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Quality and hospital choice for cataract treatments

The winner takes most

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Quality and hospital choice for cataract treatments: the winner takes most

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Abstract

We study the impact of quality on patient volume and hospital choice for cataract treatments. Our dataset covers the period 2006-2011 and includes all 854,613 patients who underwent a cataract treatment in the Netherlands. At the aggregate-level we find that, a one-point quality increase, on a scale of one to a hundred, would raise patient volume for the average hospital by 2-4%. This effect is mainly due to the performance of the top performing hospital. This effect halves after excluding this hospital from the dataset. Also at the individual-level, we find, all else being equal, that patients are willing to travel an additional 11km or more for the top performing as opposed to other hospitals. Our results suggest that the impact of quality on patient volume and willingness to travel is non-linear. Only the top performing hospital is able to attract significantly more patients.[2]

JEL Classification: I11, D12, C25

Keywords: hospital demand, patient choice, quality indicators, quality competition

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[2] The DBC-data that the authors use for the analysis in this paper is not publicly available. The quality data used in the analysis is retrieved from the internet and can be obtained from the authors.

Nederlandse samenvatting

In de Zorgverzekeringswet onderhandelen ziekenhuizen met zorgverzekeraars over prijs, kwaliteit en volume van medisch specialistische zorg. Transparantie over de kwaliteit van zorg is hierbij van groot belang. Het helpt verzekeraars om goede contracten af te sluiten, ziekenhuizen om hun zorg zo nodig te verbeteren en het helpt consumenten bij het maken van een keuze voor de beste zorgaanbieder. Eén belangrijke voorwaarde voor ons stelsel van gereguleerde concurrentie is dat consumenten actief kiezen voor een zorgaanbieder, want dit prikkelt aanbieders om de zorg beter af te stemmen op de wensen van de patiënt.

We onderzoeken in hoeverre patiënten actief kiezen en in hoeverre deze keuze van de patiënt is gebaseerd op kwaliteitsinformatie over de zorgaanbieder. De centrale onderzoeksvraag is of kwalitatief betere ziekenhuizen ook meer patiënten weten aan te trekken. Ons onderzoek heeft betrekking op staaroperaties gedurende de periode 2006-2011 en bestaat uit alle 854.613 patiënten die een cataractoperatie ondergingen. Voor de kwaliteitsinformatie hebben we gebruik gemaakt van data die het weekblad *Elsevier* jaarlijks publiceert over cataractoperaties.

Uit onze analyse blijkt dat ongeveer 20% van de consumenten verder reist dan 20 km voor een cataractoperatie en dus niet altijd kiest voor het meest nabijgelegen ziekenhuis. We vinden dat de keuze voor een verder weg gelegen ziekenhuis is gecorreleerd met de kwaliteit van dat ziekenhuis. Op ziekenhuisniveau blijkt dat gemiddeld genomen een ziekenhuis met één punt hogere kwaliteit, op een schaal van één tot honderd, 2-4% meer patiënten weet aan te trekken. Dit grote gemiddelde effect is vooral te danken aan de prestaties van het best presterende Nederlandse ziekenhuis. Wanneer we dit ziekenhuis uitsluiten van de dataset, halveert dit effect. Op individueel niveau vinden we dat de gemiddelde patiënt bereid is om minstens 6 km extra te reizen voor het best presterende ziekenhuis, in tegenstelling tot andere ziekenhuizen.

De resultaten lijken erop te wijzen dat er bij cataractoperaties een kleine maar kritische massa van consumenten is die cataractoperaties actief kiezen op basis van kwaliteit en zodoende dus zorgaanbieders prikkelen om op de kwaliteit van hun zorg te letten. Onze resultaten suggereren ook dat de invloed van kwaliteit op patiëntenvolume en op de bereidheid van patiënten om te reizen niet-lineair is. Alleen het ziekenhuis met de beste kwaliteit is in staat om aanzienlijk meer patiënten aan te trekken.

1 INTRODUCTION

Transparency in hospital quality is essential as it contributes to a patients' ability to make the appropriate hospital choice. In the Netherlands, after the introduction of a new health care system based on managed competition in 2006, hospitals started to bargain with health insurers over prices, quality and volume of care. A necessary condition for competition to work is that hospitals attract more patients by distinguishing themselves in terms of quality. The central question of our paper is whether consumers react to quality information and whether high quality hospitals are able to attract more patients.

In the Netherlands there is little selective contracting and most patients are free to choose what hospital to visit. The decision to visit a hospital may depend on various factors. Besides quality, also the distance to a hospital, waiting time and information of third parties are important factors for consumers. Patients may obtain quality information from their general practitioner (GP), family and friends or from publicly available quality information. Just recently, information on quality has become increasingly available in the Netherlands. For instance, the Dutch weekly news-magazine "Elsevier" and the Dutch newspaper "Algemeen Dagblad" (AD) annually rank Dutch hospitals on quality. In addition, from 2005 onwards, hospitals are obliged to report on a set of quality indicators on their website.

Cataract treatments are carried out in practically all Dutch hospitals. Our data covers the period 2006-2011 and includes all patients who underwent a cataract treatment in the Netherlands. Cataracts are "changes in clarity of the natural lens inside the eye that gradually degrade visual quality" (emedicine, 2011). Over the years cataract treatments have become fairly standard procedures and are associated with low medical risks (NHS, 2012). We focus only on standard day-cataract treatments to rule out reverse causality (Gaynor, 2012). By removing the more complex treatments from our sample we rule out the possibility that highly specialized hospitals attract more patients because they can perform complex treatments that cannot be performed by other hospitals. The quality variable that we use in our study is obtained from a survey where colleagues' ophthalmologists, GPs and other medical specialists are asked to rank ophthalmology hospitals or practices. This indicator is likely to be positively correlated with outcome, process and structural quality indicators, as well as reputation characteristics of ophthalmologists.

This paper builds upon the literature that studies the effect of quality on hospital demand and hospital choice. Most studies find that quality has a positive impact (Pope, 2009; Bundorf et al, 2009; Mukamel et al, 2004; Varkevisser et al, 2012; Jung et al, 2011; Varkevisser et al, 2007; Sivey, 2012; Dranove et al, 2009). This paper contributes to the literature in that it explores nonlinear effects in quality, where the best performing hospital is able to attract much more patients than we would predict based on linear quality differences. Hereby we focus in particular on the top performing segment of the market. In this paper we find that a one-point increase in quality for the average hospital results in a 4 percent increase of patient volume. This effect is mainly attributed to the top performing hospital since this effect halves to 2 per cent if the top performing hospital is removed from the sample. At the individual-level we found, as in previous studies, that quality has a positive impact on hospital choice and a negative impact on distance and waiting time. For example, on average we find that one in ten patients is willing to travel 20-40 kilometres as opposed to 0-20 kilometres for a ten point increase in quality. However, this willingness to travel is much stronger for the top performing ophthalmology hospital. Patients are willing to travel at least 11 kilometres extra for the top performing hospital as opposed to visiting any other hospital. These findings suggest that the impact of quality on patient volume and willingness to travel is non-linear; the top performing hospital attracts significantly more patients than would be expected based on linear quality differences.

The paper starts in section 2 with a literature review on the determinants of hospital choice, focusing in particular on hospital quality. In section 3, we present the descriptive statistics and our results for the aggregate and the individual-level analysis. In section 4 we discuss the results and we conclude with section 5.

2 LITERATURE REVIEW

The liberalization of the Dutch hospital market in 2001 has increased the incentives for hospitals to compete on the quality of care. From 2006 onwards, Dutch hospitals increasingly bargain with insurance companies over prices, volume and quality of care. One of the goals of introducing managed competition in the Netherlands was to improve quality. High quality may be very attractive for a hospital. It may attract more patients and improve their bargaining position vis-a-vis health insurers. That is, if patients are indeed sensitive to quality differences. It is therefore important to know the patient's willingness to travel for quality and how quality trade-offs with other factors such as distance and waiting time. Prices of cataract treatments are less important in the choice process since in the Netherlands health insurance is mandatory for the total population and out-of-pocket prices are small and independent of hospital choice.[3]

Before visiting a hospital, a patient faces a degree of uncertainty with respect to quality of a cataract procedure. Many patients may have little interest in quality aspects because ophthalmologists need to have a certification to practice anyway, or they believe that quality differences among ophthalmologists will not be that great. Another reason may be that many patients find it difficult to obtain quality information. Patients searching for quality information can access publicly available quality data, obtain information from their GP, family, friends or from prior experience. If general practitioners are able to explain the relevant quality indicators to their patients then patients will visit highly ranked hospitals more often (Bijlsma en Pomp, 2008). Although quality information can be obtained via multiple channels, this paper, as most studies, will focus solely on quality information obtained from publicly available data.

