Chapter 1

Patients' Preferences for Choice of Hospital*

by

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Karin Monstad has the sole responsibility for all economic and econometric analysis in this article. Espehaug's and Engesæter's roles have been to make data from *The Norwegian Arthroplasty Register* available and to assist with the interpretation of these data from a medical perspective.

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Abstract

What determines patients' choice of hospital, in a setting where hospital stays are rationed by waiting lists and where travel distances within the country are substantial? Through a reform implemented in 2001, Norwegian patients are given generous formal rights to choose any hospital throughout the country for elective treatment. This paper is an attempt to infer the willingness to pay for shorter waits by studying the observed allocation of operations. The trade-off between distance and quality is likely to differ according to patient characteristics. Patients' preferences are examined using a unique data set with individual patient data on one specific patient group, namely elective total hip replacements in Norway during the years 2001–2003. After a discussion of the institutional setting, the paper focuses on the trade-off that the patients make between distance and waiting time, and explores whether quality competition can be traced in the Norwegian hospital sector. The main results are that distance and waiting time are both highly statistically significant attributes, and that patients are willing to wait a considerable length of time to avoid travelling. The reluctance to travel is found to increase with age and decrease over time and with the level of education.

JEL classification: I11, C25, D12

Key words: hospital choice, waiting times, elective surgery, competition.

1.1 Introduction

Irrespective of the health system, patients' choice of hospital may be summed up as a trade-off between price, distance and quality. In a national health system (NHS) where hospital treatment is close to free at the point of treatment, price is irrelevant to the patient, but waiting lists typically occur (Cullis *et al.*, 2000) and have been given considerable political attention. In fact, waiting time has been the one aspect of quality that is highlighted in health policy in several OECD countries. One of the supply-side policies used to reduce waiting time is to increase patient choice and thereby enhance competitive pressures on providers (Siciliani and Hurst, 2005). A recent ruling in the European Court of Justice extends patients' legal rights of choice dramatically within the European Union, as it gives patients within an NHS the option of a publicly funded treatment abroad if they face undue delay.[1] In Norway a reform was launched in 2001, which established a quasi-market between hospitals with the aim to equalize waiting times across the country and improve capacity utilization.[2] However, will paving the way for "market forces" in the hospital sector make any difference?[3] To what extent a European or a national health market will emerge, depends, among other things, on patients' willingness to travel to reduce waiting time. As the willingness to pay for shorter waits may rarely be observed in the market, it must be inferred from actual behaviour or from surveys (Cullis *et al.*, 2000). The contribution of this paper is to analyse quality competition empirically, focusing on the trade-off between waiting time and distance. Patients' preferences are derived from their actual behaviour within a national health system, using register data with information on patient heterogeneity.

Patients' preferences are examined using data from 2001 to 2003 on a specific patient group, namely patients with primary total hip replacements (Furnes *et al.*, 2003). (See the appendix.) The empirical work uses a unique data set with individual patient information on socio-economic variables as well as medical data. The focus is on the demand side, and the starting point of the analysis is that all patient movement within this particular patient group is

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[1] The ruling concerned the case of Yvonne Watts, a 75-year-old British woman who claimed compensation from her Primary Care Trust after she paid to have a hip operation in France (www.news.bbc.co.uk and www.curia.eu.int). The legal rights seem to be the same as are already implemented in Norway (as of the 1st of September, 2004), but may cause changes in EU member states where services are rationed by waiting times, e.g., the UK.

[2] Hoel and Saether (2003) present arguments why a reduction in waiting times for public health treatment may not be welfare increasing.

[3] In his "Letter from America", Angus Deaton (2006) has given a vivid description of the problems of getting good information on quality and price, based on his own experience as a hip replacement consumer.

to be regarded as a choice that reflects patients' preferences, given the information they have. Of course, we only observe the actual behaviour, i.e., where the operation took place and the wait experienced. The alternatives actively considered by the different parties (patient, GP and hospital) are not known. However, patients' alternatives are described by available information on travel distances and average waiting time at different hospitals.

A general finding in the literature on hospital choice is that distance is important. Tay (2003) refers to studies that identify various proxies for hospital quality: capacity, high volume, range of services, complication rate, mortality rate etc. For hip replacements specifically, the quality criterion most often used in the medical literature is survival of the prosthesis (see the appendix). In this study, we assume that quality aspects other than waiting time are captured by a set of hospital dummies. These dummies represent dimensions of perceived quality that are fixed within the study period and in principle observable both to the patient and the researcher, but not included separately in the analysis, e.g., university hospital status or general reputation.

This patient group is interesting for several reasons. Hospital choice is an option for elective cases only, of which hip replacements constitute a large patient group (Christensen and Hem, 2004). Waiting times for hip replacements were substantial when the free choice reform was introduced, on average 30 weeks at a national level, with great geographical variation. The procedure is offered at many hospitals across the country. The average age of the patient group is high, nearly 67 years. Quality differences among hospitals have been detected, as the risk of revision is found to be less in hospitals where surgeons perform a high number of operations per year (Espehaug *et al.*, 1999; Losina *et al.*, 2004). Because total hip replacement is a type of surgery that is quite common, we would expect GPs to have a general opinion on the quality of different hospitals. The fact that information on prostheses survival related to individual hospitals or surgeons is not published in Norway should not rule out competition based on general reputation or observable quality aspects like waiting time.[4]

The trade-off between distance and quality is likely to differ between patient groups. It should be easier to interpret the results when we, like Tay, focus on only one patient group. Vrangbæk *et al.* (2006) provide an overview of the evidence about patients' awareness of the right to choose a hospital, and the data on patient movement in the Scandinavian countries. This paper is an attempt to add new insight by studying the revealed preferences of individuals within a specific patient group, also using data on socio-economic background.

[4] For more information on quality aspects of hip replacements, see the appendix.

Patients' choice is analysed within a random utility framework, using a conditional logit model.

The structure of the paper is as follows. Before the theoretical framework and the hypotheses are presented in section 3, the institutional framework is explained in some detail in section 2. Data are described in section 4, and section 5 explains the empirical specification used. The estimation results are presented and discussed in section 6. Section 7 concludes.

