A general-equilibrium analysis of the regional effects of ageing

Thijs Knaap*

August 2007

Abstract

I discuss a static general equilibrium model with regional trade and the location decision of workers and pensioners, applied to the Netherlands. The location decision is modelled using McFaddens method of unobservable preferences, so that the model gives a non-trivial distribution of inhabitants over regions. It is used to discuss the consequences of population ageing for the number of inhabitants, wages and prices in the Dutch provinces. To be able to do this in a static model, I introduce a much stylized version of the pension system. I find that in response to the changed demographics, workers move to the central provinces, while pensioners move to the periphery. Wages, prices and house prices increase especially in the periphery.

JEL codes: R13, R23, J26

Keywords: Population Ageing, Location Decision, Regional Policy.

This preliminary version August 2007 / comments welcome.

1 Introduction

According to demographic projections, the share of retired persons in the Netherlands will increase from 14 to 24 percent in the next decades (CBS, 2006). This ageing of the population is a structural change in the Dutch economy which has precipitated a national discussion of the consequences, often centered on the

*Utrecht School of Economics en Netspar, t.knaap@econ.uu.nl. I thank Yvonne Adema, Martin Grotenhuis and participants of the Netspar workshop in February 2007. This article is based in part on Knaap and Grotenhuis (2006).

prospects of the pension system.[1] In this paper, I discuss whether there is any reason to expect that ageing will lead to important regional disparities in the Netherlands.

If we assume that ageing will not cause a change in the rates of migration between different regions, it is possible to use the current regional population structure and historical migration flows to project what regional demographics will look like in the future. Derks (2004a) calculates in this fashion that the provinces of Zeeland, Drenthe and Limburg will be the first to see a large scale ageing of their population. Repercussions for regional housing markets and health care capacity are discussed in Derks (2004b).

However, the assumption of constant migration rates may not hold under a structural change like population ageing. If the location decision of workers and retirees depends partly (and differently) on local price and wage levels, it is possible that population ageing, by changing local prices and wages, will lead to different migration rates.

I investigate the regional effects of population ageing in this paper using a simple general equilibrium model, based on previous work by Koike and Thissen (2006). In this model, retirees and workers decide where to live based on regional, real, income levels. Wages and prices are endogenous and respond to changes in demand and supply, caused by demographic changes. This analysis is complementary to the earlier work by Derks: instead of extrapolating historical trends, I assume that each person makes an active location choice, based on wages and prices. The factors that influence the decision are described in a model.

This analysis is different from earlier spatial CGE-models of the Dutch economy. Next to the simplicity of the model I differentiate between retired and working persons, making an analysis of ageing possible. Knaap and Oosterhaven (2000) describe a spatial model based on New Economic Geography, with a high level of detail (548 municipalities, 14 sectors). By differentiating between personal and freight transport, they are able to assess the indirect economic effects of a railway link. Thissen (2005) builds on this work and adds frictions in the labor market and migration between regions. Their theory is derived from the so-called New Economic Geography which assumes monopolistic competition and often gives rise to large-scale models. In this exercise, we omit a detailed microeconomic foundation in favor of a model that is easy to interpret.

I find that existing differences in regional population structure can be explained, to a degree, by economic considerations. Population ageing will cause migration of workers to the center of the country, while pensioners leave for the periphery. This causes wages and prices in the periphery to increase.

[1] See the website of the Netspar research network, `http://www.netspar.nl`, for a good overview of the discussion.

In the next section I discuss the model and section 3 shows the main results of the simulations. Section 4 concludes.

2 The model

The analysis in this paper will be static in nature: I compute wages, prices and quantities traded in a single year. This necessarily means ignoring all intertemporal aspects of economic activity, such as the saving decision and the decision to accumulate human capital. For the interested reader there is a large number of other studies (see, for instance, Bovenberg and Knaap, 2005) that go into these aspects of population ageing in much detail. We do take into account an important differnce between the source of income for workers and retirees: where the income of (young) workers is derived mainly from labor, retirees get their income largely as a return to capital (through private savings, but also through occupational pension funds) and as a transfer from the young (through the govrenment-run PAYG pension system). We ignore, however, the possibility of intertemporal trade with the rest of the world, which allows agents to save without affecting the local capital stock.

