A model of internal firm relocation in the Netherlands

Draft version please do not quote

Corina Huisman[1]
and
Leo van Wissen[2]

Paper prepared for ERSA conference "Land Use and Water Management in a Sustainable Network Society", Amsterdam, 23-27 August, 2005

[1] Netherlands Interdisciplinary Demographic Institute (NIDI), the Netherlands
P.O.Box 11650
2502 AR The Hague
The Netherlands
e-mail: huisman@nidi.nl

[2] Faculty of Spatial Sciences, University of Groningen, the Netherlands
P.O.Box 800
9700 AV Groningen
The Netherlands
e-mail: l.j.g.van.wissen@frw.rug.nl

Abstract
A model of internal firm relocation in the Netherlands

This paper presents a model of internal relocation of firms in the Netherlands. Firm relocation is driven both by firm internal factors, such as growth, age, and type of activity, as well as external factors, relating to the business cycle, the geographical environment, the composition of the labor force, and the composition of the firm population, as well as linkages with other firms. Using a unique longitudinal database of firms in the Province of Gelderland in the Netherlands, we specify and estimate a model of firm relocation.

Keywords: firm demography, relocation, glm, firm migration

Introduction

This paper deals with the relocation of firms in the Netherlands. The main question is which firms, by what characteristics, decide to move.

The background of this paper lies in the development of a micro-simulation model for the population of firms in the Dutch province Gelderland. This model is supposed to be a demographic model: each firm has probabilities of giving birth to new firms, of dying, of relocation and of growing or shrinking, and thus altering the population of firms, and the spatial distribution of this population.

In earlier papers we already dealt with some of these events. Growth and shrinkage was discussed, using Gibrat’s Law, in a paper presented at the ERSA conference of 2003 in Jyväskylä (van Wissen and Huisman, 2003). Mortality was analyzed following an APC model and presented in Porto (Huisman and van Wissen 2004b). Agglomeration effects of firm start-ups and closures were analyzed following a statistic developed in the field of epidemiology (Huisman and van Wissen 2004a).

1 Framework and model

There is a substantial body of literature dealing with the analysis and modelling of firm relocation (for a recent literature review see e.g. Pellenbarg et al., 2002). Factors influencing the relocation decision in the literature are often grouped into three main categories: internal factors, external factors and location factors (Lloyd and Dicken 1992, van Dijk en Pellenbarg 2000; Brouwer et al., 2004). Firm internal factors are firm size (usually measured in terms of the number of workers), firm age, organizational structure, and type of economic activity. Firm external factors are labour market conditions, the economic business cycle, and the institutional environment, that includes government policies, rules and laws, as well as entrepreneurial culture. Traditional location factors include: availability and size of premises, accessibility, parking facilities (see also Holl, 2004). Moreover, agglomeration economies may be important locational factors as well. Here, a distinction between urbanization and localization economies is relevant. The notion that diversity, which are typical of urbanization economies, is important dates back to Jacobs (1969) who highlighted the advantages of diversity for knowledge spillovers. Over time, the characteristics of each of these factors may change, leading to a re-evaluation of the present location, and possibly to a decision to relocate.

From a demographic point of view, the relocation decision may be put in a life course or life cycle approach of the firm. Firm internal factors can be related to the ‘life cycle’ of the firms (van Dijk en Pellenbarg, 2000). Initially the production plant is small and produces at relatively high costs and can sell the product at relatively high prices. This may, for instance, permit a location in an environment serving a productive firm nursery. When the product and the firm become mature, the firm will grow. This may imply the change to another production technique, with another mix of inputs, to reduce the cost by means of utilizing economies of scale and/or of other agglomeration economies. It is likely that this also implies that another location with a larger space, better access to input and better access to markets is now the optimal location. Although for firms with many products in different stages of the product life cycle the relation between the product life cycle and the firm life cycle is less obvious, these firms may also adopt a policy of growth. In that case the firm life cycle may also lead to changing needs with regard to the location. Cities may serve as incubators or nurseries, suburbs for 'teenage' firms, whereas hinterlands are possibly attractive for mature production plants."

It is convenient to decompose the relocation process in a decision to move (yes or no) and conditional on this decision, the choice to which location. This is in line with the distinction between push/keep factors (reason to leave or to stay), and pull factors (attraction of other premises) (Van Dijk en Pellenbarg, 2000) Here we will study the first decision of moving or not.

The main challenge of studying firm migration from a demographic point of view is to be able, not only to describe and understand what is taking place, but to explain it in terms of a model and thus be able to predict the phenomenon on the basis of the expected development of its causal factors (especially in the context of micro-simulation).

In this paper, the relocation model is presented as a special case of a generalized linear model (GLM). The number of migrants is a random variable associated with a stochastic process. Model fitting consists of three interrelated steps, following McCullagh and Nelder (1989); (i) model selections (model specification or identification); (ii) parameter estimation; and (iii) prediction.

The model relates the outcome of the random process to the parameters of the process. The outcome is the number of events (migrants) in a particular time interval. In this paper, we study the trend in migration rates, defined as the ratio of the numbers of migrants and population at risk. The number and types of parameters are determined by the type of data that are available. One parameter is associated with each age, and period. Models selected to represent the data belong to the family of generalized linear models (GLMs). An important characteristic of GLMs is that they assume independent observations. In case of non-independence, the variances will be larger than in the case of independent observations. It is assumed that migrants are generated by a Poisson process; hence the observed numbers of migrants follow a Poisson distribution. The Poisson assumption is justified when the migration rate is low. In that case the Poisson assumption is an adequate approximation of the binomial distribution, which describes binary response data. The dependent variable is the migration rate, which is the ratio of the number of migrants and the total duration during which the population is exposed to the risk of migrating. Since the exposure varies with the migration rate, both the numerator and the denominator of the migration rate are random variables and are interdependent. The dependence complicates the analysis substantially. Therefore it is generally assumed that the denominator is fixed, i.e. independent of the number of migrants. If the migration rate is small, the assumption is realistic.

