENT IMPACTS OF INFRASTRUCTURE INVESTMENTS

A CASE STUDY FOR THE NETHERLANDS

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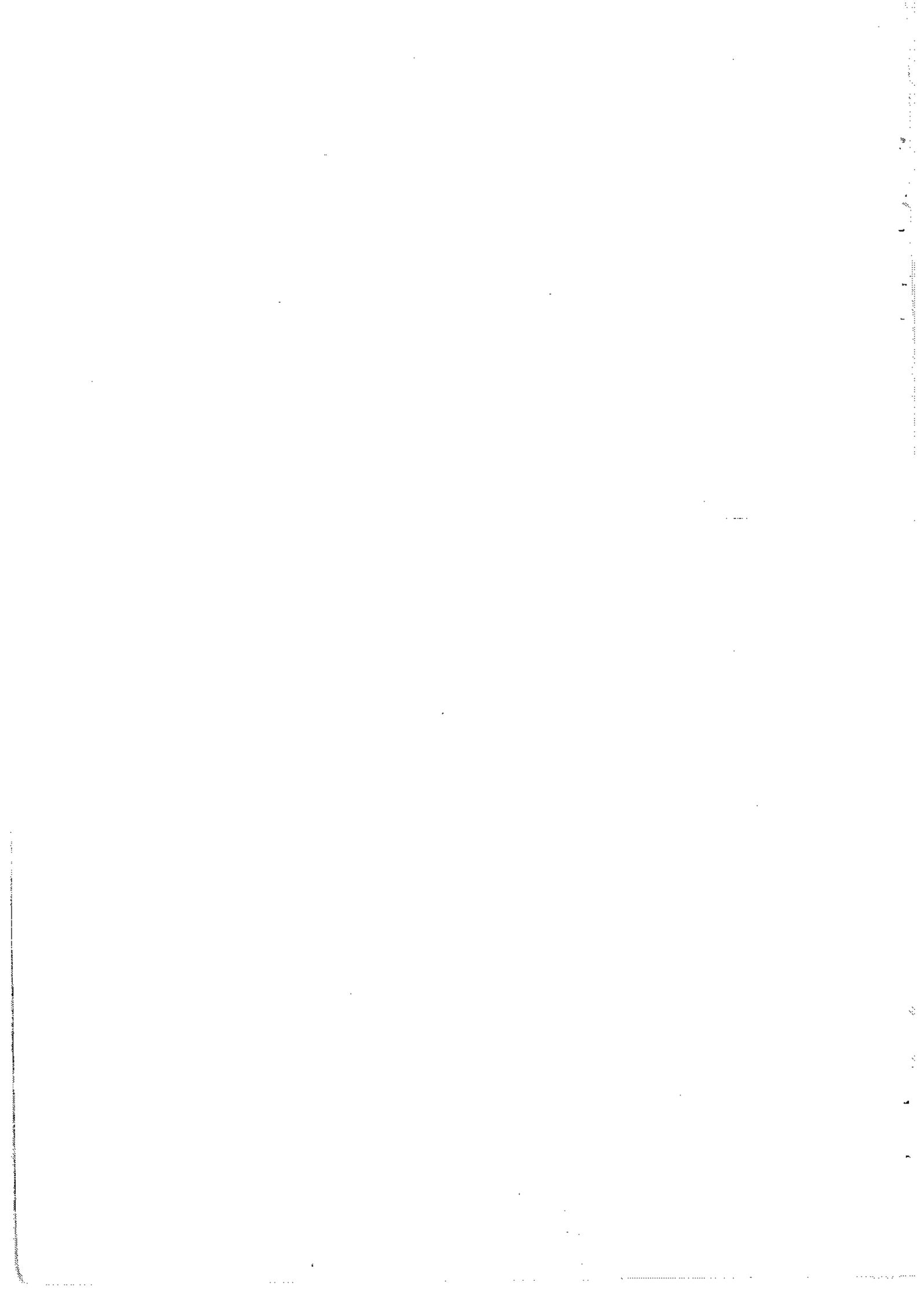
**VRIJE UNIVERSITEIT
FACULTEIT DER ECONOMISCHE WETENSCHAPPEN
EN ECONOMETRIE
AMSTERDAM**



