

The demand for housing services in the Netherlands

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Abstract

We investigate the behaviour of households on the Dutch housing market. Our primary interest lies in the effect of prices and income on the tenure choice and on the levels of housing consumption. We choose a one-dimensional concept for housing services. Differences between market values may reflect differences in house characteristics, but may also stem from differences between markets. To find the 'true' levels of housing, we break up market values of dwellings into a price component and quantity. To compute a per unit price for each household, we use the user cost concept, divided by the 'true' levels of housing. Here we take actual subsidies and levies (for the current tenure choice) and imputed values (for the alternative choice) into account. In this way, the households face individually varying prices. We use a survey data set of about 60,000 Dutch households. The behaviour is estimated using an endogenous switching regression model with equations for both tenure choice and the consumption levels for owning respectively renting a dwelling. The relation between choice and quantity is taken into account. Most resulting price and income effects are in line with standard theory.

Keywords housing economics, demand, user cost

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1 Introduction

This paper focuses on the construction and estimation of a behavioural model for the Dutch housing market. As far as we know there have been no successful attempts to do this for the Dutch situation. The model comprises the tenure choice decision of individual households, and the decision on the consumption level for both tenure choices. We carefully construct the financial instruments, because they will be used to construct prices. Section 2 discusses the literature relevant for the construction of our model. Emerging from the literature are the complications involved with the distinction between the quantity of ‘housing services’ and the prices in the value of dwellings. This issue, the construction of the measure of the housing services and their price, becomes the first step in the model. Section 3 discusses this part of the model, including the construction of the financial instruments that will be incorporated in the model. The next step is the actual model of interest, *i.e.* the behavioural model. Its set-up is discussed in section 4. The empirical results are discussed in section 5. Conclusions are phrased in section 6.

2 Housing market analysis

The housing market does not fit directly into the literature on demand and consumption of goods and services (Smith *et al.* 1988, Rouwendal 1988, Whitehead 1999). A number of standard assumptions are violated, which calls for changes in the standard neoclassical model. The supply side of the housing market cannot react at market changes immediately and may be restricted by government rules, for example on building areas. At the demand side, households are not able to adjust their consumption quickly. It takes time and money to move. This holds even more for households who just moved. Furthermore, in many countries subsidies and fiscal arrangements exist, with their own effect on behaviour and market conditions.

Within the housing market, an owner-occupied sector and a rental sector have to be distinguished. Renting is just consumption, but owning a dwelling means the household is also making an investment, thus influencing considerations of the household whether to move or not. Moreover, many governments offer financial arrangements that differ for both sectors.

To measure the consumption of housing for both owner-occupiers and tenants, we will use the classical concept of housing services. In their reviews, Whitehead (1999) and Rouwendal (1998) refer to Muth (1960) for his description of a housing service as ‘that quantity of service yielded by one unit of housing stock per unit of time’. This one-dimensional measure is equally fit for both sectors.

Despite all restrictions, we can still assume that a household maximises its utility level. This enables us to set up a standard consumption model, in which the consumption of housing services is determined by the price per housing service, income and other household characteristics (Rosen 1985:381). The household takes the consumption of housing services and that of other goods into account and determines the desired dwelling. In general, the utility function, reflecting the preferences of the household, is optimised subject to budget restrictions. In this paper, we keep housing supply constant and implicitly optimise given constraints on budget and supply.

In most research, the analysis of the housing market behaviour is restricted to recently moved households, because their choice can be seen as the closest to their real preferences. In this paper, we include all households, even if they moved into their dwelling long ago. Their situation or their considerations may have changed in the meantime, but we assume that their dwelling still sufficiently suits their preferences. Apparently staying is preferred over moving.

As said before, the distinction between the owner-occupied and the rental sector is crucial to explain household behaviour. The financial arrangements also differ often. The choice between owning and renting a dwelling (*tenure choice*) therefore has to be explicitly modelled. For example King (1980) deduces the tenure choice and the quantity of housing services from one and the same preference structure. Others jointly modelling tenure choice and quantity are *e.g.* Lee and Trost (1978), Rosen (1979) and Goodman (1988). More recent empirical applications of these models are Rapaport (1997), Ermisch *et al.* (1996) and Jaén and Molina (1994). We will take their general approach, as presented in Box 1. The next sections will clarify the steps of the model.

Box 1 Steps in the empirical analysis

Preliminary steps (Section 3):

1. Determination of the **quantity of housing services** supplied by an owner-occupied or rental dwelling .

We split the value of each dwelling into the quantity of housing services and a regional price component, using regressions of the value of the dwelling on house characteristics, separately for 46 housing market areas.

2. Determination of the **prices** of housing services, supplied by an owner-occupied or a rental dwelling.

The prices that are relevant for households are defined as the user costs per unit housing services the dwelling supplies. Here, the quantity of housing services from step 1 is used.

Behavioural model (Section 4):

3. Estimation of the **tenure choice**.

This is done in a probit regression of the owning/renting decision, with household characteristics, income and a relative price variable indicating the price of owning relative to that of renting, as explanatory variables.