A major problem in model selection is the choice of variables to be included in the systematic part of the model. The strategy adopted in this paper is to associate one parameter with each age and period category.

Let n_{xt} denote the observed numbers of migrants of age x, and period t. Let N_{xt} denote independent random variables having Poisson distribution with positive parameters λ_{xt}. λ_{xt} is the product of the migration rate and the duration of exposure to the risk of relocating in year t by an individual of age x, which is assumed to be fixed (L_{xt}). The true value consists of two components: a systematic component, predicted by the model to be specified, and a random component. To be precise, the random component must be separated into two parts. One is a part due to our ignorance, i.e. the absence of a complete observation; the other part is due to the fact that the outcome of any random process is inherently uncertain even if we have all the necessary data to predict the outcome. No distinction between the two parts is made in this paper.

Let λ_{xt} denote the systematic component and ε_{xt} the random component. The model is:

$$n_{xt} = \lambda_{xt} + \varepsilon_{xt} \qquad (1)$$

With $E(n_{xt}) = \lambda_{xt}$
$E(\varepsilon_{xt}) = 0$.

The parameter λ_{xt} of the Poisson distribution and λ_{xt} are assumed to satisfy a model that is log-linear in a set Θ of unknown parameters. One parameter is associated with each of the ages and periods. The systematic component is

$$\lambda_{xt}=L_{xt}\kappa\alpha_x\beta_t \exp \gamma Z_{xt} \qquad (2)$$

where $\Theta = \{\kappa, \alpha_x, \beta_t, \gamma\}$, γ being a k-length vector, L_{xt} is the duration of exposure assumed to be given, and Z_{xt} is a vector of covariates $Z^{(k)}{}_{xt}$, k=1,..,K. Model (2) is the multiplicative formulation of the log-linear model. The additive formulation is obtained by taking the natural logarithm of both sides. In that case, the ln of the dependent variable is linear in the parameters.

The unknown parameters must be determined from the data. This may be done using the method of maximum likelihood. To evaluate the goodness of fit of the model, we compare the likelihood achieved by the current model to the maximum of the likelihood achievable (i.e. the likelihood achieved by the full model). The logarithm of the ratio is known as the scaled deviance. The deviance is proportional to twice the difference between the log-likelihoods:

$$S(n, \lambda) = -2 \ln [L(\lambda,n)/L(n,n)] = 2[\ln L(n.n) – \ln L(\lambda,n)] \qquad (3)$$

Large values of S indicate low values of $L(\lambda,n)$ relative to the full model, increasing lack of fit. For the Poisson distribution, the deviance is

$$S(n,\lambda) = 2\sum_{xtc} \left[n_{xtc} \ln(n_{xtc} / \lambda_{xtc}) - (n_{xtc} - \lambda_{xtc}) \right] \quad (4)$$

If a constant term Ø, which is known as the nuisance parameter, is included in the model it is generally the case that $\Sigma(n_{xt}-\lambda_{xt}) = 0$ so that

$$D(n,\lambda)=S(n, \lambda)\ Ø \quad (5)$$

may be written in the more usual form of the log-likelihood ratio which is often used as a test in the analysis of contingency tables

$$D(n,\lambda) = 2\sum_{xt} n_{xt} \ln(n_{xt} / \lambda_{xt}) \quad (6)$$

In order to determine the unknown Θ parameters with maximum likelihood, we need to maximize the log-likelihood function with respect to the parameters. This results in a set of normal equations that need to be solved for the unknown parameters. The R package, which uses generalized weighted least squares, was applied. The weights are inversely related to the variances of the estimates. The algorithm uses the Fisher's scoring method and the Newton-Raphson method reduce to the same algorithm.

The expected migration rate may be written as follows:

$$\lambda_{xt} / L_{xt} = \kappa \alpha_x \beta_t \exp\gamma Z_{xt} \quad (7)$$

where the parameters are restricted as follows: $\alpha_1=1$ and $\beta_t=1$ and κ is an overall scale parameter. Alternative restrictions may be used.

3 Data

The PWE register of business establishments

The data used in this paper were obtained from the PWE (provincial employment inquiry) register of business establishments in the province of Gelderland (the Netherlands), which was provided by the Province of Gelderland. The PWE is a regional subdivision of LISA (National Information System Labour Markets). LISA was originally set up as an administrative register for the implementation of social security laws. Currently it is a main source for socio-economic and spatial-economic analysis in the Netherlands. The PWE register holds information on all business establishments in Gelderland, where paid work is being performed. Besides firm establishments the PWE register also holds information on governmental establishments, educational establishments, public health services and establishments for free professions.

The basic unit in the PWE register is an establishment, which is defined as "a location of a firm, institute, or free profession (i.e. any factory, workplace, shop or other working accommodation, or a complex of these) in which or from where an economic activity or independent profession is performed by one or more employed persons (at least one person for 12 hours per week)".

Numbers of firms

For our research we were provided with PWE-data from 1986 up to 2002. Table 1 shows the number of establishments and number of employed per year.

Table 1: Number of establishments and number of employed in the province of Gelderland, 1986-2002.

