Indirect Economic Effects of a Rail Link Along the Afsluitdijk

W.E. Romp and J. Oosterhaven

SOM-theme C: Coordination and growth in economies

Abstract
New transport infrastructure has a myriad of short and long run effects. The effects on population and economic activity are most difficult to estimate. This paper introduces three different models to estimate the impacts of new infrastructure on labour supply and demand, and carefully explains how the interaction between the models and their outcomes should be handled. The methodology is applied to a proposal for a magnetic levitation rail system from Groningen across the Afsluitdijk to Schiphol. This benchmark it is then used to derive a qualitative assessment for different trajectories and slower type of new rail infrastructure all using the Afsluitdijk. Finally, this paper discusses the remarkable differences in the quantitative outcomes with a comparable Maglev proposal that does not use the Afsluitdijk but runs through the polders of the former Zuiderzee.
PREFACE

This report describes the indirect economic effects of a rail link along the Afsluitdijk between the cities of Groningen and Amsterdam. This investigation is commissioned by Kop en Munt (Economic Development Initiative for the North of North-Holland) with the support of the Province of North-Holland and Novem (Netherlands’ Initiative for Energy and the Environment).

In a brainstorm session at Schagen, March 14, 2001, representatives of Kop en Munt, Duurzaam Noord, Ove Arup & Partners, Holland Railconsult and University of Groningen pre-selected possible trajectories and modes of transport. In this report only one of the possible variants will be studied quantitatively, while five others will be compared with this sixth only in qualitative terms.

It was decided that the main variant would be a Magnetic Levitation (Maglev) train. The reason for choosing the Maglev system as an example of a missing rail link in the Northwest of the Netherlands was based on the experience from an elaborate study into the indirect effects of parallel missing rail links through Flevoland, part of the former Zuiderzee (Elhorst et al. 2000). Maximum indirect economic effects are expected for the Maglev variant, which makes it easier to derive qualitative, comparative results for the other five variants.

Without the models developed for the earlier study the present study would not have been possible. For the present study again, especially, Thijs Knaap and Paul Elhorst were very helpful.

The authors, Groningen, January 2002
1 INTRODUCTION

In 2001, the Dutch government will decide on a major infrastructure project involving the construction of a new or better rail link between Amsterdam/Schiphol and the North of the country. Amsterdam is part of the Randstad region, the economic core of the Netherlands. By contrast, the North is considered an economically lagging region. Attempts to stimulate the northern economy with infrastructure, investment premiums and relocation of central government offices have not solved the problem yet; the unemployment rate is still relatively high and part of the once-relocated government offices returned to the Randstad (see Oosterhaven, 1996, for an overview).

The construction of a new rail link between the Randstad and the North, especially one with higher velocities, is thought to help solve the economic problems in the North as part of the new policy program “Kompas voor het Noorden”. Arguments in favour of this link focus on its indirect economic effects. Six possible variants of this rail link have been studied already (see Elhorst et al. 2000). All trajectories took the southern route through the Flevoland polders (the former Zuiderzee) and from there on either over a short planned future track via Zwolle to Groningen (the Hanzeline) or over a long entirely new track via Emmeloord, Heerenveen and Drachten to Groningen (the Zuiderzeeline).

Alternatives along the northern route using the Afsluitdijk have not yet been studied thoroughly. This alternative was rejected in an early stage, mainly because of environmental reasons (V&W, 2000). However, besides connecting the Northern Netherlands with the Randstad, this alternative also runs through the “Kop van Noord-Holland”, a region having economic problems of its own. Hence, this alternative may not only boost the economy of the northern Netherlands but also that of the North of the Province of North-Holland. For this reason, this report will study the indirect economic effects of this northern alternative.

In section 2, the trajectory of six possible alternatives across the Afsluitdijk will be described, and distances and travel times will be given. Section 3 gives a description of the models used and the results for the indirect economic effects of the
magnetic levitation (Maglev) variant through the West of North-Holland, chosen for further investigation. Section 4 gives a qualitative comparison between the indirect economic effects of all six possible Afsluitdijk variants using the chosen western Maglev variant as a benchmark. In section 5 the indirect economic effects of this Afsluitdijk variant are compared with the indirect economic effects of the comparable Zuiderzeeline variant. Section 6 concludes.
2 TRAJECTORIES OF THE AFSLUITDIJK VARIANTS

2.1 Description of all six variants

This section gives a description of six of the possible rail connections between Groningen and Schiphol airport along the Afsluitdijk. Two different main trajectories can be identified, a route that crosses through the West of North-Holland, with a main station in Alkmaar, and a route that crosses through the East of North-Holland, stopping in Purmerend and Hoorn. Within these two spatial variants three types of transport techniques may be used: an intercity railroad (IC), a high-speed railroad (HS) or a Maglev system (ML).

Each of these three types of transportation has its own characteristics. The IC-variants are relatively slow (a maximum of 160 km/h) and will mainly use existing tracks. The HS-variants are faster (about 300 km/h) but need modifications of existing tracks to reach higher speeds, while new tracks should be relatively straight with few stops in order to reach the maximum speed. A problem of these two systems is that they need relatively long distances to reach their maximum speed and to slow down again. Especially for the high-speed variant this means that only few stops should be planned in order not to increase the overall travel time too much.

The ML-variant is the fastest of the three (over 400 km/h) and is capable of fast acceleration and deceleration. Moreover it allows for sharper curves, enabling a better bundling with existing infrastructure. This makes it suitable for fast short as well as long distance transportation. A major disadvantage of the Maglev, however, is its high investment cost since existing regular rail infrastructure can not be used.