1.2 Institutional framework

Several European countries have introduced policies to enhance choice in health care (Siciliani and Hurst, 2005). Vrangbæk *et al.* (2006) point out that "[t]he Nordic experience presents a unique opportunity to study patients' choice and the hospitals' reactions to choice in a situation with little or no interference from user payments, no incentives for the GPs to refer to certain hospitals, and strong economic incentives for the hospitals to attract patients". In the setting described, we find it valid to study patient movement by focusing on patient characteristics, interpreting their behaviour as an expression of their preferences and implicit costs. In the following, we shall outline the institutional framework in more detail.

1.2.1 Demand-side incentives and restrictions

Norway's health system is largely financed by general taxes. Most services are nearly free of charge at the point of usage. Norwegian patients have been granted a legal right to choose a provider for elective treatments in somatic or psychiatric specialist care, whether as an inpatient or outpatient.[5] The Patients' Rights Act was implemented on the 1st of January, 2001. Patients' co-payment for transportation is in most cases negligible, about 27 Euros (220 Norwegian Kroners (NOK)) one way if the patient goes to a hospital in another health region, about 16 Euros (115 NOK) otherwise (payment data are for 2005).

For a large part of the population, sickness allowance is 100 per cent of the patient's regular wage during the first year of sickness leave.[6]

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[5] Patients cannot require to be treated at a more specialized institution than the one he or she was referred to, but this restriction is not binding, because all Norwegian hospitals also function as local hospitals (Christensen and Hem, 2004). The right extends to all public hospitals in the country. It was taken as granted that "public hospitals" included private non-commercial hospitals that had an agreement with hospital authorities (Ot.prp. no. 63 (2002–2003)). The patient choice was extended to private commercial hospitals by the 1st of September, 2004, which is outside the scope of this study.

[6] Self-employed and employees with high income are not automatically fully insured through the National Social Security System.

The patient is usually referred to a hospital by a GP. To assess whether a hip replacement is necessary, there is typically an examination by an orthopaedic surgeon at an outpatient clinic. The referral implies that the patient is placed on a waiting list at a particular hospital. The patient may switch to another hospital while waiting, but will then be treated as a newcomer to the latter hospital's waiting list, so there is a certain lock-in. Waiting time is defined as the time elapsed between referral and the date of hospitalization.

Information on waiting times has been made available at a free telephone service starting when the reform was implemented in 2001. More than 20000 persons called this number in 2003 (Godager and Iversen, 2004).[7]

1.2.2 GP's incentives

Whether it is the patient or the GP who makes the choice of hospital is important if the medical advisor has other preferences and/or possesses other information than the patient. The GP is likely to be better informed about the overall quality of different hospitals. Through a reform introduced June 1, 2001, each Norwegian citizen is entitled to a specified GP who is given a key role as advisor when patients choose a hospital. Most GPs are self-employed and they are financed partly by list patient capitation and partly by fee-for-service. The GP himself has no economic incentives to refer to specific hospitals. Gathering information is time-consuming and therefore costly to him (Vrangbæk *et al.*, 2006). The GP gets no direct compensation for such services, but the competition for patients introduced by a list-capitation system may give stronger incentives to engage in the matter (Carlsen *et al.*, 2005). Even if one is not willing to regard the GP as a perfect agent for the patient in general (McGuire, 2000), it is difficult to see what self-interest a GP should have in making referrals to a specific hospital, except for possible loyalty and personal relations. Still, patients may differ in their search cost. If the GP does not engage in giving information on hospital choice, differences in patients' search costs may be decisive for observed patient behaviour.

1.2.3 Hospital incentives

Total hip replacements are carried out by the majority of Norwegian hospitals, but the number of operations per year varies significantly among them.

The government allocates its budget to health regions, which are free to decide on what basis individual hospitals under their jurisdiction should be remunerated.[8] Since 1997,

[7] In May 2003 the Government launched an information service on the Internet, www.sykehusvalg.no. This study uses data for patients who entered the waiting list no later than June 2003.

hospital owners have been given economic incentives to attract patients, as part of their remuneration has been based on activity level. The rest is given as a block grant. The part that is paid based on activity was 50% of the stipulated cost per diagnosis-related group (DRG) in 2000 and 2001, 55% in 2002 and 60% in 2003 (BUS, 2005). For patients who cross health regions, the payment must be settled in an agreement between the two health regions involved. If no agreement is made, there is a standard norm stipulated by the Ministry of Health. The standard norm is 80% of the stipulated DRG cost.

There has been some publicity on allegations that hospitals specialize in some well-paid treatments (e.g., snoring operations) because payment compared to costs varies significantly both between and within DRGs. Until 2003, all hip replacements were defined in one category, DRG 209, with a stipulated cost of about 13,700 Euros. In 2003 a subcategory for complicated cases was introduced, DRG 209B, for which the compensation per treatment was about 2,000 Euros higher. Elective surgery, including hip replacements, is considered to be an economically and organizationally attractive activity for an orthopaedics department.[9]

The costs of transportation of patients in specialized care did not affect local or regional health authorities in the period studied.[10]

Hospitals that are affected by the reform have a duty to "accept all patients who choose the hospital" (Ot.prp. no 63, 2002–2003) but have a formal right to reject patients from another health region if they need to prioritize their own patients for capacity reasons (Directorate for Health and Social Affairs, circular IS-12/2004).

1.3 Theoretical framework and hypotheses

The basic notion is that patients have preferences over different attributes of hospital treatment. Relevant attributes could be travel cost, waiting time, post-operative mortality, complication rate, and survival of the prosthesis. Patient *i* is assumed to choose a hospital $h = (1,..,H)$ so as to maximize the utility function:

$$U_i(D_{ih}, W_h, q_h, Z_{ih}), \qquad (1)$$

[8] In 2000 and 2001, public hospitals were owned by 19 different counties. By the hospital reform implemented Jan.1, 2002, the country was divided into five Regional Health Authorities who themselves own "hospital enterprises", which own individual hospitals.
[9] According to an internal report from one of the Regional Health Authorities (also called "Health Regions"), elective orthopaedics is profitable to the orthopaedics department. To have a high volume of operations gives status and attracts candidates for specialization (Helse Nord, 2003)
[10] By January 1, 2004 the financial responsibility for transportation costs was placed with the regional health authorities, to give incentives so that the patient is treated near his home "when this is beneficial to the patient and reduces the cost of transportation" (Department of Health, 2005).

where D is distance to hospital, W is waiting time, q is a vector of other observable quality attributes, and Z is quality that is known to the demander, but not observed by the researcher. We focus on two of the elements of U_i, namely D and W, and expect that $\frac{\delta U}{\delta D} < 0$, $\frac{\delta U}{\delta W} < 0$, and by appropriate choice of units, that $\frac{\delta U}{\delta q} > 0$ and $\frac{\delta U}{\delta Z} > 0$.

