INTEGRAL ASSESSMENT OF URBAN CONGLOMERATION VERSUS CENTRE-PERIPHERY MAGLEV RAIL SYSTEMS UNDER MARKET IMPERFECTIONS

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[These are preliminary results. Please do not quote the data presented.]

ABSTRACT

New transport infrastructure has a myriad of effects. This paper briefly introduces three main models and their interactions to determine the wider economic effects: a commuter location model predicts the spatial reactions of the working population, and an interregional monopolistic competition equilibrium model estimates the reactions of firms and the related changes in consumer welfare. A second run of the commuter location model translates the estimated labour demand changes into labour migration, and interregional multiplier matrix translates the migration effects into consumption expenditure effects. Finally, regional unemployment-vacancy regime switch models are used to estimate efficiency effects on the imperfect labour market.

With these models two magnetic levitation rail projects, with two variants each, are investigated: an urban conglomeration project connecting the largest cities within a densely populated region and a centre-periphery project connecting a central region with a peripheral region, both in the Netherlands. The empirical outcomes provide new insights into the spatial pattern of the effects on labour supply and demand. An integral cost-benefit analysis throws more light on which projects are worthwhile or should be rejected. The centre-periphery project appears to be worthwhile if its route is carefully chosen. The urban conglomeration project appears to be doubtful, as it is rather risky.

In addition, it is argued that a project connecting two large, but distant cities probably would be rejected. Finally, the Newbery critique on the usefulness of integral cost-benefit analysis is shown to be premature.

KEYWORDS
Transport infrastructure, magnetic levitation, spatial relocation, market imperfections, integral cost-benefit analysis, Newbery critique, The Netherlands

1. INTRODUCTION

Two seminal reports (SACTRA, 1999; CPB/NEI, 2000) have recently pointed out that traditional social cost-benefit analysis by no means captures the total of all welfare effects of large transport schemes. To understand the overall impact of changes in the transportation network, it is helpful to distinguish direct and indirect effects. Direct economic effects include investment cost, exploitation cost and revenues, and transport cost and time benefits for people and freight given existing locations of people and firms. Indirect economic effects relate to the consequences of the reduction in transport cost and time for production and location decisions of people and firms, and the subsequent effects on income and employment of the population at large (Rietveld & Nijkamp, 2000; Oosterhaven & Knaap, 2002). In addition, there are both direct and indirect effects external to the market, such as congestion, safety, pollution and other environmental impacts (cf. SACTRA, 1999; Rothengatter, 2000).

An integral social cost-benefit analysis will include the direct as well as the indirect responses of economic agents and will relax the assumption of perfect competition where relevant, such as on many product markets, on the housing market and, especially, on the labour market. The stipulation on the perfect competition assumption is of great importance, as estimating the direct costs and benefits alone would only suffice for a full estimate of the total net welfare effect under perfect competition. By contrast, when the condition of perfect competition does not hold, indirect responses of economic agents require attention as they may generate possibly considerable further welfare gains or losses (SACTRA, 1999; CPB/NEI, 2000).

In 2001, the Dutch government has contemplated the construction of two magnetic levitation rail (Maglev) projects with each two variant. (1) An inner ring or an outer ring connecting the four largest cities (Amsterdam, The Hague, Rotterdam and Utrecht) in the heavily urbanised western part of the Netherlands. (2) A direct connection between Schiphol Airport in the West and Groningen in the more peripheral, rural North, either running along the south-east or along the north-west of the "IJsselmeer" lake in the middle of the country.

Recently, a more or less comparable transport scheme been rejected in Germany, namely the proposed Maglev between two big agglomeration (Hamburg and Berlin) over a much longer distance with one only intermediate stop. This paper will consider the urban conglomeration type and the centre-periphery type of Maglev with much more stops. Other projects are currently under investigation in China, Germany and the USA.

Given the recommendations for appraising the effects of transport improvements on the economy in the SACTRA report (1999, p.179), the objective of this paper is:
1) To draw out the rationale for both improvements.
2) To determine the pattern of gains and losses, in both economic activity and jobs, which will arise from the improvements.
3) To make as complete an estimate as possible of the total economic (dis)benefits of both variants of both projects, taking account of the effects of imperfect competition. This is termed a fully specified social cost-benefit analysis.

To reach this aim Section 2 explains the two projects in more detail, and Section 3 draws out the rationale behind both projects. Section 4 describes the models used to determine the indirect economic effects, and Section 5 describes the models used to value the (dis)benefits of these indirect as well as of the direct effects. Section 6 and 7 contain the results of the empirical analysis of the indirect economic effects and of the estimated cost and benefits of the two projects and their two variants. Finally, we point out further implications and conclusions in Section 8 and 9.

2. THE TWO MAGLEV RAIL INVESTIGATIONS

The research of the magnetic levitation rail system (Maglev) was part of larger investigations considering different routes, different service levels (frequency, schedule, waiting time), different price levels as well as different rail systems (also intercity and high-speed rail). This article picks out the Maglev system and only considers those routes and services that appeared to be better in the process of these investigations. It also only considers the results obtained at prevailing prices of public transport, as results for other price schemes are not available for the indirect economic effect estimates. Occasionally, we refer to other results obtained within these larger investigations.

Here we consider two magnetic levitation rail projects with each two variants: (1) An inner ring or an outer ring connecting the four largest cities of the Netherlands: Amsterdam, The Hague, Rotterdam and Utrecht. The inner ring is shorter and cheaper as it calls at the edges of Rotterdam and Utrecht, while the outer ring also calls at the city centres of Leiden and Utrecht. (2) A straight connection between Schiphol Airport and Groningen, either running along the south-east or along the north-west of the "IJsselmeer" lake in the middle of the country (see Figure 1).

The cities of Amsterdam, The Hague, Rotterdam and Utrecht are all located in the Randstad region, the economic core of the Netherlands. This region is highly urbanised with high densities of both people and economic activities. It covers 41% of Dutch population, 42% of Dutch employment and more than 48% of Dutch GDP, while its surface only covers 15% of national total. Groningen is the largest city located in the North, the poorest region of the Netherlands. The North is a peripheral region with a rural character, even though its income share in agriculture is rather small. It covers 10% of Dutch population, 8% of Dutch employment and 11% of Dutch GDP, while its surface covers 27% of national total.[1]

Each project (variant) is evaluated in relation to a baseline scenario. This scenario is based on the "European Co-ordination" scenario of the CPB (1997). Besides, we also consider the more pessimistic "Divided Europe" and the more optimistic "Global Competition" scenario of the CPB (1997). The main characteristics of these scenarios are reported in table 1. With the help of regional employment allocation and regional population projection models the total number of expected people and jobs in 2020 from CPB (1997) has been divided over the 548 municipalities the Netherlands counted in 1998 (see TNO et al.,

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[1] The GDP figure is misleadingly high as it also contains the value added form natural gas exploitation, from which this region hardly profits.

2000). The baseline scenario further consists of a projected rail and road network for 2020 with travel times and volumes (see further NEI, 2000a; Elhorst et al. 2000).

It is assumed that the Maglev proposals primarily lead to exogenous changes in the travel time matrix of public transport. Table 2 gives some representative travel times between major cities the Maglev would call at. At the same time, the speed and frequency of regular trains on some competing, existing rail links will decrease due to a reduction of the expected number of passengers. Besides, some travel times by car along the corridor of the new rail links will improve due to reduced congestion. The public transport times given include time necessary to travel to the station of departure and from the station of arrival to the final destination. Table 2 shows that the travel time by the Maglev falls below the travel time by car on several connections, even during normal hours, which is quite unique for a public transport system. The table also shows that the travel time reduction is far more significant for the connection to the North than for the new connection within the West.

3.   THE RATIONALE FOR THE IMPROVEMENTS

The primary objective of a fast rail link within the Randstad is to improve its internal accessibility by public transport. This in turn may reduce congestion and therefore improve the Randstad's internal accessibility by car. Both may strengthen the Randstad's competitive position to attract more internationally mobile production activities. Compared to other regions in the Netherlands, the need for space for the purpose of new residential areas and industrial sites in the Randstad is considerably larger. With the help of a fast rail link, it might be possible to direct the urbanisation process away from vulnerable remaining agricultural and nature areas within the Randstad, which is the secondary objective of this link.

The primary objective of a fast rail link between the Randstad and the North is to stimulate the northern economy. With a fast rail link, people could relocate to the North while keeping their current jobs in the Randstad. This increases demand for locally produced goods, which initiates a multiplier process leading to a higher level of regional production and employment. A fast rail link would also lower the prices of services to and from firms located in the North, possibly shifting the balance in favour of location in the North in spite of the 'two-way road' argument.[2] This induced activity is seen as the key to further economic development.