Year	Number of establishments	Number of employed (including part-time and agency staff)
1986	70,756	594,454
1987	71,887	608,595
1988	73,437	622,755
1989	73,242	637,286
1990	75,791	664,845
1991	76,609	696,554
1992	79,755	713,957
1993	81,749	722,556
1994	86,766	732,106
1995	90,375	751,207
1996	93,527	772,599
1997	96,113	795,361
1998	99,631	829,524
1999	102,855	856,658
2000	104,051	874,665
2001	105,693	892,064
2002	106,334	892,400

During the period 1986-2002 both the number of firms and the number of employed in Gelderland grew with fifty percent, or 2.6 percent per year. On average each establishment employed 8.5 persons (including part-time and agency staff).

The PWE files contain a lot of information per establishment. In this paper we used the following variables:

- SBI'93 code (5-digit);
- Age of the firm at the time of migration;
- Year of migration (change of 4-digit postcode);
- Number of employed (including part-time and agency staff);
- Number of employed in the year prior to migration;
- Whether or not a firm is located in the Economic Main Structure (EMS) of the province;
- Whether or not a firm is located on an industrial park;
- The type of establishment (head office, subsidiary etc.).

SBI'93 is the Dutch version of the 1993 European classification of economic activities. The European classification is called "Nomenclature générale des Activités économiques dans les Communautés Européennes (NACE)". The first four digits of SBI'93 correspond with the NACE. For national applications a fifth digit has been added (CBS, 1993). For the current analysis establishments were grouped into 4 main economic sectors. A list of the codes is given in the Appendix. Figure 1 shows the development of the number of firms by sector in the period 1986-2002. In 1986 the sector with the largest share of firms was the trade sector (33.7%). The share of firms performing activities in this sector decreased to 28.4 percent in 2002. The share of firms performing activities in the service sector grew from 27.7 to 39.4 percent, now being the largest sector. The share of industrial firms grew slightly from 12.3 to 15.1 percent, and the remaining firms had a share of 26.2 percent in 1986, declining to 17.2 percent in 2002.

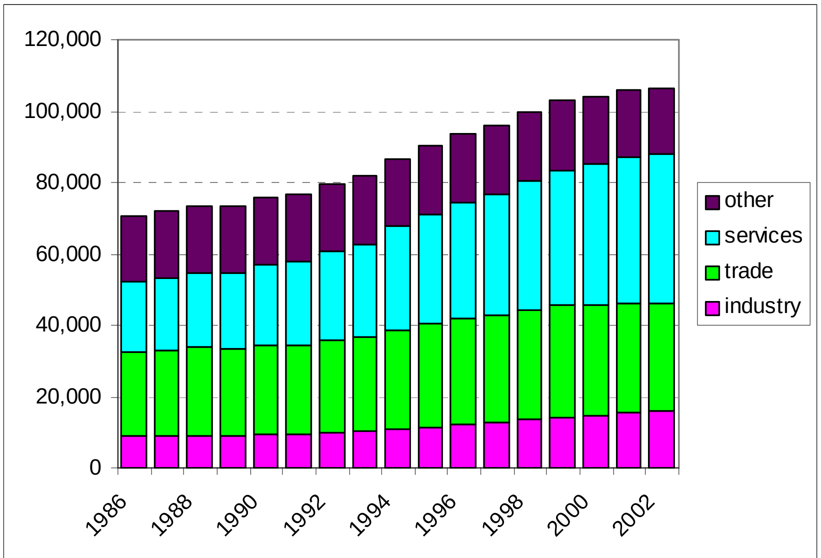

Figure 1: Number of firms by main type of economic activity in the province Gelderland, 1986-2002

In the Dutch national spatial policy plans, improvement of the international competition position plays a central role. Spatial investments will only take place where they contribute most to economic development. The National Spatial Economic Main Structure (EMS) determines where the state preferentially invests. The EMS refers to urban areas, mainports and infrastructure. To this Main Structure belong the six national urban systems: Randstad Holland, Brabantstad, Maastricht-Heerlen, Groningen-Assen, Arnhem-Nijmegen and Twente. Further it includes the national mainports Schiphol and the harbour of Rotterdam, a number of economic core-areas and greenports as can be found around Aalsmeer and in the Westland (Dekker, 2004).
The EMS covers 32 percent of the total Dutch area, 72 percent of the population aged 15 to 65, and 77 percent of all jobs (Louter, 2002).

The EMS in the province of Gelderland consists of

- an (inter-) national urban network: the junction Arnhem-Nijmegen;
- urban networks (with interprovincial aspects): urban triangle (Apeldoorn, Deventer, Zutphen) and WERV (Wageningen, Ede, Rhenen, Veenendaal);
- regional centres/formation of networks: Doetinchem and environs, Tiel and environs, Harderwijk and environs. (GS Gelderland, 2004).

In the province of Gelderland, the share of all establishments located in the EMS was constant in the period 1986-1996 (37 percent), and slightly increased afterwards to 39 percent in 2002.

In our dataset we also have information on whether or not a firm is located on an industrial park. Industrial parks are sites specifically allocated to firms. These can be sites allocated to regular economic activities, high-grade activities (such as R&D), heavy industry or transport and distribution industries or a mix of these. About 13 percent of all firms are located on such industrial parks. These 13 percent of all firms, however, constitute 30 percent of all employment in the province.

Migrants

If a firm has a different (4-digit) postcode number, in year *t+1* as compared to year *t*, it is considered a migrant during year *t*. In our dataset we also have information on the reason of disappearance of that firm from the dataset. If a firm no longer exists because it moved to either abroad or outside the province or to an unknown address in the province, it is considered a migrant too.

