Interregional migration in The Netherlands: an aggregate analysis

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Abstract:
The understanding of migration behaviour is of key importance for regional population forecasting. This paper studies the phenomenon empirically, the results are to be applied in a regional labour market model for long-term scenarios of the spatial distribution of employment and labour force. The model takes the interdependence of regional population development and local economic growth into account explicitly. Therefore, we pay particular attention to the effect of local labour market developments on migration.

Population forecasting demands for a macro approach to migration. However, certain relations that appear evident from microanalyses are difficult to trace in aggregate data. We deal with this problem in two ways. Instead of net migration we consider interregional migration flows. These contain more information and allow for a clear identification of underlying mechanisms. Secondly, we distinguish age groups and short versus long distances in our model. It has been shown using micro data that dominant migration motives differ significantly over these categories.

The generation - distribution approach is chosen as a modelling framework. For each age group, we propose a generation model based on population characteristics that projects the total number of movers per region. In a production constrained spatial interaction model, region-specific pull factors determine the distribution of these migrants. Explanatory variables cover housing, labour market and study motives. Housing market related variables dominate short distance moves. Our estimation results show that labour market variables indeed play a significant role in describing long distance moves of young adults.

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[2] Comments are highly appreciated.

1 Introduction

The understanding of migration behaviour is of key importance for regional population forecasting. CPB, Netherlands Institute for Economic Policy Analysis currently develops a regional labour market model that will provide long-term scenarios for the spatial distribution of employment, population and labour force in The Netherlands. As a part of that model, this paper proposes a model for interregional migration.

A distinctive feature of the regional labour market model is that it describes the interdependency of employment and population growth explicitly. Through migration, regional employment growth influences population development, which on its turn determines local labour force. The migration model we derive should thus establish the link from regional labour market developments to regional population growth.

In addition, the long-term scenarios pay attention to the ageing process, developments in household composition and (with a somewhat shorter horizon) local housing markets. Since we expect these issues to have repercussions on migration behaviour, the model should somehow take them into account as well.

A central question in this paper is how developments in the regional population structure, local housing markets and especially regional labour markets affect migration. In order to identify such mechanisms, we estimate an econometric migration model. Since this model is to be used for regional population forecasting, we are tied to the analysis of aggregate data.

It is a well-known fact that certain relations that appear evident from intuition and microanalyses are difficult to trace in aggregate migration data. In two ways we try to overcome this problem. Firstly, we analyse a model for interregional migration flows, thus using information from the full migration matrix. By applying modern techniques from the theory of spatial interaction modelling we enhance the accuracy of parameter estimates.

A second way to deal with the problem of aggregation is to distinguish age groups and short versus long distance moves in the data. In general, migration behaviour changes over the life cycle. We also expect motives that are dominant for a flow of migrants to depend on the distance between origin and destination. For example, microanalysis of migration behaviour in The Netherlands has shown that labour migrants are generally younger and move over larger distances than people that move for other reasons (Ekanper and Van Wissen, 2000). This implies that the way in which local labour market developments affect migration is most likely to be identified in the analysis of long distance moves of young adults.

We therefore estimate the impact of migration determinants for seven age groups, distinguishing short and long distance moves. In addition, the coefficient patterns over age and distance allow us to assess these determinants in a more credible way.

We synthesise results in a generation - distribution model. In this approach, the total number of migrants to emerge from a region is projected using aggregate measures for population and household characteristics. Local pull factors, notably the housing and labour market situation, determine the distribution of these migrants to destination regions.

The remainder of this paper is ordered as follows. The next chapter discusses the CPB regional labour market model. We explain important mechanisms and expand on the role of migration in this model. In chapter 3, we study literature on migration determinants. The analysis of the US situation is dominant in this area, but we also discuss some research on migration in The Netherlands. The generation - distribution model and theory on spatial interaction modelling are put forward in chapter 4. In the next chapter, we then present our own empirical analysis. The final chapter comments on this analysis, draws conclusions and hints at directions for further research.

2 The CPB regional labour market model and the role of migration

The CPB, Netherlands Bureau for Economic Policy Analysis, is developing a regional labour market model, which will be used to construct long-term scenarios. The regional unit is the so-called COROP area (40), which corresponds to the Eurostat NUTS 3 level. The model describes the spatial distribution of population and employment, while explicitly taking into account their interdependency. Regional unemployment is an important variable. The model should include an accurate description of interregional migration and commuting and regional specific determinants of regional employment (location factors).

In a densely populated country like The Netherlands, there is an obvious demand for policy analyses with a regional component. The model will generate estimates of land use, both for employment (business estates) and population (housing). It can also be used for regional welfare analyses, for example in the domain of infrastructure improvements, the strong urbanisation in the west of the Netherlands, regional issues in the northern provinces and issues in larger cities.

The scenarios
The general environment of long-term scenarios will be determined elsewhere within the CPB. Subsequently, CPB macro models will elaborate the scenarios into quantitative economic developments for the Netherlands. The regional model is at the end of the chain. To guarantee consistency with the macroeconomic outcomes the regional model will have to follow a top down approach. The model will describe regional developments against the background of given national trends.

Exogenous model variables
The first type of exogenous variables in the model will be related to national trends in production and labour market. What is the impact of a different national trend level or a different sector structure on the regional distribution of production and employment? National developments in (sector) employment, age structure of the population, labour force and unemployment level are fixed in the model. Another exogenous macro variable is the level of net foreign migration to the Netherlands.

The second type of exogenous variables will be related to trends in personal or household characteristics, for example education levels or trends in household composition. Regional housing stock may also be exogenous, at least in the short term. There may be a direct link with the national scenarios, but this is not necessary.

Endogenous model variables
Endogenous variables in the model are the regional distribution of employment, population, labour participation rates and unemployment. Employment is divided in 18 sectors. Population and labour force are split in sex and age groups. Labour participation rates vary among sex and age groups and among regions. Apart from sex and age, we distinguish three levels of education for population and labour force. We also attribute household characteristics to the regional population.

Bird's eye view of the model
Regional employment growth is determined through a shift-share analysis. The share component depends on the sector structure of the regional economy. The shift is computed with use of location factors, the specific regional elements that explain divergent regional developments.

Regional population projections depend on natural growth and (net) migration. Regional fertility rates and death rates are based on external information from ABF Research. Migration is split in domestic migration and foreign migration. Domestic migration in age groups is fully endogenized. The total level of foreign migration is exogenous, but the destination region is determined in the model.

Differences in *age-group-specific regional participation rates* exist is the base year. That means that national developments can not be translated uniformly over the regions. National trends will be followed in the regions via a distribution model, while taking account of certain natural upper limits. Population and participation rate determine the labour force in each region.

Regional unemployment is the difference of employment and labour force, corrected for commuting. The commuting model is described in Vermeulen (2003) and Van Ommeren, Vermeulen and De Vries (2003).

A distinctive feature of the regional labour market model is that it describes the interdependency of employment and population growth explicitly (see figure 2.1). Through migration, employment influences population development. Although the effect of local labour market developments on migration is usually small in the short term, their long-term impact can be substantial. A faster growing regional population will in itself generate faster employment growth to match the average level of facilities (shops, medical services, etc.). We therefore model population growth as location factor for the shift in employment growth.

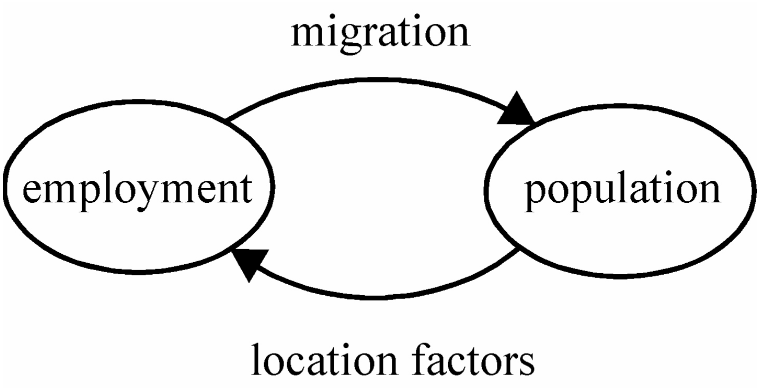

Figure 2.1: mutual dependency of employment and population growth

The migration model
The output of the migration model is net migration per region. This migration should be divided into sex, age, level of education and household composition in order to match with population in the regional labour market model. It seems preferable to distinguish age groups explicitly in the migration model. Migration behaviour changes considerably with age. Identification of labour market related mechanisms in migration data would thus be more efficient when we disaggregate these data with respect to age. In addition, a key feature of population development in the coming years is ageing. This will result in a shift in migration behaviour that would be ignored in a model for total migration. It is not feasible to distinguish sex, age in years, level of education and household composition explicitly in the migration model. Therefore we will have to apply appropriate ratios to migration flows.

Although a model for aggregate migration would ideally include all variables that affect migration, this obviously is impossible. It should however make clear how local labour market developments (like job opportunities, employment growth and unemployment) affect migration, in order to describe the interdependency of population and employment. Also, the impact of the housing stock, the level of education and household composition would preferably be included.