Summarising, six combinations of trajectory and technique will be studied. The six variants are graphically shown in figure 1 (the stations printed *cursive* define further differences in trajectories):

- Intercity West (ICW), with mainstops at Schiphol, Amsterdam-Sloterdijk, Zaandam, Alkmaar, Schagen, Leeuwarden and Groningen, and intermediate slow
trains stopping at more stations such as Heerhugowaard, Harlingen and
_Buitenpost_.

− High-speed West (HSW), with mainstops at Schiphol, Amsterdam-Sloterdijk,
  Zaandam, Alkmaar, Leeuwarden and Groningen, and with intermediate slow
  trains stopping at more stations such as Heerhugowaard, _Wieringerwerf_,
  Harlingen and _Buitenpost_.

− Magnetic-levitation West (MLW), with only stops at Schiphol, Amsterdam-
  Sloterdijk, Zaandam, Alkmaar, Leeuwarden, _Drachten_ and Groningen.

− Intercity East (ICE), with mainstops at Schiphol, Amsterdam-Sloterdijk,
  Zaandam, Purmerend, Hoorn, Leeuwarden and Groningen, and with intermediate
  slow trains stopping at more stations such as _Wieringerwerf_, Harlingen and
  _Buitenpost_.

− High-speed East (HSE), with mainstops in Schiphol, Amsterdam-Sloterdijk,
  Zaandam, Purmerend, Leeuwarden and Groningen, and with intermediate slow
  train stopping at more stations such as Hoorn, _Wieringerwerf_, Harlingen and
  _Buitenpost_.

− Magnetic-levitation East (MLE), with only stops at Schiphol, Amsterdam-
  Sloterdijk, Zaandam, Purmerend, Hoorn, Leeuwarden, _Drachten_ and Groningen.

The detailed choice of the above stations and subroutes is determined by a qualitative
cost-benefit evaluation between the possibility of use of existing track (= benefit),
picking up extra passengers (= benefit) and extra travel time for other passengers (=
cost). For example, the HS- and IC-variants in Friesland are not lead via Drachten, as
this would require unnecessary large investments in entirely new tracks between
Leeuwarden and Groningen compared to just upgrading the existing tracks via
Buitenpost. Furthermore, the Western IC- and HS-variant are assumed to follow a
different route in the North of North-Holland. The ICW-variant passes through
Schagen in order to pick up passenger from Den Helder and to use the maximum of
existing tracks, whereas the HSW-variant passes through Wieringerwerf in order the
reach the maximum speed on the longer distances.
Figure 1. Trajectories of the six Afsluitdijk-variants and the Zuiderzeeline
Of these six variants the MLW-variant is chosen as the main variant, which will be studied quantitatively. The reason is that thus Alkmaar (directly) and Den Helder (indirectly) are being served, offering a better opportunity of independent economic development, whereas serving Hoorn and Purmerend would have resulted, relatively more, in accommodating commuters’ trips. To create a benchmark the magnetic-levitation technique is chosen, as the ML-variant is certain to produce the largest effects on the working population and the employment in the various regions (compare Elhorst et al. 2000, in the case of the Zuiderzeeline variants).

2.2 Detailed description of the western Maglev variant

This section describes the MLW variant in more detail. Also a detailed timetable is provided.

The route is planned from Groningen via Drachten, Leeuwarden, Alkmaar, Zaandam, Amsterdam-Sloterdijk to Schiphol Airport. The reason to stop in the larger cities of Leeuwarden, Alkmaar and Zaandam is evident. The passenger potential of these cities is relatively large (see table 1). Not stopping would clearly hamper the profitability of the line.

The decision to stop at Drachten is based on the fact that Drachten does not yet have a railway station. The passenger potential of a ML-station in Drachten is about 130 thousand people. These people are offered an alternative for travelling by car, without the probability of substitution with existing railroads. The decision not to assume a ML-station in Harlingen is based on opposite reasons. It has already a (regular) rail connection with Leeuwarden, whereas its passenger potential is small. Stopping would increase the travel time between other stations more or less unnecessarily.

The choice for Schiphol Airport as the terminal station and not Amsterdam CS is important. The Maglev is assumed to pass Amsterdam along the western side and to stop at Amsterdam-Sloterdijk instead of Amsterdam-CS. One reason is that the

---

1 Calculated as the total population of the surrounding municipalities within 10 kilometres. Where a municipality is within 10 kilometres of two or more stations its population was added to the most accessible station.
Sloterdijk/Schiphol combination promises far more passengers than just Amsterdam CS. Another reason is the comparability and data consistency with the Zuiderzeeline study (Elhorst et al. 2000).

Table 1. Passenger potential

<table>
<thead>
<tr>
<th>Station</th>
<th>Potential</th>
<th>Station</th>
<th>Potential</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schiphol</td>
<td>472,567</td>
<td>Schagen(^2)</td>
<td>136,201</td>
</tr>
<tr>
<td>A’dam-Sloterdijk</td>
<td>430,468</td>
<td>Harlingen(^2)</td>
<td>47,246</td>
</tr>
<tr>
<td>Amsterdam CS</td>
<td>382,914</td>
<td>Leeuwarden</td>
<td>191,071</td>
</tr>
<tr>
<td>Zaandam</td>
<td>282,115</td>
<td>Drachten</td>
<td>128,915</td>
</tr>
<tr>
<td>Alkmaar</td>
<td>284,793</td>
<td>Groningen</td>
<td>365,982</td>
</tr>
</tbody>
</table>

A final point of discussion is the decision not to pass by Schagen and Castricum. This decision is based on the following evaluation:

On the one hand, an extra station at Schagen will increase the distance by 10 kilometres. This extra distance and the extra time necessary for accelerating, decelerating and stopping will give an extra travel time of 7 minutes. This extra travel time applies to the trips to and from a relevant population around the four stations in the North of about 733 thousand (see table 1).