1. Introduction

The interest in infrastructure - from both a scientific and a political angle - is exhibiting a wave-like pattern. In the period of the sixties a broad interest in infrastructure expansion emerged as a result of the unprecedented economic growth necessitating the construction of large infrastructure networks. In the seventies much more emphasis was placed on a more efficient use of existing network capacity, mainly as a result of the limits to growth discussion (including environmental externalities and resource scarcity). In the eighties the attention shifted towards infrastructure and economic stagnation, as a result of a particular interest in the relationship between public investment and employment, whilst in the second part of the eighties also the restructuring effects of new infrastructure (e.g., informatics, telematics) came to the fore (see e.g. Giaoutzi and Nijkamp, 1988)! Very recently also the relationship between infrastructure and international trade (and competition) - from the viewpoint of the unification of the European market - has been given due attention (including the interest in high speed transport systems).

Unfortunately, various contributions to infrastructure research have been either only theoretical in nature or weak in empirical foundations. Speculations on the impact of infrastructure have been more prevalent than solid scientific analyses. Apparently, the influence of infrastructure on the behaviour of economic actors (e.g., the (re)location of firms) is not a very well researched issue. For instance, in a critical overview of the research on the structural impacts of infrastructure on regional or urban development, van Gent and Nijkamp (1988) conclude that in answering this question, the following elements have to be taken in consideration:



1. Regional development is a latent concept, which cannot be unambiguously measured. Observable indicators such as gross regional product or income per capita do not capture all elements of economic development. A similar problem applies to infrastructure: this is not an unambiguous concept either.
2. The contribution of infrastructure to regional development depends also on its uniqueness. An increase in an ubiquitous infrastructure category does not exert a driving progress on a region. For instance, road expansion in an industrial area with a highly developed infrastructure network will have lower effects than that in an underdeveloped area (decreasing marginal benefits).
3. Infrastructure is a conditio sine qua non, but certainly not a sufficient condition for growth. First, infrastructure policy requires a comprehensive and tailor-made supply of all relevant infrastructure categories (due to synergetic effects). Second, infrastructure will only have a positive impact if the region at hand has already a favourable existing potential for new development. The implementation of new infrastructure in an economically weak region may even run the risk that the region at hand suffers from strong competition of enterprises in more distant regions. Thus infrastructure has to be considered in relation to the whole locational profile of an area. Third, infrastructure investments will only have a discriminating effect on regional development, if the competitive position of a region is enhanced. Fourth, the impacts of infrastructure are also co-determined by the general economic situation: in case of a less favourable economic situation, the probability of surpassing a threshold level for survivorship is much lower.

reg. ontw. = latent

infra ook
modiële concept

eff. afh. v.
uniqueness

(afh. marg.
opt. 2)

no odr., maar
geen vold.
voorw.

4. The impacts of infrastructure are also determined by technological renewal. The improvement of the regional competitive position also requires flexibility and resilience in terms of infrastructure investments.

Altogether, network infrastructure is indispensable for regional development but the extent to which it will have a decisive influence on regional growth is not unambiguous. But in any case, it is evident that regions or countries with a poor infrastructure network ('missing links') run the risk of staying behind in the national and international economic restructuring.

A major problem in most infrastructure analyses is that long-term impact inferences have to be drawn from a static and short-term framework (Lakshmanan, 1989). This is also illustrated in an interesting study of Mills and Carlino (1989) who conclude that the long-term employment effects of infrastructure investments may be several times larger than the corresponding short-term effects, although their model with distributed lags is essentially based on a comparative static production function approach. Apart from specification problems (e.g., the separation of infrastructure effects from agglomeration effects), a major flaw in infrastructure impact analysis is caused by a severe lack of reliable and up-to-date statistical information (see also Wigren 1984).

In this context, an interesting contribution has been provided by Blum (1982), who employs a Cobb-Douglas function in which the production factors related to infrastructural stocks are separately defined as input potentials characterized by spatial immobility for a medium - to short - term period. Such input potentials may refer to the transportation network, the telecommunication network or the knowledge or information network.

In any case, it is evident that in a more competitive international environment accessibility is a sine qua non for economic efficiency, i.e., that the development of appropriate infrastructure is a critical success factor for countries and regions in Europe. In this context, it is also important to call attention for the timing of infrastructure investments. For instance, Van der Zwan (1986) claims that - beside conventional long waves in economics - also infrastructural developments display cyclical movements associated with new technologies and economic upswings and downswings. Coordinated infrastructural investments (e.g., in the area of communication and transport technology) might reinforce economic growth, an idea already advocated by Hirschman (1958) in his theory on unbalanced growth (including the tuning of private and public investments).