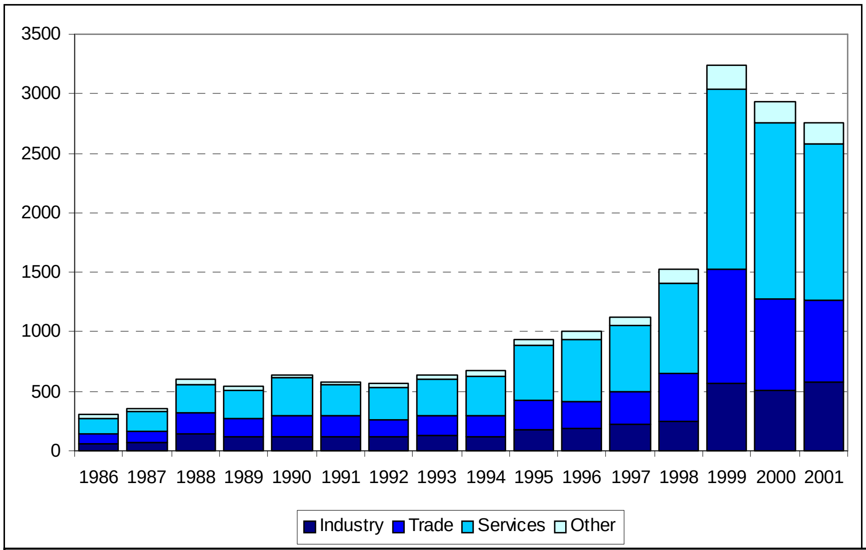

Figure 2: Number of migrants in Gelderland, by main type of economic activity, 1986-2001

In figure 2 the number of firms that migrate in the period 1986-2001 is shown. The total number of migrants increases from 304 in 1986 to 3242 in 1999. Thereafter the number decreases till 2753 in 2001.

The services sector has a relatively high share of all migrants. On average about half of all migrating firms were firms performing activities in the services sector. About a quarter of migrating firms concerned firms in the trade sector, about 20 percent in the industry sector.

Migration rates

In demography migration rates are calculated as a ratio between the number of migrants and the population. We used the same procedure for calculating migration rates for the population of firms. Since we want to include the variable age in our analysis (which is not included in the dataset, but can be derived for firms that started in 1986 or later), we selected only those firms that started in 1986 (the 1986 birth cohort) or later. A firm born in 1986, did not exist in the beginning of 1986, but appears for the first time in the database at the beginning of 1987. A migrating firm cannot be observed until one year later. Our period dimension therefore starts in 1987. This selection reduces the number of firms and the number of migrants available to our analysis, substantially. We now have information on 1,729 existing firms in 1987 to 61,256 firms in 2001 and 8 to 2,203 firms migrating respectively. For the period dimension migration rates are plotted in figure 3.

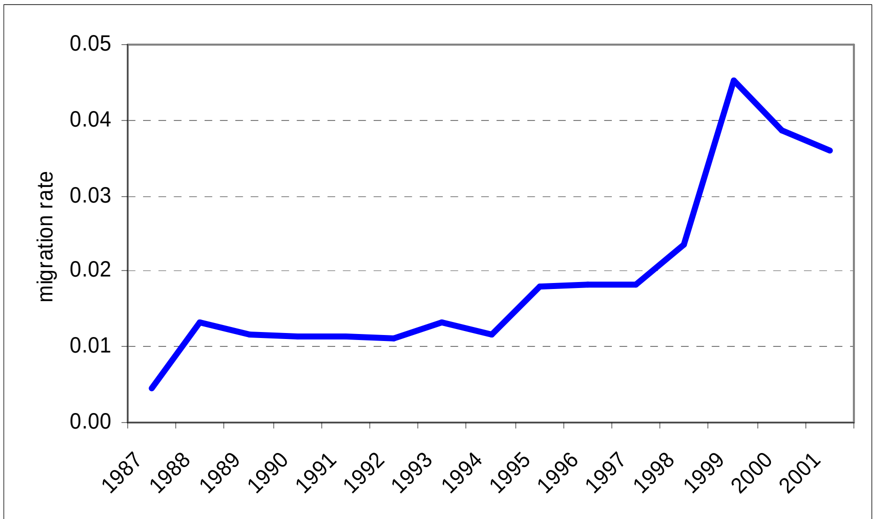

Figure 3: Migration rates by period, Gelderland, 1986-2001

In general the migration rates show an increasing trend over time, with a slight decrease after 1999. Not surprisingly, the migration rates show a similar pattern as in figure 2. Reasons for the steep increase after 1997 are (1) a strong economic boom in the Netherlands in this period; (2) the issue new industrial and office estates around this period in the province (GS 2003, p. 5).

Expectations

In our analysis we find two regional variables, which we consider to be location factors. These are whether or not a firm is located on an industrial park, and whether or not a firm is located in the Economic Main Structure (EMS). We expect that firms located in such areas show a higher propensity for migration. Industrial parks usually are located in the more peripheral areas. The need for relocation in peripheral areas is lower, because plenty of space for expansion exists. Since the government is making investments inside the EMS rather than outside, we believe that demographic behavior (births, deaths and relocations) of firms inside the EMS is much more dynamic than outside. In addition to both this dynamic behavior and the space available in the peripheral areas, we think that firms located in these areas are less attached to their premises.

The other variables used are internal factors and described below. We included period, age, size (number of employees), type of establishment and sector.

For the period variable we expect that the number of firm relocations is positively related to the cycle of economic rise and decline. This should result in a lower migration propensity in the nineties, and a higher propensity around the year 2000.