On the other hand, an extra station at Schagen will reduce travel times for passengers to and from the North of North-Holland. Their alternative boarding station would be Alkmaar. This will increase their travel time by about 17 minutes, either by regular existing rail (from Den Helder, Anna Paulowna or Schagen) or by regular car (from all of the “Kop van Noord-Holland”). This time gain applies to the trips to and from a population of about 136 thousand.

The percentage increase in travel time to and from the northern stations is smaller than the percentage reduction to and from the “Kop van Noord-Holland”, but

\(^2\) The values for Schagen and Harlingen are calculated as marginal values, i.e. including these stations will increase the passenger potential of the line with the given number. The total passenger potentials of Schagen and Harlingen are a little higher since their service areas overlap with the areas of Alkmaar and Leeuwarden. The values for Amsterdam-CS and Amsterdam-Sloterdijk are the numbers of passengers that prefer that station, the total passenger potential of either Sloterdijk or CS is the sum of both passenger potentials.
weighted with the population at hand there is a considerable difference in aggregate timeloss and timegain in favour of not stopping in Schagen. A comparable type of reasoning applies to the decision not to pass by Castricum, but there the difference in timegains and timelosses is far larger than in the case of Schagen, which made the decision an easy one.

The MLW-trajectory thus chosen runs along about 205 kilometre, with the following route and stations (see figure 1, panel 1):

- Groningen headstation, along the A7 till the crossing with the A31
- Drachten new station, along the A31 and along the rail from Groningen till
- Leeuwarden headstation, along the rail to Harlingen till the crossing with the A31
- along the A31 and the A7 till Middenmeer,
- along the N242 till the crossing with the rail from Schagen, along that rail till
- Alkmaar headstation, outside Alkmaar towards and over the A9,
- along the A9 till the crossing with the rail from Castricum, along that rail till
- Zaandam station, along that rail till
- Amsterdam-Sloterdijk station, along that rail till Schiphol Airport station

The schedule will be of a Metro type, i.e. six times per hour stopping in all five intermediate stations. This results in minimal waiting times at the intermediate stations and gives a total travel time Groningen-Schiphol of about 61 minutes (see table 2 for details).

Table 2. Distance and travel time of western Maglev variant (MLW)

<table>
<thead>
<tr>
<th>From:</th>
<th>To:</th>
<th>Distance (km.)</th>
<th>Travel time (min.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Schiphol</td>
<td>A’dam-Sloterdijk</td>
<td>12</td>
<td>7</td>
</tr>
<tr>
<td>A’dam-Sloterdijk</td>
<td>Zaandam</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>Zaandam</td>
<td>Alkmaar</td>
<td>26</td>
<td>10</td>
</tr>
<tr>
<td>Alkmaar</td>
<td>Leeuwarden</td>
<td>105</td>
<td>21</td>
</tr>
<tr>
<td>Leeuwarden</td>
<td>Drachten</td>
<td>26</td>
<td>9</td>
</tr>
<tr>
<td>Drachten</td>
<td>Groningen</td>
<td>31</td>
<td>7</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>207</td>
<td>61</td>
</tr>
</tbody>
</table>

3 This is slower than the 48 minutes of a magnetic levitation along the Afsluitdijk in V&W (2000). This is caused by different stations (A’dam-Sloterdijk and Schiphol instead of A’dam-


3 INDIRECT ECONOMIC EFFECTS

3.1 Introduction

There are two main indirect economic effects and two derived indirect economic effects, which will be estimated here (see figure 2). The two main effects both start with the exogenous changes in travel time, the derivation of which is discussed in the appendix.

Figure 2. The relationship between the different indirect economic effects.

The first main effect is related to the commuting behaviour of workers. With a fast rail link, commuters can choose dwellings with more room at lower prices with more green in the country-side further out, keeping their current jobs (housing migration). This will increase the demand for locally produced goods and services as a result of which a multiplier process is started that lead to subsequent shifts in regional production and employment (consumption induced employment).

The second main effect is related to changes in economic activity that is brought about by transport cost reductions that make both imports and exports cheaper. Both consumers and producers will buy goods and services from firms and regions further

CS and Harlingen) and a longer trajectory to reach Schiphol. This choice of Schiphol as an endstation makes this trajectory better comparable to the MZM-variant of the Zuiderzeeline in Elhorst (et al. 2000) with a travel time of 59 minutes.
away, while producers will sell their outputs to markets further away. Both consumers and producers can thus choose from a wider variety of suppliers, thus fitting their production and consumption needs better. The resulting shifts in economic activity (transport induced employment) will then induce labour supply to move with the jobs (labour migration).

In section 3.2 the type of models used will be discussed in more detail as well as the way in which the effects are calculated. The latter is done sequentially such that the endogenous outcomes of the first model serve as the exogenous input for the next model in a consistent way, without double counting the impacts. Section 3.3 then presents the empirical outcomes for the MLW-variant.

3.2 The models used and the effects measured

3.2.1 Housing migration

Reducing travel times affects the commuting behaviour of workers. With improved transport opportunities they can relocate to regions that allow for more space in and around the worker’s own house. Research shows that a majority of workers prefer this (VROM, 2000, p. 5; Sijtsma et al. 1996). Other research shows that the average commuting time does not change over time, while the distribution around the commuting travel time is relatively stable. This implies that the percentage commuters travelling a certain amount of time per day may be assumed constant.

These two results are used in a commuter location model that allocates workers around fixed regions of occupation (see further, Elhorst et al. 2000). The employment per region is determined outside this model. The workers are located in rings of regions further and further out, around the region of employment using a commuting travel time distribution table. This table gives the percentage of workers travelling in different time classes. The model distinguishes three modes of transportation: car, public transport and slow transport. The reason is that large differences in shares exist between different time classes for each mode. In lower time classes, the share of the slow transport is relatively large. In the higher time classes the train and car dominate. Beside different modes of transportation, the model also differentiates between the
four largest cities, regions with a railway station and regions without a railway station. This distinction is made because the commuting behaviour of people travelling to these different regions differs, mostly for reasons of congestion and accessibility.