4. Estimation of the decision on the **quantity of housing services**.

Two separate equations are estimated, one for each sector. The quantity of housing services is related to household characteristics, income and the price of a unit of housing services the household has to pay in its own regime. Furthermore, the models are corrected for possible unmeasured variables that may influence the tenure choice and the quantity decision at the same time (selectivity bias).

3 Prices and quantities of housing services

Step 1: Housing services

To model the behaviour of households on the housing market, we first specify how to compare dwellings. Dwellings may differ in size, quality and location. A highly valued dwelling may be larger or have more quality, but it may also just be ‘expensive’ in the sense that the higher value is not reflected in its quality (see *e.g.* Rouwendal 1998). This hampers a straightforward division into quality and price. We will turn to an estimation method to overcome this problem. Hereto we will use a one-dimensional measure for housing services. In the Netherlands, all dwellings are ‘valued’ by local authorities in order to have a uniform base for their taxation. This so-called *WOZ*-value is available for own and rental dwellings. It has to be determined following fixed rules, to represent the most probable market value at one and the same date. This means that the *WOZ*-value approximates the actual market value. For comparability reasons it is by far the best information available.

To determine regional price indices, we combine the *WOZ*-value with house characteristics like total surface area and year of construction and with neighbourhood characteristics like urban versus rural area and mean income level in the area. Following Zabel (2004) hedonic methods are used to determine the value of ‘one housing service’ (or ‘constant quality dwelling’) for all regions. We distinguish J housing markets to estimate hedonic equations for each of them. The *WOZ*-value of a dwelling P_{hj} of household h is related to structure and neighbourhood characteristics s_{hj} and n_{hj} :

$$\ln(P_{hj}) = a_{0j} + a_{1j} \ln(s_{hj}) + a_{2j} \ln(n_{hj}) + e_{ij} \quad j=1, \dots, J \quad (1)$$

After estimation, a “constant quality” price for market j can be obtained by taking average values (national average, thus of all markets j together) for s_{hj} (house characteristics) and n_{hj} (neighbourhood characteristics) yielding $P_j = \exp(a_{0j} + a_{1j} \ln(s^{mean}) + a_{2j} \ln(n^{mean}))$. This means that differences in neighbourhood characteristics within each region are interpreted as differences in quality, not in price. In the presentation, we will be primarily interested in differences between the J markets, so we convert this into a price index

$$p_j = P_j/P_1 = \exp(a_{0j} + a_{1j} \ln(s^{mean}) + a_{2j} \ln(n^{mean})) / \exp(a_{01} + a_{11} \ln(s^{mean}) + a_{21} \ln(n^{mean})) \quad (2)$$

taking market $j=1$ as reference.

We distinguish 46 Dutch housing market regions. The price indices now indicate the *WOZ*-value that corresponds to exactly one ‘housing service’ in each of the regions, supplied by a (nationally determined) average dwelling.² For each dwelling we now construct the quantity of housing services Q , by confronting the *WOZ*-value with the prevailing price index p_j :

$$Q_h = P_{hj} / p_j \quad (3)$$

Step 2: Price variables

Now we construct the prices of housing services that are relevant for households. For several reasons the price indices constructed above are not suitable here. Tenants pay rent, which is not even closely (cor)related to the *WOZ*-value. Furthermore, households are confronted with

² The choice of an “average dwelling” is crucial here; in general any other choice would yield other index values.

several financial regulations that are not incorporated in the *WOZ*-value. In the Netherlands for instance, many tenants receive a rent subsidy. In addition, all owner-occupiers face an adjusted fiscal regime in connection with their own dwelling. Mostly, paid interest on their mortgage may be deducted from their taxable income. On the other hand, they have to add imputed income from their dwelling (*eigenwoningforfait*) to their income.

We apply the so-called user cost concept to construct a price variable. This construct makes owner-occupied and rental dwellings comparable, and it takes the investment character of owned dwellings into account. Discussions of the application of this general economic concept in the housing market can be found in Smith *et al.* (1988), Elsinga and Conijn (2001) and Ter Rele and Van Steen (2001).

The user cost for a renting household is simply equal to the rent minus received rent subsidy:

$$\text{user cost}_{\text{tenant}} = \text{rent} - \text{rent subsidy} \quad (4)$$

For owners, user cost ‘is the cost (*the household*) must pay to obtain a unit of housing service by owning a unit of housing stock’ (Smith *et al.* 1988). The owner of a dwelling pays mortgage interest and has opportunity cost for the part of the value of the dwelling that is financed by capital. He also has additional expenditures like local taxes and maintenance costs. More complicated but certainly not to be ignored are depreciation of the dwelling (ageing) and the general increase of house prices. We follow Elsinga *et al.* (2005) in their implementation of the user cost formula for owner-occupiers in the Netherlands:³

³ The percentages included in equation 5 are taken from Elsinga *et al.* (2005). However, we use the actual paid mortgage interest, an estimated value of the OZB and we ignored ground lease.