New firms initially produce usually a limited number of products, with a limited number of personnel, at relatively high costs, and sell these products at relatively high prices. Relocation in this phase often is not necessary and too expensive. When the firm (and its products) becomes more mature, the firm will grow (capital and personnel), and the need for expansion or relocation will increase. At that point relocation costs become less important as compared to the gains of relocation. Once a firm (further on in adulthood) reaches its most optimal size relocation and investments in capital and personnel have been made, relocation becomes more expensive. The more employees a firm has, the more costly (costs of moving, and organizational problems) relocation becomes. We therefore expect that at first migration increases with an increasing number of employees. After a certain size the chances decrease. And for the age variable we expect that the older a firms is, the lower the propensity for migration will be.

For our sector variable, where firms are divided into four main activities (industry, trade, services and other) we expect differences in migration propensity too. Firms performing in the industrial sector for example constitute a relatively high capital intensity and made high investments in capital stock. Relocation would therefore mean a destruction of capital. Industrial firms will only move if the expected gains are very high. Firms in the services sector made fewer investments in capital, but are especially tied to their personnel. Relocation over a long distance is therefore less attractive, but relocation over short distances is relatively cheap. We expect the trade sector to show the lowest chances of moving. Firms in this sector are traditionally clusterers (shopping centers for instance), since they especially are tied to the local market. The actual cost of moving is low (low destruction of capital), but gains of moving are low too. Firms in the sector "Other" consists for 80 percent of firms in the agriculture, hunting, forestry and fishing, and for 19 percent in the transport, storage and communication activities. Especially the large share of agricultural firms, which are not very likely to move because of the large site requirements, make us expect low propensities for relocation.

The last variable we want to include concerns the type of firm. We have information on whether the firm is a head office, a subsidiary, independent or something else. Brouwer et al. (2004) also included a type variable in their analysis of relocation of firms (rather than establishments as we do) with 200 or more employees. They found that single site firms have lower chances of migrating than other firms, simply because they contain fewer sites. With our data we might translate this in: independent firms show lower chances of relocation than head offices do. Further we believe that subsidiaries have the lowest propensity for migration. It is more likely for subsidiaries to be closed and that new subsidiaries are opened somewhere else, then relocating the subsidiary.

2 Results of Log-linear analysis

In order to test for differences in migration, log-linear models were formulated (using the software package R 2.1.0). log-linear analysis of demographic processes is a way to test hypotheses on connections between categorical variables in demographic processes. In the case of migration numbers broken down by age (A), period (P), economic activity (SEC), economic main structure (EMS), industrial park (INDP), number of employed in year t (EMPL), number of employed in year t-1 (EMPLM) and type of establishment (TYPE), it is possible to test several associations.

As explained in section 2, this type of analysis yields a test criterion, the likelihood ratio, or deviation. Though this quantity does not follow a known distribution, and a formal statistical test is therefore impossible, it does give an indication of the relative importance of each of the variables in explaining the variation in mortality numbers. On the basis of this quantity one may decide whether migration is for example sector-specific or not. Results of these analyses are shown in table 2.

Table 2: Results of log-linear analysis.

	Model	Scaled deviance	Residual degrees freedom	% of explained	AIC
1	-	26,374	48,676	0.00	
2	A	26,288	48,662	0.33	40,170
3	P	23,796	48,662	9.77	37,677
4	SEC	25,960	48,673	1.57	39,820
5	EMPL	26,314	48,666	0.23	40,188
6	EMS	25,957	48,675	1.58	39,812
7	INDP	25,844	48,675	2.01	39,700
8	TYPE	26,113	48,672	0.99	39,975
9	EMPLM	26,274	48,666	0.38	40,148
10	P+A	23,394	48,648	11.30	37,304
11	P+A+SEC	23,058	48,645	12.57	36,974
12	P+A+EMPL	23,306	48,638	11.63	37,236
13	P+A+EMS	22,945	48,647	13.00	36,857
14	P+A+INDP	22,757	48,647	13.71	36,669
15	P+A+TYPE	23,110	48,644	12.38	37,027
16	P+A+EMPLM	23,297	48,638	11.67	37,227
17	P+A+EMS+INDP	22,298	48,646	15.45	36,212
18	P+A+EMS+INDP+EMPL	22,255	48,636	15.62	36,189
19	P+A+EMS+INDP+EMPLM	22,225	48,636	15.73	36,158
20	P+A+EMS+INDP+EMPLM+SEC	21,817	48,633	17.28	35,757
21	**P+A+EMS+INDP+EMPLM+SEC+TYPE**	**21,519**	**48,629**	**18.41**	**35,467**
22	P+A+EMPLM+SEC+TYPE+INDP*EMS	21,511	48,628	18.44	35,460
23	P+A+EMS+EMPLM+TYPE+INDP*SEC	21,458	48,626	18.64	35,412

Within log-linear analysis it is also possible to test for higher order interactions (for example A*P, but also interactions between each of the time dimensions on the one hand and a factor on the other). We did test for such interactions, and some of these results are shown in table 2, but the results were not satisfactory. Gains in scaled deviance were small, standard errors became too large and some parameter values became un-interpretable.

Even though the total explained deviance is rather low (almost 20%), we decided that model 21 is the optimal model, which includes two regional variables (EMS and INDP), a size-variable (EMPLM) and economic activity variable (SEC), a more legal variable (TYPE) as well as age and period.

Parameter estimates indicate whether migration rates for certain characteristics are higher than average or lower. If a parameter value is higher than zero this means that migration is higher for firms with this characteristic, values lower than zero indicate the opposite. The more a value differs from zero, the stronger the effect is.