Receiving treatment adds to utility because of health improvement, so there is an opportunity cost to staying on the waiting list. The purely health-related waiting cost may consist of several elements: foregone expected benefit, which depends on discounting, temporary pain while waiting and possibly a higher risk of a permanent reduction in health status (Siciliani, 2005). Whether waiting also results in a monetary loss depends on how well the patient is insured. As the expected average waiting time W_h differs between hospitals, so does the waiting cost. Note that the waiting time at hospital h is assumed to be the same for all patients. This could be because the patient is only informed about the *average* expected waiting time and is not given an individual expected waiting time at hospital h[11], or because there is no prioritization according to need nor any cream-skimming taking place.

There are also some costs attached to receiving treatment. The disutility connected to specific procedures executed at the hospital is considered equal for all hospitals. What may differ between hospitals is the patient's perceived *travel costs*. These costs are to be considered mainly non-monetary, reflecting the unease of travelling long distances and being away from relatives and friends during the hospital stay.[12] They depend on the patient's preferences and the travel distance or time, D_{ih}.

Given (1), we can describe a utility-maximizing patient's trade-off between D and W using the marginal rate of substitution: $MRS_i \equiv -\frac{dW}{dD}|_{dU=0}$.

The possibility that the patient will not have the operation at all is represented by the alternative $(D_{i0}, W_0, q_0, Z_{i0})$, which is the outcome if travel distance and waiting time are very high, or if other quality elements are very poor. The patient therefore faces an opportunity set A_i, where $A_i = \{(D_{ih}, W_h, q_h, Z_{ih})_{(h=1,..H)}, (D_{i0}, W_0, q_0, Z_{i0})\}$.

[11] However, by a law enforced on 1st September, 2004 all patients having elective operations are entitled to an individually set waiting time.

[12] The average length of stay at hospital is about 11 days for hip replacements. The possibility that the patient regards travelling to certain perhaps distant destinations as a good rather than a bad is ruled out, although it is conceivable. See ww.aftenposten.no/forbruker/helse/article848076.ece

The patient's problem is to maximize (1) with respect to *h*, subject to $(D_{ih}, W_h, q_h, Z_{ih}) \in A_i$. If hospital *j* is chosen by *i*, then:

$U_i(D_{ij}, W_j, q_j, Z_{ij}) \geq U_i(D_{ih}, W_h, q_h, Z_{ih}), h = 0,...., H$.

For simplicity, utility is assumed to be an additively separable function in the arguments and also to be linear in *q* and *Z*, so that for any given patient:

$$U_{ih} = f(D_{ih}, X_i; \alpha) + g(W_h, X_i; \beta) + \gamma q_h + Z_{ih}, \qquad (2)$$

where *f*(.) and *g*(.) allow distance and waiting time to enter non-linearly, X_i is a vector describing patient *i*'s characteristics, and α, β and γ are parameter vectors. The *f* and *g* functions and the parameters are to be specified in greater detail in section 5. The patient's choice of hospital is discrete and may be illustrated as shown in figure 1 (the figure is drawn for convex preferences, but non-convexity is also conceivable).

In Figure 1, the patient prefers hospital A to hospital B, because a shorter waiting time more than compensates for the extra travel. However, a corner solution with $D_{ih} = 0$ is the best attainable, so the closest hospital, C, is chosen even though it offers a much longer waiting time than A. Judged by the two attributes D_{ih} and W_h, hospital D is the best alternative. The model implies that if D is not chosen, it is because D scores poorly compared to C on Z_{ih} or q_h. Finally, we assume that hospitals want to attract as many patients as possible, which is consistent with profit-maximizing hospitals receiving a payment per treatment that exceeds marginal cost for all *i*'s.

1.3.1 Hypotheses to be tested

The hypotheses that we want to test are the following:

1. Main hypothesis: patients dislike both waiting and travelling for an operation. They may be willing to travel to a more distant hospital if they are compensated through shorter expected waiting times.
2. There should be significant differences between those who travel and those who do not on observable characteristics that according to theory influence subjective waiting costs and travel costs.

The first hypothesis states that indifference curves are negatively sloped in the (D,W) space, although one cannot rule out that patients dislike a very short waiting time because they may want time to make arrangements before having the operation. The second hypothesis says that the marginal willingness to pay for a reduction in waiting time depends on socio-economic characteristics. (We shall define MRS as the reduction in waiting time needed for patients to be willing to travel to a more remote hospital.) For example, older people should be less willing to travel because their travel costs are higher; they are frailer in general, controlling for diagnosis. They may also be less able to gather information on waiting times, while we expect education to lower information search costs. The effect of gender is difficult to predict. There should be no effect through the labour market, if patients are fully insured. Any indirect gender effect through parenthood is difficult to measure in the sample, and its expected direction is also unclear.[13]

We shall also examine whether patients' behaviour has changed over time. One might expect that over the years, as information about the reform was more widespread, patients would reveal more reluctance to wait and less reluctance to travel. Being informed about patients' rights is a necessary condition for patients to choose a hospital further away. It is not a sufficient condition, because even well-informed patients may prefer to have the operation close to their home. Therefore we cannot use data on observed behaviour to infer whether patients' access to information has improved over time. We still find it interesting to examine whether it is possible to trace a year effect, even if the interpretation is not clear.