The secondary objective of a fast rail link between the Randstad and the North is to relieve the Randstad's capacity constraints in transport infrastructure, and in land and labour markets, which result in a losses of time, higher transport costs, labour shortages, soaring housing prices and higher cost of living. As these costs are partly external to private decision-makers, they do not fully deter the spatial concentration of people and economic activities, since such costs are not taken into account in private location decisions. In as far as these factors do contribute to a flow of industry away from the economic core, they are mostly directed towards the periphery of the core or towards the core of other countries, but not towards the periphery of

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[2] Improved accessibility may also benefit the central region to the disbenefit of the periphery (SACTRA, 1999, p.16).

the country itself (Fothergill et al. 1986, Clark 1989, pp.23-25, Marshall & Wood 1995, Boeckhout & Haverkate 1995, p.165).

4.   INDIRECT ECONOMIC EFFECTS: METHODOLOGY

The indirect economic effects of an infrastructure improvement may be summarised and modelled as two relatively independent main effects on population and on employment and two derived interaction effects (see figure 2).

The *first main effect* relates to housing migration of the working population. When travel times reduce due to improvements in the transportation network, people may increase the quality of their housing accommodation and living environment, by increasing their commuting journey length, without changing their commuting journey time. This principle has been used to develop a *commuter location model* that takes actual commuting behaviour as given and then try to predict where people live given the location of their jobs. It takes the commuting journey time distribution by different transport modes (car during peak hours, public transport and slow transport) as given, and then assigns the jobs in each employment municipality to the same or other residential municipality (see Elhorst and Oosterhaven, 2002 for details).

The commuting time distribution matrix used gives the percentage of workers that commutes by one of the three modes of transport split into 25 time classes. This matrix has been further split for the four biggest cities, for municipalities with a railway station and for municipalities without a railway station. The total matrix is based on more than 70,000 observations (CBS, 1999). It has been assumed that this matrix does not change over time.[3] The time the average individual spends on travel remained remarkably stable over long periods of time despite enormous increases in incomes and the average speed of transport (Hupkes, 1977; Zahavi and McLynn, 1983; SACTRA, 1999, p.118). Journey-to-work statistics from the US Census, for example, show that mean commuting time in the largest 15 metropolitan areas increased only slightly, from 26.0 to 26.6 minutes between 1980 and 1990 (quoted from Small & Gómez-Ibánaz, 1999, p.1941).

Finally, it has been taken into account that municipalities may have a different attractiveness as a residential area, which may be measured by either the number of houses or the available land (excluding water). The first variable best approximates the existing physical possibilities to live within a municipality. For this reason this variable is suitable to test the fit of the model. It appeared that the working age population living in the 12 nuts-2 and the 40 nuts-3 regions of the Netherlands with this attractiveness variable could be estimated with an error 7%. The second variable better approximates the spatial preferences of people. Research has shown that the majority of the working population has a preference for more comfortable houses built on larger lots in neighbourhoods with more green (Elhorst et al. 1999; VROM, 2000). For this reason the second variable is more suitable to simulate longer run residential changes, provided that the housing market has time to adjust itself to the changes in the transport system and to these residential preferences.

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[3] Shifts within this matrix are nonetheless possible, as people may change their mode of transport. Modal substitution has been modelled with the help of an almost ideal demand system (see Elhorst and Oosterhaven, 2002).

The *second main effect* relates to travel cost induced employment changes. Traditional approaches to the role of transport costs in the determination of levels of economic activity assume that firms will attempt to minimise transport costs of reaching markets and acquiring inputs for a given level of activity. If the transport costs of factor inputs and outputs change differentially in different locations, the optimal location of the firm would be expected to change. Transport at the firm level will include both freight transport and personal business travel. In this investigation, we have used a bi-modal (commodities/people) transport cost mark-up:

$$p^* = \left[f_c(d_c)\right]^{\pi} \cdot \left[f_p(d_p)\right]^{1-\pi} \cdot p, \tag{1}$$

where **p** gives the share of commodity transport and *1-p* the share of business/shoping travel in the total transportation cost per sector. The following functional form is assumed:

$$f(d) = 1 + \vartheta \cdot d^{\omega}, \tag{2}$$

where **u** and **w** denote parameters to be estimated for freight and business/shopping travel and *d* denotes distance. For freight, the 548×548 municipality-by-municipality distance matrix has been used. For people, the 548×548 travel time matrix by car during normal hours and the 548×548 travel time matrix by public transport have been used weighted by their modal shares in business/shopping travel. Note that in the project variants only the latter matrix changes and that the modal shares may change due to substitution between the two modes of transport.

Imperfect competition in transport-using sectors is an important reason why traditional location approaches may produce inaccurate estimates. In the long run, changes in market access lead to entry and exit. When inter-industry linkages are reckoned with, forward and backward linkage lead to cluster and agglomeration formation. In general, a more integrated market tends to support more firms, which charge lower prices, produce at a larger scale, and offer a wider variety of products. To estimate these effects a *spatial computable general equilibrium model* (SCGE model) has been developed (see Knaap and Oosterhaven, 2000, for details).

This SGCE model fits in the new economic geography literature (cf. Fujita, Krugman and Venables, 1999) and directly extends the model introduced by Venables (1996). The basic structure resembles a similar model developed for the European Union by Bröcker (1999), but is more detailed in that fourteen different sectors have been specified and that trading relations between production sectors in different regions are estimated on bi-regional input-output data (RUG/CBS, 1999). The fourteen sector-specific elasticities of substitution (**s**) and the four parameters of the transport cost mark-up, $\upsilon_c, \omega_c, \upsilon_p, \omega_p$, have been calibrated to the baseline scenario for 2020. The SCGE model forecasts production and employment for each municipality in the baseline scenario and any project variant. The difference between the two is used as an estimation of the travel cost induced employment effects. In addition, it

calculates the welfare effect of a project variant; the increase in utility that is achieved within the country by the lower price index of consumption.

The *first derived effect* relates to labour migration of the mobile working population caused by employment changes determined in the SCGE model (see Figure 2). Note that the commuter location model predicts housing migration as a result of reduced travel times starting with a *given* level employment in each municipality, whereas this effect measures labour migration as a result of changes in employment opportunities. The residential locations of the labour migrants are again estimated with the commuter location model. Total migration is the sum of housing migration and labour migration.

The *second derived effect* relates to consumption-induced employment changes caused by the total migration of workers. Due to lack of data, this effect is not determined at the level of the 548 municipalities, but at level of the 40 nuts-3 regions in the Netherlands, using a 40x40 employment multiplier matrix of working migrants (see Oosterhaven, 2001, for details). This matrix is also based on the 14 bi-regional input-output tables of the 12 provinces in the Netherlands and the two mainport areas of Amsterdam and Rotterdam (RUG/CBS, 1999, Eding et al. 1999). The total employment effect is the sum of the travel cost-induced and consumption-induced employment effect.

5. COSTS AND BENEFITS UNDER MARKET IMPERFECTIONS

Introduction

With the above-described methodology indirect economic effect may be estimated. They provide direct useful information for policy purposes, but they fall short of a full welfare evaluation of the transport schemes at hand. For this, an integral cost-benefit analysis reckoning with market imperfections is needed. Here a full description of the methods used is given, but details are only provided for the estimation of the important benefits related to the imperfections of the labour market.

Investment costs, total exploitation costs and revenues

The investment costs have been estimated by a team of engineers on design and costs. The cost of the inner and the outer ring project in the Randstad are estimated at 6835 and 9088 billion euro. The Maglev between Schiphol and Groningen along the north-west and the south-east of the IJsselmeer are estimated at 7308 and 6666 billion euro, each estimate including a mark-up for uncertainties and risk.[4]

Total exploitation costs (as a percentage of the revenues) and the exploitation revenues have been estimated by the NEI (2001a, 2001b) using the LMS travel demand model. This model predicts a trip distribution matrix, provided that the marginal totals of the trip distribution matrix, i.e., the spatial distribution of employment and population, are given. This approach appeared to be problematic, as precisely that spatial distribution is endogenous to changes in the transport system. In co-operation with the NEI, the initial estimates of the

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[4] A consortium of four companies (HBG, Ballast Nedam, Siemens and ABN-AMRO) has offered to build the first project (the inner ring) for 5110 billion euro, and to build the second project (the south-east variant) for 4799 billion euro. These offers do not include costs for noise barriers and costs for particular architectonic facilities.

travel demand model have been adjusted for these endogenous changes in employment and population. It should be noted that total exploitation costs and revenues of the new rail link have been corrected for avoided exploitation costs and loss of revenues on existing rail links.

Time savings, consumer surplus and reduced congestion benefits
One of the prime reasons to invest in infrastructure is the time benefit for people. The time benefits from changes in the transportation network may be estimated by means of the cost-benefit analysis rule of half (Button, 1993, p. 183)

$$\sum_{i=1}^{N} \sum_{j=1}^{N} \sum_{m=1}^{M} 0.5 * (C_{ijm}^{0} + C_{ijm}^{1}) * (T_{ijm}^{0} - T_{ijm}^{1}), \tag{3}$$

where C_{ijm}^{0} and C_{ijm}^{1} denote the estimated flow from municipality i to municipality j using mode m and T_{ijm}^{0} and T_{ijm}^{1} denote the travel time using mode m, both respectively before and after the change in the transport system.