The model allocates the workers for 548 municipalities for the reference-alternative and a project-variant (in this case the MLW-variant). The difference between the two is a measure of the (avoided) migration caused by the project-variant. It should be noted that an increase in the working population of a region does not imply that workers actually have to immigrate from another region. Most of the shift may be caused by avoided emigration, already accounted for in the reference-alternative. For example, students from Leeuwarden entering the job market will no longer move to e.g. Amsterdam, but will instead commute with the Maglev to Amsterdam, thus increasing the working population in Leeuwarden and decreasing that of Amsterdam vis-à-vis the reference-alternative.

3.2.2 Employment due to travel time reductions

A fast rail link implies reductions of travel times between several regions, both along and further out from the end of the line, which generally leads to lower prices for products sold on markets further away. Thus, exports become cheaper, which leads to higher output and employment (a forward linkage). On its turn this leads to a larger demand for intermediate inputs and a larger consumption demand (two backward linkages). Besides, a reduction of transport cost leads to lower prices for products from regions further away. Thus, imports become cheaper too and local producers that use these imports can reduce their output prices and sell more (again a forward linkage). However, cheaper imports also substitute for more expensive locally produced goods, which may lead to a reduction of production and employment (a negative backward linkage).

The infrastructural effects on production and location decisions of companies will be complex. To estimate these effects a spatial computable general equilibrium model (SCGE model) is used (see further, Knaap and Oosterhaven, 2001). This model explicitly reckons with the travel times and costs on which companies decide where,
what and how much to produce. Trading relations between production sectors in different regions are estimated on bi-regional input-output data (RUG/CBS, 1999). The model distinguishes 14 different sectors and 548 regions (municipalities).

This first Dutch SCGE model gives a forecast of the production and employment per municipality for the reference-alternative and any project-variant (in this case the MLW-variant). The difference between the two is used as an estimation of the travel cost induced employment effects.

3.2.3 Labour migration

The commuter location model gives migration forecasts as a result from reduced travel times with a given employment per region. The SCGE model estimates the changes in employment per region. These employment effects of course also affect the size of the regional working population. The first effect has been labelled housing migration and the second effect is here labelled labour migration. The difference between the two lies in the migration motive; housing migration results from changes in travel times, labour migration results from changes in employment opportunities.

Labour migration can also be estimated with the commuter location model. To determine housing migration, the employment per region in the reference-alternative was used; here we use the change in employment per region due to the MLW-variant calculated with the SCGE model. The total migration of workers as a result of the new rail link is the sum of both housing migration and labour migration.

3.2.4 Consumption-induced employment

The total migration of workers induces a regional redistribution of purchasing power within the Netherlands. A new rail link will also increase the market reach of the top-services (like premier league football, opera etc.). This will reduce the consumption-induced employment in regions with a less varied supply of services. This second effect, the increase in service areas is already incorporated in the production shifts of the spatial CGE model. This section treats with employment effect of the regional redistribution of purchasing power.
This effect is not estimated at the level of the 548 municipalities as were the three earlier effects, but at level of the 40 so-called corop-regions with the aid of a 40x40 employment multiplier matrix of working migrants. This matrix is based on the 14 bi-regional input-output tables of the 12 provinces of the Netherlands and the two mainports, Groot-Rijnmond (corop 29) and Groot-Amsterdam/NZKG (corops 20-23) (RUG/CBS, 1999, Eding et al. 1999; see Elhorst et al. 2000, for details on the construction of the multiplier matrix).

3.2.5 Empirical results for the western Maglev variant

Table 3 gives a quantitative summary of the four effects, with an aggregation of the corop-regions that are least affected. The numbers between brackets indicate the %-effect relative to, respectively, the total potential working population and the total number of jobs. Figure 3 gives a view of the spatial distribution of the effects for all 40 corop-regions. Finally, figure 4 presents a spatial view of the two main indirect effects at the municipality level within the Province of North-Holland (NH). More detailed results can be given, but in view of the uncertainty involved in these kind of estimations this is not justified.

Table 3 and figure 3 show that the main housing migration effects occur in the Alkmaar region and in Friesland. Besides a greater accessibility as regards the employment concentrations in the south of North-Holland, the Frisian housing market also strengthens its accessibility as regards the employment in the city of Groningen. The latter occurs at the cost of the rest of the province of Groningen and northern Drenthe. The improvement of the accessibility of the Alkmaar region mainly regards the Amsterdam and Schiphol employment concentrations, and occurs at the cost of a deterioration of the relative accessibility of housing in the city of Amsterdam and regions further to the south, such as Utrecht and South-Holland. Thus the main housing migration impacts occur along the middle sections of the MLW-variant.

The main travel cost induced employment effects, however, occur at the ends of the new line, where the larger employment concentrations get the largest improvement in accessibility as regards the larger population and employment concentrations. Although both consumers and producers in Groningen will buy more
in the northern wing of the Randstad, the positive effect on competitiveness dominates. Producers in Groningen and also in Friesland will get better access to the largest market in the Netherlands (the Randstad region) and that gain far outweighs the loss of part of their local customers to firms in the Randstad. The effects at the other end of the line, within the province of North-Holland, are not negligible either. Firms in NH not only will get better access to the smaller markets in the northern Netherlands, but they will also get better access to each other’s markets.