1.4 Data

The data set is a pooled cross-section obtained by merging data from four different sources. Details on these data sets and the exclusion criteria follow below. The source data are from *The Norwegian Arthroplasty Register* and this paper uses data on primary hip replacement operations performed during the period 2001–2003. The data set for analysis consists of 9753 observations/patients, who lived in 427 of Norway's 434 municipalities. The operations took place at 62 hospitals distributed in 55 different municipalities. The patients' choice set is the same during the period except that one hospital did not operate in 2003 and another one is only present in the 2002 data.[14] For each operation there is information on patient

[13] In this sample, only 14% of the patients had children under the age of 18 years. A gender effect via parenthood requires an assumption that the parent role means more to women than to men, and that parenthood influences preferences in a certain direction. Having (young) children may impose higher waiting costs, e.g., from not being able to participate in activities. On the other hand, being far away from children causes travel costs to rise.

[14] Of the patients on the waiting list, 3866 entered the list in 2001 and 1917 in 2003. The total number of observations is therefore (9753*62) – 3866 – (1917*2) = 596986.

characteristics and hospital characteristics for each possible choice that the patient could make.

1.4.1 Descriptive statistics

The variables used are described in Table 1, which also shows some other variables that may be of interest. The dependent variable takes the value 1 if individual i has chosen hospital j, and 0 if individual i has chosen $h \neq j$. Key hospital characteristics are expected waiting time (in weeks) and travel time by car (in hours) from the patient's home municipality to the hospital municipality. The expected waiting time at hospital h in year t is set equal to the mean actual wait at hospital h in year t, where t refers to the year when the patient was registered on the waiting list. Important patient characteristics are gender, age at referral, level of education and the year the patient was placed at the list.

The reference individual is a man under the age of 67, who entered the waiting list in 2001, with less than completed secondary education. Seventy per cent of the patients are women and the average age is nearly 70 years. Thirty-nine per cent entered the list in 2001, 41% in 2002 and, because of truncation of the data, about 20% in 2003. Twenty-five per cent of the patients had completed at least secondary education.[15] For the *alternatives actually chosen*, the average expected waiting time is 22,4 weeks and the average travel time is 1,1 hours. The mean values for *all possible* choices that a patient could make are 24,1 weeks and 11,5 hours, respectively. Forty-one per cent of the patients had the operation at a hospital other than the closest one that offers hip replacements.

1.4.2 Construction of the data set

The main data set is from *The Norwegian Arthroplasty Register* (hereafter NAR) and consists of operations done during the period 2000–2003. Registrations are voluntary and based on registration forms that the surgeon fills in right after the operation. Both public and private hospitals report to the register, which in recent years has had a reporting rate of 98% of all hip replacements (Espehaug *et al.*, 2006). The file registers 28862 operations on 25607 individuals. For the purpose of this paper, only primary hip replacements and treatment at Norwegian hospitals were considered, so 24925 observations are relevant.[16] NAR has data on

[15] Having completed secondary education corresponds to three years of schooling after compulsory school, which for the younger part of the sample lasted nine years. The measure takes into account the fact that the length of compulsory schooling has increased over time. Thus it may be regarded as a measure of an individual's level of education *relative to* his cohort.

[16] Before matching, 3829 observations were dropped because they stemmed from revisions. Observations totalling 108 concerned operations at foreign hospitals, for which waiting time is not registered.

patients' age and gender, and medical information specifically related to the hip replacement. Data on individuals' level of education, income, number of children and marital status are from the registers of *Statistics Norway*. These two registers can be perfectly merged by means of the unique personal identification code. *The Norwegian Patient Register* (hereafter NPR) has provided information on 46166 individual hospital stays within DRG 209, which includes hip replacements as well as other operations on hips, knees, ankles etc. Only the 25752 observations that had NSCP codes relevant for primary hip replacements were kept. For each hospital stay there are data on the patient's waiting time and home municipality, the name of the hospital, whether the stay was an emergency case or not, procedures executed, main diagnosis, secondary diagnosis etc. A *Matrix of distances* between all Norwegian municipalities provides information on driving distance by car in minutes, and makes it possible to identify the closest hospital given the patient's home municipality. It should be noted that travel distances within Norway are substantial in many cases. For long distances, flights are more relevant than the use of car, which we try to take into consideration in the model specification.[17]

Data from the NPR are merged with the NAR data using the variables patient's year of birth, gender, date of operation and hospital number. After matching, the combined data set consists of 19605 observations, which is 79% of the relevant component of the original NAR data set defined above.[18]

The following adjustments have been made: 682 observations were dropped because they are registered as emergency cases, for which the patient is not entitled to choose a hospital; 975 observations lacked information on when the patient entered the waiting list; 486 observations were dropped for fear of measurement error, as the reported waiting time was less than two days or more than 999 days;[19] 859 observations entered the waiting list on July 1 2003 or later and were dropped because data are truncated; and 6199 observations concerned patients who entered the waiting list before Free Choice of Hospital was introduced in 2001. Additionally, 592 observations were dropped so that each patient only

[17] Travel time by car is a more precise measure of distance than kilometers because the use of boats and ferries is taken into account when it is relevant. The distance is measured from the centre of one municipality to the centre of another.
[18] How well the two registers match varies among the institutions. Interest lies in whether some institututions are strongly under-represented or over-represented after the match compared to their share of operations in the NAR. Differences are traced, without any obvious explanation. The data set after matching is very similar to the before-matching NAR set with respect to mean and variation of sex, age and date of operation. One source of mismatch stems from the fact that bilateral hip replacements made during one hospital stay are counted as two observations with the NAR, but only one with the NPR.
[19] This exclusion criterion has been used in other studies of waiting times in Norway (The Office of the Auditor General of Norway (2003)).

has one observation in the sample.[20] Fifty observations were defined as leverage points. The criteria used for identifying leverage points are explained in the appendix. Finally, nine observations were dropped for other reasons.