In the literature, the impact of quality has been investigated at the aggregate and at the individual-level. At the aggregate-level, studies explore the impact of quality on patient volume. At the individual-level, studies investigate the impact of quality on a patients' hospital choice and relate this to factors such as hospital distance and waiting time. Over time the individual-level approach has become the more common method.

2.1 Aggregate-level

At the aggregate-level, many studies focus on the impact of overall hospital quality on total hospital volume. Quality usually has a positive impact on hospital demand. Pope (2009) estimates the effect of hospital rankings in US News and World Report (USNWR) on hospital choice and finds that quality

[3] The price for a cataract treatment is much higher than the mandatory deductible (220 euros in 2011). Although hospitals charge different prices to different insurers, consumers are not confronted with these differences when searching for treatments.

has a positive impact on patient volume. He controls for hospital-specialty and uses year fixed-effects. The data consists of Medicare patients in California for the period 1998-2004 and other hospitals in the US for the period 1994-2002. Pope first ranks hospital on their quality performance and finds that a one spot increase in ranking results in a 1 per cent increase in patient volume. A one rank improvement in hospital-specialty relative to other hospital-specialties results in a patient volume increase of 6-7 per cent. In addition to ranking quality, he also adds the absolute overall score in linear, squared and cubed form. The absolute overall score is however insignificant. These results suggest that people pay attention to the rank and not absolute quality score. Bundorf et al (2009) compared hospital market shares before and after the release of quality information. The study provides evidence that fertility clinics that started to report a high quality of care were able to increase their market share. The authors argue that quality information used by fertility clinics, the per cent of treatment cycles that resulted in a live birth, is both very easy to understand and relevant for patients. Also, the people that attend fertility clinics are generally young and highly educated. This group may be more sensitive to quality information than the average patient (see also Bitler et al, 2006). In another study, Mukamel et al. (2004) investigate patients' choice of surgeons before and after the release of the New York State Cardiac Surgery Report cards. They find that in the period prior to the availability of report cards, patients based their decisions on the surgeons' years of experience, hospital, price and advice of their physician. Once the report cards were published, patients started basing their choices primarily on the report cards. The impact of price and surgeons' years of experience declined substantially.

In contrast, some studies find a very small or insignificant impact of quality on patient volume. For example, Howard (2006) researches the impact of report cards of kidney transplantations on patient volume in the US for the period 1999-2002, and concludes that report cards do not affect demand. He finds that the impact of quality on patient volume is significant when the sample is treated as a cross-section; if the data is treated as a panel, quality is no longer significant. The author states that a possible explanation for these results could be that the cross-section findings are biased because important hospital characteristics are missing. Another possible reason is that patients are not sensitive to small fluctuations in quality from year to year or that report cards are too difficult to understand for the average patient. A limitation to this study is however that the demand for kidney transplantations is probably mainly driven by the availability of transplants. Similarly, Mennemeyer et al (1997) find that the publication of patient death rates has a very small yet statistically significant effect on hospital discharges. They use report cards that were published by the Health Care Financing Administration (HCFA) in the period 1986-1992. Hospitals that report high death rates discharged fewer patients. The number of discharges did decline with 9 per cent if an unexpected death had been reported in the press. Apparently shocks, such as mistakes, can have quite an impact on patient volume. Romano and Zhou (2004) also find that report cards barely have an impact on patient volume. They tested whether a change in patient volume occurred after the publication of report cards. The sample consists of patients with acute myocardial infarction and patients with postdiskectomy complications in California who attended either a top or bottom performing hospital. Hospitals that reported low-mortality rates did not attract significantly more patients, nor did high-mortality hospitals experience a decline in patient volume.

2.2 Individual-level

Over time it has become increasingly popular to analyze hospital choice at the patient-level. The authors used various choice models such as conditional logits, mixed logits, and multinomial latent-class models. The current stance of the literature seems to prefer the mixed logit model for estimating hospital choice (Tay, 2003). Variables that are often included are distance, hospital attributes (such as: quality, waiting time, hospital type, hospital size) and patient characteristics (such as: age, gender, income etc.). Prices are often excluded from the analysis because patients do not usually pay for their treatments directly. Distance is included in practically all studies and has, as expected, a statistically significant negative impact on hospital choice (Varkevisser et al, 2012; Pope, 2009; Jung et al, 2011; Varkevisser et al, 2007; Sivey, 2012; Dranove et al, 2009). Waiting time tends to have a significant and negative impact on hospital choice (Varkevisser et al, 2007; Sivey 2012). The effect of waiting time on hospital choice is ambiguous. Either, patients prefer to attend hospitals with low waiting times, as they prefer to be treated sooner than later. On the other hand, patients may interpret above average waiting times as a signal of good quality (Varkevisser et al, 2009). As in the aggregate-level analysis, various types of quality variables are included. Quality indicators may reflect the structure (settings in which care occurs), process (what is done in giving and receiving care) or outcome of care (effect of care on health). Furthermore, quality indicators may be related to the hospital or be treatment specific (Mainz, 2003). Most studies include outcome measures such as mortality rates (Dranove et al, 2009), readmission rates (Varkevisser et al, 2012), reputation of the hospital (Varkevisser et al, 2012; Pope 2009; Jung et al 2011; Dranove et al., 2009) or reputation of certain specialisms (Varkevisser et al, 2012; Pope, 2009). Quality tends to have a positive impact on hospital choice. Some studies do not incorporate quality explicitly, either because of lack of data or because they choose to incorporate quality implicitly through fixed-effects. These studies focus on other factors that influence hospital choice, such as distance and waiting time.

Varkevisser et al (2012) use a mixed and a conditional logit model to measure patients' hospital choice for angioplasty in the Netherlands in 2006. They find that angioplasty patients are indeed sensitive to quality differences. On average patients are willing to travel 2 minutes longer for a 1% lower readmission rate, where patients travel 22 minutes on average. In addition, a one point increase in overall reputation, on scale of 0 to 10, results in an increase of 65 per cent in patient volume.

Furthermore, a one point increase in reputation for cardiology, on a scale of -3 to 3, results in an increase of 53 per cent in patient volume. The study is a cross-section analysis and cannot identify how a change in quality affects the probability of visiting a certain hospital. Pope (2009) explores hospital choice for Medicare patients at the patient-level using a mixed logit model. The lagged quality ranking scores (at the national-level and at the state-level), and distance dummies are used to explain hospital admission rates. Pope finds that people value the hospital being within a range of 3 miles instead of 3-6 miles at 1/10th of the hospital increasing in rank by ten spots. The study includes a fairly large number of hospitals, namely 446, a ten spot increase in the rankings is probably not too difficult to achieve. When inserting distance in linear form, patients value a one spot increase in ranking as much as a hospital being one mile closer. Jung, Feldman and Scanlon (2011) use a conditional logit to investigate how patients' perceptions for different aspects of hospital quality contribute to their hospital choice. The data is based on a survey and includes patients' perceptions on six hospital attributes and controls for distance, hospital type and the Hospital Quality Initiative (HQI) score. Some hospital attributes, such as the overall reputation and amenities, and to a lesser extent quality ratings, play an important role in hospital choice. Tay (2003) studied Medicare claims of heart attack patients aged 65 and over in the year 1994, and found that changes in the quality of cardiac care have a significant impact on patient volume. For instance, adopting a catherization lab is expected to increase patient volume by 65 per cent. Not all studies were able to include quality explicitly in the hospital choice model. For example, Varkevisser et al. (2007) explore the impact of travel time and waiting time on the decision to bypass the nearest hospital. They find that people are less likely to bypass the closest hospital as the distance to the second closest hospital increases. This impact is however much larger for orthopaedic care than for neurosurgery, suggesting that people are willing to travel further for more complex treatments. They also find that waiting time has a negative impact on hospital choice, this negative impact is larger for neurosurgery than for orthopaedic care.

Sivey (2012) studies hospital choice for cataract treatments (as in our study) in the UK for the years 2001-2004 with a (latent-class) multinomial logit model. Sivey explores the trade-off patients make between distance and waiting time, a variable that is often missing. The explicit effect of quality is not taken into account, but is controlled for by incorporating fixed hospital effects. Sivey found a waiting time elasticity of demand of -.1, and an elasticity of travel time around -1.5. Both findings coincide with earlier studies.