$$\text{user cost}_{\text{owner}} = R + i*(W-H) + o*W + \text{OZB} + \text{OPV} + T + a*W - w*W + F \quad (5)$$

where

R = paid mortgage interest

i = net rate of return on capital, if invested otherwise = market interest – tax to be paid = 4% - 1.2% = 2.8%

W = market value of dwelling

H = mortgage

o = maintenance percentage for owner-occupier, estimated at 1%

OZB = local tax specific for owner-occupiers, estimated at 0.25%*W

OPV = building insurance, estimated at 0.08% * W

T = transaction cost = tax and notary cost per move, divided by the average time between two moves to get the average annual cost, estimated at 0.95% * W

a = depreciation percentage = 0.83%

w = general increase of house prices = inflation + real increase of house prices during the last 35 years – quality reduction = 1.75% + 2.9% – 1% = 3.65%

F = effect of financial regulations concerning owner-occupied dwellings

Most of the user cost is proportional to the market value (W). In this operationalisation, the way the dwelling is financed (mortgage or ‘own money’) may cause large differences⁴.

In our model we will use a price variable p_{hj} , being equal to the user cost divided by the quantity of housing services:

$$p_{hj} = \text{user cost} / Q_h \quad (6)$$

For the actual tenure choice this is relatively simple, but for the alternative choice (a fictitious rental dwelling for an owner-occupier, or an own dwelling for a tenant) it is much more cumbersome. This is certainly true for the user cost an actual owner would have to pay in the rental situation. Due to government regulations on rent increase and targeting of certain dwellings to certain population groups, rent levels and thus the prices may vary. We suppose that an owner considering a rental dwelling will have an ‘average’ rent in mind. Therefore we base the user cost on an estimated rent, which ignores random fluctuations. See Appendix 2 for the chosen implementation. In both types of alternative situations, the financial regulations

⁴ Of course, this operationalisation does not rule out the possibility that households respond to another price concept. They may have their own evaluation of the opportunity costs of using their liquid assets to finance their house or they may be less or more sensitive to the general increase in house prices. A sensitivity analysis at this point would be interesting, but is beyond the scope of this paper.

have been simulated to compute the ‘net’ user cost. The confrontation with the (desired) quantity of housing services then yields the ‘net’ price per unit of housing services.

4 Behavioural model

For each household, we know the position on the housing market in terms of tenure choice and quantity of housing services. This can be seen as the outcome of an underlying process. To model the process, we will assume that the household chooses the alternative that gives the highest utility level. Given this assumption, the choice process can be modelled as a binary choice model.

We follow the literature in focussing on *endogenous switching regression models* to model the tenure choice and the desired quantity of housing services (Charlier *et al.* 2000). Some articles model the tenure choice in combination with the owner-occupiers’ quantities, ignoring tenants’ quantities (Ermisch *et al.* 1996, Rapaport 1997). On the other hand they incorporate an additional selection process: Ermisch *et al.* (1996) model an additional movers selection; Rapaport (1997) introduces an additional endogenous location selection.

Our approach is closest to that of Jaén and Molina (1994). They investigate the effects of fiscal regulations on the housing market in Andalusia (Spain). They model the tenure choice and have appropriate information to analyse the quantity decision for both owners and tenants. Appendix 1 describes the *endogenous switching regression model* we will use in detail. Here we will discuss the idea of the model.

We explain the *tenure choice* (step 3) using individual characteristics of households and prices per housing service, taking account of the financial regulations. Variables like income, age and composition of the household are used. Less trivial are the effects of financial regulations. They are known or relatively easy to impute for the actual situation, but also have to be determined for the non-chosen, hypothetical alternative (renting a dwelling for owners and *vice versa*). We use a relative price of owning compared to renting $p_{hj}^{relative}$:

$$p_{hj}^{relative} = p_{hj}^{owning} / p_{hj}^{renting} \quad (7)$$

The tenure choice equation now becomes as follows⁵:

⁵ The relative price is sufficient here because we explain the choice between two goods regardless of other consumption.

$$Pr[I_h^{owning}] = f(a_0 + a_1 \ln(p_{hj}^{relative}) + a_2 \ln(y_h) + a_3 z_h) \quad (8)$$

where

Pr = the probability,

f = (probit) transformation to a variable between 0 and 1,

$I_h^{owning} = 1$ if household h possesses an own dwelling and $I_h^{owning} = 0$ if it lives in a rental dwelling,

y_h = income variable

z_h = vector of other household characteristics.

In the analysis, we especially focus on the effect of income and prices on the tenure choice and quantities of housing services consumed. In analyses of the demand for housing services, permanent income is preferred to current income (see *e.g.* Olsen 1987, Goodman 1988). Since in our data set only current income is available we decided to use an approximation for permanent income (see Appendix 2).