In this paper we will pay particular attention to the measurement and impacts of infrastructure investments. Therefore, in the next section we will first define infrastructure in a more operational sense, whilst next a brief review of various infrastructure impact models will be given. Then we will present in more detail results from an infrastructure impact study in the Netherlands, with a particular view on the assessment of its economic importance in terms of investment amounts and (direct and indirect) employment effects. This study was undertaken in order to provide a more solid empirical basis for the question whether (public) infrastructure investments would significantly contribute to an improvement of the employment situation in the Netherlands. The difficulties of analysing the spin-off effects of investments in telecommunication infrastructure on the Dutch economy will be discussed using the results of a multisectoral macro-economic model.

2. Methodology of Infrastructure Impact Analysis

2.1 Identification of infrastructure

The measurement of infrastructure is far from easy. Infrastructure is usually defined as the stock of all social overhead capital that is (directly or indirectly) necessary for a proper functioning of all direct productive capital. Usually it has the following features (see Nijkamp 1986):

- immobility (in geographical sense)
- indivisibility (in terms of 'lumpiness')
- non-substitutability (in the sense of limited replacement possibilities)
- polyvalence (in terms of multiple purpose use for other activities)

In a cross-national empirical research project for the European Community a broad view of infrastructure was adopted (see Biehl, 1986). The following main infrastructure categories (subdivided into more than 100 subclasses) were distinguished:

- transportation
- communication
- energy supply
- water supply
- environment
- education
- health
- special urban amenities
- sports and tourist facilities
- social amenities
- cultural amenities
- natural environment

Clearly, in various other studies different definitions have been adopted (see for a review also Lakshmanan, 1989). A general subdivision which will also be used in this paper is into economic infrastructure (as a necessary condition for increasing productivity and efficiency) and social infrastructure (as a necessary condition for increasing individual and social welfare). Examples of the first category are roads, railways or airports, whilst examples of the second category are schools, museums or community centres.

In our study the following infrastructure items were distinguished, according to a typology made by the Dutch Social & Economic Council (1987). It is noteworthy that infrastructure does not explicitly include publicly financed network projects. Clearly, an unambiguous classification is very hard to reach; for instance, universities belong to social infrastructure, but contribute indirectly to economic efficiency (and hence may be regarded as partial economic infrastructure). Furthermore, infrastructure is exhibiting drastic qualitative changes, for instance, from conventional physical networks to teleports and logistic chains linked to various transport modes. The following categories are dealt with in our study:

- TRANSPORTATION

- * roads
- * railroads
- * waterways
- * airports
- * harbours
- * information transmission
- * pipelines

- WATER AND ENERGY SUPPLY

- * water supply
- * natural gas supply
- * electricity supply ←
- * district heating

- WATER CONTROL SYSTEMS

- * water quantity control
- * water quality control

- INFORMATION CONTROL AND KNOWLEDGE DEVELOPMENT

- * general information networks (1)
- * specific information networks (2)
- * knowledge development (3)

- CITY STRUCTURE

- * sewage
- * industrial sites
- * waste disposal
- * urban lay-out

- LAND (RE)STRUCTURING PROJECTS

- * new land (4)
- * land restructuring (5)

(1) Information networks for public use, for instance, a public library in a computer system with which people can connect their

- own home computer
- (2) Information systems for a special group of users, for instance, logistic transportation systems with shortened time needed for customs formalities
 - (3) large technological institutes
 - (4) Projects whereby, for instance land is reclaimed from the sea
 - (5) Landrestructuring projects whereby landscapes are adapted to technological development in agriculture

For each of these categories an assessment of the order of magnitude (in terms of average annual investments) and related employment impacts will be provided in section 3.

2.2 Infrastructure impact analysis

Economic infrastructure will evidently lead to various economic effects in terms of value added, productivity and employment. Clearly, infrastructure may also incorporate embodied technological progress and contribute to productivity increase via a rise in capital productivity. It may also be a substitute or a complement to various production factors.