2.3 The nonlinear impact of quality

Some studies report a nonlinear impact of quality on patient volume or hospital choice. In these studies low quality has a negative impact on patient volume while high quality is not associated with higher patient volumes. For instance, Cutler et al (2004) explored the impact of risk-adjusted mortality rates on hospital volume for bypass-surgery in New York State**.** They find that hospitals with a high-mortality rate treat 4.9 fewer patients per month, which is comparable to a ten per cent decline in patient volume for the average hospital. Remarkably, hospitals that report low-mortality rates do not experience an increase in patient volume. It is not clear whether patients who avoided the lower quality hospitals did not undergo treatment or whether they decided to go to another hospital. Similarly, a study done by Wang et al (2011) finds that after public reporting, surgeons with poor cardiac care report cards treat significantly less patients, highly ranked surgeons on the other hand do not treat significantly more patients. The report cards did not significantly affect total hospital demand. Dranove et al (2009) use a conditional choice model to test whether patients move to better quality hospitals as a result of introducing hospital report cards. The sample consists of 18 hospitals in the New York City metropolitan area. All patients who underwent coronary artery bypass surgery (CABG) in the period 1989-1991 who were living in the surrounding counties were included. They find that patients shift to better performing hospitals after the introduction of hospital report cards. This effect is however mainly driven by patients avoiding lower quality hospitals. High quality hospitals were not able to attract significantly more patients. The authors suggest that the quality of high quality hospitals was already known prior to the introduction of the hospital report cards.

2.4 Contribution to the literature

This paper contributes to the literature in that it explores nonlinear trends in quality, where the best performing hospital is able to attract much more patients than we would predict based on linear quality differences. A nonlinear trend was found in several studies, although in these studies they find that patients avoid relatively bad hospitals and highly ranked hospitals are not able to attract significantly more patients. Our contribution to the literature is that we explore the nonlinear trends and focus in particular on the top performing segment of the market. In our study the non-linear trend may be induced by the hospital that, according to our quality information, greatly outperforms all others. This enables us to test a non-linear effect between quality and volume and distance. In our individual level analysis, we allow for larger choice sets than have previously been used, by for instance Pope (2009) and Howard (2006). They restricted the choice set to a maximum of 10 hospitals, dropping any individual who visited a hospital outside their choice set. Such small choice sets may thus eliminate exactly those patients who are willing to travel for quality.

In addition we are able to incorporate the variables waiting time, distance and quality. Most studies that we have mentioned before do not include these variables simultaneously, which may cause for biased estimates. Another major difference is we do not use rankings but absolute quality scores. First of all, people do not always observe rankings directly. For example, our quality indicators from the Dutch magazine “Elsevier” were listed in alphabetical order and were not ranked in terms of quality. In addition, in the newspaper articles only the three or four top performing hospitals are mentioned explicitly. If both, rankings and absolute quality scores were available to consumers then some argue that rankings are preferred because rankings are easier for patients to comprehend than absolute quality scores (Pope, 2009). However, the use of rankings has a disadvantage as well. Rankings may neglect (at the tails) or enlarge (around the mean) the variation of quality gaps between hospitals. This variation is especially important in our study because relatively large quality differences exist between the highest quality ophthalmology hospital and the remaining hospitals.

3. DESCRIPTIVE STATISTICS

Our data set consists of 854,613 patients who underwent a fairly standard cataract treatment in the Netherlands during the years 2006 until 2011. The data was obtained from The Dutch Healthcare Authority (NZa). For every cataract treatment we have information on the hospital the patient visited and in what year the patient received treatment. Two quality indicators, overall hospital quality and ophthalmologist quality, were obtained from information published by the weekly magazine "Elsevier". In addition, we have information about the patients' residential zip code, gender and age. Furthermore, at the hospital-level we have data on the average annual waiting time. Moreover, zip code specific indicators are used as control variables and were obtained from Statistics Netherlands (CBS). These variables include: the number of males/females per zip code. The percentage of males/females aged 0-14, 15-24, 25-44, 45-64 and 65+.

3.1. Actual demand

The number of treatments carried out per year is shown in table A1. The yearly average number of cataract treatments carried out during the years 2006-2011 was 142,436. The number of treatments increased over the years 2006-2008, from 117,980 to 151,972, after which the number of treatments stabilizes around approximately 150,000 treatments. These treatments were carried out in approximately 150 hospital locations. Thus, the average hospital performs about 1,000 cataracts annually. The variation in hospital cataract treatments depends also on the number of mergers and new hospitals entering the market. In 2006 and 2007, patients could choose from 149 hospital locations, in 2008 and 2009 from 151 and 152 hospitals respectively, and in 2010 and 2011 from 153 hospital locations. It is not clear what caused the increase in cataract treatments over time (Heijink et al, 2013).

3.2. (Perceived) quality

Two quality indicators, overall hospital quality and ophthalmologist quality, were obtained from Elsevier. Elsevier annually provides a list of the top 100 Dutch hospitals, taking several aspects of quality into account (overall hospital quality). Over time, Elsevier changed the number of quality indicators and also the scales on which these indicators are measured. For example, in 2007, overall quality of a hospital was measured with seven indicators. A score of a quality indicator was expressed as either: bad, fair, average, good or excellent. In 2008, Elsevier took 23 quality indicators into account; these indicators are given points ranging from -3 to 3. In 2009, Elsevier used six quality indicators, ranging from -3 to 3, similar to the previous year. In 2010 and 2011, four quality indicators are taken into account, all indicators are given a score ranging from 1-4, where 4 is the highest score.

In addition to these overall quality indicators, Elsevier published quality indicators for specific specialisms, such as ophthalmology. This indicator reflects also the reputation of the specialism as the quality score "ophthalmologist" is the percentage of respondents that complimented the hospitals' eye specialism. Respondents were asked to judge a maximum of four hospitals, and indicate whether these hospitals stand out in terms of their medical services and practice management. The respondents include: medical specialists, head nurses and head of departments such as intensive care or operating room, GPs, managers and directors of hospitals. A correction took place for the number of internal and external respondents. In 2008 and 2009 there were, 4.787 and 4.441 respondents respectively, of which 2.862 and 2.519 medical specialists[4]. Our quality indicator is likely to be positively correlated with outcome, process and structural quality indicators, as well as reputation characteristics of ophthalmologists. The indicator may also be positively correlated with referral patterns because respondents often provide medical care referrals themselves. We used the quality scores of 2008 for the years 2008 and 2009, and the quality score of 2009 for 2010 and 2011 respectively.[5] In case data was missing, the previous or following years were used as a proxy. Fortunately, the annual variation of hospital quality is limited making these proxies hopefully fairly reliable.

In the last years an increasing number of other quality indicators have become available. For instance the Dutch website www.kiesbeter.nl collects and publishes these indicators. These indicators are process indicators such as how does a patient value the communication with an ophthalmologist, a nurse and communication about medication. During the years of our study, these process indicators received less attention in the public media and, moreover, they do not necessarily reflect outcome quality of a treatment. We tested also whether patient choice was related to these process indicators. Although not reported here, we found for two process indicators only a very weak positive correlation while the third, communication with an ophthalmologist, was weakly and negatively correlated with hospital choice. The top performing hospital of the Elsevier survey was also not among the best hospital in the rankings of process indicators.

The scale Elsevier uses for both types of quality indicators differs; overall quality is scaled 1-10 while ophthalmologist quality is scaled 0-100. Graph 1b and 1c show the average score for the two quality

[4] Elsevier also published a new quality indicator for eye specialism in 2011, based on publicly available performance, mostly process, indicators. The scores do not measure the success or failure of doctors (Elsevier, 2011). We tested separately the impact of process quality indicators (see text). The top-performing hospital in our study was not among the seven best hospitals in 2011. Thus, the fact that Elsevier decided to change the quality indicator may have a negative impact on the market position of the top performing hospital.

[5] Indeed, we find a strong correlation of 72 per cent for lagged ophthalmologist quality in the years 2009 and 2010.

indicators ophthalmologist quality and overall hospital quality (hospitals are ranked according to patient volume on the x-axis). The average of the overall hospital quality and ophthalmologist is based on the years 2007 until 2011 and 2008 until 2009 respectively. The correlation between overall hospital quality and ophthalmologist is fairly low, namely 12 percent indicating that there is a large variation in quality across different specialties in hospitals.