We analyse the *quantity of housing services* in step 4 of the model. The demand equation can be derived from an appropriate utility function. We do not derive the demand equation explicitly, but estimate the demand for housing services in the following commonly used form:

$$\ln(Q_h^r) = b_0^r + b_1^r \ln(p_{hj}^r) + b_2^r \ln(y_h^r) + b_3^r z_h^r, \text{ with } r = \{owned, rental\} \quad (9)$$

Both housing services and price and income are included in logarithms, thus allowing the parameters b_1 and b_2 to be interpreted as price- and income elasticities respectively. This also decreases the skewness of the distribution of these variables.

We introduce an extra term in both quantity equations that corrects for endogenous selection, because we assume that households consider the quantity decision and the tenure choice simultaneously (see Appendix 1).

5 Empirical results

Data

This study is based on the so-called Housing Needs Survey (*Woningbehoefteonderzoek, WBO*), a survey held in 2002 among about 60,000 households. Questions are included on the

dwelling and characteristics of the household such as income. In addition the survey contains information on subsidies and levies concerning housing. Information on the liquid assets of the households (apart from the dwelling owned) is matched statistically from the CentER Savings Survey (Van Lomwel 2003). For some of the variables in the model imputations are required. These are described in Appendix 2.⁶

Step 1: Quantity of housing services

In the first step of the model price indices are constructed measuring regional price differences. They are calculated as the price of ‘the average dwelling’ (a fictitious dwelling with national average values for each characteristic) in each of the 46 housing regions. The prices do not differ between owner-occupied and rental dwellings within each region. However, because of the unequal distribution of owner-occupied and rental dwellings over the regions, small price differences appear in the national average prices between owners and tenants (the price faced by owners is 3% lower on average). The capital Amsterdam and its surroundings face the highest price; a peripheral Northeastern region faces the lowest price.

Now the quantity of housing services supplied by a dwelling is calculated by dividing its *WOZ*-value by the price index of the relevant region. For convenience this quantity is normalised such that the quantity of housing services of the ‘average dwelling’ in the Netherlands equals 1000. The average dwelling is defined here as a dwelling that has (nationally) average values on all housing characteristics.

Table 1 gives an overview of the results for various types of dwellings. On average a detached single-family dwelling provides the most housing services (1761). Flats (657) and terraced houses (885) provide much less housing services. In general owner-occupied dwellings (1240) provide more housing services than rental dwellings (714).

⁶ In addition selections were performed to exclude observations with missing or extreme values on some variables. This holds for ‘number of rooms in the dwelling’, *WOZ*-value, income and money amounts of financial regulations. Other selections were performed on ‘rent’ (at least 600 euro per year, at most 30% of *WOZ*-value per year) and ‘remaining mortgage’ (at most 125% of market value). Then almost 58,000 observations remain.

Table 1: Mean Quantity of Housing Services by Housing Type and Ownership

	Rental	Owner-occupied	Total
Detached house	1,416	1,784	1,761
Semi-detached house	956	1,284	1,239
End-of-terrace house	822	1,063	960
Terraced house	780	972	885
Flat	611	838	657
Other (e.g. farm houses)	841	1,557	1,369
Total	714	1,240	1,000

Step 2: Prices

The prices relevant for modelling the behaviour of households are constructed in Step 2. As mentioned they are defined by the user cost divided by the quantity of housing services of Step 1. In the data set at hand not all tenants reported the correct amount of rent subsidy. Therefore the rent subsidy is calculated according to the regulation, which mainly depends on the combination of income and rent. For owners we calculate the effect on the basis of the interest paid on their mortgage. Table 2 shows the resulting prices per unit of housing services for the actual housing situation. Thus, for owners the price (per unit) of owning their home is given, while for tenants the price (per unit) of renting is given.

Table 2: User Cost per Unit of Housing Services (in € per Housing Service)

	Mean	Standard Deviation	Minimum	Maximum
Rental	5.90	2.62	0.20	37.99
Owner-occupied	4.82	1.46	0.12	42.34

On average the owner-occupied dwellings have a lower price per unit of housing than the rental dwellings. This indicates that the relatively high quantity of housing services for owner-occupied dwellings in Table 1 cannot be extrapolated to an equally high amount of user costs. The variations in both price measures are fairly high. This is especially the case for rental dwellings (44% of the mean value), where the relationship between price (rent) and the quantity of housing services is weak. This is at least partly caused by governmental policies that mitigate rent increases and facilitate a relatively low rent when a household moves into a new home⁷.

⁷ The minimum and maximum price values differ substantially. Since we include the prices into the model in terms of logarithms the difference is limited to a factor 6. Additional calculations show that including the households with the lowest and the highest prices hardly affect the estimation results.

Step 3: Tenure choice

The tenure choice can now be estimated by a probit model. Various household characteristics are used as explanatory variables. As mentioned in Section 4 we include the relative price per housing service of owning compared to the price per unit of renting (in terms of logarithms). For the actual owners we use the actual price per unit divided by a simulated price of renting a unit of housing. For the actual tenants it is the other way round: we include a simulated price of owning a unit of housing divided by the actual price of renting a unit. See Appendix 2 for the construction of these simulated prices.