Infrastructure impact analysis for assessing the effects on employment can be undertaken in two complementary ways, direct effects related to design, construction and building aspects of infrastructure provisions and indirect effects related to the derived (second order) consequences of the creation of infrastructure. The first category may be seen as the conventional (Keynesian) expenditure effects, whereas the second category refers to all effects generated by intermediate deliveries (as multiplier effects). In both cases, the pay-back effects of infrastructure investments in the framework of employment policy may play an important role (see also Kuik and Nijkamp, 1987). Furthermore, we may distinguish programme effects (or 'structuring' effects) associated with the supply of infrastructure. One group of programme effects consists of long-term structural employment effects based on maintenance and management. Another group of programme effects consists

of spin-off effects caused by changes in the relative locational attractiveness of places or regions for new enterprises.

Three different modelling approaches can be distinguished in the analysis of spin-off effects of infrastructure (cf. Rietveld, 1989).

*3 in accessibility
spin-off
effs*

Firstly, improvement of infrastructure leads to an increase in the productivity of the private production factors labour and capital. This can be modelled by means of production functions where both private and public production factors are taken into account. A sample of models following this approach has been summarized in Table 1 (derived from Rietveld, 1989). It appears that it is usually very difficult to carry out such an analysis at a high level of detail in terms of economic sectors and types of infrastructure. This is a pity, since the infrastructure requirement may vary strongly among economic sectors.

① of

Table 1:
EXAMPLES OF THE PRODUCTION FUNCTION APPROACH TO INFRASTRUCTURE MODELLING

Author	Country	Number of sectors	Number of types of infrastructure	Presence of:		Form of production function
				labour	private capital	
Biehl	E.C.	1	1	yes	no	Cobb-Douglas
Blum	F.R.G.	3	8	no	no	Cobb-Douglas
Andersson et al.	Sweden	1	7	yes	yes	Cobb-Douglas (with modification)
Snickars and Granholm	Sweden	21	5	yes	yes	Leontief
Nijkamp	The Netherlands	1	3	yes	no	Cobb-Douglas
Fukuchi	Japan	3	3	yes	yes	Cobb-Douglas
Kawashima	Japan	8	1	yes	no	linear

Secondly, improvement of infrastructure in a region or a country leads to a spatial reallocation of labour or capital. This leads to a factor movement approach to infrastructure impacts. Most of the models in this group introduce accessibility as a location factor for employment or private capital. Improvement of network infrastructure leads to an improvement of accessibility which in its turn may lead to an increase of employment or investment. We use the word 'may' on purpose,

*② factor
mobility*

since from a theoretical viewpoint an improvement of accessibility may also lead to a decrease of employment in a region. This may be the case when a local industry, formerly sheltered by isolation, cannot stand the competition of industries located elsewhere after the improvement of accessibility. However, in empirical research it is an exception when such a negative impact is found (cf. Botham, 1983).

③
interres.
handli

A third way of analyzing the effects of network infrastructure is the trade flow approach. Improvement of infrastructure leads to a reduction of transportation costs and hence to a reorientation of trade patterns. For this purpose one needs a detailed multi-regional model of the impact of infrastructure on transportation costs, as well as estimates of the sensitivity of trade flow parameters to changes in transportation costs. Examples of such models can be found in Amano and Fujita (1970) and Liew and Liew (1985).

3. A Case Study for the Netherlands

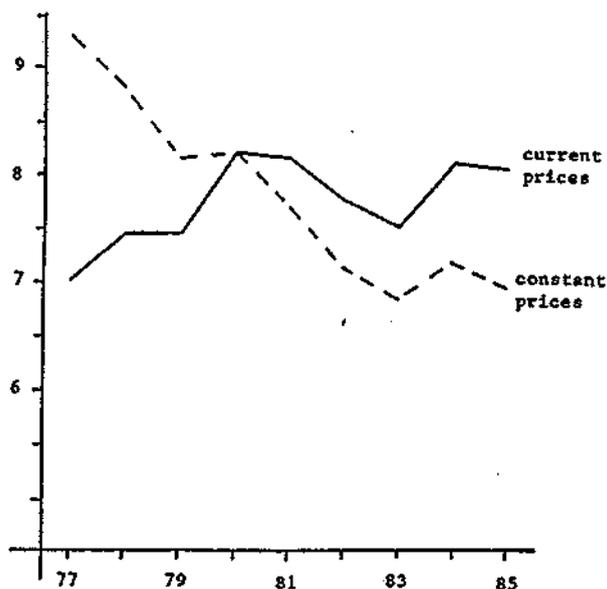
In this section a general review will be given of the development of the investments in the infrastructure network in the Netherlands. The development of the infrastructure categories and the amounts of investments in these categories throughout the last fifteen years will be shown with some common trends in infrastructural development and investment patterns in the Netherlands. It appears that officially published statistical information is not always sufficient as a data source. For various infrastructure categories a deeper investigation of raw data - and some minor estimations - had to be made in order to trace the total direct and indirect employment effects of infrastructure investments in the Netherlands in the year 1985.