3 Determinants of migration

People may have many motives to move from one place to another. When they move to get closer to their new job, we speak of *labour migration*. Neighbourhood adjustment and housing quality are motives for *residential migration*. We assume that residential migrants do not change of job. In the Netherlands, about 10 percent of all moves is labour induced and residential migration constitutes about 25 percent, but the former share increases with migration distance (Ekamper and Van Wissen, 2000). Some young people have to move to get nearby their school or university, this is called *study migration.* Obviously, there can be many other personal reasons (like a marriage or the desire to live closer to ones relatives) for a migration.

In section 3.1 we introduce the relation between migration behaviour and age or life cycle. This notion is important since it underlines our choice to model migration in age groups. The next section discusses a microanalysis by Ekamper and Van Wissen (2000), who compare characteristics of labour migrants to characteristics of other migrants. Their results lend support to our idea that pull factors affecting labour migration are most easily identified in long distance moves of young adults.

Section 3 considers the role of distance in migration decisions. It is argued that distance deterrence to residential migrants is closely connected with deterrence to commuting distances.

In the final two sections of this chapter we discuss literature on determinants of migration, with a focus on research in the Netherlands. We categorise these determinants as related to labour, residential and study migration. It is important to realise that this distinction is not always clear-cut. When someone can choose between jobs in various regions, motives like housing quality (the amenities that we discuss under residential migration) can play an important role.

3.1 The life cycle and personal characteristics

The probability that someone decides to migrate can depend on many personal characteristics, of which age is likely to be the most important. We shortly describe common mobility rate patterns over the life cycle (adapted from Plane and Rogerson, 1994, page 107).

It is generally observed that, with the exception of those under the age of 5, children have low migration propensity. The youngest group may be more mobile because children generally move with their parents, and those are likely to be in a very mobile age group. Older children make their parents less inclined to move because they would disrupt their education and social environment. Migration propensity peaks in young adult years that coincide with nest-leaving events like marriage, obtaining employment and study migration. Mobility rates then decline steadily, a second peak associated with *retirement migration* can sometimes be observed.

In figure 3.1 we show migration propensity (number of migrations divided by population size) over seven age groups in the Netherlands (the dataset we use will be described in chapter 5). This picture seems to match the above discussion of a life cycle in migration propensity.

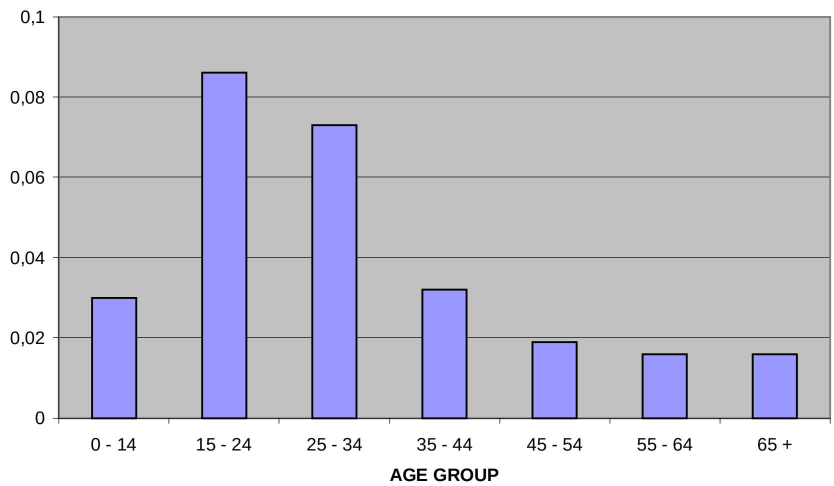

Figure 3.1: migration propensity in The Netherlands by age group

The stylised fact that after the young adult migration peak the propensity decreases with age can be explained in several ways. An economic interpretation is that as people grow older, their remaining working life becomes shorter. The discounted net benefits of a migration thus decrease (see the human capital approach in section 3.4). Another view is that people become more tied to a region (both culturally and by family and friends) when they stay longer. This phenomenon is referred to as *cumulative inertia*.

Unemployment, level of education and income are other personal characteristics that seem to influence migration. It is generally believed that the higher educated are less tied to a region and search jobs at the national rather than at the local level. Pecuniary migration costs are a smaller barrier to people with a higher income. We discuss evidence on the impact of personal unemployment and income more extensively in section 3.4.

It is important to note that although we discuss personal characteristics here, migration is a household decision. A substantial share of migrations consists of actually tied moves. One-person households are generally the most mobile, with migration propensity decreasing with household size. Two earner households choose a destination such that both partners are at acceptable distance from their work. Obviously, a household that owns their dwelling is less likely to move than a household that rents its house. Van der Vlist et al. (2002) research the effect of other dwelling characteristics on household mobility. They also find that the impact of household characteristics on mobility differ in urbanised areas from their effects in rural areas.

3.2 A micro analysis of general versus labour migrant characteristics

In this section we discuss an analysis of micro data performed by the Netherlands Interdisciplinary Demographic Institute (NIDI), which is reported by Ekamper and Van Wissen (2000). They analyse data from several vintages of the Housing Demand Study (WBO), produced by Statistics Netherlands (CBS).

The authors show that labour migrants are generally younger and move over larger distances than people that move for other reasons. This result lends support to our assumption that by dividing migrations into age groups and short and long distance moves, we get a clearer picture of the impact of labour market variables.

The authors perform two multinomial logit analyses on the WBO survey. The first one regresses all characteristics on the motive (1 if moved for labour reasons), the reference group consists of all movers. This should make clear to what extent characteristics of labour migrants differ from characteristics of other migrants.

The second analysis regresses all characteristics on labour migrants and on people who move for another reason, the reference group are all non-movers. A comparison it thus provided of characteristics of labour and other migrants to non-moves.

In this study, the following personal and household characteristics are used:
- *motive* (1 if move is labour induced);
- *sex* (1 if male);
- *age;*
- *one-person household* (1 if true);
- *living with partner* (1 if true);
- *household size;*
- *young children* (1 if households contains children younger than 6);
- *education* (ranked from 1 (primary) to 5 (university));
- *income* (ranked from 1 to 3(highest));
- *two earner household* (1 if true);
- *house owner-occupier* (1 if true);
- *dwelling type* (1 if living in a single-family dwelling);
- *employed* (1 if true);
- *weekly number of hours* (working week: 1 = 0 - 19, 2 = 20 - 39, 3 = 40 +);
- *commuting distance* (after move, kilometres: 1 = 0 - 9, 2 = 10 - 19, 3 = 20 +);
- *moving distance* (1 if migrant changes of province);
- *year of move;*

In table 3.1 we show the results of the second analysis (labour migrants and other migrants versus non-movers). Using results from the first analysis, we mark all characteristics that do not yield a significant difference between labour migrants and other migrants coefficients with a double asterisk.

characteristic	labour	other
sex	0.01 * **	0.06
age	-0.08	-0.04
one-person household	0.43 **	0.30
living with partner	0.38 **	0.15
household size	0.01 *	-0.27
young children	0.41	0.58
education	0.25	0.04
income	0.18	0.06
two earner household	0.04 *	0.35
house owner-occupier	-0.33	-0.43
dwelling type	0.88	0.62
employed	0.28	-0.18
weekly number of hours	0.13	-0.04
commuting distance	-0.03 *	0.11
year of move	-0.09	-0.06
constant	177	113
observations	186558	
Chi^2 (Prob > Chi^2)	12543 (0.0000)	
Pseudo R^2	0.0937	

Table 3.1: characteristics of labour and other migrants with non-migrants as reference group
** indicates an insignificant deviation from zero at one percent level of confidence*
*** indicates an insignificant difference between migration for labour vs. other motives with non-labour-migrants as reference group at one- percent level of confidence*
adapted from Ekamper and Van Wissen (2000), page 8 - 10

Although *men* seem somewhat more likely to move than *women*, the difference concerning labour migration is not significant. *Young people* are relatively mobile, and labour migrants are on average younger than other people.

One and two person households are relatively mobile, but the coefficients are not significantly different for labour and other migrants. The *larger the household*, the larger the probability that if it moves this will be labour induced. However, moves of households with *young children* are less likely to be labour induced. Highly *educated* people and people with a high *income* are more mobile, and are also more likely to be labour migrants than lower educated and low-income migrants. *Two-earner households* are less likely to be labour migrants.

House *owner-occupiers* are less mobile, but when moving they are more likely to be labour migrants than movers that rent a house. People living in a *single-family dwelling* are more likely to be labour migrants when they move.

The *employed* are less mobile than people who are not employed (being either unemployed or not in the labour force), but when they move, this is more likely to be labour induced. *The number of hours* worked weekly has the same effect. People who have moved and have *small commuting distance* are more likely to have moved with labour motive. The coefficients for *year of migration* indicate that the labour motive has become less important for movers over time.

An important result that is not shown in the table is that the coefficient for *moving distance* (1 if the migration is interprovincial) is found to be significantly positive against the reference group of non-labour-migrants (this coefficient is as large as 2.50).

The impact of personal and household characteristics is generally found as expected. These results can be of interest for the construction of a generation model (a model for the number of migrants generated per region).

Given that a person moves, the probability that this is a labour migration is close to 10 percent. However, when all personal and household characteristics are in favour of the labour motive, this probability can run up to about 80 percent. This validates our choice of distinguishing age groups and short and long distance moves in order to identify labour market related mechanisms.

3.3 The effects of distance

Perhaps the most important deterrent to migration is distance. It has been suggested that distance measures transportation and psychic costs to migration as well as availability of information (Greenwood, 1975). In a small country like the Netherlands, large differences in short versus long-distance transportation costs seem unlikely. Also, transportation costs are small compared to other costs associated with relocation.

