"OFFICE SUITES SUIT THE RAILWAYS": THE EFFECTS OF OFFICE LOCATION TO PUBLIC TRANSPORT NODAL POINTS ON PASSENGER MOBILITY

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1. Introduction

Dutch location policy attempts to achieve that labour-intensive employment (large number of employees per unit area) is situated close to public transport nodal points. More than on existing employment locations, attention is focused on new situations.

Some years ago, the National Institute of Public Health and the Environment (RIVM) started a research program to establish the possible effects on mobility of a large-scale relocation of existing office employment to sites well accessible by public transport (Van Wee, 1992). Following literature surveys (Van Wee, 1993a, 1993b, 1994), empirical research was carried out (Van Wee, 1995). Employees of two offices of Rijkswaterstaat, the public works department of the Ministry of Transport, Public Works, and Water Management were surveyed. Models have been estimated which describe employees' reactions to office relocation (change of dwelling yes/no, change of job yes/no) (Van Wee, 1996a). These models have been applied in a scenario study to evaluate the effects of a large-scale office relocation over a period till 2015 to sites well accessible by public transport (Van Wee, 1996b). Van Wee (1997) gives a summary of the complete research program. This paper focuses on the spatial scenario study. The Rijkswaterstaat survey and the models will be summarised. Furthermore, two of the most important methodological issues will be dealt with: the *collection of panel data using only a single survey*, and the *incorporation* of the estimated models *into the standard Dutch National Model System* (LMS).

Section 2 gives an outline of Dutch location policy. Section 3 briefly presents the Rijkswaterstaat survey. Section 4 presents the estimated models for employees' reactions to office moves. Section 5 deals with the set-up of the scenario study. Section 6 gives a short presentation of the Dutch National Model. Section 7 deals with how the developed choice models have been embedded in the National Model. Section 8 gives the main results from the scenario study. Section 9 deals with the relevance of the results for Dutch location policy. Section 10 gives the conclusions.

2. An outline of Dutch employment location policy

Central in Dutch policy are the attributes of locations and of businesses. Two concepts are introduced: the "accessibility profile" of a location and the "mobility profile" of a firm (VROM, V & W, EZ, 1990 and Van Wee, Van Der Hoorn, 1996).

The "accessibility profile" of a location describes the accessibility by public transport and car. Also the parking facilities are part of the accessibility profile. There are three location types:

- *Location type A:* These are situated close to public transport interchanges of national or regional importance. In cities and towns with an Intercity/ Eurocity railway station, the area near the station is an A-location. Employment density is high. There are few parking facilities. For new offices a maximum of 10 spaces per 100 employees is allowed in the Randstad [1] and 20 elsewhere. Connections to the motorway system are not of prime importance.
- *Location type B:* These are situated close to public transport connections of local or regional importance, and near a major local road or motorway connection. Employment density is lower than for A-locations. There are also more parking facilities. For new offices a maximum of 20 spaces per 100 employees is allowed in the Randstad and 40 elsewhere
- *Location type C:* These are situated close to a motorway connection, in or on the periphery of urban areas. Public transport connections are of no importance and there is no upper limit to the parking capacity being provided

If necessary, by means of investment in rail (public transport) or road infrastructure, new A-, B- and C-locations can be created and the profile of existing A-, B- and C-locations can be changed.

Not all locations satisfy the ABC attributes. On these "R-locations" (rest locations) further development of employment is considered undesired.

The "mobility profile" of a firm or public service is defined as the potential use of public transport by employees and visitors. The main characteristics are:

- *Labour intensity:* the number of employees per unit area
- *Car-dependence* of the firm in performing its business
- *Visitor intensity:* the number of visitors per unit area
- Dependence upon *freight* transport by *road*

The essence of the employment location policy is to match accessibility profiles of locations and mobility profiles of firms. It applies primarily to *new* situations and not so much to existing employment locations. The employment location policy is intended to be accomplished at the regional level. The character of the accessibility profiles will differ by region or agglomeration. Co-operation between national government, provinces, and municipalities is necessary. For this the concept of "transport regions" has been developed.