These gains in absolute competitiveness along the line, of course, result in a loss of relative competitiveness of firms in the rest of the Netherlands. They will loose market shares, both in the large market the northern wing of the Randstad, but also in the smaller markets in the northern parts of NH and in the northern Netherlands. These losses will be largest in the regions close by, which have the larger market shares to loose. Hence, we find the larger negative effects in Utrecht and Gelderland, and percentage-wise smaller negative effects in the southern Netherlands. Within the close-by province of South-Holland, the negative effects in the subregions with poor connections via Schiphol just dominate the positive effects in the Rotterdam- and Leiden-regions that have good connections via Schiphol to the MLW-regions. In the case of Rotterdam the good connection relates to the future direct high-speed rail to Schiphol (HSL-Zuid) which is part of the reference-alternative.

The labour migration effects of course largely follow the above employment effects. The main difference is that the (partly avoided) labour migration effects in Groningen and the Amsterdam region are considerably smaller than their employment effects. The reason is that not every labour migrant will want to live in these relatively crowded and expensive employment centres, but will in stead, partly using the MLW, spread out over the surrounding regions. This is why the labour migration effect in the north of North-Holland is +400, whereas its own employment effect is only +100. In the case of Drenthe the difference is even more remarkable. Its own main employment effect is negative due to the loss of its competitiveness, especially with regards to Groningen, whereas its labour migration effect is positive due to the spill-over of labour migrants from Groningen into especially the northern part of this province (see figure 3).
The consumption-induced employment effects of course follow the pattern of total (partly avoided) migration. Naturally, in terms of jobs, the consumption effects are smaller than the number of migrating workers that cause these effects. The spatial pattern is also a little different as consumption expenditure effects spill over into surrounding regions and have a tendency to concentrate in the regions with the relatively larger shopping centres. This is most clear in the case of the Amsterdam-region. It has a negative net migration effect, but due to consumption spillovers from migrants into adjacent regions, it has a positive “shopping” effect. In the Alkmaar- and the greater Zaan-region almost the opposite happens. They receive relative large numbers of migrants, but only capture a relatively small part of their consumption expenditures.

Finally, it is of interest to briefly look at the total migration and total employment effects, which will be the base for the qualitative comparison in the section 4. The total migration of workers is relatively largest for the small Alkmaar region (+5000) and absolutely largest for the Province of Friesland (+7000). To get the impact on total population, the number of working migrants has to be multiplied with the future average household size corrected for double-income earners. Hence, the population effects will be roughly twice as large as the migration numbers in table 3. Clearly, for total population the effects are larger in the middle sections of the new line than at the end of the line. The opposite is the case the impact on total employment. This hold especially for the northern end of the MLW in Groningen and Friesland, but also for its southern end where the largest effects are found in the Amsterdam-region (see also figure 3).
Table 3. Indirect economic effects per region for the western maglev variant (MLW).

<table>
<thead>
<tr>
<th>Region (corop-numbers)</th>
<th>Housing migration</th>
<th>Labour migration</th>
<th>Total(^1) migration</th>
<th>Tr. cost rel. empl.</th>
<th>Consum. rel. empl.</th>
<th>Total(^1) empl.</th>
</tr>
</thead>
<tbody>
<tr>
<td>North of NH (18)</td>
<td>-300 (0.13%)</td>
<td>400 (0.20%)</td>
<td>150</td>
<td>100 (0.09%)</td>
<td>50 (0.05%)</td>
<td>150 (0.14%)</td>
</tr>
<tr>
<td>Alkmaar region (19)</td>
<td>4,400 (2.88%)</td>
<td>700 (0.45%)</td>
<td>5,000</td>
<td>1,000 (1.04%)</td>
<td>700 (0.74%)</td>
<td>1,700 (1.78%)</td>
</tr>
<tr>
<td>Greater Zaan region (20-22)</td>
<td>400 (0.12%)</td>
<td>800 (0.23%)</td>
<td>1,200</td>
<td>800 (0.33%)</td>
<td>200 (0.09%)</td>
<td>1,000 (0.42%)</td>
</tr>
<tr>
<td>Greater Amsterdam (23)</td>
<td>-2,300 (-0.28%)</td>
<td>2,000 (-0.25%)</td>
<td>-250</td>
<td>2,900 (-0.39%)</td>
<td>150 (0.02%)</td>
<td>3,100 (0.41%)</td>
</tr>
<tr>
<td>Groningen (1-3)</td>
<td>-300 (-0.10%)</td>
<td>3,200 (0.92%)</td>
<td>2,900</td>
<td>4,200 (1.78%)</td>
<td>600 (0.24%)</td>
<td>4,800 (2.02%)</td>
</tr>
<tr>
<td>Friesland (4-6)</td>
<td>4,300 (1.09%)</td>
<td>2,600 (0.67%)</td>
<td>7,000</td>
<td>2,600 (1.16%)</td>
<td>1,400 (0.60%)</td>
<td>4,000 (1.75%)</td>
</tr>
<tr>
<td>Drenthe (7-9)</td>
<td>-600 (-0.19%)</td>
<td>150 (-0.05%)</td>
<td>-400</td>
<td>-600 (-0.37%)</td>
<td>-50 (-0.04%)</td>
<td>-700 (-0.40%)</td>
</tr>
<tr>
<td>Overijssel (10-12)</td>
<td>-50 (-0.01%)</td>
<td>-1,700 (-0.24%)</td>
<td>-1,700</td>
<td>-1,900 (-0.44%)</td>
<td>-300 (-0.08%)</td>
<td>-2,200 (-0.52%)</td>
</tr>
<tr>
<td>Gelderland (13-16)</td>
<td>-500 (-0.04%)</td>
<td>-3,800 (-0.31%)</td>
<td>-4,300</td>
<td>-3,600 (-0.41%)</td>
<td>-800 (-0.09%)</td>
<td>-4,400 (-0.50%)</td>
</tr>
<tr>
<td>Flevoland (14)</td>
<td>-700 (-0.26%)</td>
<td>-400 (-0.14%)</td>
<td>-1,100</td>
<td>-500 (-0.34%)</td>
<td>-150 (-0.12%)</td>
<td>-600 (-0.46%)</td>
</tr>
<tr>
<td>Utrecht and Gooi (17+24)</td>
<td>-3,100 (-0.35%)</td>
<td>-1,700 (-0.19%)</td>
<td>-4,800</td>
<td>-2,600 (-0.33%)</td>
<td>-800 (-0.03%)</td>
<td>-3,400 (-0.36%)</td>
</tr>
<tr>
<td>South-Holland (25-30)</td>
<td>-1,200 (-0.05%)</td>
<td>50 (-0.00%)</td>
<td>-1,100</td>
<td>-50 (-0.05%)</td>
<td>-250 (-0.05%)</td>
<td>-300 (-0.05%)</td>
</tr>
<tr>
<td>Southern Netherl. (31-39)</td>
<td>-1,50 (-0.01%)</td>
<td>-2,500 (-0.10%)</td>
<td>-2,600</td>
<td>-2,500 (-0.14%)</td>
<td>-600 (-0.03%)</td>
<td>-3,000 (-0.17%)</td>
</tr>
</tbody>
</table>