In view of the differences in values of time and the different indirect economic effects models for different travel motives, a distinction needs to be made between commuting trips, commercial trips (for both business and consumption) and other trips, as well as between car and public transport.[5] The time benefits of commuting trips have been calculated separately for public transport using the results for C_{ijm}^{0} and C_{ijm}^{1} from the commuter location model. The time benefits of other trips have been calculated separately for public transport substituting the results of the travel demand model of the NEI into (3). The consumer surplus changes due to faster business and shopping trips have been calculated with the help of the SCGE model. Therefore the time benefits of commercial trips need not be calculated separately, while the revenues of commercial trips need to be deducted from the consumer surplus change to avoid double-counting them.

The time benefits for commuting, commercial as well as other trips by car are due to reduced congestion. These benefits have been split into direct effects, as calculated under the assumption of an unchanged spatial distribution of employment and population, and indirect effects that are due to the changes in the spatial distribution of employment and population. Note that if employment and population moves from relatively overcrowded to relatively undercrowded regions *all* associated traffic also moves and may thus contribute to reduced congestion.

Labour market benefits
Shifts in labour supply and labour demand, the two main effects of Figure 2, have additional effects on the spatial efficiency of the national labour market in the Netherlands.

First, geographical matching benefits occur when, summed over all regions and keeping regional labour supply constant, the match between demand and supply on regional labour markets improves due to interregional shifts in labour demand. Disbenefits occur in the reversed case. Four different cases may be distinguished (see Figure 3).

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[5] Slow transport appeared to be of minor importance within this context, as congestion and the number of people substituting car or public for slow transport appeared to be extremely small.

Job benefits occur when labour demand shifts to regions with a labour supply surplus. The increase in labour demand can be realised by mobilising school-leavers, the unemployed and the inactive working age population without raising the wage rate. The equilibrium shifts to the right along the labour supply curve.

Productivity benefits occur when labour demand shifts to regions with a labour demand surplus. Withdrawal of labour from other economic activities is possible by bidding up wages. A wage increase displaces other economic activities in the region whose labour productivity is lower. Consequently, it is not employment that increases but wages and labour productivity. The equilibrium shifts upwards along the labour supply curve.

Job disbenefits occur when labour demand decreases in regions with a labour supply surplus. Unemployment will rise without affecting the wage rate. The equilibrium shifts to the left along the labour supply curve.

Productivity disbenefits occur when labour demand decreases in regions with a labour demand surplus. The number of vacancies will decrease because less productive, formerly unfilled vacancies can now be filled. This has the effect of depressing wages, as a result of which labour productivity will fall. The equilibrium shifts downwards along the labour supply curve.

It should be stressed that geographical matching (dis)benefits only occur when labour is immobile. When labour is willing to migrate as soon as employment opportunities in other regions open up, then these (dis)benefits disappear. Casual empiricism suggests that one could realistically treat primary and secondary educated labour as immobile between regions. That does not mean that this type of labour stays put; they do move often from one (public) house to another, but they very rarely leave a region, especially due to barriers on the housing market (De Galan and Van Miltenburg, 1991; Hughes and McCormick, 1987). In sum, job (dis)benefits may occur for primary and secondary educated people, but not for the higher educated as they are willing to migrate to other regions as soon as job opportunities in these regions open up. Another assumption made in the empirical analysis is that the productivity (dis)benefits are not as large as the job (dis)benefits if there were no labour demand surplus, but only 10%.

Due to increased commuting distances, labour markets tend to increase in size. Wider labour market benefits occur as firms are able to access a larger pool of workers. Qualitative benefits occur as firms are able to access better skills. In the empirical analysis these benefits have been approximated by the willingness to commute over longer distances. The latter has been estimated by the larger number of workers crossing the borders of nuts3 regions and by the assumptions that in 10% of these cases firms are able to access better skills and that labour productivity due to these better matches increases by 10%.

Quantitative (dis)benefits occur when firms are able to fill more or less vacancies. Again four different cases might occur. If commuting flows shift between regions which both have a labour demand surplus or a labour supply surplus, the number of vacancies at the national level remains the same. If commuting flows shift from regions with a labour supply surplus to regions with a labour demand surplus, the number of vacancies decreases. Conversely, if commuting flows shift from regions with a labour demand surplus to regions with a labour supply surplus, the number of vacancies decreases. Just as with the geographical matching (dis)benefits, these quantitative wider labour market (dis)benefits only occur when

labour is immobile. Within this labour segment, the size of these (dis)benefits further depends on the relation between the inactive and active part of the working age population and the willingness to commute.

It is to be noted that this approach is not complete. First, short run effects may exceed long run effects. Second, both sets of four cases assume either a labour demand surplus or a labour supply surplus, while the UV or Beveridge curve assumes a convex relationship between these two variables. One improvement in future research would be to analyse the labour market within the SCGE model based on recent work of Pissarides (2000). Finally, the analysis does not consider international efficiency effects. These latter effects are taken from Bröcker (quoted from TNO et al., 2000) and BCI (2001).

Housing market benefits

The housing market in the Netherlands has traditionally been a heavily regulated. In a free market for land, external effects would cause too much land to be allocated to housing, potentially leading to 'urban sprawl'. Restrictive spatial planning in the Netherlands to avoid 'urban sprawl' appears to have two effects. First, it puts a constraint on consumer preferences. Several consumer surveys have indicated that individual preferences for spacious houses on large lots, particularly in the upper segment, are not fully satisfied. Second, it creates an artificial scarcity of building land in comparison with agricultural land. Due to this artificial scarcity, an additional economic rent emerges when transforming agricultural land into building land. Unrestricted supply would result in equal land prices for each house category in comparable locations, but the imbalance between supply and demand has resulted in higher prices per square metre for expensive single-family houses on larger lots (Creusen, 1999).

Another feature of the Dutch housing market is the market power of property developers. They buy agricultural land on prospective building sites to achieve a strong bargaining position in acquiring the building order. As a result, property developers are able to capture a substantial part of the scarcity rent on land. An indication for this is that total construction prices tend to increase more rapidly than the actual construction costs (i.e., material costs, wages and other (non-material) expenses; see Creusen, 1999). The consumer has no more influence on this process than to buy or not to buy a completed house.

Public investment costs for developing new residential areas and building costs of housing tend to be higher in densely populated regions and to be lower in sparsely populated regions, respectively in central and peripheral regions. It should be noted that they also tend to be higher in more urbanised than in more rural areas within the same region (Sievers and Keers, 1992). Generally, houses in densely populated regions are smaller and built on smaller lots, while the neighbourhood is less green and the distance to green recreational areas is larger. Due to the fact that the housing market is imperfect, a relocation of the Dutch population as a result of new infrastructure, may lead to additional benefits (in addition to the time benefits) if on balance more people move from densely to sparsely populated regions or, conversely, to additional disbenefits.

Environmental and non-monetised (dis) benefits

The main environmental (dis)benefits of a new rail link relate to noise, safety, landscape and carbon dioxide and nitrogen oxide emissions. Three different effects must be considered. First, the construction and the service of a new rail link cause environmental disbenefits, also

because it further increases the mobility of the Dutch population. By contrast, the substitution of public for car transport due to a new rail link cause environmental benefits. Finally, the relocation of employment and population may cause benefits or disbenefits in different regions. Although many of these effects are quantified, only few of them could be valued in monetary units.

6. RESULTS: INDIRECT EFFECTS

Figure 4 to 7 show the nuts-3 regions that benefit (red) and the nuts-3 regions that disbenefit (blue) from the four different project variants in terms of employment and population. A negative effect does not necessarily mean that people or jobs gets lost but that the autonomous growth component will be lower than in the baseline scenario.

The first objective of the rail link between the four largest cities in the Randstad is to strenghten the Randstad's competitive position. The numbers underlying figure 4 and 5 show that due to the redistribution of employment within the Netherlands, employment in the Randstad increases by 1700 jobs in the inner variant and 1950 jobs in the outer variant. From an international viewpoint, employment in the Randstad further increases by approximately 1300-1420 jobs (BCI, 2001). The second objective is to relieve the Randstad. In both variants 3000 people leave the Randstad. These figures are relatively small.

When looking at other regions and at intra-regional changes within the Randstad, we may conclude that the urban rail link strengthens the process of suburbanisation. Within the four big city agglomerations, the municipalities of Amsterdam, Rotterdam, The Hague and Utrecht see their population decrease, whereas the surrounding municipalities close to a train station see their population increase. This suburbanisation process also extends to regions adjacent to the Randstad. Whereas these regions see their number of jobs decrease, their population increase. By contrast, the peripheral North hardly benefits from a fast rail link in the Randstad, neither in terms of employment nor in terms of population. Its number of jobs decreases slightly, its number of people increases only slightly.