2.1 Production and ownership

We split consumption into two categories: consumption of housing services (rent, property upkeep or interest on a mortgage) H and other consumption, C. The utility of agent k is agent k is

$$U_k = \beta \log C_k + (1-\beta) \log H_k. \tag{1}$$

Given that this agent lives in region j where the price of consumption goods is p_j and the price of housing services is p_j^H, the variable part of the indirect utility function can be written as

$$V_k = \log E_k - \beta \log p_j - (1-\beta) \log p_j^H \tag{2}$$

with E_k the agent's income.

Services in the housing sector are produced using a fixed stock of houses. The production of other consumption goods is done with a Cobb-Douglas production function that takes labor (share α) and capital (share $1-\alpha$). Capital is mobile between regions and will spread so that returns are equal, where

$$r = \frac{1-\alpha}{\alpha} \frac{L_j}{K_j} w_j. \tag{3}$$

In other words, the regional wage is proportional to the regional capital-labor ratio K_j/L_j.

We make a simple assumption about the ownership of production factors. A fraction η of the stock of houses and the capital stock are owned by the retired, while the other $1-\eta$ belongs to the workers. Each worker and retiree gets an equal share of the proceeds of these stocks, irrespective of where these proceeds are realized. This means that the nominal income of retirees is independent of where they live. Regardless of their place of residence, they get a fixed share of the income generated by the capital and housing stock. Those who have not yet retired own a third factor, their own, inelastically supplied, labor. Income for this group equals the sum of the regional wage and the worker-share of the rents. In formulas,

$$E_k = \begin{cases} w_k + \frac{(1-\eta)\sum_j rK_j + p_j^H H_j}{\mathrm{work}} & \text{worker} \\ \frac{\eta \sum_j rK_j + p_j^H H_j}{\mathrm{pens}} & \text{retiree}. \end{cases} \tag{4}$$

Here, work is the number of workers and pens the number of retirees.

Old-age income provisions in this model consist of the ownership of a part of the houses and capital stock that is automatically transferred to agents when they reach the retirement age. We set the initial value of η so that the income of a retiree in 2006 is about 88 percent of that of a worker. The value of these benefits is affected by ageing in two ways: firstly, the absolute increase in the number of retirees decreases the share that each of them gets out of the economic rents of capital an housing. Secondly, because of the impending decline in the capital labor ratio, the size of these rents relative to wages will fall.

We expect only the second effect to manifest itself in reality. The first-pillar PAYG income and occupational pensions are mostly indexed to wages, but this link may be severed in case of financial problems. The first effect will be circumvented in practice by the accumulation of foreign assets and a paying down of the national debt, which increases the amount of assets available to cover pension benefits. We compensate for the first effect in the model by increasing parameter η when the number of retirees goes up. This keeps the income of retirees constant, by transferring some of the rents from the workers to the retirees.

2.2 Regional variation

Taking the regional supply of labor (L_j) and regional wages (w_j) as given, we can compute regional production using the above assumptions. Full competition in the manufacturing sector will make the price (at factory) equal to marginal costs, so that

$$q_j = w_j^{\alpha} r^{1-\alpha}. \tag{5}$$

We assume that the price that the consumer actually pays increases with the distance from the manufacturer. If we measure transport costs in units of the product itself, we can express this relation as a markup. In region i, the price of a product from region j is equal to $q_j \cdot \tau_{ij}$.

In reality, the value of τ_{ij} will be different for different types of goods and services. Our lumping together of the complete bundle into one category of 'consumer goods' forces us to pick an average value for the transport markup. Following Koike and Thissen (2006), we base this value on the average travel time between provinces. In doing so we ignore economies of transport that arise when distances increase, and effect that is taken into account in Oosterhaven et al. (2000).