3.1 General evolution of infrastructure investments

In the Netherlands nearly 80 % of the total expenditure in infrastructure is public investment, of which some 75 % is invested by lower governments. The projects not financed by the government are mostly semi-state company projects such as energy-supply projects.

The total amount of infrastructure investments in the Netherlands rose sharply after the Second World War. The expenditures needed to restore the war damage were not yet completed, when a great part of the south-west of the country was flooded in 1953. To defend the nation against the sea an extensive system of walls and dikes was initiated, the so-called Deltaplan. These works were finished only recently. The economic upswing in the sixties made huge investments in public infrastructure not only necessary but also possible. In the seventies it became clear that growth has its limits. The saturation point is reached and the financial position of the government could not bear any more high infrastructural investments. Figure 1 shows over the period 1977-1985 that, although the investment in the civil engineering works

Figure 1:
INVESTMENTS IN CIVIL ENGINEERING WORKS IN THE NETHERLANDS
IN CURRENT PRICES AND CONSTANT PRICES OF 1980 FOR THE
PERIOD 1977-1985 (IN BILLION DUTCH GUILDERS)



in current prices rose slightly, the investments in constant prices of 1980 demonstrates a sharp decline (from 9.0 billion in 1977 towards 6.9 billion in 1985). As a share of the national production, the decline is even more pronounced.

3.2 Common trends in the growth path investments in various infrastructure categories

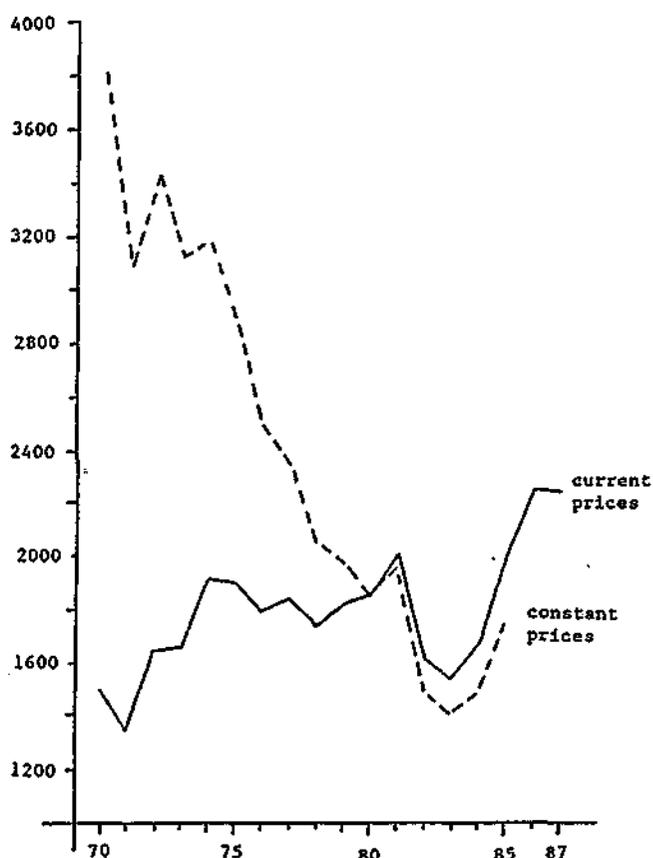
The first common trend in the development of most infrastructure categories with a network structure is a growth in terms of the length of the total network in the sixties and early seventies. After this period there is a tendency that the length of the network remains constant, but that the capacity of the existing links increases. For instance, in the early period the total amount of miles of highway rose rather fast, whilst in the latter period there is a tendency for growth to take place mainly in the form of an increase in the number of lanes on the highways. In the period 1970-1988 the total amount of travel miles in the Netherlands doubled, so that the need for a further increase of the road capacity is clear. There are two infrastructure categories with a network structure that demonstrate different development patterns, i.e., waterways and railroads. Both exhibit a declining network in the sixties and seventies because of the closure of unremunerative goods-lines. Remarkable is that the railroad network expands again in the eighties due to the construction of new commuter lines in or into the metropolitan area 'the Randstad'.