The ophthalmologist data shows that in 2008 the top performing hospital obtained a score of 66 and in 2009 this increased to 84, in both years this was by far the highest score. The difference in the quality scores between the hospitals and to what extend they are correlated with outcome quality indicators is unknown. The fact that the top performing hospital is indeed an outlier is confirmed by their reputation; it has acquired the status of centre of excellence and has received several additional awards for its quality in the past years.

3.3. Waiting time

A consumer can observe waiting times at the internet website www.kiesbeter.nl. We obtained the yearly average waiting time in weeks per hospital from the NZa. On average the waiting time was 5.80 weeks. Hospitals show great variation in the average waiting time, the minimum and maximum waiting time in this data set was 0 and 21 weeks respectively. Also, the waiting time tends to fluctuate considerably over time. For example, the correlation of waiting time in 2007 and 2008 was only 52 per cent.

3.4. Distance

The majority of the population, of which most are woman aged 70-75 years old, does not travel far for a cataract treatment. Travelling was based on the kilometres between the patients' zip code of residence and the hospitals' zip code[6]. In graph A1a we show that about 80 per cent of all patients travels 0-20km and about 15 per cent travel between 20-40km. Very few people travel more than 60 km, although we observe a small jump in 2011. This trend is also visible in table A1 summary statistics. The average number of kilometres travelled in this sample increases slightly from 13.48 km in 2006 to 16.40 km in 2011.[7] A lot of patients that travel far choose for the top-performing hospital. Graph A1b shows that about 50% of all the patients that visit the top performing hospital travel 60km or more. Over time the percentage of patients who travelled more than 60km going to the top performing hospital declined to 34 per cent in 2011.

[6] Another possible way to estimate travelling would have been in terms of time required to travel to the hospital. Varkevisser et al. (2007) for instance uses travel time by care between the patient's zip code and hospital zip code. Actual travel time depends on the route and accessibility of public transportation. However, in most cases the distance in kilometres will be not that different from distance in travelling time, especially for people travelling a far distance.

[7] For the top performing quality hospital, patients were willing to travel longer: on average 21.10 km.

3.5. Predicted demand

Hospital demand depends also on location. A hospital located in a densely populated area with few competitors will attract, simply by chance, more customers. In the aggregate-level analysis we will study whether hospitals are able to attract more patients than expected according to the hospitals' location. Therefore, we introduce predicted demand as the expected number of patients if all patients would visit their nearest hospital. We define predicted demand in two ways: predicted demand "DBC" (Pr DBC), predicted demand based on location only, and predicted demand "zip" (Pr zip), predicted demand based on location, age and gender characteristics. See appendix for a more detailed explanation as to how both forms of predicted demand were derived.

Graph 1a shows the gap between actual demand and Pr DBC (demand difference "DBC"), and Pr zip (demand difference "zip"). Graph 1b and 1c show our two quality indicators: ophthalmologist and overall hospital quality. On the x-axis, the hospitals are ranked according to actual demand. From the graphs it is clear that there is one hospital that outperforms all others in terms of ophthalmologist quality and the gap between actual demand and predicted demand. The gap is much smaller for the second largest hospital. For the remaining hospitals, the difference between actual and predicted demand slowly deteriorates as patient volume declines.

To see how actual demand, Pr DBC and Pr zip differ per hospital, Graph A2 shows all three variables with the hospitals ranked according to actual demand on the x-axis. This graph clearly shows that there is one hospital that enjoys a fairly large market share. Actual demand quickly drops from 40,000 to 16,000 almost immediately after which actual demand slowly decreases until it almost reaches 0.

3.6. Correlation matrix

Before turning to our regressions, it is insightful to look at the correlations in Table 1a.

Firstly, both quality variables are positively correlated with patient volume. The variable ophthalmologist quality shows however a much stronger correlation with actual demand than overall hospital quality, namely 47 per cent and 15 per cent respectively. As noted before, the correlation between the both quality variables is small with 12 per cent.

The correlation matrix shows a small negative correlation between waiting time and patient volume (−18 per cent) which suggests that hospitals with longer waiting times experience somewhat lower patient volumes. Waiting time is also negatively correlated with quality suggesting that better quality hospitals generally have lower waiting times.

Table 1b shows how all variables are correlated when the top performing hospital for cataract treatments is excluded from the sample. The correlation between ophthalmologist and actual demand drops to 26 per cent, as opposed to 47 per cent. This implies that the top performing hospital contributes a lot to the correlation between ophthalmologist quality and actual demand. We find the opposite effect for the correlation between the two predicted demand measures and actual demand. The correlation becomes stronger and increases from 63 per cent to 74 per cent, respectively, and from 34 per cent to 44 per cent. This may correspond with the observation that 88 per cent of the patients who visited the top performing hospital bypassed the closest hospital while in the total sample on average only 37 per cent bypassed the closest hospital.

4. METHOD AND RESULTS

4.1. Method

Aggregate-level analysis

At the aggregate level we use a simple OLS model to estimate the effect of quality on patient volume. Similar to Pope (2009) we estimate the OLS model:

$Y_{i,t}$ represents the total number of cataract treatments with DBC-code 110005540031 carried out at hospital *i*, in year *t*. Variable $w_{i,t}$ is the average annual waiting time in weeks for hospital *i* in year *t*. The term is a vector of lagged ophthalmologist and lagged overall quality of hospital *i*. [8] Year dummies, , are included to capture year-specific effects. The regression spans four years 2008-2011. To explore how the impact of ophthalmologist quality on patient volume is driven by the top 10 performing hospitals, we run the regression 10 times, every time eliminating the best performing hospital from the data set.

A limitation of the OLS model is however that it does not control for differences between hospitals, such as: the number of specialists, the resources available, spare capacity etc. (Perotin, 2010). To control for this problem we run a fixed effects model with the same variables. As was already mentioned by Pope, one of the major problems when estimating the impact of quality on patient volume is that there is usually very little variation in hospital quality over time (Pope, 2009). An alternative approach for fixed effects is to control only for some observable hospital characteristics by using a predicted demand variable (see section 3.5). The following model explores how quality of hospital *i* affects the difference between actual and predicted patient volume:

The model differs from the previous regression in that we have included , which represents the number of predicted DBC's for hospital *i*, in time *t*. We will run the regression twice, first with Pr DBC and, next, with Pr zip.

Individual-level analysis

[8] Some studies insert the absolute values of quality (Bundorf et al., 2009: Jung et al., 2011: Varkevisser et al., 2012), other studies use rankings (Pope, 2009).

A mixed logit model is used for the individual-level analysis as this is generally used to model hospital choice on a patient-level (Tay, 2003). The model is used to analyze how patients value quality relative to other factors such as distance. The mixed logit model is more flexible than the conditional logit model because it allows for random taste variation, unrestricted substitution patterns and correlation in unobserved factors over time (Train, 2009). Under the mixed logit model the parameters that are associated with each observed variable are not fixed, but varies with patients. The conditional logit model on the other hand, assumes the parameters are fixed; hence differences in preferences are related to observed characteristics of the patient and are captured through the inclusion of interaction variables. We use a standard utility function of individual *i* attending hospital *q* in time *t*:

represents the explanatory variables quality, distance and waiting time. The error term is also unobserved and is assumed to be independent and identically distributed. Parameter is a vector of coefficients and is unobserved. Parameter is treated as a random parameter and is integrated over all its possible values of β, then weighted by the density of β to obtain the unconditional choice probability, of person *i*, choosing hospital *q*, in year *t*.

The 854,613 patients in our data set are free to choose any hospital in the Netherlands. With approximately 150 hospitals to choose from this would result in approximately 134 million patient-hospital combinations. Unfortunately, a mixed logit cannot be computed with a data set of this format. Therefore we make some restrictions.

First, since the lagged quality indicator ophthalmologist is only available for the years 2009 and 2010, the set is reduced to these two years only. In addition, the choice set is reduced to the closest 20 hospitals[9]. Peter Sivey and Howard use a similar approach, they restrict the choice set to the closest 10 hospitals only (Howard, 2008; Sivey 2012). Our choice set is somewhat larger because the focus of this study is on the top performing hospital, and for precisely this hospital patients are willing to travel far. If the choice set is restricted to the closest ten hospitals, then 5 per cent of the patients are eliminated from the sample of which 18 per cent of the patients is coming from the top performing hospital. If we allow for a choice set of twenty hospitals, only 2 per cent of the patients are eliminated,

[9] Allowing for larger choice sets did not results in significantly different estimates

and, only 7 per cent of the patients that visited the top performing hospital is dropped. If a patients' choice falls outside his/her choice set, the mixed logit is not able to estimate someone's preferences hence the patient is dropped from the sample. All these restrictions resulted in 2,996,205 patient-hospital combinations that we will use in our estimations.