The first objective of the fast rail link between Amsterdam and Groningen is to stimulate the peripheral North. The numbers underlying figure 6 and 7 show that employment increases by 3950 jobs in the south-east variant and by 8050 jobs in the north-west variant. From an international viewpoint, employment in the North further increases by approximately 120 jobs in the North, as well as 80 jobs in Flevoland (NEI, 2000). The working population increases by 4000 people in the south-east variant and 9400 people in the north-west variant. In sum, the North indeed catches up. Nevertheless, it is difficult to say whether these effects are large or small. In comparison with the autonomous growth component they are small, while from the perspective of the existing population who wants to live in a quiet environment, they are large. From a policy viewpoint, they are large as well: The only measure that has created a comparable number of jobs in the North is the spreading policy of government services in the 1970s (see Oosterhaven, 1996). What we may conclude from these figures is that the north-west variant is approximately twice as effective as the south-east variant, and that the centre-periphery project is more effective in creating jobs in the North than the urban conglomeration project.

The second objective is to relieve the Randstad. In the south-east variant 7045 people leave the Randstad, whereas in the north-west variant the working population in the Randstad increase by 100 people. In addition to this, we have found that the working age population increases by 720 people when a TGV system is chosen in the south-east variant. These contrary figures can be explained by the fact housing migration tends to be negative in the Randstad, but travel cost-induced employment and therefore labour migration tends to be positive, especially in the agglomeration Amsterdam. These results show two things. First, the pull of a TGV train, contrary to a magnetic levitation train, appears to be insufficient to help relieve the Randstad. Second, whereas in the north-west variant the areas centred round the end points benefit from the new infrastructure, they do not or to a lesser extent in the south-east variant. Conversely, whereas in the south-east variant the region between the end points benefit from the new infrastructure, it does not or to a lesser extent in the north-west variant.

To illustrate the latter point, we further look at the regions of the North of North Holland and Flevoland. The North of North-Holland is located between the Randstad and the North at the north-west variant. Just as the North, it is a peripheral region with a rural character, a shortage of jobs and a relatively high unemployment rate. A fast rail link through this region does not appear to be of much help. The increase of its number of jobs and the size of its working population is restricted to 150. On the other, in the south-east variant these numbers decrease by 450 and 600, respectively.

Flevoland is located between the Randstad and the North at the south-west variant. A fast rail link trough this region is extremely effective. Employment increases by 4300 jobs and the working population increases by 12750 people. There are several explanations for this. This region has three stations located at the new line, one of them not yet connected to the rail network; the region has been reclaimed from the sea (today known as the "IJsselmeer" lake) in the 1960s and 1970s and therefore has still lots of space; and the most populous municipality of Flevoland (Almere) is located within 30 kilometres from Amsterdam and Utrecht. For these reasons, the region is attractive to commuters. The results confirm this. Whereas migration into the North consists of housing migration for 26% and labour migration of 64%, migration into Flevoland consists of housing migration for 85% and labour migration for 15%.

7. RESULTS: SOCIAL COST-BENEFIT ANALYSIS

In this section we present the results of our social cost-benefit analysis. We have calculated the net present value (NPV) in 2010, using a social discount rate of 4%[6] over a 30-year and a 50-year period, in prices of 2000. The problem with the 30-year period is that it does not cover the life of the project. The problem with the 50-year period is that the social discount of 4% does not cover the risks of the project. Therefore, we have also calculated the internal discount rate over both periods. The internal discount rate, especially over the 50-year period, shows to which extent the social discount rate may be raised for risks without obtaining a negative net present value. It is assumed that the construction of the new rail link takes place over the period 2010-2015 and that exploitation starts afterwards. Indirect effects are assumed

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[6] This discount rate is prescribed by the national government.

to be zero in 2015 but to increase by 20%-points each year and to reach 100% in 2020. Finally, it is assumed that investments costs are spread over the first five years of construction; 33, 17, 20, 20 and 10 percent in the urban project and 10, 15, 30, 30 and 15 percent in the centre-periphery project (NEI, 2000, 2001).

Exploitation cost and revenues have been calculated at prevailing prices in public transport by first class. The NEI has determined that a price increase of 30% would be optimal from the point of view of the company running the line. Unfortunately, it has not been investigated to which extent this price increase would dampen the indirect effects.

The time benefits of commuting trips in public transport have been calculated assuming a value of time of 7.00 euro per hour, 2 trips a day, 220 working days each year and annual growth rate of 1.1%.[7] The consumer surplus of commercial trips has been calculated using the SCGE model and an annual growth rate of 1.6%. The time benefits of other trips have been calculated starting with a value of time of 4,30 euro per hour, 285 trip days and a growth rate of the value of time of 0.6%.

The labour market benefits have been calculated assuming that the proportion of higher educated and of primary and secondary educated people is 35% and 65%, that labour productivity grows at 2.3% each year (see table 1), and that a job values 36,192 euro for all types of workers and 29,218 euro for a primary or secondary educated worker on a yearly basis.[8]

The determination of the housing benefits and of the indirect benefits of reduced congestion is based on a previous study (Elhorst et al. 1999). The direct benefits of reduced congestion are taken from NEI (2000,2001).

Table 3 show the results of our social cost-benefit analysis. From this table it can be seen that total benefits of the urban project and of the centre-periphery project are close together, excepting the north-west variant of the latter type of project. By contrast, the composition of the benefits is completely different. The urban project has higher exploitation revenues and time benefits. Congestion is also reduced considerably, whereas the centre-periphery project does only help indirectly due to the fact that on balance more people leave the Randstad. The geographical productivity benefits and the qualitative wider labour market benefits also appear to be higher. As many people substitute public for car transport, the carbon dioxide and nitrogen oxide emissions diminish, as a result of which these benefits are also positive. By contrast, in the centre-periphery project the negative effects dominate this positive effect, as substitution is rather small. Benefits that appear to be lower or even negative are the consumer surplus and the geographical net job benefits. This whole set of results can be explained by the fact that the central region is more densely populated and the periphery more sparsely populated, that the central region has a labour demand surplus and the periphery a labour supply surplus and that, on average, product prices in the central region have been estimated to be less than 20% higher and in the periphery to be more than 30%

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[7] In the EC-scenario the real wage rate increases by 1.7% each year (table 1). The HCG (1998) has determined that the income elasticity of the value of time for commuting trips is approximately 0.65. Consequently, the value of time grows by 1.1% each year in the EC-scenario.
[8] These numbers have been obtained dividing net national product by the total number of workers in the Netherlands.

higher due to monopolistic competition than they would have been assuming universal perfect competition.

The investment costs depend on the length of the routes and the extent to which they are build in an urban or rural environment. The latter explains why the urban project is more expensive and also why the outer variant connecting city centres is more expensive than the inner variant connecting the edges of the main cities. Connecting city centres, on its turn, has the advantage that all benefits increase except for the congestion reduction. Train stations in city centres cannot be reached easily, as a result of which fewer people will substitute public for car transport and the congestion reduction will decrease. However, the impact of this effect appears to be that large that, on balance, the benefits of both variants equalise.

The exploitation costs in the urban project are also higher than in the centre-periphery project, as approximately twice as much trains are needed - the frequency with which the trains are running is 10 versus 6 trains per hour - and approximately 15% more personnel. Consequently, exploitation costs exceed the exploitation revenues in the urban project.

Adding up all monetised benefits and costs over a 30-year period shows that none of the projects has a positive net present value, but as has been said this period does not cover the life of the project. Adding them up over a 50-year period shows that the south-east variant of the centre-periphery project has a positive net present value. It has a internal discount rate of 5.6%, which means that the social discount rate may be raised for risks by 1.6% without obtaining a negative net present value.

The outer variant of the urban project has a large negative net present value, even over a 50-year period and should be rejected. The north-west variant of the centre-periphery project has a small negative present value and an internal rate of return close to 4% over the 50-year period. It should nonetheless be rejected, as the south/west variant appears to be a much better alternative.

The inner variant of the urban project is a doubtful case. It has a small negative present value and an internal discount rate close to 4% over the 50-year period. From Table 3 it can be seen that these figures improve in the more pessimistic "Divided-Europe" and in the more optimistic "Global Competition" scenario (see the description in table 1): the net present value becomes positive and the extent to which the social discount rate may be raised for risks amounts to 0.25% to 0.5%. Remarkably, the net present value also improves in the more pessimistic scenario. The explanation is that the labour market benefits within the central region are much higher in this scenario. If the unemployment rate is 4.5% or 2.8%, as in the "European Co-ordination" and "Global Competition" scenario, the central region is characterised by a labour demand surplus. Under this circumstance, the increase in product demand due to new infrastructure does not lead to more jobs but to displacement of other, less productive economic activities, both form a national and international point of view. If the unemployment rate is 8%, as in the "Divided Europe" scenario, the central region is characterised by a labour supply surplus, just as in the rest of the country. Under this circumstance, every job can be filled without displacing others.