Table 3 contains the estimation results of Step 3: the explanation of the probability a household owns its home rather than rents it. As expected a high price of owning (relative to renting) a unit of housing decreases the probability of being an owner-occupier. Given the values of all other variables, a higher income corresponds to a higher probability of owning. Age also has a positive relationship with the probability of owning. However, the probability of owning is somewhat lower for youngsters and elderly. A household living in the same dwelling for a longer time is more probable to own that dwelling.⁸ High liquid assets (not connected to a dwelling) do not affect the probability of owning significantly, while physical disabilities and a bad health decrease this possibility. Finally, the results indicate that the probability of owning is relatively small for ethnic minorities, especially for non-western minorities.

⁸ We included this variable because the behaviour of households who have been living longer in their home may differ from that of recently moved households. We don't model dynamic processes.

Table 3: Probability of Owning a Dwelling

	Parameter		Standard deviation
Log (relative price)	-0.30	*	0.01
Log (permanent income)	1.14	*	0.04
(Age/10)	0.39	*	0.03
(Age/10) ²	-0.04	*	0.00
(Time living in dwelling/10)	0.09	*	0.01
(Time living in dwelling/10) ²	0.01	*	0.00
<i>Type of household (reference category: couple without children)</i>			
Single man	-0.03		0.03
Single woman	0.01		0.03
Couple with children	0.32	*	0.02
Single parent family	-0.14	*	0.03
Other ^a	0.53	*	0.05
<i>Education (reference category: low)</i>			
Medium	0.23	*	0.02
High	0.29	*	0.02
<i>Physical disabilities (reference category: no disability)</i>			
Slight	-0.13	*	0.02
Moderate/severe	-0.25	*	0.02
<i>Subjective health status (reference category: healthy)</i>			
Unhealthy	-0.05	*	0.01
Log (liquid assets)	-0.01		0.01
<i>Native country (reference category: Netherlands)</i>			
Morocco	-1.11	*	0.07
Turkey	-0.83	*	0.06
Netherlands Antilles	-0.84	*	0.08
Surinam	-0.44	*	0.04
Southern Europe	-0.52	*	0.09
Other non-Occidental	-0.74	*	0.05
Other Occidental	-0.30	*	0.02
Constant	-12.59	*	0.40
Number of cases	57,947		
Wald chi ² (test against constant-only model)	13,936.4	*	
Pseudo R ²	0.22		

^a Other multi-person households, e.g. co-habiting relatives

*: significant at the 5% level

Step 4: Quantities of housing services

Table 4 gives the estimation results for the explanation of the quantity of housing services for owner-occupiers and tenants separately. Unmeasured variables possibly affect both the tenure choice decision and the quantity of housing services. The linear regression model accounts for this effect through the inclusion of a selectivity correction parameter (the inverse Mills' ratio, see Appendix 1).

In accordance with theory the price elasticity of owner-occupiers is negative: more expensive housing implies a smaller consumption of housing services. As expected the income elasticity is positive, and it even exceeds 1. This implies that households with a higher income spend much more on housing. One-person households and single parent families consume less housing services than other types of households. Age is positively related to the consumption of housing services, with a small downward curvature. In addition a longer stay in the same dwelling and higher liquid assets correspond to a higher consumption of housing services for owner-occupiers.

The large positive parameter of the inverse Mills' ratio indicates that the self-selection into the owner-occupier state is a relevant issue. There are unobservable factors that positively affect the choice to buy a dwelling (tenure choice, step 3) which also strongly increase the quantity of housing for owner-occupiers. This result is also found in literature (*e.g.* Rapaport 1997:255).

The second part of Table 4 gives the results of the analysis of Step 4 (the quantity of housing services) for tenants. Again we find a negative price elasticity. However, here the income elasticity is small and not significantly different from 0. Compared to the analysis for owner-occupiers in Table 4 the parameters of the other explanatory variables are mostly smaller. Sometimes the parameters have a different sign than in Table 4, even if they are still significant due to the large sample. Again the parameter of the inverse Mills' ratio, which in this equation indicates the self-selection into the tenant state, is positive however much smaller than among owners.