How do consumers divide their spending over the different regions? Spending on housing services will necessarily be all local, so that the rental rate p_j^H for the H_j houses in region j is set according to

$$p_j^H = \frac{(1-\beta)E_j}{rH_j}. \tag{6}$$

with E_j total spending in region j. For consumption goods we use the model of Harker (1987), which assumes imperfect information regarding the available products and their price. The share $s_{i,j}$ of products from region i in region i's spending is equal to

$$s_{i,j} = \frac{y_i \exp(-\lambda q_i(1+\tau_{i,j}))}{\sum_k y_k \exp(-\lambda q_k(1+\tau_{k,j}))} \tag{7}$$

Here λ is a parameter that indicates the amount of information available to consumers. If $\lambda = 0$, there is zero information about relative prices and spending is divided over regions according to each region's share in total production. This is akin to assuming that consumers pick items randomly. With increasingly large values for λ, the share of the cheapest supplier goes to one. Using this formulation, we write the price index of consumption goods in region j as $p_j = \sum_i s_{i,j} q_i \tau_{i,j}$.

For setting the value of λ, we look at the share of its own expenditures that a typical province commands. In The Netherlands, between 40 percent and 54 percent of purchases is made in the home province (RUG/CBS, 1999, Table 2.2). This is as a fraction of all purchases; as a fraction of domestic purchases the number ranges between 52 percent and 71 percent. Knaap and Oosterhaven (2000) argue that not every purchase made in the home province can conceivably be made outside the province (for instance, services that are extremely nontradable such as education) and so transport costs do not explain all of the fraction of purchases made at home. In the simulations below, I set $\lambda = 20$ so that 26 percent of purchases, on average, is made in the home province.

The above framework allows us to compute both demand and supply of consumer goods and services. Equality between these two is, at this stage, mere coincidence (for instance, demand equals supply if λ happens to be equal to 0). But regional excess supply or demand can be eliminated by varying local wage rates w_j. An increase in w_j has three different effects: via (5), the price of consumer goods increases which reduces demand. Capital moves into the region (via 3), which increases production and thus supply. These two effects work so that excess demand can be eliminated by increasing the wage rate. A third effect works in the other direction: with higher wage, local income goes up via (4), which increases local demand. When the distribution of pensioners and workers across different regions is known, it is possible to solve the problem of local excess demand or supply numerically, where the solution is a vector of local wage rates.

2.3 The location decision

Where does the pensioner live? On the one hand it appears that the distribution of retirees across regions is largely similar to that of workers. But the two are not completely the same. In figure 1 I plot the difference between the share of workers and the share of pensioners in each province in The Netherlands. As noted in Derks (2004a), the provinces of Drenthe, Zeeland and Limburg can be characterized as relatively 'grey,' while Utrecht, North Holland and Flevoland are relatively 'green.'

Despite the differences in figure 1, the main conclusion from this data is that the demographic characteristics of the provinces are very similar. Even if the location decision depends on local wages and prices, these will not alone determine the outcome. It seems reasonable that the preference for a region will also be affected by characteristics of that region that the modeller cannot observe, such as the qualities of the landscape, the presence of family members and the distance to attractions elsewhere in the country. It is important that these personal preferences also play a role in the model of the location decision.

A specification that allows both observable and unobservable characteristics to play a role in the location decision is McFadden's (1977). This model assumes that three factors play a role in the location decision. The first is a quantifiable, economic, and observable, factor. In our model, I will use indirect utility (2). The second factor is non-observable and is constant across individuals for every region. This factor represents all the non-observable regional characteristics that influence the location decision. It is represented by the unknown coefficient Θ_j.