According to model 21 the variables behave as hypothesized. Inside the EMS migration rates are higher (0.40) than outside the EMS (0.0). More or less the same holds for Industrial parks: firms on industrial park show higher migration rates (0.65) than firms outside industrial parks. Firms with 6-10 employees have the highest migration rates (0.66), the more employees a firm has, the lower the chances of migration. For firms with 100 or more employees the estimates follow this pattern but become insignificant. This insignificancy is not so surprising since the number of firms with 100 or more employees in the dataset is small (0.34%). For the sector variable the parameters also behave as expected: from the lowest to the highest mortality rates we find respectively trade (-0.31) other (-0.18), industry (0.0), and services (0.13).

In figure 4 the parameters and standard errors for *age* are plotted. Apart from the last age group, migration rates clearly decrease with age. The older a firm is, the less likely it is the firm will decide to migrate. The impact of age on migration is the strongest on the highest ages. With an increasing age also the standard errors increase.

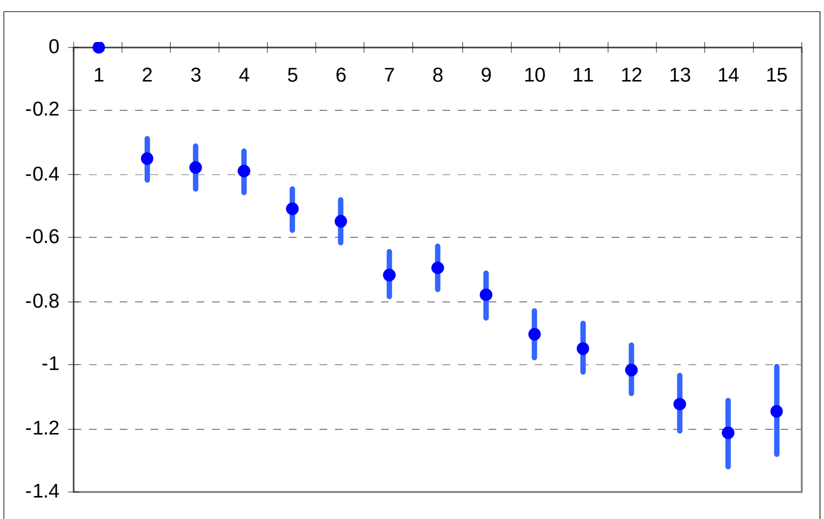

Figure 4: Parameter estimates and their standard errors for the age variable in model 21

Table 3: Parameter estimates for model 21

		Estimate	Std. Error	z value	Pr(>|z|)	
Constant	(Intercept)	-5.59806	0.35449	-15.792	< 2e-16	***
Year	1987	not defined because of singularities				
	1988	0.69085	0.37581	1.838	0.066023	.
	1989	0.58146	0.37070	1.569	0.116758	
	1990	0.66638	0.36424	1.830	0.067321	.
	1991	0.66592	0.36262	1.836	0.066295	.
	1992	0.71618	0.36065	1.986	0.047057	*
	1993	0.91709	0.35890	2.555	0.010611	*
	1994	0.83425	0.35827	2.329	0.019883	*
	1995	1.28384	0.35651	3.601	0.000317	***
	1996	1.34089	0.35624	3.764	0.000167	***
	1997	1.34621	0.35609	3.780	0.000157	***
	1998	1.63025	0.35551	4.586	4.52E-06	***
	1999	2.30084	0.35489	6.483	8.97E-11	***
	2000	2.16340	0.35490	6.096	1.09E-09	***
	2001	2.09705	0.35494	5.908	3.46E-09	***
Age	1	not defined because of singularities				
	2	-0.35279	0.09729	-3.626	2.88E-04	***
	3	-0.37849	0.09819	-3.855	1.16E-04	***
	4	-0.39123	0.09870	-3.964	7.38E-05	***
	5	-0.51026	0.09979	-5.113	3.16E-07	***
	6	-0.54664	0.10045	-5.442	5.26E-08	***
	7	-0.71425	0.10253	-6.966	3.26E-12	***
	8	-0.69545	0.10346	-6.722	1.79E-11	***
	9	-0.78128	0.10642	-7.341	2.11E-13	***
	10	-0.90264	0.10903	-8.279	< 2e-16	***
	11	-0.94757	0.11377	-8.329	< 2e-16	***
	12	-1.01347	0.11852	-8.551	< 2e-16	***
	13	-1.12221	0.13288	-8.445	< 2e-16	***
	14	-1.21618	0.15839	-7.678	1.61E-14	***
	15	-1.14459	0.20977	-5.457	4.86E-08	***
Sector	Industry	not defined because of singularities				
	Trade	-0.30665	0.02968	-10.331	< 2e-16	***
	Services	0.13016	0.02683	4.851	1.23E-06	***
	Other	-0.18299	0.04556	-4.017	5.90E-05	***
Employed	None	not defined because of singularities				
	One	0.53526	0.09399	5.695	1.23E-08	***
	2-5	0.58452	0.09380	6.231	4.62E-10	***
	6-10	0.65901	0.09842	6.696	2.14E-11	***
	11-25	0.62978	0.10201	6.174	6.66E-10	***
	26-50	0.61651	0.11947	5.160	2.46E-07	***
	51-100	0.5693	0.14612	3.896	9.78E-05	***
	101-250	0.24078	0.20458	1.177	0.239219	
	251-500	0.22874	0.45667	0.501	0.616459	
	501-1000	-0.36582	1.00468	-0.364	0.71577	
	1000+	-7.15996	104.7203	-0.068	0.945489	
EMS	Outside EMS	not defined because of singularities				
	Inside EMS	0.40293	0.01896	21.251	< 2e-16	***
Ind Park	Outside Ind P	not defined because of singularities				
	Inside Ind P	0.65249	0.02387	27.334	< 2e-16	***
Type	Head Office	not defined because of singularities				
	Subsidiary	-0.50551	0.04045	-12.497	< 2e-16	***
	Independent	-0.04883	0.01976	-2.472	0.013445	*
	Other	-0.12683	0.28921	-0.439	0.660989	
	Unknown	0.80493	0.07331	10.979	< 2e-16	***

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Figure 5 shows parameter estimates and their standard errors for the *period* dimension. Indeed there seems to be a relation between the economic business cycle and migration decisions of firms. Especially in the most recent years migration chances are considerably higher, than in the beginning of the period. The more recent the year, the more significant parameter estimates become.