Table 4: Quantity of Housing Services

	Owner-occupiers			Tenants	
	Parameter		Standard deviation	Parameter	Standard deviation
Log (price owning)	-0.44	*	0.01		
Log (price renting)				-0.47	*
Log (permanent income)	1.60	*	0.02	0.00	0.02
(Age/10)	0.75	*	0.01	-0.01	0.01
(Age/10) ²	-0.06	*	0.00	0.00	*
(Time living in dwelling/10)	0.05	*	0.01	-0.05	*
(Time living in dwelling/10) ²	0.03	*	0.00	0.00	0.00
<i>Type of household (reference category: couple without children)</i>					
Single man	-0.23	*	0.01	-0.01	0.01
Single woman	-0.22	*	0.01	0.01	0.01
Couple with children	0.40	*	0.01	-0.04	*
Single parent family	-0.39	*	0.02	0.04	*
Other ^a	0.72	*	0.02	0.01	0.01
<i>Education (reference category: low)</i>					
Medium	0.39	*	0.01	-0.03	*
High	0.48	*	0.01	-0.07	*
<i>Physical disabilities (reference category: no disability)</i>					
Slight	-0.20	*	0.01	0.02	*
Moderate/severe	-0.42	*	0.01	0.03	*
<i>Subjective health status (reference category: healthy)</i>					
Unhealthy	-0.08	*	0.00	0.01	*
Log (liquid assets)	0.01	*	0.00	0.00	0.00
<i>Native country (reference category: Netherlands)</i>					
Morocco	-2.09	*	0.05	0.13	*
Turkey	-1.48	*	0.04	0.09	*
Netherlands Antilles	-1.37	*	0.06	0.06	*
Surinam	-0.72	*	0.02	0.02	0.01
Southern Europe	-0.77	*	0.03	0.07	*
Other non-Occidental	-1.16	*	0.03	0.05	*
Other Occidental	-0.40	*	0.01	0.06	*
Inverse Mills' ratio	2.47	*	0.03	0.45	*
Constant	-12.70	*	0.27	6.97	*
Number of cases	32,527			25,420	

F (test against constant-only model)	587.7 *	524.1 *
R ²	0.38	0.42
Root MSE	0.32	0.26

^a Other multi-person households, *e.g.* co-habiting relatives

*: significant at the 5% level

6 Conclusions

We set up a model to describe the behaviour of households at the housing market. The tenure choice is modelled in combination with the decision on the quantity of housing services. In the model, income and prices per unit of housing services are used as explanatory variables (combined with other household characteristics). The prices (may) differ between the different tenure types and are designed to take financial regulations into account.

The resulting price effect for the tenure choice is with -0.30 much smaller than the effect of permanent income ($+1.14$). The price elasticities for the quantities of housing services are quite similar with -0.44 and -0.47 for owner-occupied and rental dwellings respectively. However, the income elasticities differ greatly: $+1.60$ in the owners' regime versus not significantly different from 0 in the tenants' regime. Part of the explanation may be found in the permanent income variable that had to be estimated. For the rental market, it is likely that the somewhat loose relationship between rents and quantities of housing services in the Netherlands forms part of the explanation. Restrictions at the rental market due to assignment rules also play a role.

Another explanation may be found in the lifetime pattern of households on the housing market. It is possible that they start in a rental dwelling at the beginning of their housing career, and move to an owner-occupied dwelling when their income is high enough according to their opinion. If this is the case, the relationship between income and quantity of housing services will be weaker for tenants.

Appendix 1 Endogenous switching regression model

In the empirical analyses we apply an *endogenous switching regression model*. This model describes the behaviour of households using two regression equations for two regimes. A third equation, the selection equation, determines the regime that is appropriate for the household. Here the model will be discussed briefly. A more detailed description can be found in Maddala (1983:223-228,283-287).

The model consists of three equations. The first one is the selection equation, which identifies whether a household h owns or rents the dwelling in which it is living:

$$w_h^* = Z_h \gamma + u_h,$$

where w_h^* is an unobserved, latent variable. This is a standard probit model. Observed is the outcome I_h , where $I_h=1$ if $w_h^* \geq 0$ and $I_h=0$ otherwise. Without loss of generality, we consider $I_h=1$ if household h owns the dwelling, while $I_h=0$ for tenants. Depending on I_h , and thus on the sign of w_h^* , one of the two regime regression equations is estimated for each household, describing the amount of housing services y_h consumed by household h :

$$\begin{array}{ll} \text{regime 1:} & y_h = X_{1h} \beta_1 + u_{1h} \quad \text{if } I_h=1 \text{ (owner),} \\ \text{regime 2:} & y_h = X_{2h} \beta_2 + u_{2h} \quad \text{if } I_h=0 \text{ (tenant).} \end{array}$$

The model is an *endogenous* switching regression model because we allow for correlation between the error term u_h in the selection equation and the errors u_{1h} and u_{2h} in the regime equations. It implies that the (observed) choice made by a household for regime 1 or regime 2 is related to the number of housing services y that would be chosen under the different regimes. Because y_h is observed only for the chosen regime, we deal with two non-randomly selected groups. In OLS regressions for each of the two groups separately, the estimated values for β_1 and β_2 do not measure the true effect of the variables in X_{1h} and X_{2h} on y_h , because the influence of the variables on selection of the regime is neglected.

Therefore we have to use an estimation method that controls for these respective influences. Following common approaches we assume a trivariate normal distribution with a zero mean and a covariance matrix Σ ,

$$\Sigma = \begin{bmatrix} \sigma_1^2 & \sigma_{12} & \sigma_{1u} \\ & \sigma_2^2 & \sigma_{2u} \\ & & 1 \end{bmatrix},$$

where the variance of u_h is set equal to 1. Its value is not identified because only the sign of w_h^* is observed and not the true value.