The third factor also cannot be observed: it is a personal preference for regions

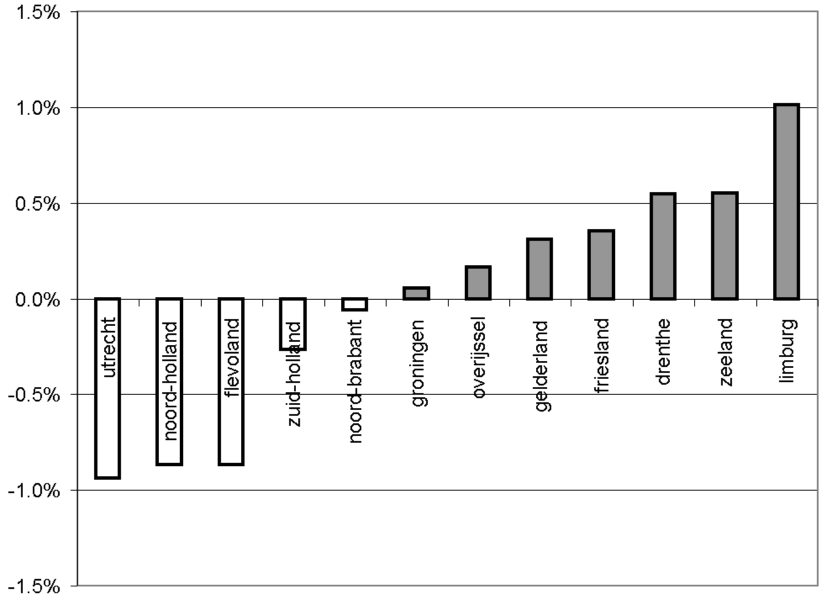

Figure 1: The difference between the share of workers and pensioners that live in each province. For example: 7.27% of those between the ages of 20 and 64 live in Utrecht, while 6.33% of those 65 and over do. The difference, 0.94%, is in this graph. Source: CBS (2006)

that differs across people. It is this factor that causes different people to make different locational choices when faced with the same regional characteristics. The presence of preference variation at the level of the agent is an attractive aspect of this model, because it explains why we do not observe complete agglomeration in practice. If all agents had similar preferences, it would be hard to explain why they would *not* all choose the same region. Preference heterogeneity leads to a more stable equilibrium among regions, something that is verified by Tabuchi and Thisse (2002) who show that the use of McFadden's specification in NEG models indeed leads to more stable equilibria.

In formulas, McFadden's location model implies that each agent k will choose to live in the region with the highest

$$V_{j,k} = V_k + \Theta_j + \epsilon_{j,k} \tag{8}$$

with V_k from (2) and $\epsilon_{j,k}$ an error term that indicates personal preferences. A standard result is the following: when ϵ is distributed around zero with a Gumbel distribution, the location choice is described by the logit model and the probability that this agent picks region j is equal to

$$\xi_j = \frac{\exp[\mu(V_{j,k} + \Theta_j)]}{\sum_k \exp[\mu(V_{j,k} + \Theta_k)]}. \tag{9}$$

Here μ is a variable that indicates the variance of ϵ: a high value of μ corresponds to a low variance, so that the influence of personal preferences is relatively small. The extreme case $\mu = 0$ indicates that economic and other aspects of the region have no influence whatsoever, and that agents pick a region at random.

2.4 Calibration

In section 2.2 I describe how the model can be solved, given a distribution of workers and retirees across regions. Now that the mechanism behind this distribution has been discussed, we can proceed to solve the entire model. Given a distribution of people, wages and prices are computed and given those wages and prices, a distribution of people follows. This sequence can be repeated until convergence. Since a change in the number of workers and retirees will lead to a new equilibrium, we can then make a projection about the effects of population ageing.

The only matter still to be solved is to find an initial equilibrium of the model that corresponds to the current situation. To this end, we use recent data on population, income and house prices in the twelve Dutch provinces. Table 1 shows part of this data.

From the first two columns, we can compute the vector of regional wages that brings equilibrium to the regional markets for consumption goods. From that computation also follows a vector of regional house prices, p_j^H. To match these with the data, we set local housing stocks H_j so that house prices are proportional to those actually observed (the third column in table 1).