Policy measures for car restraint can be distinguished into "pull" measures and "push" measures. Pull measures (incentive-based) aim to reduce the growth in car use by improving the alternatives to the private car, e.g. public transport, carpooling or the bicycle. Push measures (disincentive-based) try to reduce car mobility by making car use itself less attractive: fuel price increases, road pricing, parking restrictions. From a large body of literature (reviewed in Baanders et. al., 1991) it can be deduced that pull

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[1] The highly urbanised western part of the Netherlands including the four largest cities

measures alone are by far not sufficient to contain the growth in car use: on most spatial relations public transport, even improved, is not a competitive alternative to the car, neither with respect to time, or place, or convenience. ABC policy is part of a comprehensive policy package combining pull and push measures by both improving public transport and restraining parking.

The attention for company relocation in location policy has been limited until now. In the Netherlands every year, however, about 6-8% of firms move. In 1992 the absolute number of companies moving was 58,000, involving 180,000 employees (Pellenbarg, 1996). At least 70% of all moves is over short distance (within the same town or conurbation) (Van Steen, Van Der Velde, 1993). The question of employees' reactions is, therefore, very relevant.

3. The Rijkswaterstaat survey

3.1. Design

The survey for the empirical research was carried out among employees of two offices of Rijkswaterstaat, the public works department of the Ministry of Transport, Public Works, and Water Management. These offices moved from Rijswijk and The Hague to one central building "De Maas" in Rotterdam over about 20 km. The survey took place among all employees who worked in the department half a year before the relocation, including people who had resigned since then. This means that anticipating behaviour could be observed as well. It was known from the literature that people may already move or change job before the actual company relocation takes place.

The survey was carried out 4½ years after the office relocation. Therefore, panel data could be obtained: changes in dwelling and working locations and in person and household data are available over a period of 5 years. Because collection of true panel data over a period of 4 ½ years would have been awkward, retrospective questioning has been used instead. The advantage is that data collection is relatively cheap and that data are readily available. The disadvantage is the chance of selective non-response: employees who have changed employer as well as dwelling are difficult to trace. In this study, it was possible to obtain practically all the addresses of "lost" employees via former colleagues.

To the survey data, network data for car and public transport were added. These concern travel distances and travel times between various living and working locations before and after the office relocation. Using these, it can e.g. be evaluated whether a short commuting distance (before the office relocation) increases the probability of moving together with the employer.

3.2. Results of the Rijkswaterstaat survey

More than half (58%) of the respondents has not moved and has stayed with the same employer. About one quarter (23%) has moved, but has stayed with the same employer. 8% Has changed employment, but has not moved. 6% Has both changed employment and dwelling. 4% Has stopped working; of these people only 1 has moved. Change of employment is often accompanied by a change of dwelling, but normally not as a consequence of an office relocation.

Many respondents have moved within the same residential area. Only a small part has moved towards the new office location. Therefore, even after 4 ½ years, the relocated offices are still situated ex-centric with respect to the dwellings of employees. Employees having changed job have on average about the same commuting distance as before the change.

Spatial behaviour (change of dwelling yes/no, change of job yes/no) is related to a large number of *person and household* variables (like income, age and household size), to various characteristics of the *transport system* (like the commuting distance before the office relocation and the degree to which employees' commuting distance would increase due to the office relocation without changing residential location), and to *interactions* between variables.

4. Models for employees' reactions to office relocation

To evaluate the effects of a relocation of employment, one can use a "traditional" transport model (like the National Model (LMS) of the Ministry of Transport (Bovy et.al., 1992)). Because such a model is usually based on cross-sectional data, it calculates the long term equilibrium situation between demographic, economic, and spatial developments. To account for the medium-term effects (about 5 years after an office relocation), employees' reactions have been modelled using the survey data base. The resulting models are intended to be embedded in and to enhance traditional models. Two types of models have been estimated:

- ❑ A model which describes the reaction type of workers when confronted with an office relocation (change of dwelling yes/no, change of job yes/no)
- ❑ A model which describes whether employees changing dwelling and not changing job will move within the same residential area (because of life cycle reasons) or to another residential area in the direction of the new job location.

The models contain person and household variables and level of service variables. Especially important appears to be the degree to which employees' commuting distance would increase due to the office relocation in the event that they would not change residential location.