The psychic costs of a distant move can constitute of being far from one's relatives and friends, but also of leaving a region to which one feels culturally attached. In spite of the small size of the country, substantial cultural differences amongst Dutch regions can be perceived (compare Limburg and Friesland).

Before moving, people are likely to want information about the housing market in the region of destination in order to obtain housing. In the case of labour migration, they also may need information about the labour market in order to get a new job. Some information may be costly to acquire for more distant regions (local papers provide information about the own region). Psychic costs and availability thus seem the most important contributors to distance deterrence in the Netherlands.

Residential migration and commuting distances

For a residential migrant, distance will deter in different manner than for a labour migrant. A residential migrant does not change of job. This implies that the new residence must be at acceptable commuting distance from his or her job location. The distance deterrence for residential migration is thus closely connected to the distance deterrence for commuting.

It has been observed that in the past twenty years, people in the Netherlands have accepted larger commuting distances. Accepting a large commuting distance implies that people can search a residence of their liking a larger area, distance deterrence to residential migration should thus have decreased. Ekamper and Van Wissen (2000) contend that a substitution has taken place from labour migration to commuting, distance deterrence to labour migration should thus have increased. The relation between job and residential location in the Netherlands has also been researched by Van Ommeren (2000) and Van der Vlist (2001).

Information

It is not clear to what extent information costs contribute to distance deterrence for labour migration. A first observation to be made is that many job vacancies are nowadays posted on the Internet. Freely accessible WebPages match people to jobs even abroad. This certainly decreases the cost of acquiring information on (distant) job offers. Van Dijk et al. (1989) stress the importance of the role played by institutions. Local offices of the Dutch Labour Exchange have access to a national database, so an unemployed person can obtain information of vacancies from all over the country. This is one of the reasons why unlike in the United States, speculative migration (move to search a job elsewhere) hardly occurs in the Netherlands.

We point out two sources of information that do have limited spatial scope. Firstly, many vacancies (especially for lower skilled jobs) are posted in regional papers. These papers may be the main source of information for people that do not read national papers nor use the Internet. Secondly, information about vacancies, but also information about characteristics of the potential employer may come from friends and relatives.

3.4 Economic determinants of migration

Keynesian and neo-classical theories both assume migration to be an equilibrating force. In a Keynesian world, wages are downwardly rigid so unemployment can exist, and migration serves to equilibrate regional unemployment differentials. In the neo-classical view, migration serves to equilibrate wage differentials (Hart, 1975). In this section, we discuss research on the impact of unemployment, employment opportunities and income on migration. We then shortly address the question to what extent migration does function as an equilibrating force in reality.

The Lowry model

Lowry (1966) is the first to incorporate Keynesian and neo-classical theories of migration in a spatial interaction model. Since his work is seminal and bears much similarity to the model that we propose, we discuss it somewhat more extensively. The model takes the form of equation (3.1).

$$M_{ij} = cL_i^{\alpha 1} L_j^{\alpha 2} U_i^{\alpha 3} U_j^{\alpha 4} W_i^{\alpha 5} W_j^{\alpha 6} d_{ij}^{\gamma} . \qquad (3.1)$$

The number of migrants from region i to region j is denoted M_{ij}. and c is a constant. The (non-agricultural) labour force in the region of origin L_i can be interpreted as the population at risk. The destination labour force L_j reflects the potential number of economic opportunities. The unemployment rates U_i and U_j measure relative competition in the origin and destination labour market. The wages W_i and W_j measure relative attractiveness of the regions. Finally, the distance d_{ij} between two regions is expected to have a deterrent effect on the number of migrants.

Lowry estimates this model (in logarithmic form) on census data for movement between metropolitan areas from 1955 to 1960, results are shown in table 3.2. In the first model, economic variables are omitted, the second model is the economic gravity model (3.1). The labour force coefficients are near 1, as expected (a region that is twice as large is, disregarding scale effects, expected to produce and attract the double number of migrants). The distance deterrence coefficient is negative, but insignificant in the first model. As we see from the R^2 statistic, including the economic variable unemployment and wage only marginally improves the fit. Since the first model is symmetric (the flow from i to j equals the flow from j to i), net migration as projected by the second model is small compared to total incoming or outgoing migration. This phenomenon is often observed in practice and it is called the *Lowry effect*.

The only significant economic variable is unemployment in the region of destination, which is a clear deterrent, but unemployment in the region of origin appears with counterintuitive sign. The wage coefficients have expected sign but are not significant.

Lowry's conclusion that only economic destination characteristics seem to have influence on migration stirred a debate amongst regional economists that is summarised by Plane and Rogerson (1994).

variable	standard gravity	economic gravity
intercept (c)	-7.91	-12.75
labour force (L_i)	1.02 ***	1.05 ***
labour force (L_j)	1.02 ***	1.09 ***
unemployment (U_i)		-0.13
unemployment (U_j)		-1.29 ***
wage (W_i)		-0.03
wage (W_j)		0.24
distance decay (d_{ij})	-0.26	-0.49 ***
R^2	0.51	0.56

Table 3.2: Lowry's estimation result for a standard gravity model and for model (3.1)
Adapted from Lowry (1966), table 1 (page 15) and table 2 (page 17)
*Coefficients marked with *** are significantly different from zero at the 0.999 level of confidence, other coefficients are not significantly different from zero at the 0.95 level of confidence*

The role of unemployment
The insignificance of unemployment in determining outmigration (or even unanticipated signs) has been found more frequently (Greenwood, 1975). One possible explanation is that the unemployed constitute only a small fraction of the population, so that the effect disappears in studies of aggregate data.

Analysing the Panel Study of Income Dynamics, DaVanzo (1978) finds that the unemployed are more likely to move than the employed. Higher area (regional) unemployment rates encourage the outmigration of the unemployed, but exert little influence on the employed. These results are confirmed (with some controversy about the effect of area unemployment) in a survey on migration as spatial job-search by Herzog et al. (1993).

Van Dijk et al. (1989) compare US and Dutch labour migration behaviour. For the Netherlands, they find also that unemployed are more likely to move than the employed, but area unemployment works in opposite direction. However, the former effect is found to outweigh the latter.

Employment and population growth
Employment and job growth would seem obvious pull factors for labour migration. Borts and Stein (1964) argue instead, that migration causes employment growth (this line of reasoning is continued by Steinnes, 1978). These opposing views are partly reconciled by Muth (1968, 1971), who estimates a simultaneous equations model of net migration and employment change. His results show mutual dependency, though tend to favour the Borts and Stein hypothesis. On the basis of the substantial shift in net migration towards the South and West, the US witnessed in the seventies, Greenwood (1985) contends that unemployment and job growth are key drivers of migration. Also, he attributes part of the employment growth in the South and West in this period to population growth, fuelled by migration. Greenwood concludes that “employment and population changes seem almost certain to interact simultaneously” (page 524).

Note that this is also the view we take in the regional labour market model (chapter 2), where we assume that through migration, employment influences population development. We also model population growth as location factor for the shift in employment growth.

The human capital approach
It can be expected that ceteris paribus, a migrant will select the region of destination where he can earn the highest (real) income. The human capital theory as proposed by Sjaarstad (1962) states that the migrant will move to this region when the present value of his net gains exceeds the present value of the costs associated with the migration. Apart from moving costs, these can consist of higher cost of living in the region of destination (housing costs). Herzog et al. (1993) note that this theory implies that personal as well as area unemployment augment outgoing migration.

Since income is a personal characteristic, the human capital theory is difficult to reconcile with aggregate migration data (Greenwood, 1975). It can be analysed from these kind of data whether migrations occur from areas with low average wage to areas where it is higher (the Lowry model provides an example). However, this approach disregards of heterogeneity in jobs and workers. Potential migrants in the region of origin might not have the characteristics needed to obtain a higher income in the region of destination. In addition, the costs associated with migration should be taken into account, which requires a measure for regional purchasing parity that can be difficult to derive.

Hedonic income
The meagre performance of income variables in basic economic gravity models has led attention to control variables for location-specific amenities (Plane and Rogerson, 1994). The underlying idea is that such amenities (climate for instance) would attribute to hedonic (psychic) income. The first to shed light on the role of location-specific amenities where Graves and Linneman (1979). In an empirical analysis, Graves (1979) shows indeed that income typically is insignificant when disregarding of these amenities, but it is significant in a complete model. We discuss amenities somewhat more extensively in the next section.

Migration as an equilibrating mechanism
Most research we discussed in this section (except the work of Graves and Linneman) assumes convergence to an equilibrium where either regional unemployment differentials (Keynesian view) or regional income differentials disappear (neoclassical view). However, a considerable body of literature questions the equilibrating role of the market mechanism in redistributing labour resources over space (Van Dijk et al. 1989).

A first objection to the efficiency of migration as redistribution of labour force is the often-observed high correlation between incoming and outgoing migration (the Lowry effect). Only to some extent, this can be explained by heterogeneity in jobs and labour force. A second criterion of macro efficiency we mention here is the size and persistence of wage and unemployment differentials. The spatial distribution of unemployment in the Netherlands seems to have been rather stable over the past decades. We finally point to a paper by Broersma and Van Dijk (2002), who show that in the Netherlands, changing labour participation is far more important than spatial adjustment in dealing with labour demand shocks (without making use of migration data explicitly). All this evidence contrasts the observation that the unemployed are more likely to migrate (micro efficiency).