One of the outcomes of this computation is the desired distribution of workers and pensioners across regions. We cannot expect this desired distribution to match the actual distribution in table 1), since we have not yet accounted for the unobserved qualities. This is remedied by setting the Θ_j such that the desired distribution over provinces ξ_j exactly matches the observed distribution. To be able to match both the pensioners' and the workers' distribution, we compute a different Θ-vector for each group. This is not unreasonable, since some of the qualities of a region that make it attractive for retirees, such as peace and quiet, may make it less attractive for those of working age.

The other parameters are set as follows: the return to capital r is the numéraire and the total capital stock is set at 5. Initially, the workers and retirees own equal shares of the economy's capital and housing stock, so that $\eta = 0.5$. The parameter λ, that influences the consumption decision, stands at 20 as discussed above.

	inhabitants 20-64	65+	house price	income 20-64	Θ_j 20-64	Θ_j 65+
Groningen	359	85	181	$1,966$	$-0,341$	$-0,815$
Friesland	384	97	198	$1,982$	$-0,749$	$-0,821$
Drenthe	287	79	215	$1,982$	$-0,475$	$-0,471$
Overijssel	669	159	211	$1,986$	$-0,008$	$-0,059$
Flevoland	228	33	207	$2,003$	$-2,210$	$-2,443$
Gelderland	1.196	285	255	$2,006$	$0,510$	$0,855$
Utrecht	728	147	277	$2,005$	$0,513$	$0,667$
Noord-Holland	1.636	360	273	$1,998$	$1,630$	$1,727$
Zuid-Holland	2.129	488	233	$1,997$	$1,003$	$1,133$
Zeeland	225	65	192	$1,977$	$-1,132$	$-1,187$
Noord-Brabant	1.488	344	261	$2,002$	$1,134$	$1,366$
Limburg	696	185	200	$1,980$	$0,124$	$0,047$

Table 1: Inhabitants (thousands) from CBS (2006), average house price for August 2006 (thousands of euros) from Kadaster (2006). The other columns are the author's own computations.

We set $\mu = 30$, which gives a reasonable influence of economic factors on the location decision. Consumers spend a fraction $\beta = 0.8$ of their income on consumption goods and the rest on housing services. The matrix $\tau_{i,j}$ is taken from Koike and Thissen (2006) and contains markups between 0.9% (deliveries internal to Flevoland) to 23.5% (purchases from Groningen delivered to Zeeland). The labor share of production is $\alpha = 0.75$.

The resulting wage rates and Θ_j's are in the rightmost columns of table 1. Pensioners have a constabt income of $2,148$, regardless of their region of residence. The nominal income of workers fluctuates across regions, and is highest in the center regions.

The Θ_j's indicate which provinces are favored, for non-observable and non-economic regions. These numbers add to the real income from formula (2) to explain the observed distribution across provinces. Two things are notable: firstly the Northern provinces of Groningen, Friesland and Drenthe, as well as Southern Zeeland are out of favor with both pensioners and workers. Secondly, the preference of retirees for the provinces of Limburg and Zeeland (figure 1) seems to stem from economic factors, for the non-economic factor Θ_j is smaller for retirees than for workers. For the third 'grey' province, Drenthe, the difference in non-economic factors is negligable.

After this calibration, the model can reproduce the current number of workers and retirees in each province. It does this using economic factors such as income and the prices of real estate, as well as a vector of non-observable, non-economic factors. In the next section, we assume that the latter stay constant, while we change the demographic composition to reflect population aging. This will change the economic equiliobrium as well as the incentives in the location decision.