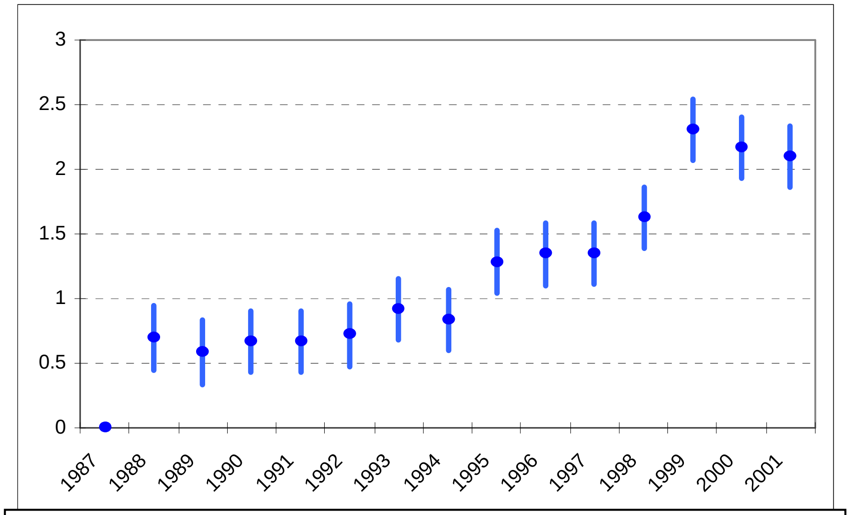

Figure 5: Parameter estimates and their standard errors for the period variable in model 21

Figure 6 shows the parameter estimates for the number of employed in year t-1. Parameter estimates first increase with the number of employed, to a maximum estimates for 6 to 10 employed. Thereafter the estimates decrease with size of the firm. It is most likely that the smaller firms are growing firms, and therefore the need for relocation is high. Further for smaller firms the costs of moving are relatively low. The larger a firm is, the more costly a relocation becomes. Gains of the new location as compared to the old location have to be much higher.

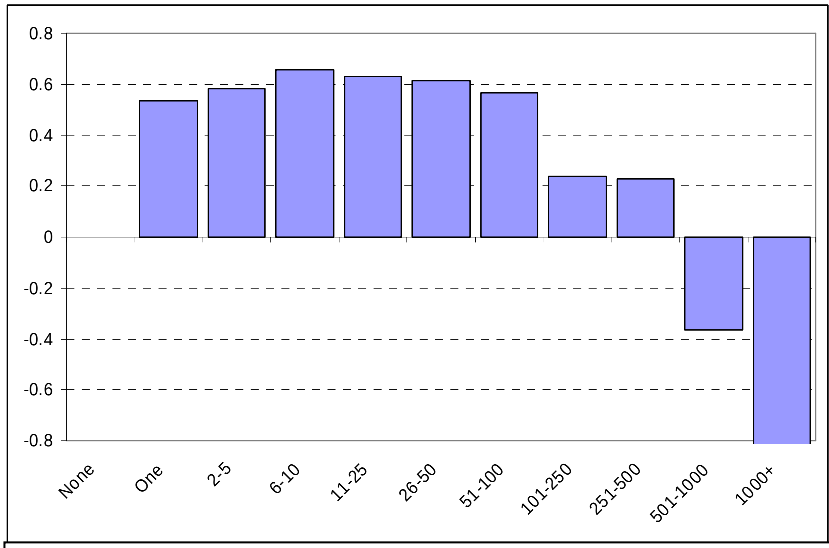

Figure 6: Parameter estimates for the number of employed in year t-1 in model 21

In figure 7 the remaining estimates, for whether or not a firm is located in the economic main structure of the province, whether or not a firm is located on an industrial park, the sector in which the firm is performing activities, and the type of establishment, are plotted.

Obviously if a firm is located either inside the EMS or in an industrial park (or both), it has a larger probability of moving to another location. Probably these areas are one the one hand more dynamic areas where firms come and go. But on the other hand firms located in these areas are less attached to the premises.

Sector is an important variable as well. The industry sector indeed is less likely to move than the services sector. Because the investment in capital stock and the capital intensity of industrial firms are much higher than for firms in the services sector chances differ. Firms in the trade sector have the lowest chances of moving. Not surprisingly, since firms in this sector are the most tied to the local market. Moving to another location is not likely to offer big gains.