\(^1\)Because of rounding off the effects individually, the separate effects do not always add up to the total.
Figure 3. Indirect effects of the MLW-variant per corop-region.
Figure 4. Main indirect effects of the western maglev (MLW) variant in North-Holland.
4 QUALITATIVE COMPARISON OF ALL SIX AFSLUITDIJK VARIANTS

Table 4 contains a qualitative comparison of all six variants for a rail link across the Afsluitdijk distinguished in chapter 2. The scores result from down-scaling the total effects of the MLW-variant with the lower speeds and the different locations of the stations of the other variants. Besides reckoning with speed and trajectory differences, use has been made of the differences between the impacts of comparable variants from the Zuiderzeeline study (i.e. between ZIC, ZHS and MZM in Elhorst et al. 2000). Extrapolating from this experience, however, was not straightforward as the length of the new tracks is quite different. In the case of the Zuiderzeeline IC- and HS-variants, new tracks run over 115 km from Lelystad all the way to Groningen. In the case of the Afsluitdijk new tracks are restricted to 71 km between Harlingen and Hoorn in the case of the eastern variants, and to almost the same distance plus the small 12 km stretch from Alkmaar south along the A9 in the case of the western variants.

This smaller length of new tracks and the consequently smaller time gains dominate the differences between the impacts for the Maglev variants on the one hand and the impacts for the IC and the HS-rail variants on the other hand. For Groningen and Friesland this down-scaling of impacts will be smaller as they benefit more from the new tracks than the regions in the province of North-Holland (NH). Groningen and Friesland still get a faster rail connection to the economically heavy Amsterdam-region, but the regions within North-Holland using the IC- and HS-variants only get a better access to the economically lighter weight Northern Netherlands.
Table 4. Qualitative effects of all six Afsluitdijk variants.

<table>
<thead>
<tr>
<th>Population effects</th>
<th>ICW</th>
<th>HSW</th>
<th>MLW1</th>
<th>ICE</th>
<th>HSE</th>
<th>MLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>North of North-Holland</td>
<td>0</td>
<td>0/+</td>
<td>0</td>
<td>0</td>
<td>0/+</td>
<td>0</td>
</tr>
<tr>
<td>Alkmaar region</td>
<td>0</td>
<td>0/+</td>
<td>++</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hoorn &amp; Purmerend2</td>
<td>0</td>
<td>0</td>
<td>0/+</td>
<td>0</td>
<td>0</td>
<td>++</td>
</tr>
<tr>
<td>Zaanstreek, IJmond &amp; Haarlem</td>
<td>0</td>
<td>0</td>
<td>0/+</td>
<td>0</td>
<td>0/0</td>
<td>0/+</td>
</tr>
<tr>
<td>Greater Amsterdam</td>
<td>0</td>
<td>-</td>
<td>0</td>
<td>0</td>
<td>0/0</td>
<td>-</td>
</tr>
<tr>
<td>Groningen &amp; Friesland</td>
<td>+</td>
<td>++</td>
<td>+++</td>
<td>+</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>Rest of the Netherlands</td>
<td>-</td>
<td>-</td>
<td>-----</td>
<td>-</td>
<td>-</td>
<td>-----</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Employment effects</th>
<th>ICW</th>
<th>HSW</th>
<th>MLW1</th>
<th>ICE</th>
<th>HSE</th>
<th>MLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>North of North-Holland</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Alkmaar region</td>
<td>0</td>
<td>0</td>
<td>0/0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hoorn &amp; Purmerend2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Zaanstreek, IJmond &amp; Haarlem</td>
<td>0</td>
<td>0</td>
<td>0/0</td>
<td>0</td>
<td>0</td>
<td>0/0</td>
</tr>
<tr>
<td>Greater Amsterdam</td>
<td>0</td>
<td>0/0</td>
<td>+</td>
<td>0</td>
<td>0/0</td>
<td>+</td>
</tr>
<tr>
<td>Groningen &amp; Friesland</td>
<td>+</td>
<td>++</td>
<td>+++</td>
<td>+</td>
<td>++</td>
<td>+++</td>
</tr>
<tr>
<td>Rest of the Netherlands</td>
<td>-</td>
<td>-</td>
<td>-----</td>
<td>-</td>
<td>-</td>
<td>-----</td>
</tr>
</tbody>
</table>

1 The results in this column correspond to table 3. The other columns are intrapolated.
2 Hoorn & Purmerend are taken from, respectively, the corop-regions 18 & 23 (see table 3).