1.5 Econometric framework

In principle, the allocation of operations could be thought of in a multinomial response setting where each of the 62 hospitals is regarded as a possible outcome, without any natural ordering. However, the question of interest is not which particular hospital is chosen, but rather the trade-off between specific hospital attributes, and whether attributes are valued differently depending on patient characteristics.[21]

To study how the trade-off $-\frac{dW}{dD}|_{dU=0}$ varies between patients on observable characteristics, we follow Tay (2003) and estimate a patient-level probabilistic choice model with interaction terms for patients' characteristics. The model to be estimated is:

$$U_{ih} = V_{ih} + \varepsilon_{ih}, \tag{3}$$

where ε_{ih} is an idiosyncratic patient–hospital error, which represents quality that is observable only to the patient and is treated as random. It corresponds to Z_{ih} in (2).

The functions *f* and *g* in (2) are assumed to be polynomials of degree *m* in D_{ih} and W_h, respectively. Therefore, V_{ih} can be specified as follows:

$$V_{ih} = \sum_{l=1}^{m} (\sum_{k=1}^{K} (\alpha_{0l} + \alpha_{kl} X_{ik}) D_{ih}^{l} + \sum_{k=1}^{K} (\beta_{0l} + \beta_{kl} X_{ik}) W_h^{l}) + \gamma q_h, \tag{4}$$

which is defined over all hospitals *h* = 1,.., *H*. Using a logit model, the probability that patient *i* chooses hospital *h* is given by:

[20] These cases concern patients who have two primary operations in the sample (one on each hip), which will be separate registrations in the NAR. They will appear as separate observations in the merged sample when the operations took place at different dates (during different hospital stays according to the NPR). Data for the oldest operation are retained.

[21] McFadden's choice model (McFadden, 1974), can be estimated by a conditional logit model, which in some respects is similar to a multinomial logistic regression. The models are suitable for different problems and have different data requirements: multinomial logit is intended for use when all that is known are the characteristics of the alternative chosen (and possibly the characteristics of the chooser), whereas conditional logit is suitable when we know the characteristics of the alternatives not chosen, as well. If all independent variables are attributes of the chooser, then the conditional logit model is exactly the same as multinomial logit (Stata reference manual, 2003). Both models share the Independence from Irrelevant Alternatives assumption. See Wooldridge (2002), p 500.

$$P_{ih} = \frac{e^{V_{ih}}}{\sum_j e^{V_{ij}}}.$$

The coefficients to be estimated are α_{0l}, α_{kl}, β_{0l} and β_{kl}, as well as the term γq_h. X_{ik} is patient *i*'s value for the patient characteristic *k*.[22] Thus, the marginal utility of waiting and of travel time is allowed to differ according to the patients' gender, age, level of education or the year they were placed on the waiting list.

The model can be estimated as a logit if one assumes that ε_{ih} is extreme-value i.i.d. (McFadden, 1974). The key assumption is that the errors are independent, which means that the unobserved portion of utility for one alternative is unrelated to the unobserved portion of utility for another alternative. To have independent errors, or ε_{ih} representing "white noise", V_{ih} must be well specified (Train, 2003, p 39). The concern is that there might be unobserved quality that is correlated with the observed quality regressors, so that the estimated effects will be biased. For instance, demanders could perceive long waiting lists at a hospital as a signal of high quality of treatment. To take into account unobserved quality, we have estimated the term γq_h in (2) by means of a dummy for each hospital. The dummy does not interact with patient characteristics. Implicitly, the effect of unobserved hospital-specific quality is assumed to be constant over the sample period, which is two and a half years. The time dimension enters the model through the element of the *k* vector that represents the year when the patient was placed on the waiting list.

In this case, it was not necessary to define a narrower choice set for computational reasons. The logit framework relies on the assumption that each ε_{ih} is independently, identically distributed extreme value. If this assumption is correct, the trade-off should be the same for two different choice sets.

If this assumption proves to be violated, so that the unobserved portion of utility is correlated over alternatives, a mix-logit model may be appropriate.

[22] For the reference individual, for whom X_{ik} =0 for all *k*, the expression simplifies to

$$V_{ih} = \sum_{l=1}^{m} (\alpha_{0l} D_{ih}^{l} + \beta_{0l} W_{h}^{l}) + \gamma q_h .$$

1.6 Results and discussion

To estimate (3) we tried different specifications of how waiting time and travel distance enter the model. For comparison, we estimated a very simple specification called “model A”, where there are only linear terms for distance and waiting time. It seems to be a strong restriction to impose a linear relationship between utility on the one hand and waiting time or distance on the other. Therefore we shall focus on results from a quadratic specification (“model B”) and a cubic one (“model C”). For ease of interpretation, only the interaction terms with the *level* form variables are included, i.e., α_{kl}, and β_{kl} in (4) are set equal to zero for $l > 1$. The signs of the estimated effects are the same in the different models, but the level of statistical significance varies somewhat, as can be seen from Table 2.[23] A non-linear relationship is especially motivated by the fact that when patients travel long distances, they will go by plane and not by car. Also, it cannot be ruled out that a patient will regard very short waits as inconvenient, because the long hospital stay and recovery period imply planning and making arrangements.

In the following, the overall effects of distance and waiting time on utility are discussed. Subsequently, separate effects of age, gender and education are commented upon, as well as how they change over time. Finally, we discuss the estimated trade-off for different patient categories (combinations of gender, age, education and year of referral) and compare our findings to other studies. The results are shown in Tables 2 and 3.

Distance and waiting time

Distance proves to have a significant negative effect on utility in both models. The variables concerning distance, which are distance, $(\text{distance})^2$ and, in model C, $(\text{distance})^3$, each turn out to be statistically significant at the 1% level, in estimations with a varying set of related interaction terms. The results with the full set of interaction terms are presented in Table 2. The disutility curve estimated in model C resembles the pattern of a cost curve; it is increasing for small travel distances, then flattens out or even falls, and becomes steeper and rising for high values.[24] With a quadratic utility function, the negative effect of distance is found to decrease for higher values of distance, so the disutility curve is concave.

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[23] The interaction terms that are found to be statistically significant are the same in models A and B, except the interaction term between distance and gender, which is significant only in model A.