We estimated the model twice, first with quality ophthalmologist in linear form, and second with quality dummies allowing for nonlinear effects. The average score of the variable quality ophthalmologist in the year 2009 and 2010 is used as the quality indicator. Quality dummies are created for every 10-point interval namely: 70-80, 50-60, 30-40, 20-30, 10-20 and 0-10 (quality dummy 0-10 is excluded avoiding multicollinearity). There were no hospitals with an average quality score ranging between 60-70 and 40-50. In both regressions, all coefficients are assumed to be normally distributed. We also hypothesize a nonlinear effect of distance where the negative utility of having to travel an additional kilometre is expected to fall with distance (Sivey, 2012). The following distance dummies are incorporated: 0-20 km, 20-40km, 40-60km, 60-80km, 80-100km and 100+km (the last dummy variable is again excluded from the regression to avoid multicollinearity).

For reasons of comparison, both regressions were also run using a conditional logit. The conditional logit serves as a good comparison to the mixed logit as this generally gives similar results. The mixed logit is more preferred as it relaxes the IIA assumption and generally yield more precise estimates, the coefficients tend to be of similar size (Train, 2003).

4.2. Results

Aggregate-level analysis

The regression results are shown in table 2. The regression in the first column (All hospitals (1)) shows that the ophthalmologist quality indicator has a statistically significant impact on patient volume. In the year 2008, 2009 we find that a one point increase in quality results in approximately 57, respectively 64 more patients. For the average hospital, this translates into about a 4 per cent patient volume increase. Over time, 2010-2011, this quality effect on patient volume has declined somewhat to approximately 2 per cent. Furthermore, we find that waiting time is negatively correlated with patient volume; an increase in waiting time by one week results in approximately 66 fewer patients. For the average hospital, this translates into a 4 per cent patient volume decrease. In the second column in Table 2 (All hospitals (2)) the variable overall hospital quality is added. The impact of ophthalmologist quality and waiting time on patient volume remains fairly stable and overall hospital quality is not significant in any year. This suggests that overall hospital quality is less predictive, indeed the hospital with highest overall quality is not necessarily also the best ophthalmology hospital.

Our findings coincide with other studies in that quality has a positive impact on patient volume (Pope, 2009; Varkevisser et al, 2012; Tay, 2003; Bundorf et al, 2009; Mukamel et al, 2004). For instance, Pope (2009) finds that an increase in the rankings by one spot is associated with an increase of 1 per cent in patient volume. It is not possible to compare his findings with our predicted patient volume increase directly because Pope uses rankings instead of absolute quality scores, and we have no information about the distribution of his absolute quality scores. We do however know that his sample includes 446 hospitals. If we assume that quality of these hospitals is linearly distributed on a scale of 0-100, then the average quality difference is 0.23. In that case, a one point quality increase results in a 4.5 per cent increase in patient volume. This is close to the 4 per cent increase that we find. Furthermore, Pope concludes that on average about 5 per cent of the change in non-urgent patient volume can be attributed to changes in the rankings. If we perform a similar exercise and estimate the number of cataract patients that took quality into account, by multiplying the number of patients by the number of patients affected by the quality changes, times the average change in quality (a similar calculation was done by Pope) — we find that approximately 26,000 patients, or 10 per cent, made their choice on the basis of quality. If we exclude the top performing hospital from our sample then the number of patients that based their choice on quality dropped substantially to 12,000, or 5 per cent. If the top performing hospital is excluded then we find similar percentages of patients as in Pope (2009).

Some studies however find a much larger impact of quality on patient volume. For instance, Tay (2003) finds that for instance the adoption of a lab for catherization is expected to increase patient volume substantially, namely by 65 per cent. The introduction of this high-tech service is however quite a drastic change, and allows for new treatments to take place. For our cataract treatments these sort of major changes in technology are not applicable.

Next, we ran the same regression ten more times, every time eliminating the best quality hospital from the sample. The evolution of the percentage increase in patient volume for the average hospital for each successive regression is shown in Graph A3 in the Appendix. Eliminating the best hospital from the sample about halves the impact of quality on patient volume. It is obvious that the top performing hospital has a large impact on the average effect.[10]

In Table 2 (last two columns) we run the same regressions as before but now without the top quality performing hospital. The effect of ophthalmologist quality appears to be much smaller and is now only significant in the years 2008 and 2009. For example, in 2009 the effect on patient volume is about halved, from 64 to 32 additional patients, after excluding the top performing hospital we find

[10] The results are available from the authors upon request.

that effect of waiting time on patient volume remains stable. Finally, the effect of overall quality remains insignificant. This result suggests that only the top performing hospital is able to attract a significant amount of extra patients as a result of higher quality. One reason may be that other high quality hospitals have only a quality close to the average quality of the sample. Graph 1B shows that the top performing hospital has a mean score of 75 per cent, whereas the first and second runner up hospitals have mean scores of 50 and 38 per cent, while the remaining top performing hospitals have a score of around 30 per cent. To conclude, our results suggest that patients are mainly interested in the top performing hospital.

If we run a fixed effects model, with the same variables, none of the variables turn out to be significant[11]. A major problem with the fixed effects model is that hospital quality does not vary much over time, and the quality effects are largely absorbed by the fixed effects.

Our aggregate results are quite robust; similar results show the actual versus predicted demand regressions in Table A2a. In the first column (All hospitals) ophthalmologist quality still has a significant impact on the difference between Pr DBC and actual demand, but in the second column (Without top performing hospital) the impact becomes insignificant. Waiting time has a negative and significant impact on attracting additional patients, a one week increase in waiting time results in approximately 45 fewer patients. The results change only slightly if we use Pr zip instead of Pr DBC (Table A2b).

Individual-level analysis

Table 3 shows our mixed logit results. In the first regression quality is linear and in the second regression we included dummies allowing quality to be non-linear. For every variable the mean and standard error of the coefficient is presented in the first row. The second row shows the value of the standard deviation of the coefficient and the corresponding standard error. Overall, the results show that patients have a preference for hospitals with higher quality and lower waiting times.

We can conclude that ophthalmologist quality has a positive impact on the likelihood to visiting a hospital. This is in line with findings in other studies such as Varkevisser et al (2012), Pope (2009), Jung et al (2011) and Tay (2003). While the coefficients in a mixed logit model cannot be interpreted individually, they show the relative importance of the patients' decision-making. For instance, we can estimate how important quality is relative to distance. In the first regression, the coefficient on ophthalmologist is .032, and the difference between the utility gained from choosing a hospital within a range of 0-20km as opposed to 20-40km is 2.97 (7.50-4.53=2.97). This suggests that patients value

[11] Results are available upon request.

the hospital being within a range of 0-20km as opposed to 20-40km 9 times more than a hospital having 10 points higher quality. In other words, out of every 10 patients, one patient will choose to travel 20-40km for a ten point quality gain while the other nine will visit a hospital that is within 20 km. Alternatively, we can conclude that the negative utility for traveling an additional km, given that the hospital is within a range of 20 km, is 2.97/20=.15. This implies that patients are willing to travel .032/.15=.2 km more for a one-point increase in quality, given that the hospital is within a range of 20km. On average patients travel 14.22 kilometres, hence patients are willing to travel 1.4% more for a one point quality increase. Varkevisser et al (2012) also estimates the willingness to travel for quality**.** They find that on average patients are willing to travel 2 minutes longer for a 1% lower readmission rate, where patients travel 22 minutes on average. In this case patients are willing to travel 9% longer for a 1% lower readmission rate. A fair comparison is however difficult to make because their quality indicator readmission rate is very different from our variable ophthalmologist quality. Furthermore, the complexity of treatment and the average age of the patients differ which may also affect the willingness to travel.

In the second regression, we indeed observe a non-linearity effect. The estimators of the quality dummies show that for the highest category ophthalmologist 70-80 the estimated effect is more than two times higher than that of the remaining quality dummies. This suggests that patients have a stronger preference for the top performing hospital, and a much weaker preference for hospitals falling in the quality ranges, 50-60, 30-40, 20-30 and 10-20. Hospitals falling in these categories are however preferred over hospitals that fall in the reference group (Ophthalmologist: 0-10). The size of non-linear effect becomes visible if we estimate a patients' willingness to travel. The results show that for the top performing hospital, on average patients are willing to travel 17km extra as opposed to visiting a hospital with quality 0-10 (given that the hospital is within a range of 20km), and 11km extra as opposed to visiting any of the hospitals with a quality level between 20-60.