The model describing the reaction type of workers when confronted with an office relocation (change of dwelling yes/no, change of job yes/no) is given in Table 1.

Table 2 gives the model that describes whether a worker who changes dwelling but not employer will move within the *same* residential area or to *another* residential area, in the direction of the new work location. Only workers who would be disadvantaged by a distance of at least 14 km (when not moving and changing job) are considered to have a choice to move to another residential area. In other words: moving workers having a disadvantage of 14 km or less, by definition (in the model) move within the same residential area.

For those workers moving to another residential area, in the direction of the new office location, a new dwelling zone has to be established. This has been done using an algorithm deduced from the Rijkswaterstaat survey: there were not enough observations to estimate a model.

Table 1: Model for reaction type

Choice alternative	*variable*	*class*	*value of parameter*	*stand. deviati on*	*t-value*
1 not moved; same employer					
1	constant		3.352	0.758	4.4
1	age	=< 45 year	-2.275	0.634	-3.6
1	education	=< mulo, mavo (high school)	1.905	1.07	1.8
2 not moved; other employer					
2	constant		-0.139	0.536	-0.3
	income	< Dfl 37.000	-1.111	0.655	-1.7
3 moved; same employer					
3	constant		0.126	0.539	0.2
	income	Dfl 37.000-51.000	1.020	0.355	2.9
3	household situa-tion	single, living with parents	1.122	0.389	2.9
3	education	=< mulo, mavo (high school)	1.733	1.11	1.6
3	difference in car distance	advantage; or less than 10 km disadvantage	-0.969	0.376	-2.6
4 moved; other employer					
4	income	Dfl 37.000-51.000	0.458	0.568	0.8
4	education	mbo, havo, vwo (senior high school)	-2.140	1.06	-2.0
4	difference in car travel time	<10 min	-0.986	0.574	-1.7

Number of cases:		217
Number of times chosen:		
	alternative 1:	129
	alternative 2:	20
	alternative 3:	53
	alternative 4:	15
Initial log likelihood:		-300.82
Same with constant:		-229.56
Final log likelihood:		-198.30
Rho square w.r.t. zero coefficients:		0.34
Same w.r.t. model with just constants:		0.14

Table 2 Model for the probability of moving to another residential area for workers who do change dwelling, but do not change job

variable	*class*	*value parameter*	*standard deviation*	*t-value*
commuting distance	0-8 km (auto)	0.451	1.11	0.4
interaction term[1)]	1	-2.357	1.02	-2.3
constant		-0.273	0.924	-0.3
likelihood 0-coefficients			-21.48	
likelihood only constants			-16.55	
final likelihood			-13.45	
Rho square w.r.t. 0-coeff.			0.374	
Rho square w.r.t constants			0.187	

1) The interaction term is either 0 or 1. If net income is Dfl 37,000-51,000 AND education level is at least HBO (polytechnic), then its value is 0, in all other cases it is 1.

5. A spatial scenario for relocation of office employment

A scenario for 2015 was evaluated, in which in essence 50% of Dutch employment at C- and R-locations is transferred to A- and B-locations. Basis for the expected socio-economic development is the European Renaissance (ER) scenario of the Dutch Central Planning Bureau (CPB, 1992). Of course, not all employment is eligible for transfer. Therefore. retail employment and agricultural employment are excluded. Also, particular rules have been defined to select plausible A- and B-locations as destinations for the transfer. The maximum distance over which transfer of firms takes place is 20 km. The resulting scenario has been submitted for comment to the Spatial Planning Agency (RPD) of the Dutch Ministry of Housing and the Environment (VROM), to assess whether "impossibly high" concentration of employment could arise. This appeared not to be the case, although higher land costs could result. The total number of transferred jobs is 796 thousand, or 12% of all jobs in the ER scenario. The scenario is suitable for sketch planning purposes, but not for detailed forecasting and policy evaluation, having insufficiently fine detail at the regional level. Because the choice models were estimated on a survey giving the reactions of workers after 4 ½ after the office relocation, it is implicitly assumed that the firms are transferred in (a suitable interval around) 2010.