3.5 Residential and study migration

As we have discussed in section 3.1, migration is intimately related with a household life cycle. Events such as young adults that leave their parents' dwelling, marriage and extension of the household with children are always or often associated with a change of residence. Changes in income or housing market (so that a certain dwelling becomes or ceases to be affordable) can lead to a move as well.

In a densely populated country like the Netherlands, *supply* of appropriate and affordable housing can be an important restriction to destination choice. In cities like Almere and Zoetermeer for example, many people live that work in Amsterdam and The Hague since housing is cheaper there. Housing supply and housing price (both in the rental and in the owner-occupier sector) can thus be expected to be important determinants of destination choice.

Apart from supply, location-specific *amenities* are thought to play an important role in (residential) migrant destination choice. Amenities contribute to the quality of living in a certain region. Porell (1982) values several (dis)amenities so as to compensate for differences in regional wages. Apart from climate characteristics he includes dummies like the availability of parks and public swimming pools in his analysis.

We do not expect climate differences to be relevant in the Netherlands. Suyker (1981) estimates a net migration model for the Netherlands where he finds a significantly positive coefficient for woodlands per capita that increases, this value increases with age.

Population density can serve as a proxy for availability of natural scenery. It also seems plausible that all kinds of congestion (traffic) are less present in less densily populated areas, which would attribute to the quality of living there. Instead, some people might prefer access to cultural entertainment (like theatres), which could lead them to choose residence in a more densely populated, urbanised area.

Study migration occurs when someone wants to move closer to her or his school or university. This migration motive is closely related to age and life cycle. The destination choice depends most importantly on the choice of school or university. Sa et al. (2002), who study determinants of university choice in a gravity model, show how this choice can be influenced by amenity considerations.

4 The generation – distribution model

4.1 What migration quantity to model?

Before proposing a migration model we have to decide on how to measure the dependent variable. There are roughly three possibilities namely net migration, total incoming and outgoing migration per region and the entire matrix of migration flows. Obviously, in population forecasting it is the net migrations that counts in the end. However, in this section we will argue that modelling all interregional flows is prefereble in the context of the regional labour market model. A discussion of the topic can also be found in Plane and Rogerson (1994).

Information and identification
The first point we make is about *information*. When studying a cross section of net migration in the Netherlands, we would have 40 observations. This figure would double when analysing total incoming and outgoing migration. The analysis of the interregional migration matrix is on 1600 observations, and thus contains the most information by far.

Why is this information important? The regional labour market model will produce *scenarios* of the spatial distribution of employment and population. These scenarios have to be well explained in terms of underlying *mechanisms* at work, like for for instance the effects on migration patterns of changes in population characteristics or in local labour and housing markets. We are less interested in a reduced form net migration model that forecasts the quantity without explaining it in a satisfactory way.

Theoretically, migration flows are best understood when both the region of origin and the region of destination are taken into account. The aggregate level of education of the regional labour force provides an illustrative example. This variable can be thought to have a negative impact on net migration, since the well educated are relatively mobile, thus causing more than average outmigration. On the other hand, it might proxy high income, thus making the region attractive.

In practice, it is a common observation that total incoming and outgoing migration in a region are highly correlated, and that net migration is but a small fraction of these quantities. This is sometimes referred to as the *Lowry effect*. An immediate consequence is that small relative changes in incoming or outgoing migration cause large relative shifts in net migration. In other words, net migration is a highly volatile quantity, and therefore difficult to explain.

As we have seen, there can be many reasons for someone to migrate, that would be best described in many different models. However, aggregate data do not distinguish these reasons not personal characteristics of the migrants (except age in our case). The identification of underlying mechanisms in aggregate migration data is thus notoriously difficult. Therefore we want to make use of as much information as practically feasible.

Regional population characteristics
When describing the net migration in a region, only population characteristics of this region and a (weighted) average of characteristics of the other regions can be used. This procedure to a large extent disregards the spatial distribution of these characteristics. Suppose that a region is close to another region that has a particularly young or highly educated population. This region would then be likely to receive a larger share of young and highly educated migrants than the average characteristics of the other regions would imply. This can to some extent be compensated by appropriate weighting, but a model for migration flows will always account for the distribution of regional population characteristics in a more accurate way.

4.2 The generation - distribution approach

A rather common way to describe interregional migration flows is by means of a *generation - distribution model*. In such a model, the number of people that decide to move (the generation) and the distribution of these migrants over regions of destination are treated separately. The former is projected using regional population size and characteristics, basically following a life course approach.

We give an example of a simple generation model based on age group and sex specific migration propensities. Let O_i be the total of flows that originate in regio i. The probability that someone in age group l an gender s decides to move is denoted $p_{l,s}$, and $POP_i(l,s)$ refers to the specific regional population size. The generation model is then described in equation (4.1).

$$O_i = \sum_{l,s} p_{l,s} POP_i(l,s) \tag{4.1}$$

The distribution of flows is determined in a model that accounts for distance, size of the destination region and region-specific pull factors. Since the total of flows that originate in a region (including intraregional flows) should always add op to regional generation, we specify a *production constrained* spatial interaction model. In the next section we explain how such a model works technically.

The generation - distribution framework provides a natural way to accommodate both personal and household characteristics and other region-specific explanatory variables in a migration model.

We have discussed some personal and household characteristics that affect migration propensity in chapter 3. For example, young adults, the well-educated and one-person households are relatively mobile. However, the observation that certain groups are more mobile than others in itself does not reveal any information about the sort of destination that these people would choose (although migration patterns can differ significantly by group). The generation model (4.1) is easily extended to include aggregate measures for these characteristics, but they are disregarded in the distribution model.

Regions specific pull factors only play a role in the latter model. Here we include variables like indicators of the local labour and housing market situation.

A more technical advantage of the generation - distribution model (compared to the unconstrained spatial interaction model) is that estimates of the effects of pull factors are far more accurate. We come back to this point in the next section. As pointed out in the previous section, this accuracy is needed for proper identification of mechanisms underlying migration patterns.

4.3 Spatial interaction models

There is a long tradition in modelling interregional migration by means of gravity models. Already in 1885, Ravenstein observed in his “Laws of Migration” that both origin and destination population size and the distance between them should be taken into account. The first to estimate an economic gravity model was Lowry (1966), we have discussed his work in the previous chapter. Founders of the modern theory of spatial interaction models are Wilson (1970), who derived a formulation based on maximisation of entropy, and Alonso (1978). For our research, we have made extensive use of the exposition by Fotheringham and O’Kelly (1989).

The most elementary spatial interaction model for migration bears strong resemblance to the *Newtonian gravity model*. The law of gravity tells us that the force two objects exert on each other is proportional to their masses and inversely proportional to the square of the distance between them. In the standard migration gravity model, the masses are replaced by population size. The population of the region of origin is referred to as the *population at risk*. A population that is twice as large can be expected to produce twice as many migrants. The population size of the region of destination is assumed to be proportional to the number of migrants that can be accommodated (in terms of housing and jobs, for example).

The standard gravity model takes the form of equation (4.2), where M_{ij} denotes the migrant flow between the origin i and the destination j, c is a constant, P_i stands for the population size in region i, and d_{ij} denotes the distance between regions i and j.

$$M_{ij} = cP_iP_j f(d_{ij}). \tag{4.2}$$

It is a stylised fact that incoming and outgoing migration are highly correlated, and that net migration is but a small fraction (the Lowry effect). In the standard gravity model (4.2) net migration is zero. This is easily seen since the migrant flow from region *i* to region *j* is of equal size as the flow in opposite direction (see also Plane and Rogerson, 1985).

Lowry has extended this framework to include economic variables (chapter 3). He points to an undesirable feature of his model, namely "the interchange between each pair of places is independent of that between each other pair" (1966, page 13). Plane and Rogerson (1985) argue that the *competing nature of destination opportunities* should be taken into account. A rigorous implementation of this idea is provided by Fotheringham, we discuss it in the next section. However, a first way of dealing with the concept of competing destinations is the imposition of restrictions on the total of outgoing flows per region.

In a *production constrained* spatial interaction model, the sum of flows that originate in a region is imposed to equal the observed value. It can take the form of equation (4.3), where O_i denotes the sum of outgoing flows in region *i*, and *K* explanatory variables are summarised in the symbol W_{ij}^{θ}.

$$M_{ij} = O_i \frac{P_j^{\beta} W_{ij}^{\theta} d_{ij}^{\gamma}}{\sum_j P_j^{\beta} W_{ij}^{\theta} d_{ij}^{\gamma}}, \; W_{ij}^{\theta} \equiv \prod_{k=1}^{K} \left(W_{ij}^{k}\right)^{\theta_k} \tag{4.3}$$

The explanatory variables W_{ij}^{k} measures the overall attraction to migrants of attribute *k* in destination *j*. Note that explanatory variables that only depend on the origin *i* would drop out of equation (4.3). The production constrained model is thus most appropriate for the analysis of pull factors. This model type is quite generally used for modelling migration flows. The approach is recommended by Plane and Rogerson (1994) and Fotheringham (1993) provides references to numerous migration models that are built in this way.