[24] The shape of the utility curve varies between patient categories. Here we shall only report the range where disutilty is increasing or decreasing for *all* cells. For the subsample with the lowest level of education, disutilty rises up to a travel time of 12 hours, then it decreases for distances between 16 and 19 hours and increases again for values of 23 hours or above. The subsample with more education is less reluctant to travel but shows a

Waiting time has an estimated negative effect on utility in both models. An F-test shows that the effect of the waiting times variables taken together is statistically significant at the 1% level both in models B and C. Similar to distance, the estimated marginal utility with respect to waiting time that model C yields is negative for all patient categories when estimated at mean values. Furthermore, the disutility from waiting rises over all values within the relevant range of waiting time. However, the economic significance of waiting time is small in terms of mobility (see Table 3).

Gender, age and education

Women are found to be less reluctant to wait and more reluctant to travel than men in both models, but the effect is not statistically significant, not even when the two gender interaction terms are tested together as a group. Old people are found to be less willing to travel than younger people, and the effect is statistically significant. The patient characteristic that proves to have the largest impact on preferences is level of education. Patients with more education are less willing to wait and more willing to travel, and the magnitude of the coefficients shows that the education effect on preferences is stronger than the age effect.

Change over time

There are several statistically significant changes from 2001 to 2003 showing more reluctance to wait and less reluctance to travel, but virtually no significant changes from 2001 to 2002. This result holds for both models. The change in the coefficients is relatively much larger for the waiting time variables than for the distance variables.

1.6.1 Discussion

Preferences for waiting and travelling clearly vary among patient categories. How willing they are to trade off a short distance for a shorter waiting time generally depends on where in the distribution of those variables the trade-off is measured. In Table 3, the trade-off in model C has been estimated at mean values for each patient category, after the sample has been split into two subsamples dependent upon patients' level of education. The estimated trade-off varies considerably between the two subsamples. At cell level, the MRS for the subsample with less education is 1.5 to two times higher than the sample with more education. For instance, the trade-off for the average individual in the reference group was 94 weeks in 2001,

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similar pattern: disutilty increases up to a travel time of 11 hours, then it decreases for distances between 14 and 21 hours and increases again for values of 24 hours or above.

112 weeks in 2002 and 47 weeks in 2003, whereas the estimate for the same combination of age and gender but with more education was 52 weeks, 57 weeks and 32 weeks, respectively.

Within the cells belonging to the same year and subsample, there is a consistent ranking with respect to willingness to travel, as follows: younger men, older men, younger women and older women.[25] However, the most important factor in explaining the estimated MRS remains the level of education, as an older, more educated woman is more willing to travel than a younger, less educated man.

Within each subsample, the variation in the estimated trade-off is primarily along the time dimension. Table 2 shows that there is remarkably less reluctance to travel for shorter waits in 2003 than in 2001.[26] Note that the sharp decline in the MRS over time is partly because of the fact that the trade-off is measured at different values, particularly because mean waiting time has decreased for all patient categories in the period 2001–2003 (see Table 4). Within each year, the MRS is also estimated at somewhat different values for different cells. To isolate the time effect, we have estimated the MRS at the same values of waiting time and distance over the years, i.e., at mean values for each combination of gender, age and education. There is still a large difference between the MRS estimated in 2003 and in 2001 (not reported here).

However, the estimated change from 2001 to 2003 is not robust to changes in sample size. A robustness check using a somewhat smaller sample (9650 individuals instead of 9753, i.e., excluding those who travelled further than a distance within the first two quintiles of all possible distances) yields similar results concerning the effect of gender, education and age. However, the 2003 variables are not found to be statistically significant taken together in model C and the interaction term for the distance variable in 2003 has the opposite (negative) sign in both specifications. Thus, the result that there is a change in preferences over time seems to be driven by a small group of patients who chose extraordinarily long travel distances.

When we find that there are no statistically significant changes in revealed preferences over time for the large majority of the patient group, it could be because patients are not better informed of their rights in 2003 than in 2001 or because they truly prefer having the operation

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[25] The exception is younger women in 2003.

[26] Concerning the estimate for 2002 it should be kept in mind that the change from 2001 to 2002 is not found to be statistically significant.

within a short travel distance. The two possible explanations cannot be disentangled, given the data we have.[27]

There is measurement error in the distance variable, as distance is measured at municipality level, from the (administrative) centre of the municipality where the patient lives to the centre of the municipality where the hospital is located. Thus, distances for within-municipality travel are set to 0, which is of course under-reported.[28] A more accurate measure, e.g., based on zip codes, is not available. The measurement error should be small if hospitals are located near the administrative centres and if patients have to go via their home municipality centre e.g., to reach major roads, train stations or airports. Then the distance variable could be interpreted as an extra travel distance, net of the distance to the home municipality centre. The measurement error is $e=x-x^*$, where x^* and x are the true and the measured value of an explanatory variable, respectively. Under the classical errors-in-variables (CEV) assumption that $Cov(x^*,e) = 0$, the magnitude of the estimated effect is underestimated (Wooldridge, 2003). In the case of within-municipality travel, the CEV assumption is violated because e and x^* are perfectly negatively correlated. Many patients chose a hospital within their home municipality, and for them the experienced distance is underestimated, which means that the reluctance towards distance appears to be greater than it actually is.[29]

We found that age and level of education influences preferences for this patient group. Other studies done within a national health system with waiting times show somewhat contradictory results, and different dependent and explanatory variables are included. Varkevisser (2006) finds that the likelihood of bypassing the nearest hospital decreases with age, while gender is insignificant. In a Danish study, Birk and Onsberg Henriksen (2005) found no statistically significant effects of age or gender on patient mobility[30], and a Norwegian enquete study in 2002 (Godager and Iversen, 2004) found that age is insignificant

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[27] The studies by Godager and Iversen (2004) and Christensen and Hem (2004) shed light on how widespread information about patients' rights is, but they are single cross-section studies.

[28] About half of the patients in the sample live in municipalities that host a hospital and 32% of the patients chose to have the treatment within their own municipality.

[29] The across-municipality measurement error should be less than the within-municipality error. A separate estimation was made for a subsample of patients (4766 of 9753 patients) who did *not* have a hospital located in their home municipality. In both models B and C, the coefficients had the same signs and the same variables were significant as when we used the full sample.