With these assumptions it is possible to formulate the likelihood function explicitly (Franses and Paap 2001). However maximisation can be cumbersome. Simpler is to apply Heckman's two-step estimation method, which gives consistent (but inefficient) parameter estimates. The idea of the two-step method is that in the regime equations the expected value

of u_{1h} and u_{2h} is included.⁹ Maddala (1983:224) shows that the relevant expected values are given by:

$$E(u_{1h} | I_h=1) = -\sigma_{1u} M_{1h}$$

and

$$E(u_{2h} | I_h=0) = \sigma_{2u} M_{2h},$$

where $M_{1h}=\phi(Z\gamma)/\Phi(Z\gamma)$ en $M_{2h}=\phi(Z\gamma)/[1-\Phi(Z\gamma)]$. These factors are known as the *inverse Mills' ratios* or the hazards of (self-) selection into the first and second regime. The expected values of the error terms made due to the endogenous selection are included in the regime-equations as additional explanatory variables. Therefore the two regime equations become:

$$\begin{aligned} \text{regime 1:} \quad y_h &= X_{1h} \beta_1 - \sigma_{1u} M_{1h} + \varepsilon_{1h} & \text{if } I_h=1, \\ \text{regime 2:} \quad y_h &= X_{2h} \beta_2 + \sigma_{2u} M_{2h} + \varepsilon_{2h} & \text{if } I_h=0. \end{aligned}$$

The error terms in these equations are defined as $\varepsilon_{1h}=u_{1h}+\sigma_{1u}M_{1h}$, and $\varepsilon_{2h}=u_{2h}-\sigma_{2u}M_{2h}$, such that the expected values of ε_{1h} and ε_{2h} equal zero.

The implementation of the two-step method is now as follows. First, the selection equation is estimated as a probit model for all observations, explaining whether a household currently owns or rents the dwelling in which it is living. This gives estimated values $\hat{\gamma}$ for the parameters γ , which can be used to calculate the estimated values \hat{M}_{1h} en \hat{M}_{2h} . These are then included in the regime equations, instead of the unknown constructs M_{1h} en M_{2h} . The two regime equations can be estimated by OLS to get consistent estimates of β_1 , β_2 , σ_{1u} en σ_{2u} . Identification requires that at least one component of both β_1 and β_2 is equal to zero (possibly the same) while the corresponding component in γ is not equal to zero. Such an exclusion restriction is advisable because otherwise identification is solely based on the normality assumption.

Appendix 2 Implementation

The survey we use (WBO) does not contain all information we need. The following information had to be imputed.

⁹ The inclusion of the expected values of the errors avoids omitted variable bias due to the selection. However it introduces a measurement error, because it is not possible to include the true values. Only the expected values can be included (Kennedy, 5th ed., p.291).

Market value of dwellings

To compute the user cost, we need the market values of all dwellings in 2002. In the WBO only owner-occupiers were questioned about the market value. *WOZ*-values were obtained for all dwellings from Statistics Netherlands (CBS). This makes the *WOZ*-values a more valuable data source. However, the *WOZ*-values have 1999 as reference date. To convert this to 2002, we calculated the market values as proportion of the *WOZ*-values for owner-occupiers per housing market region. This regional proportion was applied to the *WOZ*-values of all dwellings to obtain the most reliable estimates of market values.

User cost

The mortgage interest a household pays is known in the WBO. The opportunity cost is not known but is calculated as the market interest minus non-paid tax, applied to their liquid assets to finance their dwelling.

The user costs for the non-chosen type of housing (a rental dwelling for an owner-occupier or an own dwelling for a tenant) are imputed. Two problems arise here. Firstly, we have to determine what quantity of housing services would be desired in the alternative situation. We performed a regression analysis to estimate the differences in the quantity of housing services between owners and tenants, corrected for all other household characteristics (including income), the duration the household has lived in this dwelling, and region. The *ceteris paribus* result is that tenants consume almost 30% less of housing services than owners.

The second problem concerns the calculation of the user costs in the simulated situation. We know the desired quantity of housing services, and hence the *WOZ*-value. For each owner, we had to estimate the rent level. This is estimated by regressing the rents of actual tenants on the *WOZ*-value and the duration the household has lived in this dwelling for each region separately. We included the duration variable to take account of restrictions on the rent increase. The regression result enabled us to impute the rent level in the case of a move to a rental dwelling, *i.e.* with duration zero. This rent level is also used to impute the rent subsidy.

For each tenant, we needed to impute the liquid assets the household would use to finance an owner-occupied dwelling. We used the average percentage (68%) of their capital that recently moved households put into their dwelling. The remaining debt is used to impute the mortgage interest, once again by a regression analysis of paid interest on the remaining

debt and other household characteristics. The mortgage interest is also used to impute the effect of financial regulations for owner-occupied dwellings.