It is rather difficult to trace the yearly investments of certain infrastructure categories over a longer period of time. Specific problems arise when different governments (e.g., local, regional or national) subsidize each others investments. For example, the State subsidizes road investments of the provinces which in their turn

subsidize local road investments. This problem does not arise when there is only one prime investor, such as the railroad company, the telephone company and the energy-supply companies.

The investment pattern of the electricity-supply company (see Figure 2) is a typical example of the pattern which can be observed for

Figure 2:
INVESTMENT PATTERN ELECTRICITY COMPANIES IN THE NETHERLANDS
IN CURRENT PRICES AND CONSTANT PRICES 1980 FOR THE PERIOD
1970-1987 (IN MILLION DUTCH GUILDERS)



most infrastructure categories. There is a tendency of a small rise of the amounts of investment in current prices but, on the other hand there is a rather strong decline in constant prices of 1980. Again the railroads show a rather different pattern. Both current prices as well as constant prices demonstrate a rising tendency. This is due to the government policy to stimulate public transport systems as a substitute for private car ownership. This reorientation of investment policy away

from the road system towards more advanced railway systems can be observed in several other European countries (cf. E.C.M.T., 1988). The European railway system is showing signs of a logistic saturation path for its conventional infrastructure, but is - in view of high speed railway transportation - certainly not at the end of its life cycle as is sometimes believed (cf. Andersson and Batten, 1988).

3.3 Direct and indirect employment effects

In this section the direct and indirect employment effects of the investments in the different infrastructure categories are put together to provide an overview of the total employment effects (excluding programme effects) of infrastructure investments in the Netherlands in 1985. For each category the direct and indirect employment effects per million of investment are calculated. The direct employment effect per million investment varied from 5.5 towards 9.0 manyear. The indirect employment effect ranged from 3.5 towards 5.4 manyear. It was almost impossible to calculate figures for the rather new infrastructure categories of 'Information control and Knowledge development'. The assessment of all figures is presented in Table 2.

Obviously, the figures on indirect employment are most difficult to obtain. They can be computed in principle by means of employment multipliers generated in the context of input-output analysis. However, an input-output matrix with this degree of sectoral detail is not available. Therefore the indirect employment effects had to be estimated on the basis of raw data on the input structure of various segments of the construction sector.

Altogether, with a total investment in infrastructure of roughly 9.2 billion Dutch guilders, nearly 88.000 manyears were involved. This implies roughly that an extra investment of about 105.000 guilders in

Table 2:
**INVESTMENTS IN ECONOMIC INFRASTRUCTURE AND THE DIRECT AND
 INDIRECT EMPLOYMENT EFFECTS (1985)**

Category	Investment	Employment	
		Direct	Indirect
TRANSPORTATION			
roads	2.600	14.300	12.740
railroads	585	3.510*	2.106*
waterways	130	1.040	624
airports	95	570	342
harbours	164	966	573
information transmission	978	4.172	2.503
pipelines	7	42	23
WATER AND ENERGY SUPPLY			
water supply	419	2.514*	1.466*
natural gas supply	429	3.432	2.145
electricity supply	1.990	11.110	5.000
district heating	290	1.619	730
WATER CONTROL SYSTEMS			
water quantity control	132	∫3.590	∫2.166
water quality control	487		
CITY STRUCTURE			
sewage	460*	3.640	2.116
industrial sites	51*	306	183
waste disposal	15*	90*	60*
urban lay-out	nn	nn	nn
LAND (RE)STRUCTURING PROJECTS			
new land	∫370	∫2.479	∫1.480
land restructuring			
TOTAL	9.202	53.380	34.257

* = estimation
 nn = figures unknown

infrastructure would create a new job. It must be admitted that the volume of labour created by infrastructure is relatively small compared to the total number of unemployed (about 500.000 persons). Nevertheless, an increase of government expenditure in this direction would be a welcome contribution to the decrease of unemployment. Such an increase of public investment may also have negative effects on employment in the private sector, however. Crowding out at the capital market may lead to a decrease of private investments, e.g. due to higher interest rates. One must be aware that there may also be an opposite effect of public investments on private investments, however, i.e., when spin-off effects occur. Such effects will be discussed in the next section.