Finally, there are a number of technical advantages to the choice of a production constrained spatial interaction model. It is noted in Fotheringham and O'Kelly (1989) that these models produce substantially more accurate results that unconstrained models (like the Lowry model). Also, the imposition of restrictions makes the estimation of pull factors far more efficient.

4.4 Competing destinations

Coefficients of the production constrained model (4.3) can be estimated for each region. It is a common procedure to estimate region specific distance decay parameters, in order to deal with spatial heterogeneity. However, many studies portray a bias in these coefficients where migrants from peripheral regions appear to be more deterred by distance than migrants from central regions. As Fotheringham (1993) notes, it is extremely difficult to explain why migrants would exhibit such behaviour, as in fact it would seem more plausible that migrants from peripheral regions bridge larger distances. This problem has come to be known as the *spatial structure effect*.

In a number of studies, Fotheringham proposes both a behavioural explanation of the spatial structure effect and an econometric solution to remove biases in the distance deterrence coefficients. The behavioural concept he puts forward is *hierarchical destination choice*. An assumption underlying the basic production constrained spatial interaction model is that individuals consider and evaluate every alternative before choosing a region of destination. In our modelling context, the assumption would thus be that people study labour and housing markets in 40 regions before choosing where to move. It is contended however that in reality, people take only a very limited number of alternatives into consideration. The idea of hierarchical destination choice is that people first evaluate clusters or groups of alternatives, and then evaluate options in a selected cluster.

We want to interpret this notion in the context of migration in The Netherlands. As we have noted in chapter 3, substantial cultural differences between parts of The Netherlands can be perceived. Some people have strong preferences to live or not to live in for example the west of the country (Randstad) or in the south. These people would thus choose a destination within the part of the country that they prefer. A less standard but in our opinion rather plausible view on hierarchical destination choice is that people might choose a job first, and then a residence in a region on acceptable commuting distance.

A consequence of hierarchical destination choice is that large clusters are perceived to be less attractive and small clusters relatively more attractive than is assumed in model (4.3). We give an illustrative example. Suppose that someone chooses between moving to Amsterdam or to Rotterdam. Since Amsterdam is larger, it offers more housing and job opportunities (disregarding of the local housing and labour market situation). The standard model (4.3) would therefore assign more probability to a choice for Amsterdam. However, it is likely that a priori the individual will put equal weight to the two alternatives. The larger cluster of Amsterdam will thus be perceived as less attractive relative to this model.

A relatively simple solution to the spatial structure problem is to include a variable that measures *centrality* of the region. Central regions are more likely to be part of larger clusters. In the light of the above discussion, this implies that this centrality index or *competition parameter* should appear with negative coefficient. Fotheringham (1993) proposes a competition parameter in the form of equation (4.4).

$$COM_i = \sum_{j \neq i} \frac{POP_j}{d_{ij}^{\gamma}} \tag{4.4}$$

The population POP_j measures the size or attractiveness of region j. The more attractive regions close to region i are there, the more competition this region will experience in attracting migrants.

The value of 1 is usually chosen for the distance decay parameter γ. Although this is often ignored in the literature, it is our contention that this parameter should at least correspond to observed distance deterrence in migration behaviour. Moreover, since clusters must be smaller than the entire set of possible destination regions (the country), we think that there should be more distance deterrence in the competition parameter. For example, when we interpret hierarchical destination choice as a choice for a dwelling after a choice for a job, this parameter should reflect the deterrence to commuting distances.

4.5 Short and long distance moves

In spatial interaction models like (4.3), the number of migrants generally decreases with the distance between two regions. However, the explanatory variables work equally strong on short and long distance migrant flows. In other words, the parameters measuring attraction of region specific pull factors to migrants are independent of the distance they have to bridge. In the context of aggregate migration between COROP regions in the Netherlands, we strongly doubt the validity of this assumption.

We have seen in chapter 3, that labour migrants generally move over larger distances than other migrants (Ekamper and Van Wissen, 2002). This implies that the share of labour migrants in the aggregate migration flows increases with distance. It can thus be expected that labour market related pull factor coefficients change (and become more significant) with distance. In contrast, we expect that pull factors that reflect housing quality (like population density) are most important to people who move over shorter distances (residential migrations). The share of migrants that are motivated by these factors in the aggregate flows should decrease with distance. Coefficients should thus become less significant with distance. More formally, in model (4.3) the coefficients of the explanatory variables W_{ij} are distance dependent and should be denoted $\theta(d_{ij})$.

Estimation of the model would become rather complicated if we would allow much freedom in the specification for the functional form of the distance dependence of coefficients. In this paper, we propose the form (4.5).

$$\theta(d_{ij}) = 1_{d_{ij} \leq d*}\theta_1 + 1_{d_{ij} > d*}\theta_2 \tag{4.5}$$

The coefficient of a pull factor is estimated θ_1 if the move is over a distance shorter than d^*, and it is estimated θ_2 otherwise. A significant difference of θ_1 and θ_2 then provides evidence of changing relative importance of push factors over distance. This framework allows us to estimate impact of local housing and labour market developments more accurately.

5 Empirical analysis

5.1 Data

The migration data
We analyse migration between 40 Dutch COROP regions in the year 2000. These data stem from municipal administrations (GBA). Each person that moves to another municipality is legally obliged to subscribe there. These records are reported to Netherlands Statistics (CBS). This institute aggregates the data to interregional migration matrices. We study this matrix for 7 age groups (0 - 15 - 25 - 35 - 45 - 55 - 65 - ..).

Household composition is not distinguished in the data. It is important to bear in mind that in reality, the decision to move is a household rather than an individual decision, which means that a substantial part of all migrations are *tied moves*. For instance, by far the largest part of all moves in the first age group are tied moves. A migration model for this group thus describes behaviour of a subset of the population in older age classes (those with young children).

The way in which the data are collected implies that we consider only moves between municipalities. Residential moves that take place within a municipality (probably a considerable share) are not observed. This introduces heterogeneity, since the average size of a municipality differs over COROP regions. We discuss consequences in section 5.2.

We note that the registration duty makes our data generally more accurate than survey data (like the Housing Demand Study). It can occur however, that people do not comply with the registration duty. Students sometimes remain subscribed in their parents' municipalities, for example. This might introduce some small biases that we do not discuss further in this paper.

Distance between regions
The distance matrix has been constructed under the authority of AVV Transport Research Centre. This institute has a large dataset of traffic flows in 1995. A subset has been taken that consists of all work trips by car. The average distance of these trips from one region to another is considered the distance between these regions. This method also yields a measure for average distance within (or for size of) a region.

As we have put forward in chapter 3, the distance deterrence for residential migration is closely connected to the distance deterrence for commuting. Thus, distances for residential migration will be conceived in the same way as distances for commuting. This lends support for our choice of using this distance matrix.

Explanatory variables
Most data we use come from Netherlands Statistics (CBS). This bureau has up to date information about national and regional population and household development, and also produces national population projections.

Netherlands Statistics yearly surveys the labour force. From 1999 onwards the Labour Force Survey (EBB) consists of 320 000 samples. We use this source for labour force characteristics like regional unemployment and level of education. It also contains data on commuting.

The same bureau produces national and regional accounts. The national accounts provide a time series of sectoral employment, both for employees and self-employed (in persons and years). The regional accounts provide time series of employees per sector. We have estimated the regional distribution of self-employed with data for the year 1997. The regional labour force is computed as the sum of regional employment and regional unemployment, corrected for net commuting.

Finally, we use historical data on the regional housing stock that were provided by ABF Research.

5.2 The generation model

We want to project the total number of migrants that emerges from a region by means of a *generation* model. The most important determinant of this number is the size of the *population at risk*, the number of people that could decide to migrate. In chapter 3 we have discussed, what effect other personal and household characteristics should have. This section investigates how aggregate measures of these characteristics work out.

The first step is to compute the part of the regional generation that can be explained by age group and sex specific migration propensities. In table 5.1 and in figure 3.1 we show migration propensity for each group. This is computed as the total number of migrants divided by the total number of people (both in the year 2000). Between brackets, we show the standard deviations of computed regional propensities. These figures are consistent with the *life cycle* approach to migration (chapter 3). Young adults are the most mobile, and the propensity then decreases with age. It appears that the mobility peak is experienced at a younger age for women than for man.

age group	M	V
0 - 14	0.031 (0.007)	0.030 (0.007)
15 - 24	0.072 (0.015)	0.100 (0.018)
25 - 34	0.076 (0.015)	0.070 (0.014)
35 - 44	0.036 (0.008)	0.028 (0.006)
45 - 54	0.020 (0.004)	0.018 (0.004)
55 - 64	0.017 (0.004)	0.015 (0.004)
65 +	0.015 (0.003)	0.016 (0.003)

Table 5.1: age group and sex specific migration propensities in 2000 (standard deviations of regional propensities between brackets)

We then consider the difference between the generation we observe and the application of the propensities to the regional population structure, which we name the *generation residual*. On this residual, we estimate an econometric model for each age group, with aggregate measures for personal characteristics as explanatory variables.

Personal *unemployment* augments to migration propensity (chapter 3). Therefore, regional unemployment is expected to increase the generation. We consider the unemployment rate in deviation of the national rate as explanatory variable. Because it can be expected that some time passes between the spell of unemployment and the decision to migrate, we use a year lag.

The *higher educated* are expected to be more mobile. The share of the higher educated (people with a university or higher vocational degree) in the labour force is considered.