The exceptions to this general finding are only few. In the case of the western route we expect the HS-variant to still have slight positive population effects in the case of the North of North-Holland and the Alkmaar-region due to the better access of their housing markets for commuters from the Amsterdam area. For the eastern HS-variant, this of course only applies to the North of North-Holland and not to the Alkmaar region. Furthermore, these small positive effects only hold for population and not for employment. In the case of employment only the Amsterdam-region profits measurably from the better access to northern firms and consumers, both because of the own size of its economy and because of the variety of the supply of its services.

Finally, there will of course be important differences between the western and the eastern variants. These are most clear when the two Maglev variants are compared. The MLE will induce effects in the Hoorn/Purmerend region, whereas the MLW will induce effects in the Alkmaar region. In the case of housing and labour migration, the
effects will be more of less comparable in size with +5000 for the Alkmaar-region (see table 3). In the case of employment, the effects will be smaller and less comparable. We do not expect sizeable employment effects for Hoorn/Purmerend and relatively small effects for the Alkmaar region (+1700, see table 3). In the case of the slower variants, there will be no significant differences between the eastern and the western variants within North-Holland since mainly existing tracks will be used.
As already noted in the introduction other alternatives exist for a rail link between the Randstad and the North. Two of them were studied quantitatively in Elhorst et al (2000): the Hanzeline, and the Zuiderzeeline. On both trajectories different types of transport and service concepts are possible. Elhorst et al. (2000) forecasted the largest indirect effects for the so-called MZM-variant. This variant runs over a long entirely new track from Schiphol via Almere, Lelystad, Emmeloord, Heerenveen, Drachten to Groningen (see figure 1), with in total seven stops (including terminal stations). This feature and the almost equal travel time from Schiphol to Groningen (59 minutes) makes this MZM-variant through Flevoland the most comparable with the MLW-variant along the Afsluitdijk.

In table 5 the total indirect effects and the differences of the Afsluitdijk MLW-variant and the Zuiderzee-line MZM-variant are shown. As could be expected, the MLW-variant is more positive for the regions in the province of North-Holland. They now present a possible housing location for employees from the Randstad, while the gain in competitiveness results in increased production and employment. Especially the Alkmaar region benefits from a fast connection with Amsterdam resulting in an increase of the working population of 5,000 instead of a loss of 350 with the MZM-variant. The employment raises to 1,700, whereas in the MZM-variant there is a loss of also 350.

More surprising is the gain in the northern part of the Netherlands. Although the Zuiderzeeline-MZM also connects these regions with the Randstad better, this region as a whole gains more by the implementation of the Afsluitdijk-MLW. The province of Groningen for instance attracts 2,600 more employees and 1,500 more jobs than with the Zuiderzeeline-MZM. Even for the province of Drenthe, which is not connected directly by the Afsluitdijk-MLW, the result is clear-cut; this province attracts 1,000 more employees, and 700 jobs.
Table 5. Total effects of the Afsluitdijk (MLW) and the Zuiderzeeline (MZM) Maglev variants.

<table>
<thead>
<tr>
<th>Region (corop-numbers)</th>
<th>Total migration effects</th>
<th>Total employment effects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MLW</td>
<td>MZM</td>
</tr>
<tr>
<td>North of NH (18)</td>
<td>150</td>
<td>-600</td>
</tr>
<tr>
<td>Alkmaar region (19)</td>
<td>5,000</td>
<td>-350</td>
</tr>
<tr>
<td>Greater Zaan reg. (20-22)</td>
<td>1,200</td>
<td>-2,000</td>
</tr>
<tr>
<td>Greater Amsterdam (23)</td>
<td>-250</td>
<td>-450</td>
</tr>
<tr>
<td>Groningen (1-3)</td>
<td>2,900</td>
<td>250</td>
</tr>
<tr>
<td>Friesland (4-6)</td>
<td>7,000</td>
<td>5,000</td>
</tr>
<tr>
<td>Drenthe (7-9)</td>
<td>-400</td>
<td>-1,400</td>
</tr>
<tr>
<td>Overijssel (10-12)</td>
<td>-1,700</td>
<td>-2,600</td>
</tr>
<tr>
<td>Gelderland (13-16)</td>
<td>-4,300</td>
<td>-4,100</td>
</tr>
<tr>
<td>Flevoland (40)</td>
<td>-1,100</td>
<td>13,000</td>
</tr>
<tr>
<td>Utrecht and Gooi (17+24)</td>
<td>-4,800</td>
<td>-3,600</td>
</tr>
<tr>
<td>South-Holland (25-30)</td>
<td>-1,100</td>
<td>-700</td>
</tr>
<tr>
<td>Southern Netherl. (31-39)</td>
<td>-2,600</td>
<td>-2,500</td>
</tr>
</tbody>
</table>

1 MZM effects are taken from tables 4.2 and 5.3 of Elhorst et al. (2000)
2 Because of rounding, this column may not precisely match the difference between the other two.

The explanation of this remarkable result is the province of Flevoland. For the northern Netherlands this is a more serious competitor on the markets in the northern wing of the Randstad than the Alkmaar- and the Zaan-region. Flevoland clearly gains from the Zuiderzee-line, especially in term of population (+13,000), but also in term of employment (+4,200). In the case of the Afsluitdijk MLW it looses these gains not only to the Alkmaar- and Zaan-regions, which have a comparable spatial position to Amsterdam, but also to the northern Netherlands, which is located much further away, but nevertheless picks up part of the loss of Flevoland.