Finally the type of firm: of the known types of establishments, the head offices are the most likely to move. The independent firms come at a second place and the subsidiary firms are the least likely to move

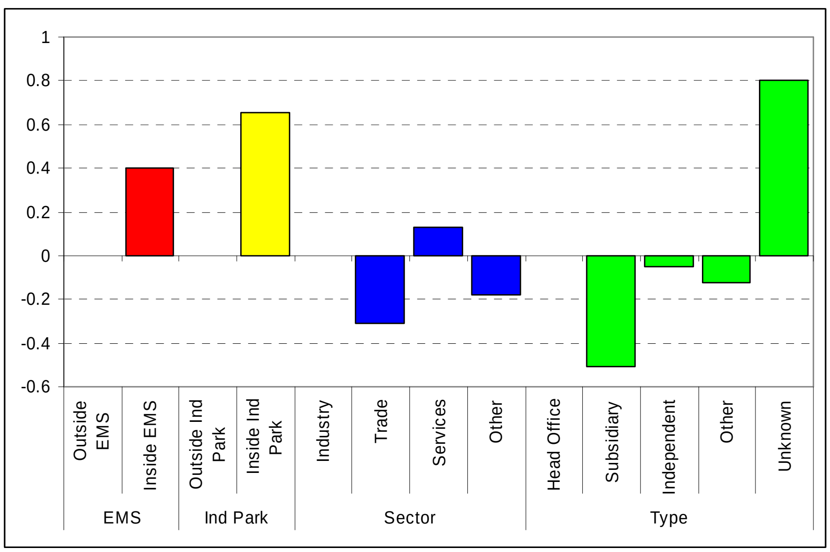

Figure 7: Parameter estimates for EMS, Industrial Park, Sector and Type of establishments for model 21

5 Conclusions

In this paper we tried to investigate the characteristics of firms that have an influence on the decision of firms to relocate. A general linear model was applied and extended by introducing explanatory variables. The explanatory variables all worked as expected. Migration rates inside the Economic Main Structure are higher than outside the EMS and the same is true for firms located on industrial parks. The more employees a firm has, the lower the probability of migration. Further, also economic activity matters. Lowest migration rates were found in the trade sector, the highest in the services sector.

Demographers consider projection making as a main part of their activities. Whether projections are feasible within firm demography remains to be proven. This model of firm relocation is one element in such an approach. Together with other cornerstones of demographic components a simulation model will be built. The variables used in this migration submodel are usually generally available.

References

Brouwer, A., I. Mariotti and J. van Ommeren (2004) The firm relocation decision: An empirical investigation. Annals of regional science (2004) 38: 335-347

CBS (1993) Statistiek van het ondernemingenbestand 1993. Voorburg/Heerlen: Centraal Bureau voor de Statistiek [Statistics Netherlands].

Dekker (2004) "Ruimte voor Groei," speech van minister Dekker tijdens het MIPIM-congres in Cannes op donderdag 11 maart 2004 (VROM website).

GS Gedeputeerde Staten van Gelderland (2003), Van trekkracht naar slagkracht. Nota bedrijventerreinen 2002-2006, GS Provincie Gelderland, Arnhem

GS Gedeputeerde Staten van Gelderland (2004) Hoofdlijnennota voor het Streekplan 2004, GS Provincie Gelderland, Arnhem

Holl, A. (2004) Start-ups and relocations: Manufacturing plant location in Portugal, Papers in Regional Science 83, 649-668

Huisman, C. and L. van Wissen (2004a) Localization effects of firm startups and closures in the Netherlands Annals of regional science (2004) 38: 291-310

Huisman, C. and L. van Wissen (2004b) A multistate demographic model for firms in the province of Gelderland. Paper presented at the ERSA conference in Porto, Portugal 2004

Jacobs, J. (1969) The economy of cities. Random House, New York

Lloyd, P.E. and P. Dicken (1992) Location in space. A theoretical approach to economic geography, 2nd ed. Harper & Row, London

Louter (2002) De Economische Hittekaart van Nederland, Den Haag

Marshall, A. (1890) Principles of economics. MacMillan, London

McCullagh, P. and J.A. Nelder (1989) Generalized linear models. London, Chapman & Hall (second edition).

Pellenbarg, P.H., P. van Steen and L.J.G. van Wissen (2005) Ruimtelijke aspecten van de bedrijvendynamiek in Nederland [Spatial aspects of firmdynamics in the Netherlands] Koninklijke van Gorcum, Assen

Pellenbarg, P.H., L.J.G. van Wissen and J. van Dijk (2002) Firm migration. In: McCann P (ed.) Industrial Location Economics. Edward Elgar Publishing, Cheltenham

Van Dijk, J. and P.H. Pellenbarg (eds.) (1999) Demography of firms Spatial Dynamics of firm behaviour. Nederlandse Geografische Studies 262, Groningen

Van Dijk, J. and P.H. Pellenbarg (2000) Firm relocation decision in the Netherlands: an ordered logit approach. Papers in regional science 79: 191-219

Van Wissen, L. and C. Huisman (2003) Firm growth across regions. A regional test of Gibrat's Law. Paper presented at the ERSA conference in Jyväskylä, Finland 2003

Appendix

Grouping of 1-digit economic activities into four main sectors

1-digit economic activity	Number of establishments		Main sector
	1986	2002	
A Agriculture-hunting-forestry	16,389	14,705	Other
B Fishery	13	20	Other
C Extracting minerals	27	25	Industry
D Manufacturing	4,261	6,938	Industry
E Public Services	90	39	Other
F Construction industry	4,426	9,058	Industry
G Repair of consumer goods and trade	19,992	25,363	Trade
H Catering industry	3,884	4,803	Trade
I Transport storage and communication	2,045	3,533	Other
J Financial institutions	1,991	2,762	Services
K Commercial services	6,119	20,653	Services
L Public administration and social security	855	562	Services
M Education	2,758	3,246	Services
N Health care and welfare	3,747	6,108	Services
O Culture recreation and other services	4,156	8,517	Services
P Household activities	2	0	Other
Q Extra-territorial bodies	1	2	Other
Total	70,756	106,334	Total