One-person households generally move more often that other households. We therefore include the ratio of one-person to total households in the model. This variable is distinguished for each age group, where the age of the head of household is used. Obviously, this variable cannot be used for the first age group.

We finally introduce a more technical variable. Our data consist of all moves between municipalities, aggregated to COROP regions. However, large municipalities will on average produce relatively less generation, since a larger share of residential moves can be accommodated in the own municipality. Thus regions with large municipalities will have relatively little generation. We use the average population size of municipalities per COROP region to control for this effect. This regional mean size is subtracted from the national average, and divided by the national average for normalisation.

All explanatory variables are considered *in deviation of their national average*. It would have been more efficient to differentiate the other explanatory variables to age groups as well. However, we do not dispose of such data.

The average population size of municipalities in region i is denoted PSM_i. Let U_i be the unemployment rate, EDU_i stands for the share of higher educated, $H_i(l)$ refers to the share of one-person households in age group l. The generation residual is denoted $RES_i(l)$ and C is a constant. All explanatory variables are taken in deviation of the national average. Since larger regions produce more migrants, we scale the regressant to the regional population in the corresponding age group, referred to as $POP_i(l)$. The model we estimate for each age group is given in formula (5.1), where variables are considered in deviation of their national average. The α_k's are the coefficients to be estimated, the residual of this estimation is denoted ε_i.

$$\frac{RES_i(l)}{POP_i(l)} = \alpha_1 PSM_i + \alpha_2 U_i + \alpha_3 EDU_i + \alpha_4 H_i(l) + C + \varepsilon_i \qquad (5.1)$$

We estimate this model by means of Ordinary Least Squares. In table 5.2, we show estimation results for age group 3, which contains the largest group of migrants. We report t-statistics based on White Heteroskedasticity-Consistent Standard Errors.

generation residual in age group 25 - 35	model (5.1)
municipality size	-0.009 (2.8)
unemployment rate	0.173 (2.8)
share of higher educated	0.069 (1.4)
share of one-person households	0.110 (3.0)
constant	0.007 (3.8)
number of observations	40
R^2	0.619

Table 5.2: estimation of model 5.2
White Heteroskedasticity-Consistent t-statistics between brackets

It appears that all coefficients have expected signs, with only the share of higher educated being insignificant at the five-percent level of confidence. Regions with large municipalities generate fewer migrants. High unemployment augments the generation. It is remarkable that we find this result for regional unemployment. Numerous studies on aggregate data have found insignificant or counterintuitive results for this variable. Regions with a highly educated labour force have a more mobile population, and the same holds for regions with a large proportion of one-person households. It is somewhat puzzling though, that we find a significant constant having taken all explanatory variables in deviation of their national average. Together, these variables explain more than half of the variance in the generation residual.

In the appendix, we show regression results for all age groups and for total regional generation. Except for the first, average municipality size has the expected sign in each group. It is not significant everywhere. The coefficient is large in the second and third age group, which contain the most migrations.

Unemployment is significant in all age groups and has expected sign. The coefficient is high in the first and the second age group. For the first group this could be interpreted as follows. When the head of household is unemployed and there are children, she or he will be particularly eager to get a job, even if it is elsewhere. This is consistent with the NIDI research (section 3.2), that observes that if someone moves, the fact that she or he is part of a larger household increases the probability that this is a labour migration.

The share of higher educated in the labour force has expected sign for each age group, though nowhere significant. As expected, it is large for the third and the fourth age group, which have the largest participation rates.

The share of one-person households has expected sign for each age group as well. It only is significant in the third age group.

Finally, the constant is only significant in the third and the fourth age group, and the largest part of the variance is explained in the third age group.

We conclude that coefficients have expected signs for every coefficient for almost every age group. The development of coefficients over age groups is generally as expected, with labour market related characteristics especially relevant for young adults. It is important to realise that the number of observations is small and the risk of a spurious regression exists. However, the pattern of coefficients over age groups lends credibility to our results.

5.3 The distribution model

The migrants that are projected to emerge from a region will be allocated to destination regions in a distribution model that takes account of pull factors. In this section we will estimate a production constrained spatial interaction model in order to select variables that determine the relative attraction of destinations.

Ideally, such a model would include all factors that somehow affect migrant decisions. Ignoring determinants leads to biases in the coefficient estimates of other variables. However, in the context of the regional labour market model, we are tied to a very limited number of explanatory variables. These variables reflect our interest in certain specific mechanisms, like the impact of local labour market developments and shifts in population structure or household structure.

Aggregate migration cannot simply be split into residential, labour and schooling migration. First of all, these motives are not the only ones for migration (personal motives like nest-leaving of divorce are ignored). Secondly, a combination of labour and residential motives can make someone decide to move. It is thus only for the sake of clarity that we present explanatory variables in these categories.

Variables related to residential migration

It seems obvious that the destination housing market situation is relevant for all migrants, since a house is an indispensable requirement for a migration. Currently, the housing market is rather tight, especially in the west of The Netherlands. Consider the example of Flevoland. This region is on acceptable commuting distance from regions like Amsterdam, where housing is relatively expensive. Over the past decades, it has witnessed a considerable growth of the housing stock. We think that the large flow of incoming migrants there is to substantial extent due to the relatively loose housing market situation.

Probably the best indicator of the local housing market situation would be an average selling or rental price (ideally distinguishing several housing types). Data on these variables exist, but we will not endogenise them in the regional labour market model. Since prices are difficult to predict, we disregard of this variable.

The housing market situation is to some extent captured by *growth of the housing stock* (the regional housing stock divided by its one-year lag). A fast growing housing stock can be expected to exert downward pressure on housing prices. It should thus be easier to find appropriate and affordable housing in regions that experience a large housing production. We have access to data on the housing stock and information on building projects in the near future (collected by ABF Research). Therefore, we use housing growth as an explanatory variable.

A characteristic that would attract migrants with a housing motive in particular is housing quality. Two problems associated with this characteristic are that it is difficult to quantify and difficult to aggregate. Houses in the Amsterdam centre (the ‘grachtengordel’) are very popular, but what variable would capture this attractiveness? And if we would find such a measure, how would it perform on the region taking the suburbs into account as well? And then of course the next question would be to what extent we can predict such a measure in order to forecast migration flows?

Because of these problems, we do not want to include such quality variables in the regional labour market model. We do however consider the *population density*. This variable is easily projected since population is an endogenous model variable. There are two ways to interpret the effects of population density.

In general, people will prefer a large house to a small house and a large garden to a small garden. Large houses with large gardens are most likely to be found in less densely populated areas. Density thus measures quality. In addition, more natural scenery will be available in these areas. In contrast, densely populated areas will probably provide more access to facilities like cultural entertainment. Especially for younger age groups, this interpretation might lead to a positive effect of the variable.

Population density also proxies housing prices. Generally, residences are more expensive in densely populated areas. Although we associate the variable strongly with residential mobility, cheaper housing would also imply a higher real income, thus becoming a motive for labour migration.

Labour market related variables

The Lowry model uses unemployment, employment opportunities and income as explanatory variables for economic migration. We have discussed these determinants extensively in chapter 3. In our migration model, we use similar variables. The *unemployment* rate in the region of destination is used as a proxy for tightness of the local labour market.

A labour migrant by definition has new a job in (or near) the region of destination. This implies that the region must have generated a vacancy or employment opportunity. We expect that regions that provide many job opportunities attract more labour migrants. We proxy this mechanism with two variables.

In general, the number of vacancies is roughly proportional to the employment level. A larger local labour force provides more competitors for these vacancies. A first proxy for employment opportunities would thus be the ratio of *jobs to labour force*. However, this variable ignores commuting. Migrants can choose for a destination region that is on acceptable commuting distance from their work. Competitors can come from regions at acceptable commuting distance from the region where the vacancy emerged. Taking this into account leads to a variable as defined in equation (5.2). In this equation EOP_i stands for employment opportunities in region i, the variable that we will include in our model. The employment level (in persons) is denoted by EMP_i and the labour force is referred to as LAB_i. The distance d_{ij} deters with a coefficient that follows from our research on commuting (Vermeulen, forthcoming).

$$EOP_i = \left(\sum_j \frac{EMP_j}{d_{ij}^3} \right) \left(\sum_j \frac{LAB_j}{d_{ij}^3} \right)^{-1} \tag{5.2}$$

The second proxy we use for employment opportunities is *employment growth* (level of employment divided by its one-year lag). A region that experiences positive employment growth is in an upswing of the (local) business cycle. It is a common observation that the ratio of vacancies to employment is higher during such upswings. This region will thus generate more job opportunities than explained by (5.2).

In our model, we disregard of *income*. First of all, this is not an endogenous variable of the regional labour market model. Wages are difficult to predict. In addition, the variable we would theoretically need is hedonic real income. That is, income compensated for amenities and regional purchasing power (see chapter 3), and it is very difficult to quantify these variables.

Study migration

We make the assumption that the relative size of universities and higher vocational training institutes remains unchanged in the future. Two explanatory variables are constructed by according the relative size of the institute to its region. These variables are included in the model for migrations in the second age group (15 - 24). Regions with large education institutes will thus attract more students.

Distance decay and spatial heterogeneity

It is common practice to allow for region specific distance decay parameters (see for example Fotheringham and O'Kelly, 1989). The shape and ordering of the regions makes that migrants from one region have to bridge longer distances than migrants from other regions. Compare for example the central region of Utrecht and Limburg in the south of the country. This is a form of *spatial heterogeneity* that would be ignored when assuming one distance decay parameter for the entire country.