6. The Dutch National Model System (LMS)

By the design of the National Model System (LMS) in the mid-eighties an integration has been achieved between state-of-the-art disaggregate modelling and techniques for building complete aggregate origin-destination (O-D) matrices. The LMS consists of a series of submodels, each of which is based on model structures compatible with rational individual (and household) decision making, and which are calibrated using disaggregate data on individuals and households. The main contractor for development of the LMS has been Hague Consulting Group (HCG).

The main parts of LMS will be described below.

1. *Prototypical Sample NSES*

The prototypical sample is a sample of roughly 1000 households from the Netherlands National Travel Survey. In this sample 44 household categories, based on the household size, the number of members employed, the number of women employed and the age of the head of the household, are represented. Based on the characteristics of each household and its members, expansion factors are calculated for each household - category for both the base year and the forecast year so that the total expanded sample matches a number of target values corresponding to the base year and to the demographic/economic scenario in the forecast year of interest. The sample is used successively for each of 345 zones covering the Netherlands.

2. *Disaggregate models of household driving license holding and car ownership*

Logit models were estimated to predict the number of licenses in every household in the prototypical sample. The number of cars owned in every household in the sample is computed using the same kind of logit models. The totals of license holding models and car ownership models are constrained to national totals derived from other sources.

3. *Tour frequency models*

Based on purpose designed surveys, using both cordon/screenline data and household interviews, models were estimated for the frequency of making journeys for various purposes. These models are applied to each person in the prototypical sample.

4. *Mode and destination choice models*

The aim of the mode and destination choice models is to predict the distribution of tours over possible combinations of destinations and modes. To improve the estimates of local accessibility this model uses greater geographical detail for its calculations. The Netherlands is divided in 1302 subzones. The results of this model are conditional on the outcome of the license holding and car ownership models.

Using the results of the mode and destination choice models forecasts can be made of changes in the mobility patterns in the Netherlands.

5. *Assignment*

Forecasts of network use are made using the base matrices. Using growth factors derived from the application of the other models for both base year and forecast year and using exogenously derived growth factors for freight traffic, matrices are derived for the forecast year.

These matrices are assigned to the network using a capacity restraint assignment algorithm that takes account of both a possibly restricted inflow on a link due to congestion and restricted outflow capacity due to congestion on downstream links (blockade) (Bakker et al., 1994).

Congestion and period specific pricing policies affect the traveller's choice of departure time through the time-of-day model. This model was estimated using Stated Preference data. Using a feed back loop the effects of congestion on mode and destination choice are also modelled.

7. The embedding of the developed choice models into the National Model

First, forecasts are made using the standard LMS for the reference situation 2015, without relocation of employment. In this step, reference O-D matrices fur the purpose "commuting" are derived. Hence, for each zone, the origins (dwellings) and commuting times by mode of people working in that zone are known. Next, job locations are transferred according to the spatial scenario chosen. For the job locations transferred, the spatial behaviour of workers is evaluated using the explanatory variables (including the level of service variables) and the models developed in the study. Once new dwellings and work locations are known, new O-D matrices can be derived. The rules for assignment of new dwelling zones and employment zones to people with various reaction types are given in Table 3

Table 3: Assignment in the scenario of new dwelling and job location zones after office transfer

	Reaction type	Dwelling assignment	Job location assignment
1	Not moved, same employer	New dwelling location = old dwelling location	Take as new commuting destination the zone where the office has been transferred to
2	Not moved, other employer	New dwelling location = old dwelling location	New job location = old job location [a)]
3	Moved, same employer		
3 (A)	*Small* reduction of commuting distance (10 km or less)	New dwelling location = old dwelling location	Take as new commuting destination the zone where the office has been transferred to
3 (B)	*Large* reduction of commuting distance (10 km or less)	Determine new dwelling location as described in text	Take as new commuting destination the zone where the office has been transferred to
4	Move, other employer	New dwelling location = old dwelling location	New job location = old job location

a) The commuting distance in the new situation is practically the same as that in the old situation, see Van Wee (1995), p 276-277

In the case of a *new dwelling* location (reaction type 3(B)), the procedure is as follows. From the Rijkswaterstaat survey it appears that the new dwelling location of employees who have moved is on average situated about 7.5 km from the new job location. Hence, the dwelling locations are assigned to the LMS subzones surrounding the work zone in such a way that the average distance (weighted by number of houses) to the work zone is 7.5 km. To keep the total number of households constant, some existing households have been "removed" from those zones where other households have moved to. Likewise, "new" households have been "added" to those zones where moving households have departed from. These "added" households are assumed to have the same characteristics (employment location, commuting travel mode, etc.) as the households already living in the zone.