3 Simulations

The demographic projections of CBS (2006) are used to create table 2. Population ageing can be observed from the change in the dependency ratio, which goes from 23.1% in 2006 to 43.8% in 2040. In the above model, the location decision of pensioners is affected differently by the changing economic incentives than that of workers. In this section we change the composition of the population according to the projections in table 2 and describe the results.

age group	2006	2040
20-64	10.023.640	9.171.311
65+	2.318.802	4.017.161

Table 2: Ageing in The Netherlands, from CBS (2006)

3.1 The situation in 2040

We solve the model using a numerical version of the above model.[2] After changing the number of retirees, I adjust the parameter η, which indicates the share of the economic rents that retirees obtain. As discussed in section 2.1, increasing this parameter so that nominal benefits stay constant reflects the reality that retirees have in fact saved for their pensions by investing in the (unmodelled) rest of the world. At the time of their retirement, we should therefore expect the flow of pension benefits to increase.

Workers are decidedly worse off in this arrangement, since the increase of rent payments to retirees comes from their endowment. Part of this reflects reality, namely the part of pensions that is financed through a pay-as-you-go arrangement in which the current cohort of workers pays the benefits of the current retirees. But mostly this change is a correction for the fact that this static model cannot follow the accumulation of assets by the older generation. In 2040 η increases from 0.50 to 0.86.

Earlier we calibrated the non-observable preferences over the different regions for pensioners and workers in 2006. In order to run these simulations we have

[2]This software can be downloaded from the following addres: `http://knaap.com/ageregmod`

to decide whether these preferences are specific to the persons that make up the group of workers or pensioners in 2006, or whether they are specific to the *status* of being of working age or retired. In the first case, we need to adjust the Θ_j's of the pensioners in order to correct for the fact that part of the workers of 2006 are now retired, and hence the preferences of the group of retired agents have shifted. In the latter case, we can continue to use the parameters that we calibrated for 2006.

I describe two cases: the simulations in table 3 assume that preferences are completely specific to the persons that make up the cohort. In this case the vector Θ_j that belongs to the retirees is almost completely overwritten by that from the workers, since the fraction of the cohort that was already 65 years old in 2006 is very small. In table 4 I assume that half the value of Θ_j is a function of being a worker or a pensioner, while the other half is personal. This means that the new Θ_j for retirees is an average of the two columns in table 1.

The model does not include inflation so that changes in wages and prices should be interpreted as real rather than nominal. We see that the bigger capital-labor ratio leads to a higher wage rate in all provinces. Regional differences are small.

The change in the property structure of houses and capital decreases the income of workers, despite their increase in wages. The income of pensioners stays constant by assumption. Rising wages alse imply an increase in the prices of consumption goods. These price increases are largest in peripheral regions because part of production is moved to the center. This means that inhabitants of those regions have to import a larger share of their consumption bundle, thereby wasting more money on transport costs.

Because each inhabitant spends a fixed fraction $1 - \beta$ on housing services and we assume that the stock of housing is constant, the house prices vary directly with the level of spending in each province. Spending increases as the population increases, but goes down when the average income goes down. The resulting patteren in house prices is somewhat mixed: Flevoland sees a decrease despite an increase in inhabitants, and other central regions see a similar decline. House prices go up in the Northern provinces, in Zeeland and Limburg.

The changes in wages, prices and preferences lead to a different distribution of pensioners and workers across the regions. Pensioners' incentives to locate include price levels of consumption goods and houses, but not local wage levels *per se*. Workers respond to local wages as well as prices when deciding where to live. We see that the share of Gelderland, South Holland and North Brabant among workers increases; pensioners on theother hand are leaving those provinces. The opposite flow can be seen in the more peripheral regions of Groningen, Zeeland and Limburg.

The model only considers the population of 20 years and over. According to demographic projections, this population has increased with 6.8 percent nationally in 2040. But the rate of growth is not equal in all provinces. Groningen grows fastest between now and 2040, at a rate of 14.0 percent. Gelderland is slowest with 3.7 percent. The growth consists solely of pensioners, as the number of workers is projected to decrease in every region after 2020.

Table 4 shows that part of the projected migration between provinces is sensitive to our assumptions about the non-observable preferences of pensioners. Table 4 shows the projection where we assume, contrary to the projection in table 3, that a larger share of those preferences is age-specific. The patterns of migration are qualitatively similar, but smaller on average.