The above findings should be nuanced if the non-monetised benefits and costs would be large and the evidence as a result would be otherwise, but that is not the case. First attempts to

monetise the impacts on safety, noise and the build and natural environment have made clear that these effects are relatively small and not necessarily negative. As these estimates are not fully reliable, table 3 only contains qualitative estimates. The "++" or "--" sign indicates that the effect is not only positive or negative but also that the magnetic levitation rail system does better or worse in comparison with its high-speed train counterpart. The "-/+" sign in the urban project is used to indicate that the non-valued environmental effects are negative with respect to the build and natural environment, and positive with respect to safety and noise, but that the overall effect is uncertain. Finally, the question of efficiency measured by the net present value should be balanced against the question whether the regional distribution of employment and income become more equitable. This question of fairness in distribution has already been discussed in the last section.

In conclusion, we may say that the centre-periphery project is worthwhile, but that its route should be carefully chosen. The SACTRA report (1999) has concluded that the effects of transport improvements are subject to strong dependence on specific local circumstances and conditions. It has been found that the south/west variant is much better than the north-west variant, as it connects cities not yet connected to the rail network and the region between both end points in the former variant is able to benefit more from the new infrastructure than in the latter variant due to its attractive living environment.

The urban project appears to be rather risky. A positive result is only attainable for the inner variant over a 50-year period under favourable economic conditions and then still for an internal rate of discount that is not much higher than the social discount rate of 4%. This result is generally considered too weak to go ahead with the magnetic levitation rail system in the Randstad.

8.   FURTHER IMPLICATIONS

The results of both types of projects also throw more light on the potential outcome of the German project connecting two large, but distant cities. Exploitation revenues and reduced congestion will be low, as this project only competes with air transport. Time benefits due to commuting and housing benefits will be negligible, as the distance between these two cities is simply too large for commuting and only one stop has been planned. Geographical net job benefits and net wider labour market benefits will not occur, as both cities will have the same labour market characteristics. This means that already six types of benefits will be lost or significantly reduce. Consequently, this type of project may expect to have a large negative net present value and a low or even negative internal discount rate.

The last issue to discuss is the ratio between the benefits that have been computed in our (almost) integral social cost-benefit analysis and the benefits that would have occurred under the condition of perfect competition. Newbery (quoted from SACTRA, 1999, p.101) has argued, starting with a theoretical model, that biases in the latter benefits due to the prevalence of imperfect competition would generally be too small to worry about, as this ratio is about 1.025, also known as the Newbery critique. By contrast, Venables and Gasiorek (quoted from SACTRA, 1999, p.101), also using a theoretical model, have found that most

model permutations give ratios above 1.3 and that a few exceed 1.6. However, empirical evidence corroborating these ratios is lacking. Moreover, these theoretical models do not consider all additional welfare gains. They usually assume environmental and housing externalities equal to zero and assume a market-clearing labour market.[9]

From table 2 it has been derived that the ratio between both types of benefits is approximately 1.2 in the urban conglomeration project and 1.8 in the centre-periphery project. Although the last ratio appears to be quite high, it can be explained reasonably well. First, mark-ups due to monopolistic competition instead of perfect competition were estimated to range from 0.2 in central to over 0.3 in peripheral regions. These figures are comparable to those found by Harris (0.16 to 0.29, see SACTRA, 1999, p.101). This means that the additional gains in the urban-peripheral type of project may expected to be much larger. Second, our analysis not only covers product markets, but also the labour market, housing market and the transport market for passengers, which from a spatial viewpoint are anything but perfect. In the centre-periphery project almost every additional effect appears to be positive, including the indirect external effect on the transport market for passengers, as people substitute public for car transport. This is an important empirical finding that, up to now, is unknown and proves that the Newbery critique was premature: New public infrastructure between urban and peripheral regions, if its route carefully chosen, may well contribute to national welfare due to large additional benefits caused by market imperfections.

9. CONCLUSIONS AND CAUTION

The value of this paper is twofold. First, it is one of the first studies that has attempted to measure the comprehensive net total of all social costs and benefits of new transport infrastructure, taking account of the effects of imperfect competition. Second, it is one of the first studies that has attempted to measure this net total for magnetic levitation rail systems. It has been concluded that a centre-periphery project is worthwhile if its route is carefully chosen, that an urban conglomeration project is rather risky, and that a project connecting two large, but distant cities should be rejected.

Finally, we repeat the main assumptions on which the latter conclusion is based, as some of these assumptions may have had the effect that the wider economic effects on which the social cost benefit analysis is based are overestimated and some others that they are underestimated (see Elhorst et al., 2000, for details). The results obtained with respect to housing migration may have been overestimated, as they have been calculated at prevailing prices and assuming that positive demand shifts on the housing market are accommodated in the long run. The results may have been underestimated if the willingness to commute may further grow in the future. The results obtained with respect to employment changes and in addition labour migration may have been underestimated as the SCGE-model does not yet take account of scale, cluster, and image effects. All wider economic effects may also have

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[9] Newbery also does not deal with additional welfare gains accruing from linkage effects and agglomeration effects and the entry and exit of firms (SACTRA, 1999, p.101).

been underestimated as second-order effects were not taken into account, but as the first-order effects are already relatively small these effects are almost negligible.

ACKNOWLEDGEMENTS

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Table 1 Main economic indicators of three scenario's of the Netherlands, 2000-2040

	European Coördination (EC)	Divided Europe (DE)	Global Competition (GC)
Variables measured in annual percentage changes			
Contractual wages	3.7	4.8	3.2
Consumer price index	2.0	3.3	1.4
Labour productivity	2.3	1.8	2.5
GDP	1.8	1.2	2,4
Variables measured in levels in 2020			
Population (×1000)	17717	16205	16890
Employment (×1000)	7512	6334	7802
Unemployment	4.5%	8.0%	2.8%

Table 2: Average travel time (in minutes) between main cities along the proposed trajectories (1).

From	To	Car	PT Before	South-east	North-west
Groningen	A'dam Airport	135	173	100	96
		Car	PT Before	Inner ring	Outer ring
Amsterdam	The Hague	51	98	87	98
The Hague	Rotterdam	33	55	51	54
Rotterdam	Utrecht	64	75	74	61
Utrecht	Amsterdam	40	76	76	76

(1) Including time neccesary to travel from origin to the station of departure and from station of arrival to final destination.

Table 3 Social cost-benefit analysis of two magnetic levitation systems, two variants each:

NPV in 2010, millions of euro, price level 2000, discount rate 4%, EC-scenario

	Inner urban ring Randstad	Outer urban ring Randstad	Amsterdam-Groningen, north-west	Amsterdam-Groningen, south-east
Exploitation revenues	1518	2034	1090	1357
Time benefits commuting	1340	1374	662	650
Consumer surplus (business/shopping)	198	282	862	1416
Time benefits other trips	347	645	164	161
Geographical net job benefits	-459	-804	2278	1715
Geographical net productivity benefits	106	177	-431	-334
Qualitative labour matching benefits	168	199	36	32
Quantitative labour matching benefits	146	199	-162	266
International job benefits	401	401	310	310
International productivity benefits	173	173	133	133
Housing market benefits	107	101	26	358
Direct reduced congestion	1957	1193	0	0
Indirect reduced congestion	47	44	12	157
Environmental benefits (CO_2 and NO_X)	98	34	-160	-146
Total benefits	6148	6053	4820	6074
Investment costs	6189	8229	6440	5875
Exploitation costs	1898	2280	894	1094
Balance 2010-2040	-1938	-4456	-2514	-895
Internal discount rate	2.1	0.7	1.1	2.5
Balance 2010-2060	-47	-2775	-363	1690
Internal discount rate	4.0	2.5	3.7	5.6
Remaining benefits 1)	++	+	++	++
Remaining costs 2)	-/+	-/+	-	-
Loss of leisure time 3)	250	700	-3600	-3400
Regional redistribution fair?	p.m.	p.m.	p.m.	p.m.
Balance 2010-2060 Pessimistic DE-scenario	1012	-1138	-1966	207
Balance 2010-2060 Optimistic GC-scenario	438	-2033	-886	2215

1) Qualitative estimate of non-valued scale, cluster, image and second-order effects

2) Qualitative estimate of non-valued environmental effects

3) Loss of leisure time is minus the national number of jobs by which employment increases