The ABC parking restrictions from the Dutch location policy are also assumed to be applicable to the transferred job locations. This means that the number of parking places increases proportionally to the number of jobs. The modal split has been left unchanged for every O-D relation, although in reality (marginal) changes might occur due to changed congestion levels on trunk roads[2]. The choice of an alternative parking location is considered as a separate travel mode.

Given the procedures for use of the prototypical sample NSES, various person and household data are not available in the computer at the moment that the spatial choice models for employees' reactions to office relocation are in operation. It is, therefore, assumed that the labour force is distributed uniformly over the Netherlands. In other words: employees of transferred firms in e.g. Amsterdam have the same distribution over e.g. age, income, education as employees of transferred firms in e.g. Groningen (in the north of the country).

As explained in section 4, the spatial choice models for employees' reactions to office relocation describe behaviour in the *medium term*, because they take account of lags in behaviour. The results can be compared with the normal results from the standard application of the LMS for the *long term*. In this case, standard application of the LMS means that job locations are transferred to sites well accessible by public transport. This causes the zonal attraction variables in LMS to change. The next step is the application of the standard (cross-sectional) suite of the tour frequency and distribution/mode split submodels.

8. Results

The assumed office relocation has effect especially on commuting travel, although other travel purposes are also influenced. In this paper, only results for commuting travel are given. See **Table 4**.

From the Table, it appears that the spatial scenario increases total kilometrage (all travel modes) in the long term equilibrium situation by 2.4%. The calculated increase over the medium term, using the models for employees' reactions to office relocation is 3.2%. This is logical: the pattern of living and working locations will adapt itself only in the long term. In the medium term most workers do not move together with their employer. Therefore, the firms transferred are situated in first instance (i.e. in the medium term) ex-centrally with respect to their employees. Furthermore, it appears that the kilometrage as car driver reduces both in the medium and in the long term, and

[2] Hence, the LMS submodels themselves are not used in the evaluation of the land use policy measures in the scenario. These submodels are only used to derive the reference O-D matrices for the base situation without land use policy measures.

that the kilometrage by other modes increases. The increase for the slow modes is smaller than that for car passenger and public transport.

From the Table it is also clear that the effects in the medium term are markedly different from those in the long term. For example the reduction in car kilometrage is 4.0% in the long term, but only 1.3% in the medium term, using the models for employees' reactions to office relocation. Likewise, the increase of the slow modes in the long term (4.5%) is much larger than that in the medium term (1.8%).

Table 4 Kilometrage commuting traffic per scenario (2015)

Travel mode	Index unchanged policy	Transfer of employment: LT effects (index w.r.t. unchanged policy)	Transfer of employment: MLT effects (index w.r.t. unchanged policy)
Car driver	100	96.0	98.7
Car passenger	100	116.6	117.0
Public transport	100	117.2	113.2
Slow	100	104.5	101.8
TOTAL	100	102.4	103.2

Unchanged policy:	European Renaissance scenario, current government policy
Transfer of employment:	LT effects: transfer of employment, long term equilibrium situation as calculated by LMS
Transfer of employment:	MLT effects: transfer of employment, medium term situation, as calculated by the spatial choice models for employees' reactions to office relocation developed in this study

The effects of the spatial scenario, at first glance, seem limited. The effects, however, are expressed relative to the total journey to work kilometrage in the Netherlands. Therefore, it can be inferred that by transferring (only) 12% of employment, car kilometrage is reduced by 1.3% (in the medium term). In the long term the reduction is (even) 4.0%. The share of the transferred employment in total car kilometrage is 13% and, therefore, a bit higher than the share in total employment of 12%. This is because mainly firms at C and R locations are involved , which have a relatively high share of car use. The calculated reduction of car use in commuting of the employees concerned is 10% (medium term) to 31% (long term).