[30] The sample is small (125 hip and knee patients responded to the questionnaire out of a study group of 144) and the maximum travel distance is 66 km, which is small within a Norwegian setting. Level of education was not included in the study.

and gender is significant only at the 10% level.[31] The latter study supports our finding that level of education matters. Gravelle *et al.* (2002) point out that education can be correlated with morbidity, the propensity to consult and the propensity to have private health insurance and use private hospitals. In our study, morbidity that is picked up by the age variable is corrected for at the individual patient level. The use of private health insurance and commercial hospitals for hip replacements is negligible in the study period.

Our finding that distance is a very important attribute for demand is supported for instance by Tay (2003) and, within a national health system framework, by Gravelle *et al.* (2002). The latter have examined the effect of waiting times on admissions, not hospital choice, and find a significant negative effect. Varkevisser (2006) analyses the decisions of two groups of Dutch patients to bypass the nearest hospital. He finds that extra travel time and low waiting time at the nearest hospital significantly decrease the probability of bypassing. The negative effect of extra travel time is much stronger for orthopaedic patients than for neurosurgical patients, who appear to put more weight on waiting time. Kjerstad and Kristiansen (2005) study 14 different DRGs and find large differences among the groups with respect to the probability of migrating given various covariates, among them age and gender; however, they did not control for waiting time differences among hospitals. Thus, patient group heterogeneity has to be taken into account.

1.7 Conclusion

Distance seems to be a very important attribute when patients consider hospital choice for elective hip replacements. Waiting time is also found to be statistically significant and to have a negative effect on utility, but the estimated effect, when it comes to behaviour, is found to be small. The fact that the marginal effect of waiting time on utility is estimated to be negative rules out the possibility that long waiting lists may be regarded as a signal of good quality. The model includes a hospital-specific fixed effect, which should cover time-constant effects like reputation.

The estimated trade-off varies considerably between models and patient categories. Patients are categorized according to age, gender, education and the year of referral. Avoiding distance is especially important to older people, and the estimates show no statistically significant gender differences. Clearly, the most important factor for the

[31] Their sample was patients with an unknown diagnosis who were on the waiting list or who had been hospitalized within the previous 12 months, who were asked to answer whether they “considered choosing a hospital themselves”.

estimated marginal rate of substitution is level of education. Irrespective of age, gender and year of referral, a patient with more education is less reluctant to travel and less willing to wait. In the estimated sample, the mean patient of each category is less reluctant to travel for an operation in 2003 than in 2001, although this result is not robust to changes in sample size.

The most striking finding is the great reluctance to travel among patients having a primary hip replacement. The most mobility-inclined patient as measured by the marginal rate of substitution, a man under the age of 67 with higher education who entered the waiting list in 2003, must on average have a reduction in waiting time of 32 weeks to be willing to travel one extra hour.

When discussing the implications for health policy, caution must be exercised because the results refer to a specific patient group. Also, we cannot expect to see the full effect of the reform within the data period, which is two and a half years after its implementation. Given the data we have, we cannot decide whether low mobility is an expression of patients' preferences or is because of a lack of information on patients' rights and available alternatives. Still, the results indicate that the focus on waiting time in health policy might be overdimensioned.

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Figures and tables

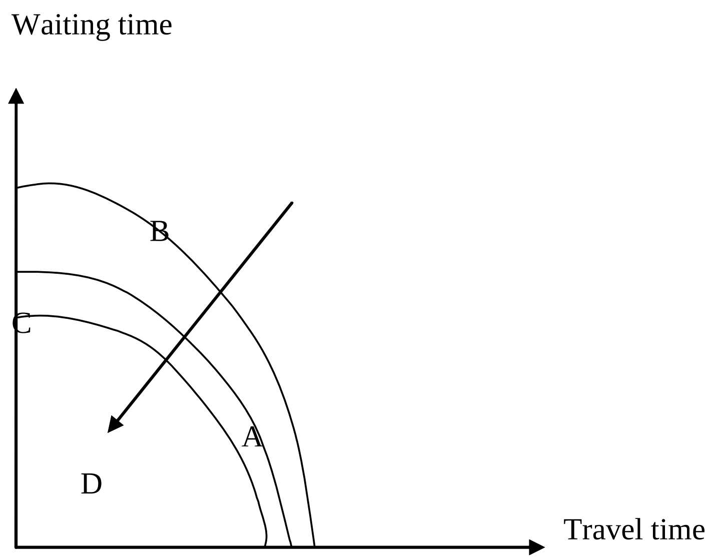

Figure 1. Patient preferences for elective surgery

Table 1. Descriptive statistics
for the alternatives actually chosen

Variable	Obs	Mean	Std. Dev.	Min	Max
Operation year	9753	2002.19	0.75	2001	2003
1 if placed on waiting list in 2002	9753	0.41	0.49	0	1
1 if placed on waiting list in 2003	9753	0.20	0.40	0	1
1 if female	9753	0.70	0.46	0	1
Age when placed on waiting list	9753	69.62	10.74	18	98
1 if age is above 66 years	9753	0.67	0.47	0	1
1 if have completed at least sec. education	9753	0.25	0.43	0	1
actual wait, days	9753	157.00	118.42	2	999
expected waiting time, weeks	9753	22.39	8.55	3	93.57
travel time, hours	9753	1.08	1.80	0	35.03
travel time to closest hospital, minutes	9753	29.25	45.92	0	465
1 if patient chose another hospital than the closest	9753	0.41	0.49	0	1

There are 596986 observations (combinations of hospitals and patients) and 9753 individuals in the sample. The table shows the values for the alternatives actually chosen.