Figure 1: Proposed trajectories
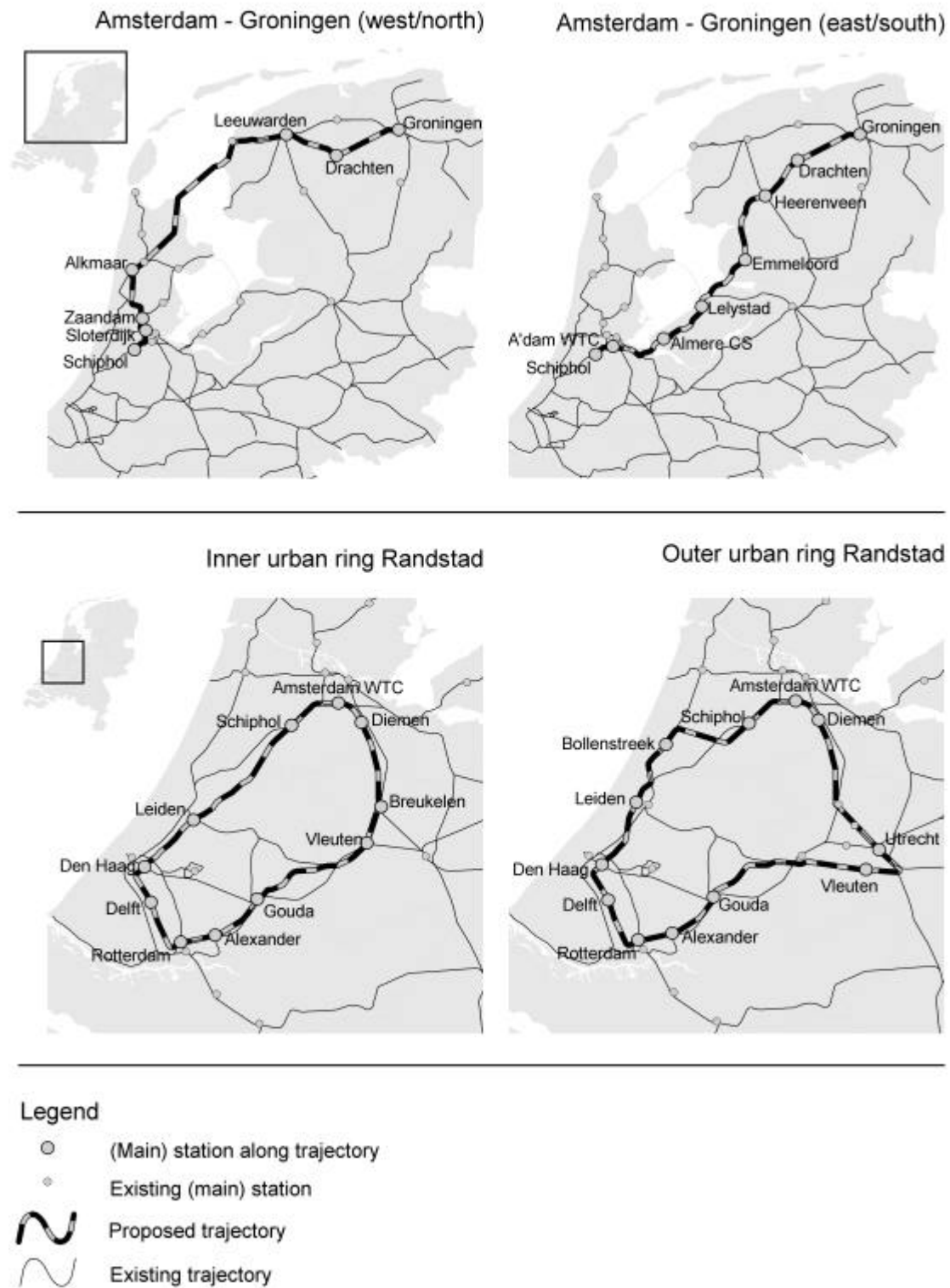
Figure 2 The relationship between the different indirect economic effects and further effects
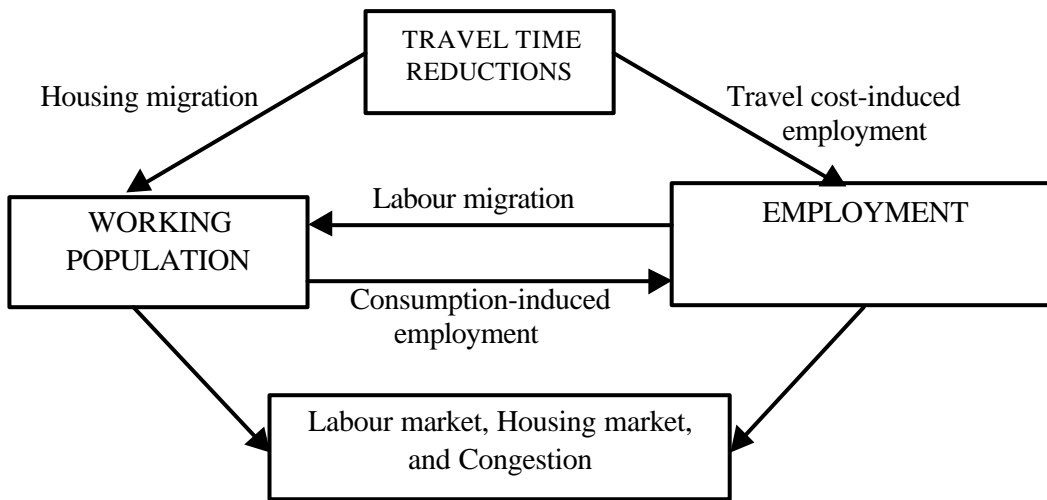
Figure 3 The effects of interregional labour demand shifts when labour supply is immobile
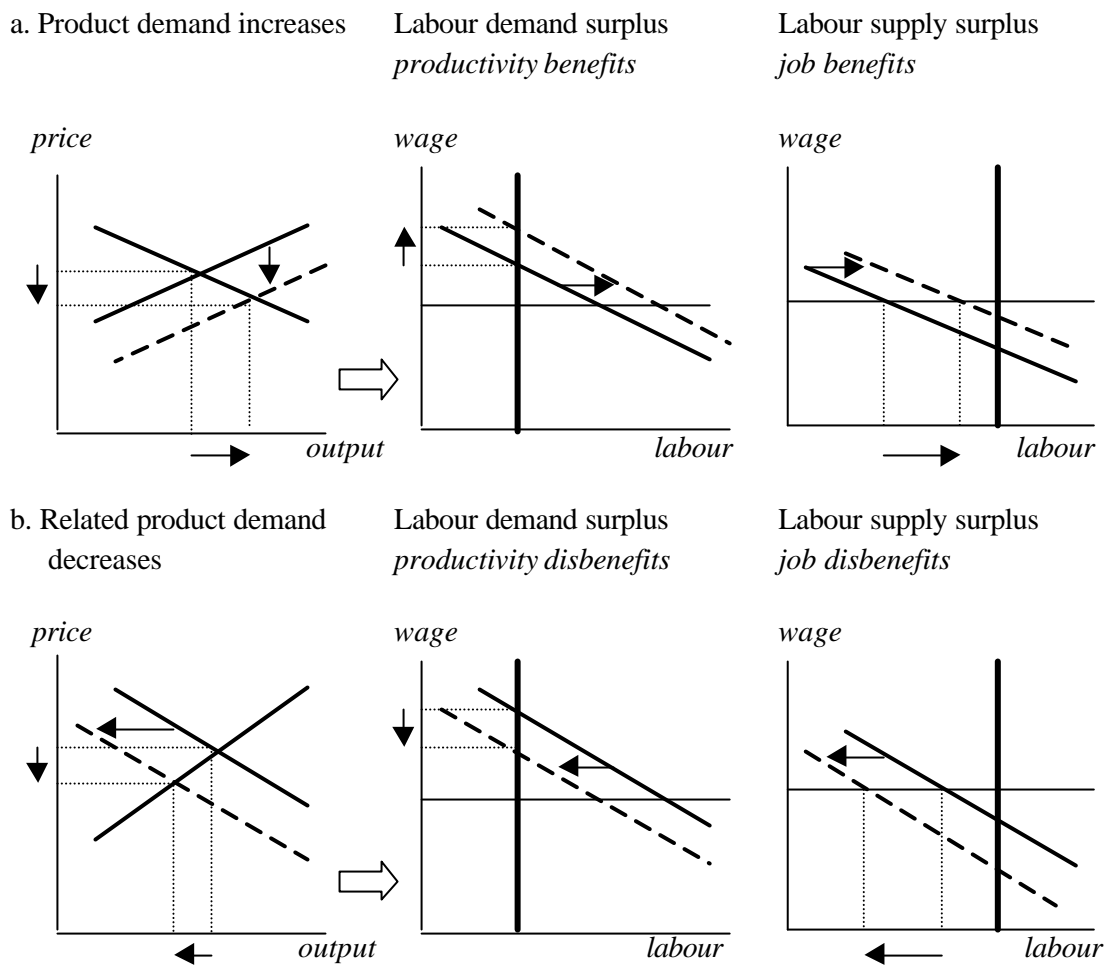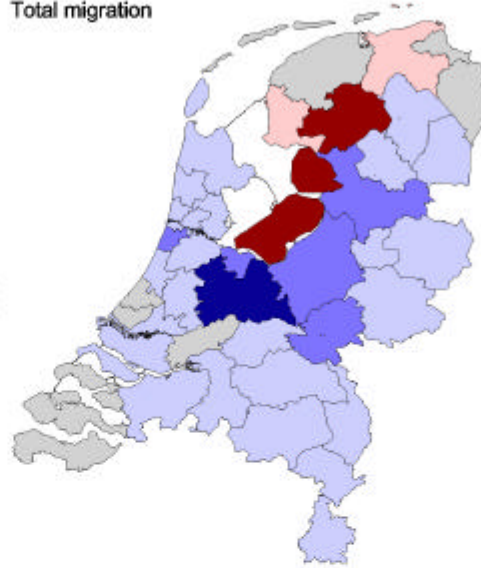
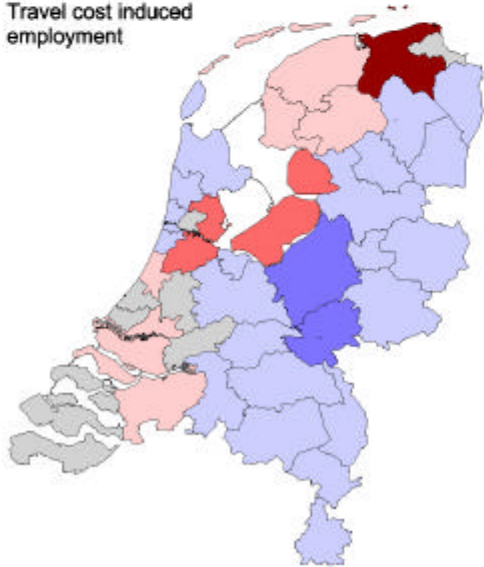Zuiderzeelijn MZM