Comparable, but much smaller effects hold for Gelderland, South-Holland, Utrecht (and Gooi) and the rest of the Netherlands.
CONCLUSION AND CAUTION

It should be noted that the above results are subject to a series of qualifications (see Elhorst et al. 2000, for details). The housing migration results may represent an over-estimation, as the commuter location model does not take possibly higher ticket prices into account. The employment results, on the other hand, most probably represent an under-estimation of the real effects as the CGE-model does not yet take cluster and agglomeration economies into account.

Evidently, only looking at the indirect effects, the fastest variant is the best. Then, the only choice left seems to be the trajectory choice. Based on the analysis in this report, however, it is not possible to declare the either western or the eastern route as superior in terms of indirect effects. Such a conclusion needs to be founded on comparable estimates for the eastern variant.

Furthermore, it should be noted that the indirect economic effects, although important, only represent one of the effects of new infrastructure. In fact, the effects studied in this report mainly relate to the interregional redistribution of jobs and people. Whether or not this redistribution is such that a net national employment effect or a net national output effect occurs is not studied here (cf. Elhorst and Oosterhaven, 2001, for the Zuiderzeeline). One thing is sure, however, the Maglev variants produce by far the largest indirect effects, but they are also by far the most expensive in terms of investment cost. Hence, a serious conclusion can not be drawn without an integral social cost-benefit analysis (cf. Oosterhaven, 1999, CPB/NEI, 2000).
APPENDIX: CONSTRUCTION OF THE MUNICIPAL TIME MATRICES

The commuter location model requires travel times between municipalities by public transport, car and slow transport. The spatial CGE model also requires travel times, but weighted over all three modes of transport. Almost the same matrices were used as in Elhorst (et al. 2000), only the public transport matrix differs slightly. This appendix describes in a nutshell how these matrices were constructed. For details the reader is referred to Elhorst (et al. 2000).

Data sources

Three types of data were used to construct the matrices:

− AND (2000) data on travel times and distances between zip code areas by car during normal hours. The shortcoming of these data is that they are only available for the current transportation network and that they are not adjusted for peak hours.

− Hague Consultancy Group (HCG) data on travel times by train between 1308 LMS-subzones, including waiting time, for the reference-alternative. The problem with this data is that the time necessary to travel to the station of departure and from the station of arrival to the destination zone was not included.

− HCG data on travel times by car between 345 LMS-zones for the reference-alternative. This data distinguishes between part of the day and motive (business, commuting and other).

Public transport

To estimate the travel times between municipalities in the reference-alternative the following steps were made:

− From the HCG-network a submatrix was distilled with only those subzones that have a railstation. This matrix gives travel times by train from every station to every other station.
− To give a realistic estimation of all public travel times, travel times by bus (the Interliner travel times in the northern part of the Netherlands) were added to this matrix. This resulted in an almost complete network, connecting all subzones with a railway- or bus-station.

− To estimate the travel times by train in the MLW-variant not only the travel times by bus were added but also the travel times by Maglev between the ML-stations along the MLW.

− To generate a complete network (some connections were missing) a shortest path algorithm was applied on both matrices. A penalty time was introduced to correct for waiting time at stations.

− The time necessary to travel to the station of departure is determined as the time from the subzone of departure to the nearest subzone with a station. The time from the station of arrival to the destination subzone was determined as the time from the station closest by the subzone of destination. These two travel times were taken from the AND dataset, assuming that the trips to and from the station are all done by car.

− These access and egress times were added to the travel time from station to station to arrive at a public transport travel time-matrix.

Private car transport

To construct travel times by car a distinction was made between the matrix for the commuter location model and the matrix for the SCGE model. For the migration model commuting times by car in the morning rush hours were used from the NEI (2000) data set. For the SCGE model, business times over the whole day were used. These two matrices were given on the LMS-zone level, and were then transformed into the finer municipality level (for details, see Elhorst et al. 2000). These matrices were used in the calculation of the reference-alternative and the MLW-variant, assuming that no significant congestion effects occur. This was done because no alternative data was available.
Slow transport

To construct a travel time matrix by slow transport, the distances in kilometres from the AND dataset at the postal code level were transformed into distances at the municipality level. Based on mobility research (CBS, 1999) estimates were made of the time needed to travel 1 to 2 km, 2 to 3 km until 24 to 25 km. Above 25 km an average time of 5 minutes per kilometre was used. As a final correction the travel time within each region was adjusted for the extent of urbanisation of the region.

Construction of the average travel times

The SCGE model requires a weighted-average travel time matrix as input. This matrix is based on the travel time by public transport and car, assuming that no business trips are made by slow transport. The share each transport mode gets is determined as follows:

NEI data on trips per motive were used to determine the share of each mode of transport on a 31x31-zone level. This division is based on a division by the NEI for the Zuiderzeeline study (NEI, 2000). The zones with a MLW-station were separated from the 28x28 NEI-division. This resulted in a 31x31-zone matrix that was transformed into a 548x548-matrix at the municipality level, assuming that the modal shares are relatively constant between two municipalities in the same zone. The modal shares in the 31x31-zone matrix were adjusted for the MLW-variant based on the modal shifts in the Metro-variant of the Zuiderzeeline study (MZM).

The next step calculates a weighted-average for the reference-alternative and the MLW-variant. A problem arises with regards to the choice of weights, as realisation of the MLW-variant implies that the product “transportation” changes. It is not correct to compare the travel time of a product “transport” that consists of 90% private car and 10% old fashioned public transport with “transport” that consists of 60% private car and 40% superior magnetic-levitation. There are three possible solutions. Using the shares of the reference-alternative would lead to an (implicit) under-estimate of the use of public transport in the MLW-variant. Using the shares of the MLW-variant would lead to an (implicit) over-estimate of the use of public
transport in the reference-alternative, hence, the simple arithmetic average of the shares is used.
REFERENCES