As discussed in chapter 4, a bias in these parameters is often observed that can be alleviated by including a *competing destinations* variable. We include age group specific competing destination variables as given in formula (5.3). The competing destinations variable in region i for age group l is written as $COM_i(l)$. The age group population size in this region is denoted $POP_i(l)$. The distance d_{ij} deters with a coefficient that is roughly the average of region specific coefficients (1.5).

$$COM_i(l) = \sum_{j \neq i} \frac{POP_j(l)}{d_{ij}^{1.5}} \tag{5.3}$$

Plane and Rogerson (1994) state about the distribution model that "the overall accuracy of the modelling efforts depends to a great extent on how well the p_{ii} (diagonal) elements are modelled" (page 204). Since we do not need to explain intraregional migrant flows (they disappear in net migration), we model them by including region-specific dummy variables for the diagonal elements of the migration matrix. In this way, all explanatory variables are estimated on migration flows that are interregional. We also deal with heterogeneity that stems from different municipality sizes (see the previous section).

We finally include a *dummy for migration to adjacent regions*. Since origin and destination can be very close (closer than some intraregional moves), these regions contribute in a somewhat different way to distance deterrence estimates then do other regions.

Short and long distance moves

We believe that the importance of pull factors in explaining aggregate migration flows, and therefore their coefficients, changes with the distance between two regions. In equation (5.4) we repeat the formalisation of this concept as introduced in chapter 4.

$$\theta(d_{ij}) = 1_{d_{ij} \le d*}\theta_1 + 1_{d_{ij} > d*}\theta_2 \tag{5.4}$$

Roughly speaking, the coefficient θ_1^k measures the impact of explanatory variable W_{ij}^k on short distance moves, and θ_2^k measures how it affects long term moves.

A practical issue is how to choose the threshold value $d*$. In our research we have taken the value of 75 kilometres. We think that by far the largest part of commuters travel over shorter distances (for example, the distances in the triangle Amsterdam, The Hague, Utrecht are all smaller than 75 km). Residential migrants that do not change of job are thus generally expected to move over distances smaller than this threshold value. Pull factors triggering residential migration are thought to differ from factors that trigger labour migration. Therefore, this framework allows us to identify more accurately the impact of residential and labour migration related variables.

Finally, we allow for different distance deterrence behaviour for short and long distances. We estimate a distance deterrence coefficient for each region. In addition, we estimate a constant mark-up to this parameter for short distances. This mark-up is not region-specific.

Estimation

We estimate the effect of pull factors on migrant destination choice in a production constrained spatial interaction model (chapter 4). In equation (5.5) we present a linear form of model (4.3) that can be estimated with OLS (see Fotheringham and O'Kelly, 1989, page 45 for a derivation of this result). Note that by doing the transformation, the total number of outgoing flows per region O_i drops out.

$$\begin{aligned}\left(\log M_{ij} - \frac{1}{n}\sum_j \log M_{ij}\right) &= \beta\left(\log P_j - \frac{1}{n}\sum_j \log P_j\right) + \sum_k \theta_k \left(\log W_{ij}^k - \frac{1}{n}\sum_j \log W_{ij}^k\right) \\ &\quad + \gamma\left(\log d_{ij} - \frac{1}{n}\sum_j \log d_{ij}\right) + \varepsilon_{ij}\end{aligned} \tag{5.5}$$

The logarithmic transformation introduces heteroskedasticity that can be alleviated by using weights as proposed by Sen and Soot (1981), see expression (5.6). The flow from region *i* to region *j* is weighted more when it is larger.

$$WEIGHT_{ij} = \left(\frac{1}{M_{ij}} + \frac{1}{M_{ji}} + \frac{1}{M_{ii}} + \frac{1}{M_{jj}}\right)^{-0.5} \tag{5.6}$$

We have estimated the generation model with all explanatory variables as described in this section. In order to avoid simultaneities in the regional labour market model and because we expect a time lag between the decision to migrate and the actual migration, we have used one year lags of all explanatory variables.

Results for the third age group

We show estimation results of the generation model for the third age group (25 - 34), which is the largest, in table (5.3). The population coefficient is near one, as expected. The region-specific distance deterrence coefficients are all found significantly negative. They range from -0.9 (Groningen) to -1.9 (a central region under Utrecht). As expected, distance deterrence is stronger for short distance moves, the mark-up is -0.64. The dummy's for intraregional migration are insignificant. The dummy for migration is found with a small negative coefficient. Omitting this variable would lead to overestimation of migration to adjacent regions. As expected, the competing destinations variable is found with negative coefficient.

Growth of the housing stock, indicating a relatively loose housing market, is a significant attractor for both short and long distance moves. The coefficient for short distance moves is significantly larger than the coefficient for long distance moves. For short distance moves, density is found with negative significant coefficient. This supports our interpretation of this variable as a measure for housing quality and price. For long distance moves, however, it appears with positive sign. This is difficult to interpret. It may have to do with the attraction of large cities in the west of the country.

age group 25 - 34	d_{ij} < 75 km	d_{ij} > 75 km
standard gravity model		
population (25 - 34)	0.91 *** (54)	
distance decay (region specific)	negative significant (***)	
additional distance decay (d < 75 km)	-0.64 *** (15)	
dummy own region (region specific)	insignificant	
dummy adjacent region	-0.071 *** (3.8)	
competing destinations (25 - 34)	-0.41 *** (7.5)	
residential migration variables		
growth housing stock	15 *** (5.7)	5.1 * (1.7)
population density	-0.27 *** (8.6)	0.12 *** (3.8)
labour migration variables		
unemployment	-0.06 (1.0)	0.26 *** (4.4)
employment to labour force	-0.84 *** (3.5)	1.7 *** (7.1)
employment growth	0.0 (0.0)	5.4 *** (3.5)
R^2 (weighted)	0.985	

*Table 5.3: a production constrained model for migration in the age group 25 - 34 (absolute t-values between brackets, * (**, ***) indicates significant difference from zero at 10 (5, 1) percent level of confidence)*

For short distance moves, we find a negative coefficient for unemployment. Although it comes with expected sign, it is not significant. Since labour migrants constitute a larger part of long distance moves, we would certainly expect this coefficient to be negative. However, we find it with significant positive sign.

We can explain to some extent why an insignificant result could be found. Long distance migrants are usually the well educated, and unemployment is highest under the low educated. In other words, the impact of the variable is highly obscured since we do not take heterogeneity of jobs and labour force into account.

The significantly positive coefficient for unemployment on long distance moves is puzzling. Since unemployment is relatively high in large cities, it could reflect their attraction.

The ratio of employment to labour force, corrected for commuting, is found with negative significant coefficient for short distance moves, and it is found with positive significant coefficient for long distance moves. The short distance coefficient is puzzling since we would expect a positive sign. A possible explanation is that the housing price might be positively correlated with this variable. This would deter especially residential migrants, who constitute a relatively larger share of short distance moves.

The impact of employment growth is completely insignificant for short distance moves, and it is positive significant for long distance moves.

We conclude that standard gravity variables are the most important for explaining migration flows in the third age group. Variables that we associate more with residential migration perform well for short distance moves. Variables rather attributed to labour migration perform well for long distance moves. This supports our view that residential migration is dominant on short distance moves and that labour migration constitutes the larger part of long distance moves.

Results for seven age groups
In the appendix, we show estimation results for seven age groups and for total distribution. For all age groups, the population coefficient is significant and close to 1. The value decreases somewhat with increasing age, except for the group 65 +. The region-specific distance decay variables are negative significant for all age groups. The mark-up in distance decay for short distance moves is negative significant. It is smallest in absolute value in the second age group, and then increases with age. The dummy for migration to adjacent regions displays the same pattern. The competition parameter is found to be around -0.5, with a very high value for the second age group and a very low value for the seventh.

Growth of the housing market is found with positive significant coefficient for short distance moves in all age groups except the seventh. It is lowest for the fourth age group, but the differences are not very large. For long distance moves, the variable is significant at the five percent level of confidence for the first, the fifth and the sixth age group.

For short distance moves, density is found with negative significant coefficient in every age group. This coefficient increases with age, with a particularly low value for migrants between 15 and 25. We would expect a negative coefficient for long distance moves as well. Interestingly, we find this for all age groups except the second and the third, the groups where labour migration is thought to play the most important role.

The impact of unemployment on short distance moves is found insignificant for every age group. Except for the second age group, this variable is found to have a significant positive impact on long distance moves. It is rather difficult to explain why this is so.

We find a significant negative coefficient for the ratio of employment to labour force in the first four age groups, it is insignificant in the last three groups. This is somewhat counterintuitive, we have put forward the interpretation of housing prices. This is slightly conflicting with the pattern over age groups, if we assume that housing migration becomes more important with age.

We expect the variable to have the clearest impact on long distance moves, since the share of labour migrants is relatively higher in this group. Indeed we find a positive significant coefficient from the second to the fifth age group, with the highest value for the migrants between 25 and 35. This is exactly the pattern over age groups that we would expect for the importance of labour motives in migration.

For employment growth, results are comparable. This variable is insignificant in determining migration over short distances for all age groups. It is positive significant for long distance moves from the second to the fourth age group. Again, this follows the pattern over age groups that we would expect.