Housing migration
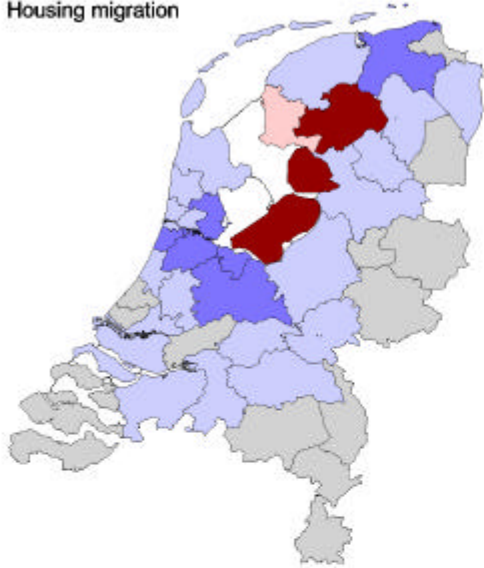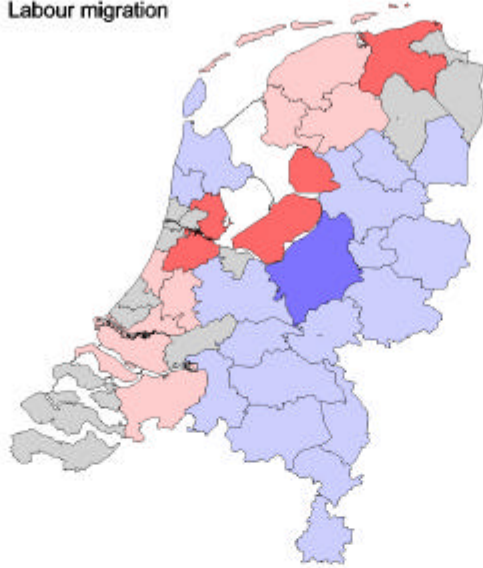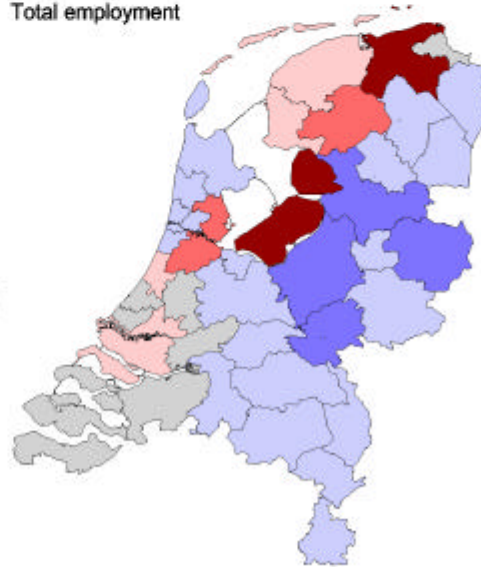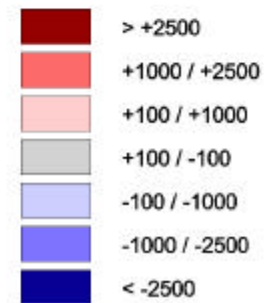
Labour migration

Total migration

Travel cost induced
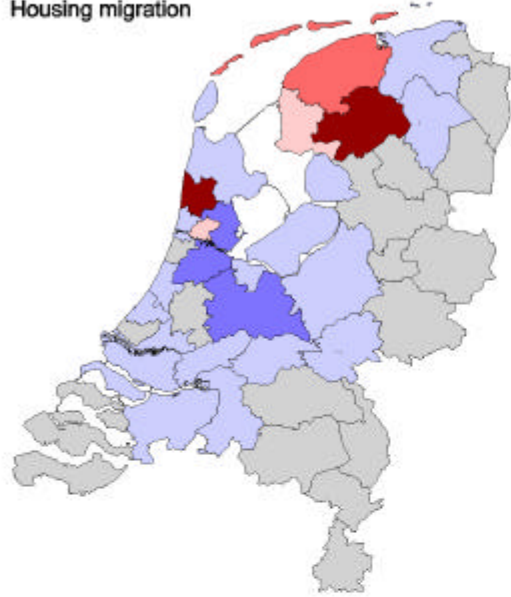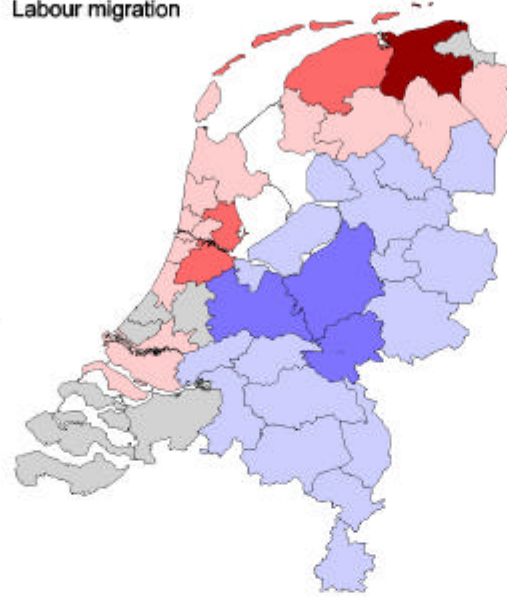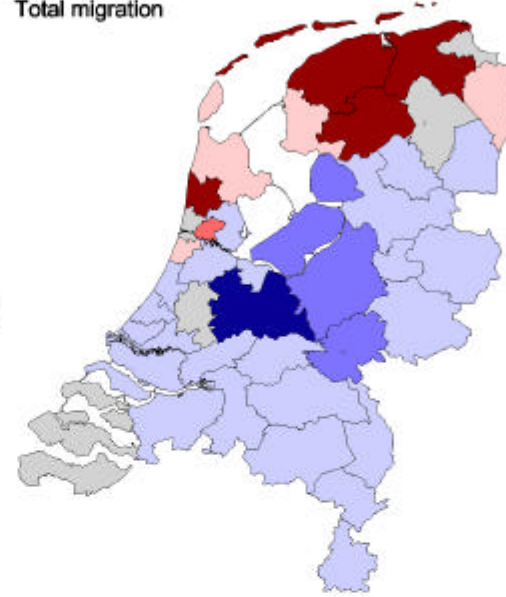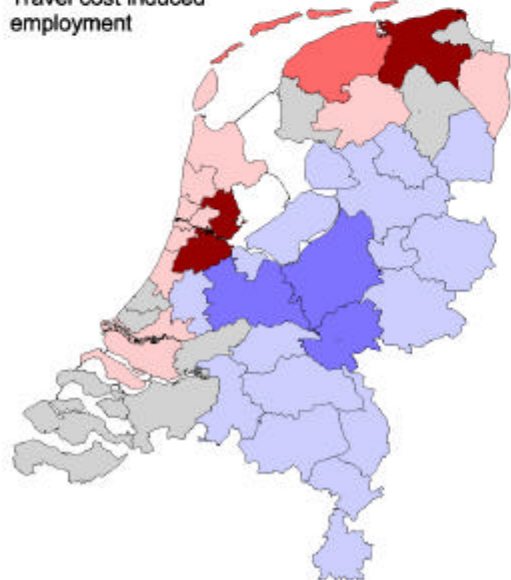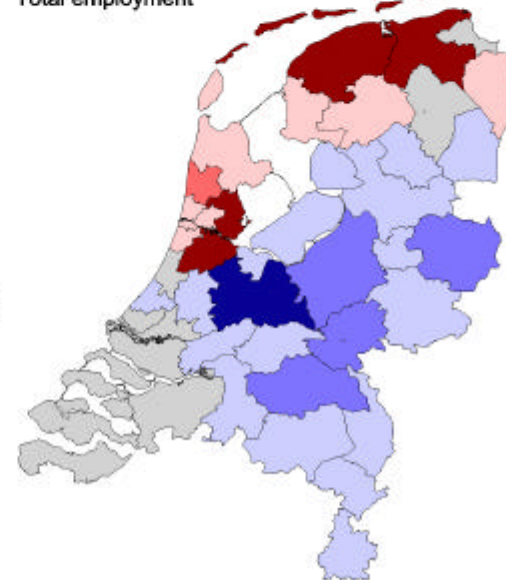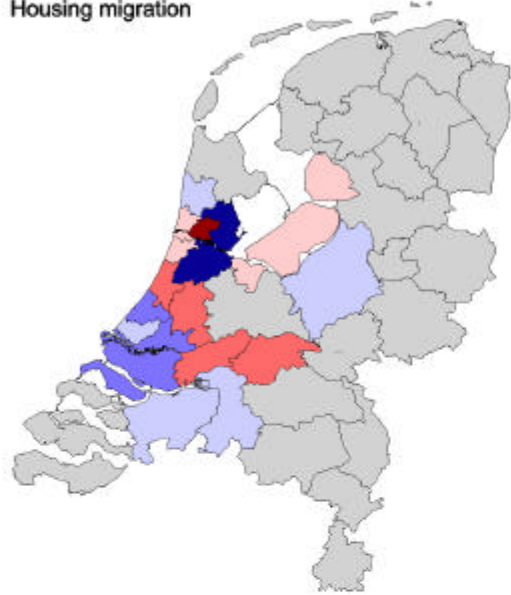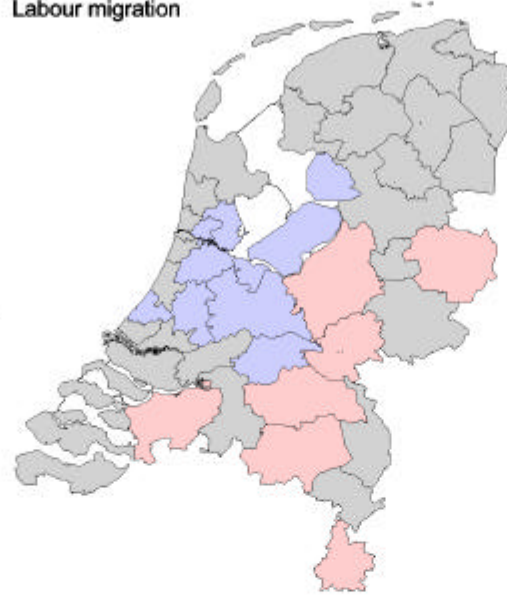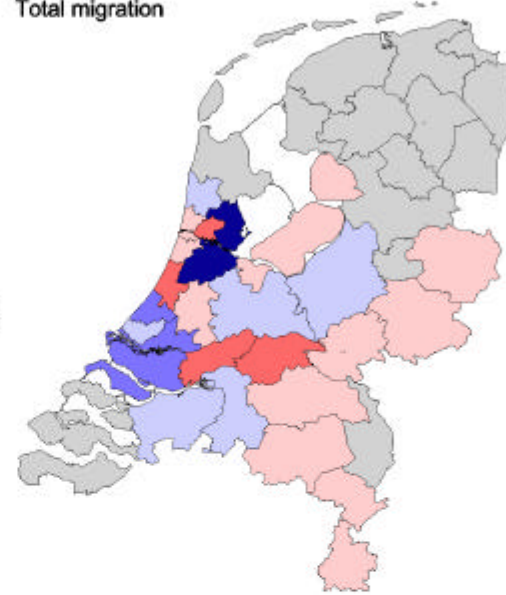employment