Table 2. Hospital choice — estimated coefficients

	Model C			Model B		
Hospital choice	Coef.	Std. Err		Coef.	Std. Err	
Expected wait	–0.0374	0.0296		–0.0060	0.0100	
100*(Expected wait)^2	0.0498	0.0705		–0.0196	0.0099	**
1000*(Expected wait)^3	–0.0048	0.0048				
Distance	–2.3298	0.0356	***	–1.7544	0.0346	***
100*(Distance)^2	14.0524	0.3693	***	3.0366	0.0546	***
1000*(Distance)^3	–2.6641	0.1176	***			
Female interacted with:						
Expected wait	0.0033	0.0041		0.0025	0.0040	
Distance	–0.0214	0.0161		–0.0274	0.0212	
Old interacted with:						
Expected wait	–0.0002	0.0039		–0.0018	0.0038	
Distance	–0.0883	0.0169	***	–0.1627	0.0224	***
Year 2002 interacted with:						
Expected wait	0.0048	0.0062		0.0022	0.0054	
Distance	0.0189	0.0187		0.0658	0.0245	***
Year 2003 interacted with:						
Expected wait	–0.0166	0.0114		–0.0259	0.0082	***
Distance	0.0473	0.0207	**	0.0864	0.0248	***
Education interacted with:						
Expected wait	–0.0157	0.0047	***	–0.0162	0.0046	***
Distance	0.0985	0.0171	***	0.1025	0.0233	***
Number of obs		*596986*			*596986*	
LR chi2 (76)		*53579*			*52419*	
Prob > chi2		*0.0000*			*0.0000*	
Pseudo R2		*0.6676*			*0.6532*	

Single, double and triple asterisks indicate significant coefficients at the 10%, 5% and 1% levels, respectively. The models also include a dummy for each hospital (see equation 4).

Table 3. Hospital choice — estimated MRSs
for different patient categories, evaluated at mean values

	Less than secondary education				At least secondary education			
	Male		Female		Male		Female	
	<67 years	>67 years	<67 years	>67 years	<67 years	>67 years	<67 years	>67 years
MRS 2001	94	99	113	120	52	56	59	61
MRS 2002	112	116	141	151	57	61	65	69
MRS 2003	47	48	51	55	32	32	31	38

The marginal rate of substitution shows the reduction in waiting time, in weeks, needed to be willing to travel one extra hour. The estimates used are from model C and refer to equation (4). Mean values are reported in the table below.

Table 4. Mean values of distance and waiting times

	Less than secondary education				At least secondary education			
	Male		Female		Male		Female	
	<67 years	>67 years	<67 years	>67 years	<67 years	>67 years	<67 years	>67 years
2001, n =	*271*	*477*	*593*	*1605*	*205*	*188*	*247*	*280*
Distance	1.26	1.09	1.21	0.99	1.16	0.84	0.90	0.80
expected wait	26.19	26.43	26.14	26.06	25.30	24.66	23.96	23.41
2002, n =	*251*	*498*	*578*	*1643*	*196*	*242*	*246*	*316*
Distance	1.41	1.38	1.31	0.99	1.14	0.74	0.99	0.73
expected wait	23.21	23.03	22.91	22.86	21.12	20.29	21.72	20.97
2003, n =	*109*	*231*	*264*	*803*	*96*	*119*	*120*	*175*
Distance	1.07	1.36	1.29	0.98	1.36	1.36	1.85	0.78
expected wait	15.05	16.13	15.93	15.93	15.70	14.23	14.50	15.12

Expected wait is measured in weeks and distance is measured in hours of travel time.

Appendix

Leverage points

To detect leverage points, the choice set was divided into quintiles with respect to waiting time and distance, and the number of individuals who chose an alternative within each combination was counted. Observations that belonged to combinations with less than 10 individuals were dropped (50 observations). The table below shows the distribution of the 9803 observations that made up the data set before the 50 observations mentioned were excluded.

Appendix Table 1. Distribution of patients within the choice set

			Expected wait, quintiles					
			1	2	3	4	5	Sum
Distance, quintiles		*upper cut-off*	*15.8*	*19.5*	*24.5*	*29.2*	*93.6*	
	1	*3.3*	1950	2038	1893	1792	1421	9094
	2	*7.5*	134	119	81	172	50	556
	3	*9.8*	27	17	18	11	7	80
	4	*19*	18	7	7	9	5	46
	5	*53*	12	7	2	6	0	27
			2141	2188	2001	1990	1483	9803

Expected wait is measured in weeks and distance is measured in hours of travel time.

A short note on quality aspects of hip replacement

Total hip replacement is an operation designed to replace a hip joint that has been damaged most often by some form of arthritis, which causes pain, stiffness and deformity.[32] When arthritis has caused severe damage to the joint, a total hip replacement may be needed and the operation usually allows the patient to return to everyday activities (www.cdhb.govt.nz). This paper uses data on primary total hip replacements, which constituted 87% of all total hip replacements in 2004 (NAR, 2005).

A common procedure-specific measure of quality of total hip replacement is survival of the prosthesis, which refers to the duration from the primary operation until revision or until

[32] In 2004, 75% of the primary hip replacements were because of primary osteoarthritis. The second and third most common reasons for having the operation are fracture of the femoral neck and congentital dysplasia of the hip (The *Norwegian Arthroplasty Register*, 2005).

the patient dies or study closure. This paper focuses on primary hip replacements, but some patients may need a repeat operation of the hip replacement, most often because some of the components implanted have loosened.[33]

Total hip replacement is a type of surgery that is quite common. In Norway, more than 7000 operations take place every year (NAR, 2005) and most hospitals around the country can perform it. Still, there is some specialization among the hospitals. For instance, in Northern Norway, only two out of 11 hospitals offer revisions (Helse Nord, 2003), and complicated cases, where comorbidity often plays a part, are treated at university hospitals. The number of operations per year varies a lot among hospitals. The risk of revision is less in hospitals where surgeons perform a high number of operations per year (Espehaug *et al.*, 1999; Losina *et al.*, 2004). NAR has detected that some prostheses have a higher rate of revision. It has been recognized as a problem that surgeons use implants whose effect has not been documented clinically (Furnes *et al.*, 2003; Nordsletten *et al.*, 2002). Information on prosthesis survival related to individual hospitals or surgeons is not published in Norway, unlike in Sweden.

This study uses data on elective treatment. It is not obvious that data on mortality from emergency orthopaedic treatment are relevant for assessing the overall quality of the orthopaedics department or the hospital. A recent study shows that for some hospitals, the probability of death within 30 days from hip fracture is 65% greater than the average. The authors emphasize that data are not easily comparable and that this finding cannot be used to rank hospitals (*The* Norwegian Knowledge Centre for the Health Services, 2005).

[33] Of all hip protheses implanted in 1987–1990, 81% were still intact 16 years after the operation (NAR 2005).