We only include variables for study migration in the second age group. All variables have expected sign. Only the impact of higher vocational education on short distance moves is not significant. Interestingly, the variable for university size does not perform well in the model for total migration. This underlines our choice for distinguishing age groups.

We conclude that the pattern of coefficients over age groups reflects our view that labour motives are most important for young adults, and that residential (and study) migration dominate the other age groups. This becomes particularly clear when assessing the impact of the labour market variables employment to labour force and employment growth on long distance moves.

6 Conclusions and recommendations

In this paper, we propose a model for interregional migration that is to be built into the CPB regional labour market model. The migration model establishes the link from regional labour market developments to regional population growth. Also, the impact of the ageing process, developments in household composition and local housing markets are incorporated.

The total number of migrants that emerges from a region is explained with the regional population size distinguishing sex and age groups. In addition, the effects of local unemployment, the average level of education and the share of one-person households are taken into account. In an econometric analysis, we find that local unemployment increases the number of migrants. The higher educated and one-person households are also found to be more mobile. The coefficients exhibit credible patterns over the age groups.

A distribution model links these migrants to destination regions. Pull factors that affect the distribution are determined in a production constrained spatial interaction model. In short distance moves, growth of the housing stock and population density are the most important factors for all age groups. We find that the ratio of jobs to labour force and regional employment growth are significant attractors for young adults that migrate over longer distances. Again, the coefficients we find exhibit credible patterns over distance and age groups.

The link from regional labour market developments to migration is thus well established. Regions that have a large unemployment rate generate more migrants, and regions with favourable labour market conditions attract more migrants.

Finally, we make some remarks on our analysis and we recommend some lines of further research.

It would be interesting to study the relation between local employment and population growth in a simultaneous equations model (Muth, 1968, 1971).

There is a considerable body of literature on the relation between commuting and residential mobility. Migration, commuting and participation would preferably be studied in an integrated framework (another simultaneous equations model).

In the econometric analysis, we assume parameters to be constant over time. A study of migration panel data on migration would further understanding of temporal aspects of the phenomenon.

In this research, we have focussed on labour migration. Especially for short distance moves, we have found some unsatisfactory coefficients. A more extensive study of determinants of residential and other forms of migration might shed some light on the issue.

The meagre performance of unemployment in the distribution model can partly be explained by heterogeneity of jobs and labour force. Using employment data that distinguish age and level of education might yield better results.

Finally, this paper may not have dealt sufficiently with household structure and the fact that a substantial part of migrations are tied moves.

variable in destination	0 - 14		15 - 24		25 - 34		35 - 44		45 - 54		55 - 64		65 +		total	
	coeff.	t-stat.	coeff.	t-stat.	coeff.	t-stat.	coeff.	t-stat.	coeff.	t-stat.	coeff.	t-stat.	coeff.	t-stat.	coeff.	t-stat.
municipality size	**0.001**	(0.5)	**-0.012**	(2.5)	**-0.009**	(2.8)	**-0.001**	(0.6)	**-0.001**	(0.8)	**-0.001**	(0.7)	**-0.002**	(1.9)	**-0.003**	(1.9)
unemployment	**0.237**	(6.3)	**0.519**	(5.1)	**0.173**	(2.8)	**0.133**	(4.1)	**0.070**	(3.6)	**0.051**	(2.2)	**0.040**	(1.9)	**0.156**	(4.8)
level of education	**0.045**	(2.3)	**0.016**	(0.3)	**0.069**	(1.4)	**0.048**	(1.5)	**0.015**	(0.9)	**0.010**	(0.6)	**0.007**	(0.8)	**0.032**	(1.1)
one-person household			**0.021**	(0.6)	**0.110**	(3.0)	**0.039**	(1.2)	**0.031**	(1.4)	**0.029**	(1.5)	**0.043**	(1.8)	**0.044**	(1.7)
constant	**0.000**	(0.2)	**0.000**	(0.2)	**0.007**	(3.8)	**0.002**	(2.3)	**0.001**	(1.3)	**0.001**	(0.8)	**0.001**	(0.9)	**0.002**	(1.8)
# migrants	89 041		153 822		185 453		84 072		44 071		25 012		32 626		614 097	
R^2	0.433		0.549		0.619		0.450		0.364		0.217		0.267		0.489	

Appendix 1: estimation results of the generation model (section 5.2) for seven age groups

variable in destination	0 - 14		15 - 24		25 - 34		35 - 44		45 - 54		55 - 64		65 +		total	
	coeff.	t-stat.	coeff.	t-stat.	coeff.	t-stat.	coeff.	t-stat.	coeff.	t-stat.	coeff.	t-stat.	coeff.	t-stat.	coeff.	t-stat.
population (age group)	**0.86**	(41.0)	**0.93**	(29.5)	**0.91**	(54.0)	**0.86**	(43.7)	**0.82**	(36.9)	**0.77**	(28)	**0.90**	(34.4)	**0.82**	(26.4)
distance decay (40)	neg. sig.		neg. sig.		neg. sig.		neg. sig.		neg. sig.		neg. sig.		neg. sig.		neg. sig.	
distance (d < 75)	**-0.81**	(17.3)	**-0.32**	(7.7)	**-0.64**	(14.8)	**-0.77**	(16.5)	**-0.86**	(17.1)	**-0.99**	(17.3)	**-1.02**	(17.7)	**-0.59**	(14.4)
dummy own region (40)	insignificant		insignificant		insignificant		insignificant		insignificant		insignificant		insignificant		insignificant	
dummy adjacent region	**-0.18**	(8.0)	**-0.07**	(3.2)	**-0.07**	(3.8)	**-0.14**	(6.7)	**-0.14**	(6.6)	**-0.21**	(7.9)	**-0.33**	(13.7)	**-0.11**	(5.7)
competition (age group)	**-0.61**	(9.3)	**-0.83**	(15.1)	**-0.41**	(7.5)	**-0.50**	(8.0)	**-0.53**	(7.5)	**-0.45**	(5.2)	**-0.08**	(1.0)	**-0.58**	(10.2)
housing growth (d < 75)	**18.49**	(6.1)	**17.30**	(5.3)	**15.26**	(5.7)	**13.39**	(4.7)	**19.34**	(6.3)	**23.06**	(6.1)	**3.97**	(1.1)	**14.22**	(5.1)
housing growth (d > 75)	**7.56**	(2.4)	**0.53**	(0.2)	**5.14**	(1.7)	**4.25**	(1.3)	**7.16**	(2.0)	**13.53**	(3.4)	**4.41**	(1.1)	**3.65**	(1.2)
density (d < 75)	**-0.37**	(10.2)	**-0.09**	(2.5)	**-0.27**	(8.6)	**-0.37**	(10.7)	**-0.36**	(9.7)	**-0.48**	(10.5)	**-0.68**	(15.7)	**-0.33**	(9.9)
density (d > 75)	**-0.09**	(2.5)	**0.12**	(3.9)	**0.12**	(3.8)	**-0.08**	(2.4)	**-0.10**	(2.7)	**-0.19**	(4.3)	**-0.25**	(6.0)	**0.02**	(0.8)
unemployment (d < 75)	**-0.01**	(0.1)	**-0.10**	(1.5)	**-0.06**	(1.0)	**-0.03**	(0.5)	**0.10**	(1.4)	**0.13**	(1.6)	**-0.04**	(0.6)	**-0.08**	(1.3)
unemployment (d > 75)	**0.31**	(4.6)	**0.09**	(1.5)	**0.26**	(4.4)	**0.23**	(3.6)	**0.41**	(5.7)	**0.52**	(6.0)	**0.35**	(4.2)	**0.23**	(3.7)
job opport. (d < 75)	**-0.94**	(3.3)	**-1.23**	(3.9)	**-0.84**	(3.5)	**-0.80**	(3.1)	**0.18**	(0.6)	**0.15**	(0.5)	**-0.36**	(1.1)	**-1.10**	(3.9)
job opport. (d > 75)	**-0.07**	(0.3)	**1.20**	(4.3)	**1.70**	(7.1)	**0.73**	(2.9)	**0.65**	(2.4)	**0.20**	(0.6)	**0.10**	(0.3)	**0.98**	(3.8)
job growth (d < 75)	**-0.78**	(0.5)	**-1.10**	(0.6)	**0.01**	(0.0)	**-0.15**	(0.1)	**-0.47**	(0.3)	**1.17**	(0.6)	**3.25**	(1.8)	**1.62**	(1.0)
job growth (d > 75)	**0.90**	(0.5)	**3.67**	(2.1)	**5.36**	(3.5)	**3.33**	(2.0)	**0.72**	(0.4)	**0.63**	(0.3)	**-0.14**	(0.1)	**5.79**	(3.5)
university (d < 75)			**0.11**	(3.7)											**-0.02**	(0.9)
university (d > 75)			**0.14**	(4.1)											**0.01**	(0.4)
higher voc. (d < 75)			**0.04**	(1.6)											**0.12**	(4.7)
higher voc. (d > 75)			**0.09**	(3.2)											**0.10**	(3.5)
# migrants	89 041		153 822		185 453		84 072		44 071		25 012		32 626		614 097	
R^2 (weighted)	0.976		0.978		0.985		0.982		0.982		0.970		0.981		0.985	

Appendix 2: estimation results of the distribution model (section 5.3) for seven age groups

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