Furthermore, the results in table 3 show that all distance dummies are positive and statistically significant. The impact of distance is similar in both models. The size of the coefficients on the distance dummies declines with distance, indicating that patients have a significant preference for hospitals that are close by. These results are found in many studies (see e.g. Sivey (2012) and Pope (2009).

For some of the variables the standard deviation of the coefficient is significant, which implies that there is patient heterogeneity. For instance, in the first regression patients show significant variation in how they value quality relative to distance and waiting time. The second regression infers that patient heterogeneity exists only if the quality score falls in the range 70-80 or 30-40. For the remaining quality categories, patient heterogeneity is not significant. In addition, we find that patients do not vary significantly in how they value distance (except for distance dummy 0-20km in the first regression).

The results of the conditional logit can be found in table A3 in the appendix. The table shows almost identical results to the mixed logit estimates. The mixed logit allows for people to make different tradeoffs between quality, distance and waiting time. From our dataset we observe however that 88 per cent of the patients who visited the top performing hospital bypassed the closest hospital, while on average only 37 per cent bypassed the closest hospital. So, again, people seem to visit the nearest hospital or they value quality and visit the top performing hospital. In other words, there is not much variation in how people make trade-offs, hence the estimates are very similar. In graph 2 we plotted the actual and predicted values of the total number of visits over the sample period. The graph shows no irregularities, but it is clear that the mixed logit model captures only part of the variation in our data.

5. CONCLUSION

The question we raised in this paper was "*Do higher quality hospitals attract significantly more patients?* This paper showed that about 80% of the population chooses for a hospital within a range of 20km, and less than 5% of the population is willing to travel far, more than 60km.We found that in our six year period, only the top-performing hospital was a leader in the ophthalmology market and was able to attract significantly more far-away patients than other hospital. The hospital dominated also our estimation results. At the aggregate hospital level we found that the volume effect, of attracting patients if hospital quality is increased, halved if the top-performing hospital is excluded from our sample. At the individual-level we found, keeping all else equal, that patients are willing to travel an additional 11km or more for the top performing as opposed to other hospitals. Over the years this trend seems to have decreased and far away patients increasingly travel to other hospitals as well. We cannot explain this new trend in the market with our limited dataset but it suggest that other aspects, such as marketing, new quality measures that increasingly become available or that enhanced competition plays a role. For example, the liberalization of the Dutch hospital market has led to more specialization of ophthalmology hospitals and new clinics have entered the market.

Since our quality measures are based on the opinions of doctors it may include various quality dimensions. The cataract treatments that we study in this paper are relatively easy treatments to perform, so differences in medical outcomes are likely to be small among hospitals. We cannot tell exactly what the most important quality aspect of the top performing hospital is, but it is likely that many dimensions play a role, such as reputation effects or an efficient management.

Another concern of these types of studies is causality (Gaynor, 2012). Are patients attracted by the high quality of the hospital or is the hospital highly specialized and can it perform certain types of cataract treatments that cannot be done in other hospitals? We have tried to rule this reverse causality argument out by focussing exclusively on standard day-cataract treatments, and thus removing the more complex cataract treatment from our sample. Our communication with ophthalmologists confirmed that the cataract treatments that we study in this paper are relatively straightforward and could be performed by all eye-specialists. The specialization argument is much more relevant for highly complex care, such as treating heart attacks (see e.g. Chandra and Staiger, 2007). However, some spill-over effects in our study may still exist. Patients may want to be on the safe side and prefer a specialized hospital, even for relatively simple cataract treatments.

The fact that few patients seem to consider quality when choosing hospitals is also confirmed by our finding that long waiting lists are not correlated with higher quality. Indeed, we find that an increase in waiting time results into a decrease in patient volume for the average hospital. However, this correlation could easily turn around if quality becomes more transparent and the most important argument in a patients' decision-making process for hospital choice.

Whether a winner takes most strategy is applicable to other treatments will depend on the nature of the treatment. Our research shows that for relatively standard cataract treatments it is possible to become a dominant player in the market and to attract far away patients. However, for some treatments investing in quality may simply not be very rewarding. For example in the market for kidney transplants quality could be relatively unrewarding because availability is much more important. A winner takes most strategy is probably also less successful for urgent care, as one of the most important factors will be the accessibility to the hospital. For patients with a chronic disease the market might be very rewarding because many of these patients might be very sensitive to quality differences. However, very rewarding markets may attract a lot of competitors making it much harder to become a dominant player. Further research would be needed to explore whether "a winner takes most" occurs for other treatments as well.

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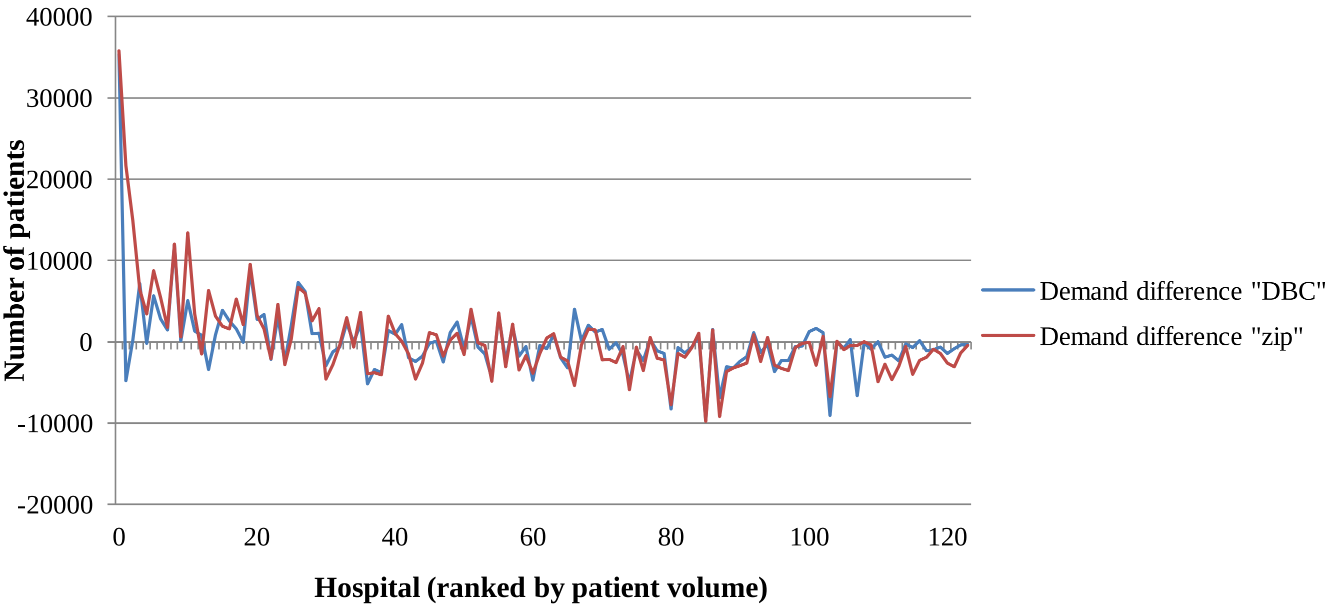
Table 1a: Correlation matrix

	Patient volume	pr DBC	pr zip	waiting time	Ophthalm ologist	hospital quality
patient volume	1.0000					
pr DBC	0.6277	1.0000				
pr zip	0.3377	0.6586	1.0000			
waiting time	-0.1778	-0.0568	0.0095	1.0000		
ophthalmologist	0.4748	0.0521	-0.0109	-0.1434	1.0000	
hospital quality	0.1518	0.0676	0.0044	-0.1144	0.1176	1.0000