Open

3.4 Spin-off effects of infrastructure

The empirical analysis of spin-off effects of infrastructure is a difficult task. As an example of the problems one usually encounters, we discuss the results of a study on the impacts of investments in telecommunication infrastructure on the Dutch economy. For this impact study, a multisectoral macro-economic model has been used (SECMON). See Driehuis (1987) for a description of the main features of the model. Schrijver and Van Westrenen (1987) present simulation results of a dfl. 500 million increase in yearly investments in communication infrastructure during a five year period. Six different types of effects are distinguished:

1. An exogenous investment impulse in infrastructure leads to an increase in domestic production and employment because of input-output relationships. A countervailing effect is that the rate of interest rises, which leads to a decrease in other investments.
2. A change in consumption patterns occurs (more videotex, less leisure activities), which has differential effects on employment in the various sectors.
3. Improved telecommunication leads to an increase of intermediate deliveries of this sector to other sectors.
4. An increase in telecommunication infrastructure leads to a higher labour productivity. This results in a combination of a price decrease, higher production and less employment.
5. In a similar way one may also expect a higher capital productivity, which leads to a decrease in prices and investments, and an increase in production.
6. The price decrease mentioned in 4 and 5 implies also increased competitiveness at the international market, so that export increase.

Model simulations show that the six effects are very different in size and sign. As far as the employment impact is concerned, the largest effects are the labour productivity effect (4) which is negative, and the export effect (6) which is positive. The overall effect on employment of the infrastructure impulse is scarcely larger than zero. However, the effect on the aggregate production level is clearly larger than zero (a yearly increase of about 0.5 %, the export effect being the dominant component).

In the simulations, the situation in the rest of the world is assumed to be constant. If there would be similar investment programs in the other countries, the effects on the Dutch economy would be clearly smaller. In that case the Dutch infrastructure program would only help to maintain the existing market shares: the export effect would be zero.

It is helpful to analyse this result in terms of generative versus distributive growth. Distributive growth occurs when a region grows at the expense of other regions. Generative growth occurs when the overall system of regions grows. The present simulation results suggest that a considerable part of the positive effect on production in the Dutch economy is in fact a redistribution from elsewhere. This conclusion holds true at the national level. At the regional level an even larger share of the total effect would consist of redistribution effects.

Although SECMON is a well-developed economic model, it needs several additional assumptions in order to arrive at the simulation results. It seems that the simulation results depend as much (or even more) on these additional assumptions as on the parameters of the SECMON model. For example, additional assumptions are needed on changes in consumption patterns, input-output coefficients, labour productivity

and export growth in order to use the SECMON model for simulating the employment impact of the investment programme. The assumptions have to be made at an ad-hoc basis, which underlines how difficult it is to generate the spin-offs of specific infrastructure investments.

4. Concluding remarks.

*Causality -
causal. > prob.*

Infrastructure is an indispensable factor for economic development. Yet its role is often poorly understood. A major problem concerns causality: almost all modelling approaches assume that regional development follows infrastructure improvement. The reverse may be equally true, however, as was already pointed out by Hirschman (1958). Thus, correlations between the two elements say nothing about the effectiveness of infrastructure policies as a tool for regional development.

*also may
= prob. ?*

There are clear decreasing returns to scale in infrastructure. Adding another highway in an already well developed region will not give a large economic response. Investments in new types of infrastructure may have much larger effects.

*KT:
dir
indir*

Direct and indirect employment effects of infrastructure investments may be quite large, but they only exist in the short run. Input-output analysis is a suitable tool for this purpose, but standard input-output tables are not always directly applicable, since technical coefficients may be rather different for particular infrastructure projects.

*LT:
spin-offs*

Spin-off effects of infrastructure take place in the long run. Some modelling approaches have been discussed in this paper. It is seldomly recognized that spin-off effects of network infrastructure may

be negative for some of the regions concerned. For instance, negative effects may occur when domestic producers cannot stand the competition from other producers after an increase in accessibility.

Many regional studies do not clearly distinguish between distributive and generative effects of infrastructure. In such studies substantial employment effects may be found, but these may be mainly distributive by nature. By neglecting the jobs lost in other regions, one may easily arrive at exaggerated effects of infrastructure on employment.

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