4 Conclusions

In this paper, I study the effects of ageing on the distribution of inhabitants and economic activity across regions in The Netherlands using a simple, static, general equilibrium model of the twelve Dutch provinces. The model deliberately neglects the intertemporal buildup of assets and other elements of pension provision in order to concentrate on relative prices and wages in the different regions and their implications for the spatial distribution of the population.

I find that the relatively small differences between 'grey' and 'green' provinces can to some extent be explained by economic factors such as local prices and wages. Population ageing causes a change in these prices and wages which leads to migration: workers move to the central regions of Gelderland, South Holland en North Brabant while retirees move outward to Groningen, Zeeland and Limburg. However, in each single region the national trend of more pensioners, less workers dominates. The migration pattern increases relative wages and prices in the peripheral provinces.

This analysis is complementary to projections made using historical migration patterns and demographic projections, such as Derks (2004a). It is likely that the structural changes in the economy will lead to changes in migration patterns, and this analysis indicates the likely direction of change.

The simple nature of the model that was used has the advantage that the effects of changes in demand and supply can be traced in a relatively simple fashion. That there exist drawbacks is clear: the different sectors of the economy are treated as one, and the role of both public and private pension providers is not taken into account. A further development of the model may remedy these shortcomings, but will make the results harder to understand.

References

Bovenberg, A. L. and T. Knaap, “Ageing, Funded Pensions and the Dutch Economy,” CESifo working paper no. 1403, CESIfo München, 2005.

CBS, “Bevolkingsprojectie en statistieken,” Centraal Bureau voor de Statistiek, Heerlen, `http://statline.cbs.nl`, 2006.

Derks, W., “Vergrijzing en regionale markten,” *ESB* 89 (2004a), 65–66.

Derks, W., “Zorgdruk op de provinciale arbeidsmarkt,” *Kwartaalschrift Economie* 1 (2004b), 109–114.

Harker, P. T., *Predicting intercity freight flows* (Utrecht, The Netherlands: VNU Science Press, 1987).

Kadaster, “Gemiddelde koopsom augustus opnieuw licht gestegen,” Persbericht augustus, `http://www.kadaster.nl`, 2006.

Knaap, T. and M. Grotenhuis, “Vergrijzing in de regio: een projectie van de regionale gevolgen van de vergrijzing,” *Kwartaalschrift Economie* 3 (december 2006), 445–458.

Knaap, T. and J. Oosterhaven, “Het eerste ruimtelijke algemene evenwichtsmodel voor Nederland, met resultaten voor de magneetzweefbaan Schiphol-Groningen,” *Maandschrift Economie* 65 (2000), 89–107.

Koike, A. and M. Thissen, “Dynamic SCGE model with Agglomeration Economy (RAEM-Light),” Ongepubliceerd manuscript, RPB, Den Haag, 2006.

McFadden, D., “Modelling the Choice of Residential Location,” Cowles Foundation Discussion Papers 477, Cowles Foundation, Yale University, 1977, beschikbaar via `http://ideas.repec.org/p/cwl/cwldpp/477.html`.

Oosterhaven, J., J. P. Elhorst, T. Knaap, W. E. Romp, T. Stelder and E. Gerritsen, “Ruimtelijk Economische Effecten Van Zes Zuiderzeelijn Varianten,” REG publicatie 22 , Stichting Ruimtelijke Economie, Groningen, 2000.

RUG/CBS, “Regionale samenhang in Nederland,” REG publicatie 20 , Stichting Ruimtelijke Economie, Groningen, 1999.

Tabuchi, T. and J.-F. Thisse, “Taste heterogeneity, labor mobility and economic geography,” *Journal of Development Economics* 69 (October 2002), 155–177.