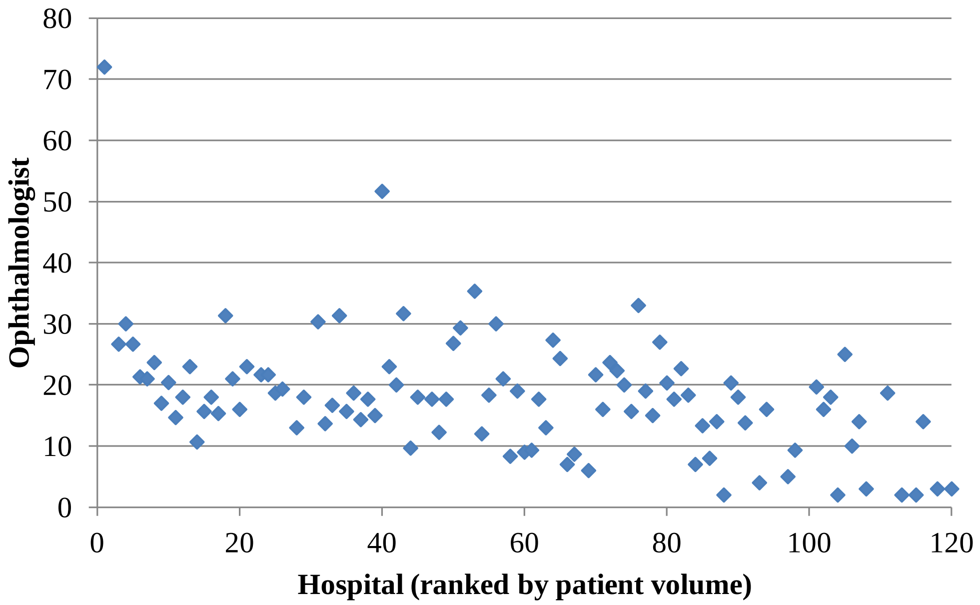
Table 1b: Correlation matrix (excluding the top performing hospital)

	Patient volume	pr DBC	pr zip	waiting time	Ophthalm ologist	hospital quality
patient volume	1.0000					
pr DBC	0.7391	1.0000				
pr zip	0.4367	0.6575	1.0000			
waiting time	-0.1587	-0.0618	0.0026	1.0000		
ophthalmologist	0.2568	0.1061	0.0521	-0.1153	1.0000	
hospital quality	0.1259	0.0738	0.0131	-0.1087	0.0841	1.0000

Graph 1a: Actual demand and predicted demand difference



Graph 1b: Ophthalmologist quality scores (range 0-100)



Graph 1c: Overall hospital quality

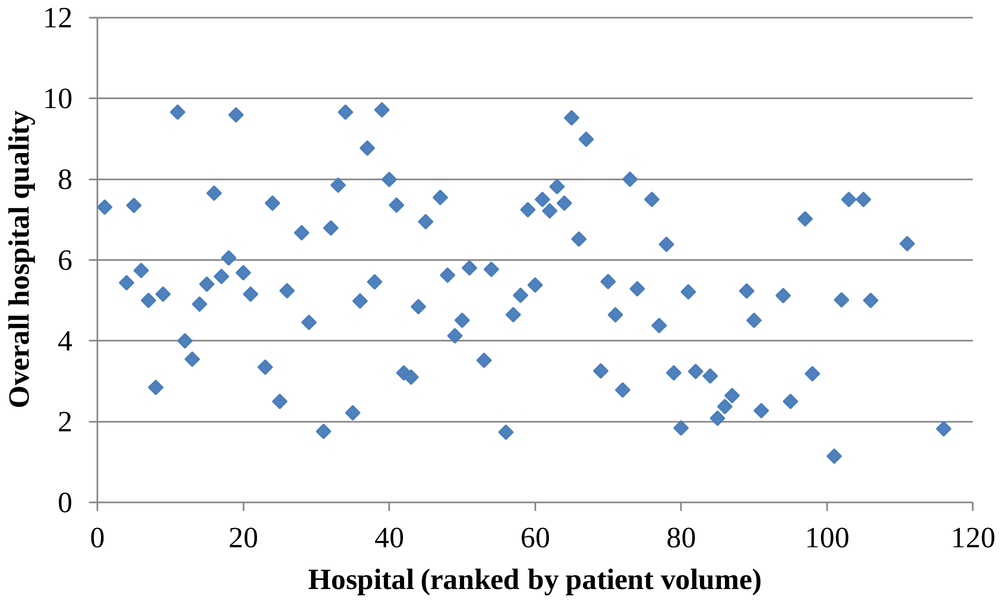


Table 2: Patient volume, ophthalmologist quality and overall hospital quality

	All hospitals (1)	All hospitals (2)	Without top performing hospital (1)	Without top performing hospital (2)
Ophthal-mologist 2008	56.56*** (10.35)	52.96*** (10.84)	33.76** (11.23)	27.09* (11.64)
Ophthal-mologist 2009	63.93*** (11.44)	61.43*** (11.73)	31.90* (12.97)	27.95* (13.09)
Ophthal-mologist 2010	34.08*** (9.08)	35.55*** (9.64)	15.67 (10.74)	14.40 (11.45)
Ophthal-mologist 2011	34.07*** (9.21)	32.77** (9.73)	5.69 (11.03)	1.06 (11.61)
Hospital quality 2008		18.40 (38.28)		13.85 (34.73)
Hospital quality 2009		43.62 (39.71)		39.49 (36.02)
Hospital quality 2010		-47.56 (59.58)		-48.57 (54.04)
Hospital quality 2011		25.61 (44.88)		38.94 (40.81)
Waiting time	-66.11*** (15.24)	-66.75*** (16.96)	-64.60*** (14.11)	-65.68*** (15.12)
N	317	284	313	280
adjusted R2	.27	.26	.10	.08

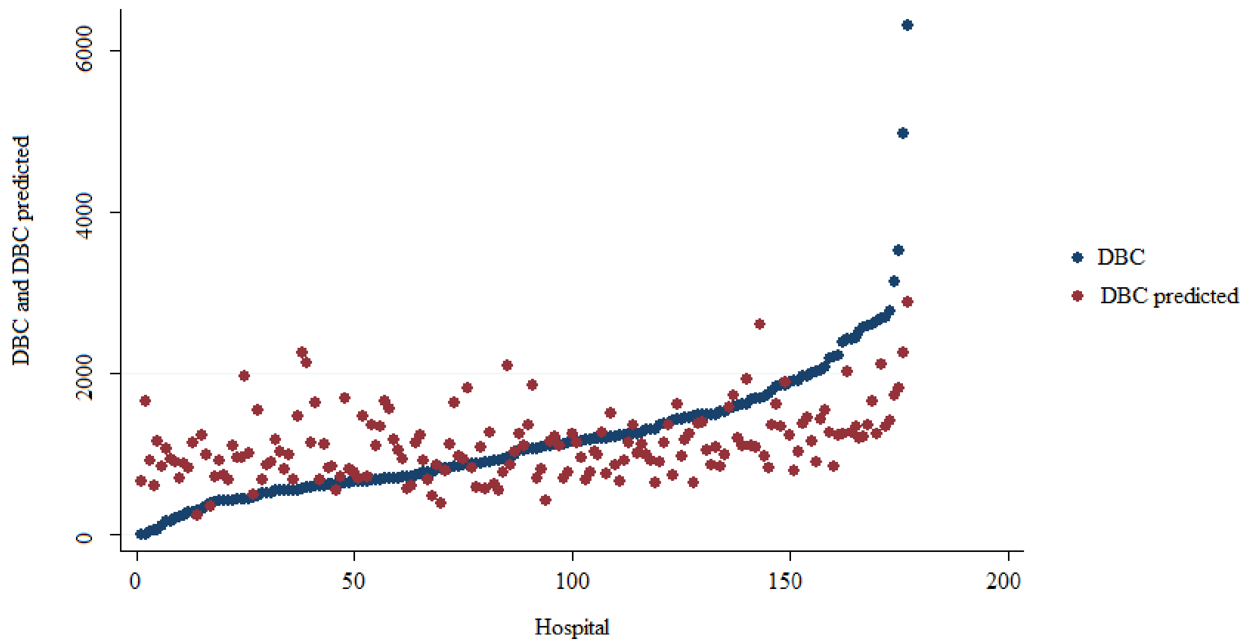
1.) Year dummies are not presented here.
2.)* significant at p<.05; ** significant at p<.01; ***significant at p<.001
3.) The sample size in column "All hospitals (2)" is larger than in "All hospitals (1)" because of missing overall hospital quality observations in the second regression. The same holds for "Without top performing hospital (2)" and "Without top performing hospital (1)".