Consumption induced
employment

Total employment

Effect per Corop

> +2500

+1000 / +2500

+100 / +1000

+100 / -100

-100 / -1000

-1000 / -2500

< -2500

Afsluitdijk MLW

Housing migration

Labour migration

Total migration

+

=

Travel cost induced
employment

Consumption induced
employment

Total employment

+

=

Effect per Corop

> +2500

+1000 / +2500

+100 / +1000

+100 / -100

-100 / -1000

-1000 / -2500

< -2500
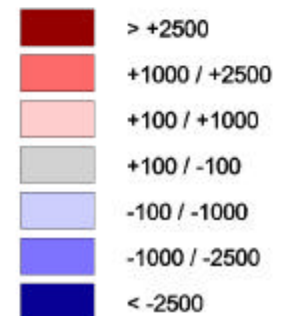
Rondje Randstad Binnenflank

Housing migration

Labour migration

Total migration

Travel cost induced employment

Consumption induced employment
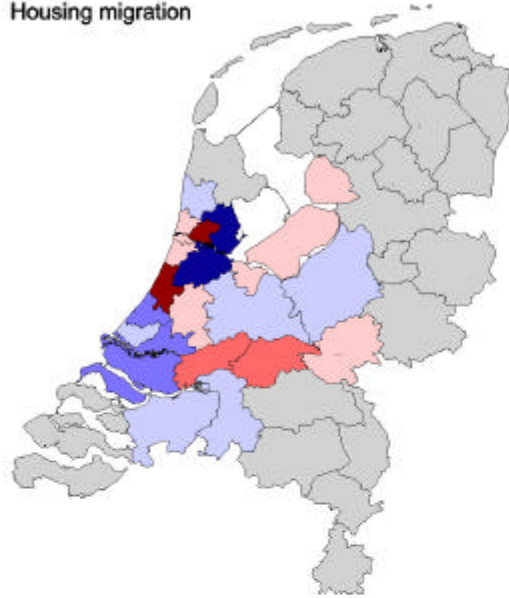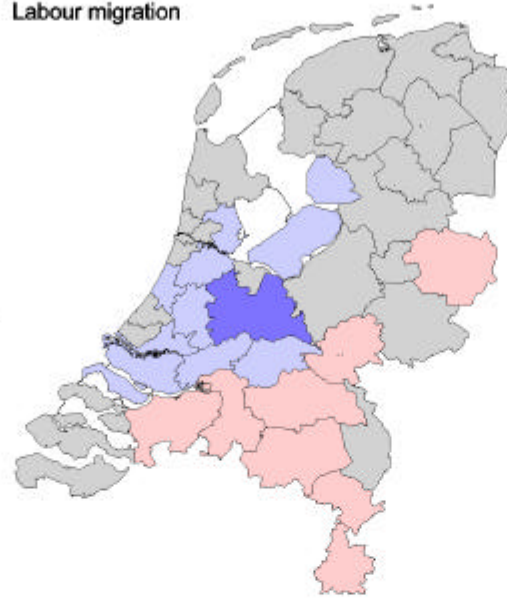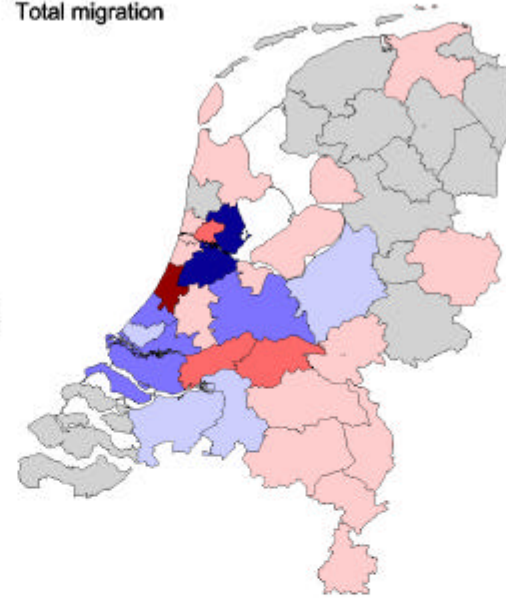
Total employment

Effect per Corop

■	> +2500
■	+1000 / +2500
■	+100 / +1000
■	+100 / -100
■	-100 / -1000
■	-1000 / -2500
■	< -2500
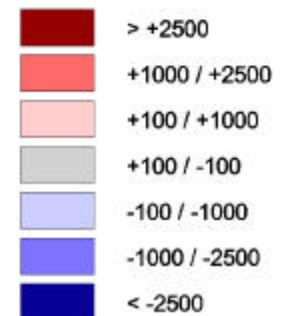
Rondje Randstad Combi

Housing migration

+

Labour migration

=

Total migration

Travel cost induced employment

+

Consumption induced employment

=

Total employment

Effect per Corop

■ (dark red)	> +2500
■ (red)	+1000 / +2500
■ (light pink)	+100 / +1000
■ (grey)	+100 / -100
■ (light blue)	-100 / -1000
■ (blue)	-1000 / -2500
■ (dark blue)	< -2500