Thissen, M., “Regional Applied general Equilibrium Model for the Netherlands,” in F. van Oort, M. Thissen and L. van Wissen, eds., *A survey of spatial economic planning models in the Netherlands. theory, application and evaluation* (Rotterdam: NAi publishers, 2005).

	wages	income 20-64	price index	house price	share workers	share retirees	workers	retirees	inhabitants 20+
Groningen	9.89%	−5.82%	7.66%	5.30%	−0.55%	2.00%	−22.5%	168.6%	14.0%
Friesland	9.56%	−5.92%	7.49%	2.04%	−0.27%	0.80%	−14.9%	106.2%	9.6%
Drenthe	9.57%	−5.86%	7.48%	1.00%	−0.06%	0.01%	−10.4%	73.8%	7.8%
Overijssel	9.41%	−5.94%	7.24%	1.25%	−0.14%	0.59%	−10.5%	88.2%	8.5%
Flevoland	9.24%	−5.89%	7.28%	−0.54%	0.01%	0.31%	−8.2%	111.6%	6.8%
Gelderland	9.17%	−5.91%	7.21%	−2.03%	0.87%	−3.27%	−1.8%	26.9%	3.7%
Utrecht	9.10%	−6.04%	7.18%	−0.99%	0.08%	−0.03%	−7.5%	72.4%	5.9%
North Holland	9.17%	−6.04%	7.13%	−0.08%	0.02%	0.30%	−8.4%	76.6%	6.9%
South Holland	9.13%	−6.04%	7.12%	−0.67%	0.38%	−1.30%	−6.9%	62.4%	6.1%
Zeeland	9.32%	−6.26%	7.26%	4.54%	−0.39%	1.13%	−24.5%	143.4%	13.2%
North Brabant	9.14%	−5.99%	7.17%	−1.31%	0.59%	−2.17%	−4.9%	47.7%	5.0%
Limburg	9.39%	−6.07%	7.19%	2.79%	−0.54%	1.65%	−15.6%	109.2%	10.6%

Table 3: Projection for **2040** relative to 2006, with unobservable preferences over regions agent-specific. All columns are changes in percent, except for the shares of workers and retirees; these give the change in percentage-points. Source: author's computations.

	wages	income 20-64	price index	house price	share workers	share retirees	workers	retirees	inhabitants 20+
Groningen	9.69%	−5.97%	7.27%	3.54%	−0.20%	0.91%	−13.6%	116.4%	11.2%
Friesland	9.46%	−6.01%	7.29%	1.44%	−0.13%	0.37%	−11.6%	88.7%	8.7%
Drenthe	9.48%	−5.93%	7.29%	1.11%	−0.04%	−0.03%	−9.7%	71.9%	8.0%
Overijssel	9.38%	−5.96%	7.20%	0.90%	−0.06%	0.28%	−9.3%	80.4%	7.9%
Flevoland	9.24%	−5.89%	7.27%	−0.92%	0.04%	0.19%	−6.9%	97.0%	6.2%
Gelderland	9.20%	−5.88%	7.25%	−1.32%	0.37%	−1.67%	−5.6%	49.6%	5.0%
Utrecht	9.16%	−5.99%	7.24%	−0.97%	0.03%	0.08%	−8.1%	75.5%	6.0%
North Holland	9.22%	−6.00%	7.17%	−0.12%	0.02%	0.28%	−8.4%	76.4%	6.9%
South Holland	9.21%	−5.98%	7.18%	−0.43%	0.15%	−0.57%	−7.9%	68.6%	6.4%
Zeeland	9.37%	−6.23%	7.15%	2.95%	−0.19%	0.50%	−16.4%	104.2%	10.7%
North Brabant	9.20%	−5.94%	7.22%	−0.86%	0.24%	−1.05%	−7.0%	61.0%	5.8%
Limburg	9.42%	−6.05%	7.12%	2.11%	−0.24%	0.70%	−11.7%	88.6%	9.4%

Table 4: Projection for **2040** relative to 2006, with 50% of unobservable preferences over regions agent-specific and 50% age-specific. All columns are changes in percent, except for the shares of workers and retirees; these give the change in percentage-points. Source: author's computations.