9. Relevance for location policy

The results of the spatial scenario raise the question whether policies aimed at transfer of jobs to locations well accessible by public transport should take account of lags in reactions of workers. These lags have different effects in the medium term and in the long term: often the effects are larger in the long term. The effects of spatial policy may take years to materialise. If we focus exclusively on the long term, we may overestimate the effects of spatial policy. It is even questionable whether the long term equilibrium will ever be reached. For many spatial and infrastructural measures, continuous disequilibrium may more often be the rule than long term equilibrium. Given the dynamics in the office sector for example, firms might already have moved once again, before the long term equilibrium has been reached.

What recommendations can be made from the results of the study? The general picture is that transfer of offices to locations well accessible by public transport may cause substantial reduction of car use and substantial increase in public transport use, certainly in the long term. We believe, however, that no policy of "force" should be used. The costs of transferring firms may be very high and may not be in proportion to the benefits for accessibility and the environment. It may be more prospective to find firms which have already plans to move (see Heidemij, 1991). Likewise, to firms situated at C and R locations the advantages of a railway location could be presented. Once these firms are prepared to move, "tailor-made" measures can be designed to stimulate them to relocate to A or B locations. The (future) availability of capacity (land, office buildings) is a necessary condition, to be fulfilled by anticipating spatial policy. Also, improvements in public transport and bicycle infrastructure will play a role, and possibly subsidies. Finally, the quality of the railway station environment is important. This can be improved by preventing mono-functionality (work only) and by situating also housing and amenities (especially retail shops and restaurants) near railway stations. Liveliness and objective and subjective safety would be improved and the contrast with the neighbouring historical city centre reduced. One may think of buildings where the lower floors are used for retail shops and restaurants, the middle floors for apartments, and the top floors for offices. We think that discussion between government and private sector and an information system for requirements and potentials for relocation are more important than just a jar with "money". In some instances, however, money can act as a lubricate.

10. Conclusions

Dutch location policy tries to get "the right firm at the right location". The attention for office relocation has, however, been limited until now. Every year, however, about 6-8% of firms move. The number of jobs involved in office relocation every year is relatively large (1992: about 180,000. A large majority of these moves is over short distance (about 70% within the same conurbation). More attention for office moves is, therefore, desirable.

In the case of an office relocation over about 20 km or less the overwhelming majority of workers does not change employer and does not move or only moves within the same residential area. Therefore, in evaluating the effects of employment relocation, one has to estimate explicitly the (lagged) effects on employee behaviour in the medium term, to be able to evaluate the full effects on mobility. It is not sufficient to deal with the "long term equilibrium situation". If one focuses exclusively on the long term, one may overestimate the effects of spatial policy. It is even questionable whether the long term equilibrium will ever be reached. For many spatial and infrastructural measures, continuous disequilibrium may more often be the rule than long term equilibrium. Given the dynamics in the office sector for example, firms might already have moved once again, before the long term equilibrium has been reached.

Using a limited number of cases it has been shown to be feasible to develop and estimate spatial choice models for employees' reactions to office relocation over distances of up to 20 km (change of dwelling yes/no, change of job yes/no). The models contain person and household variables and level of service variables. Especially important appears to be the degree to which employees' commuting distance would increase due to the office relocation in the event that they would not change residential location.

When panel data are desirable, but when it is impossible to interview households on several occasions, retrospective questioning can be used instead. The advantage is that data collection is relatively cheap and that data are readily available. A necessary condition, however, is a good record of households in the before-situation and a good tracking system for categories of households which have a relatively high probability of non-response.

The estimated models have been fairly easily incorporated into the standard Dutch National Model System (LMS). The models have been applied in a scenario study to evaluate the effects of a large-scale office relocation over a period till 2015 to sites well accessible by public transport. The results are highly dependent upon whether the lagged reactions of employees to office relocation are explicitly dealt with. The effects upon car kilometrage, for example, are three times as large in the long term equilibrium situation than in the medium term situation, where the lagged reactions are taken into account.

A scenario for 2015 was evaluated, in which in essence 50% of Dutch employment at C- and R-locations is transferred to A- and B-locations, well accessible by public transport. Car kilometrage of employees affected reduces by 30% in the long term, but only by 10% in the medium term situation, when lagged reactions are taken into account.

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