Liquid assets

Information on the liquid assets of the households (apart from the dwelling owned) has been matched statistically from the CentER Savings Survey (Van Lomwel 2003). The matching is done by imputation on the basis of probit analysis (for all households: the presence of assets) and regression analysis (for households with assets: the size of the assets). The explanatory variables are economic position, age, household type, spatial variables, income, educational level, tenure choice and housing expenditure.

Permanent income

Income is only available for one year (2002). To construct a permanent income variable we performed a regression analysis of the logarithm of (household) income on household characteristics and job features like the number of working hours. We also include dummy variables for the 46 regions to capture the influence of economic differences between regions. The income concept is net of taxes, but before financial regulations. Also included is the imputed income from owner occupation.

The analysis yields an explained variation of 64%. Age has the well-known parabolic effect and the level of educational attainment has a positive effect increasing to 33% for the highest level. Problems with health decrease income but not too much (maximum 8%). The effect of region varies, but is mostly smaller than 5%.

Literature

Charlier, Erwin, Bertrand Melenberg and Arthur van Soest (2000). "An analysis of housing expenditure using semiparametric cross-section models". *Empirical Economics* 25: 437-462.

Elsinga, M.G. and J.B.S. Conijn (2001). *Woonuitgaven en woonkosten van huishoudens*. Delft: DUP Science (Volkshuisvestingsbeleid en Woningmarkt 31).

Elsinga, Marja, Cor Lamain, and Gust Mariën (2005). *Huurbeleid en stedelijke vernieuwing. Een verkenning van de effecten van modernisering* (OTB, Delft)

Ermisch, J.F., J. Findlay and K. Gibb (1996), “The Price Elasticity of Housing Demand in Britain: Issues of Sample Selection”, *Journal of Housing Economics*, 5, 64-86.

Franses, P.H. and R. Paap (2001), *Quantitative Models in Marketing Research*, Cambridge, UK: Cambridge University Press.

Goodman, A.C. (1988): “An Econometric Model of Housing Price, Permanent Income, Tenure Choice and Housing Demand”, *Journal of Urban Economics*, 23, 327-353.

Jaén, Manuel and Agustín Molina (1994), “Un Análisis Empírico de la Tenencia y Demanda de Vivienda en Andalucía”, *Investigaciones Económicas*, 18, 143-164.

Kennedy, P. (2003), *A Guide to Econometrics*. 5th Edition. Malden, USA: Blackwell Publishing Ltd.

King, M.A. (1980): “An Econometric Model of Tenure Choice and Demand for Housing as a Joint Decision”, *Journal of Public Economics*, 14, 137-159.

Lee, L-F. and R.P. Trost (1978): “Estimation of Some Limited Dependent Variable Models with Application to Housing Demand”, *Journal of Econometrics*, 8, 357-382.

Maddala, G.S. (1983), *Limited-dependent and qualitative variables in econometrics*, Cambridge, UK: Cambridge University Press.

Muth, R.F. (1960). “The demand for non-farm housing”. In: Harberger. A.C. (ed.) *The demand for durable goods*. Chicago: University of Chicago Press.

Olsen, E.O. (1987). “The demand and supply of housing service: a critical survey of the empirical literature”. In: Mills, E.S. (ed.), *Handbook of Regional and Urban Economics*, Vol. II, Amsterdam: North Holland, 989-1022.

Rapaport, Carol (1997), “Housing Demand and Community Choice: An Empirical Analysis”, *Journal of Urban Economics*, 42, 243-260.

Rosen, Harvey S. (1985). "Housing Subsidies. Effects on housing decisions, efficiency, and equity". In: A.J. Auerbach and M. Feldstein (eds.), *Handbook of Public Economics*, vol. I, p. 375-420. Amsterdam: North-Holland.

Rosen, H.S. (1979): "Housing Decisions and the U.S. Income Tax: An Econometric Analysis", *Journal of Public Economics*, 11, 1-23.

Rouwendal, Jan (1988). *Discrete choice models and housing market analysis*. PhD-dissertation. Vrije Universiteit Amsterdam.

Rouwendal, Jan (1998). "On housing services", *Journal of housing economics*, 7, 218-242.

Smith, Lawrence B., Rosen, Kenneth T. and Fallis, George (1988). "Recent Developments in Economic Models of Housing Markets". *Journal of Economic Literature*, XXVI, 29-64.

Ter Rele, Harry and Van Steen, Guido (2001). *Housing subsidisation in the Netherlands: Measuring its distortionary and distributional effects*. CPB Discussion paper No. 2, The Hague: CPB Netherlands Bureau for Economic Policy Analysis.

Van Lomwel, A.G.C. (2003). *Rapportage onderzoek Imputatie Vermogenscomponenten*. Tilburg: CentER Applied Research.

Whitehead, Christine M.E. (1999). "Urban housing markets: theory and practice". In: P. Cheshire and E. S. Mills (eds.), *Handbook of Regional and Urban Economics*, Vol. III, Amsterdam: North Holland, 1564-1566.

Zabel, Jeffrey E. (2004), "The demand for housing services", *Journal of Housing Economics*, 13, 16–35.