Table 3: Mixed logit

		(1)		(2)	
	Parameter	**Value**	**Std. error**	**Value**	**Std. error**
Ophthalmologist	Mean of coefficient	.032***	(.00)		
	Std. dev. of coefficient	.01***	(.00)		
Ophthalmologist 70-80	Mean of coefficient			2.53***	(.02)
	Std. dev. of coefficient			.70***	(.05)
Ophthalmologist 50-60	Mean of coefficient			.80***	(.04)
	Std. dev. of coefficient			.20	(.13)
Ophthalmologist 30-40	Mean of coefficient			.90***	(.02)
	Std. dev. of coefficient			.96***	(.03)
Ophthalmologist 20-30	Mean of coefficient			1.09***	(.01)
	Std. dev. of coefficient			.01	(.02)
Ophthalmologist 10-20	Mean of coefficient			.87***	(.01)
	Std. dev. of coefficient			.01	(.01)
Distance					
0-20 km	Mean of coefficient	7.50***	(.06)	7.54***	(.06)
	Std. dev. of coefficient	.11**	(.04)	.00	(.01)
20-40km	Mean of coefficient	4.53***	(.05)	4.55***	(.06)
	Std. dev. of coefficient	.02	(.02)	.00	(.01)
40-60km	Mean of coefficient	2.22***	(.06)	2.26***	(.06)
	Std. dev. of coefficient	.18	(.10)	.05	(.03)
60-80 km	Mean of coefficient	1.19***	(.06)	1.25***	(.06)
	Std. dev. of coefficient	.07	(.06)	.02	(.05)
Waiting time	Mean of coefficient	-.01***	(.00)	-.02***	(.00)
	Std. dev. of coefficient	-.00	(.00)	.00	(.00)
Log likelihood		-242,184		-240,920	
# of observations		2,665,880		2,665,880	

1.) Year dummies are not presented here.
2.)* significant at p<.05; ** significant at p<.01; ***significant at p<.001

Graph 2: Mixed logit estimations: actual demand and predicted demand



Appendix

Predicted demand

Predicted demand “DBC” is defined as the sum of cataract patients for which this hospital was closest. In 14 cases, two or more hospitals shared the same zip code. In those cases patient volume was divided by the number of hospitals that share the same zip code.

Predicted demand “zip” was defined as the predicted number of Dutch citizens for whom this hospital was closest, taking into account age and gender differences of the population. The probability for an individual to obtain a cataract treatment was obtained by dividing the number of patients by the number of Dutch citizens in the same age/gender category. The age categories used were: 0-14, 15-24, 25-44, 45-64 and 65+. For instance, the probability of a 60 year old female to need cataract treatment is:

We derive predicted demand “zip” for hospital *i* by multiplying the probability for all gender/age categories by the corresponding number of citizens in these categories for which hospital *i* was closest.

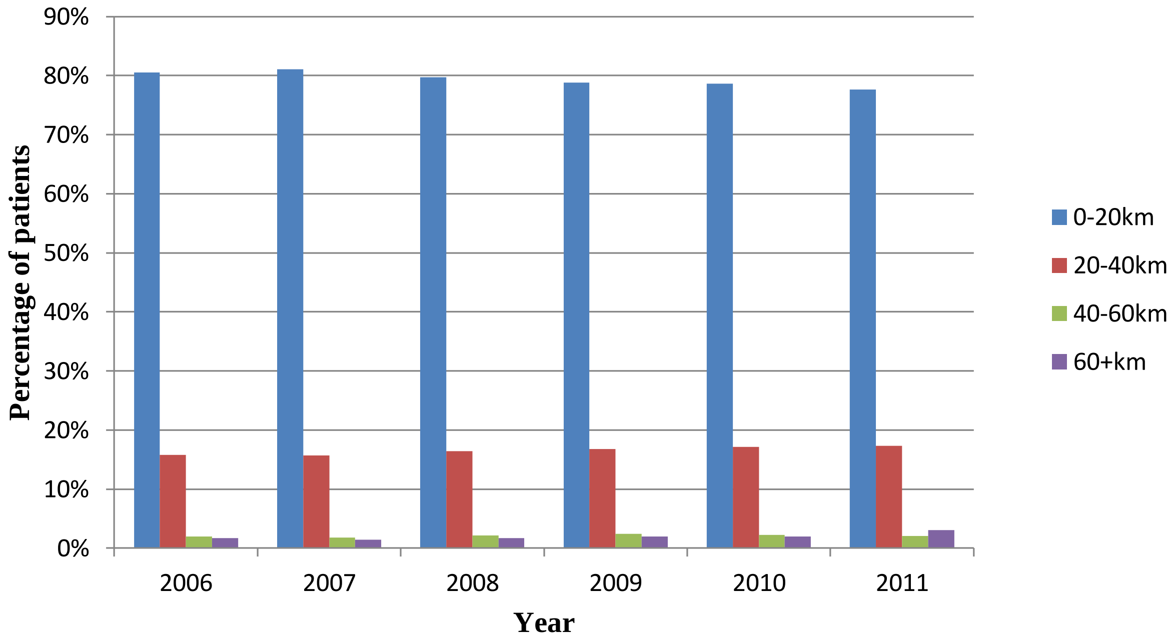
A limitation to the construction of predicted demand “DBC” is that it was based on patient-level data and incorporates the effect of supplier induced demand. A limitation that applies to predicted demand “zip” specifically is that only age and gender were used to predict someone’s’ probability to need cataract treatment. Other factors that influence someone’s chance to need cataract treatment, such as income or ethnicity could be taken into account to obtain a more precise estimate.

Another problem that arose was missing data from the CBS data set. To calculate the predicted demand we use the sum of the number of female/male inhabitants per age category for all zip codes for which the hospital was the nearest hospital. For some zip codes, data is missing on the number of inhabitants, which might underestimate predicted demand for some hospitals.

Table A1: Summary statistics

	2006	**2007**	**2008**	**2009**	**2010**	**2011**
Total DBCs	117,980	139,474	151,972	145,097	151,826	148,264
Total hospitals	149	149	151	152	153	153
Average distance	13.48	13.20	13.66	14.26	14.44	16.40
Average waiting time (in weeks)	6.73	6.71	6.22	5.23	5.25	4.85
Average ophthalmologist quality (on a scale 1-100)	18.48	18.48	18.48	19.14	20.52	19.91
Average overall quality (on a scale 1-10)	5.09	5.09	5.14	5.08	5.77	5.49

Graph A1a: Distance travelled over time (per distance category)



Graph A1b: Percentage of patients who went to the top performing hospital (per distance category)

Graph A2: Actual demand, predicted demand DBC and predicted demand zip

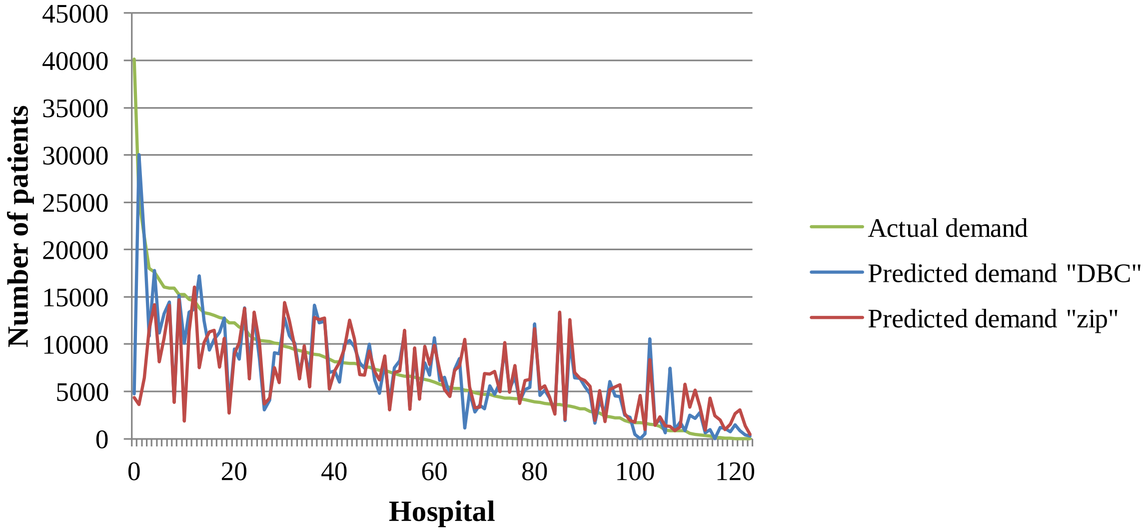


Table A2a: predicted demand DBC

	All hospitals	Without top performing hospital
Ophthalmologist 2008	46.72***	11.37
	(9.22)	(8.42)
Ophthalmologist 2009	50.88***	5.27
	(9.97)	(9.48)
Ophthalmologist 2010	42.29***	17.55*
	(8.20)	(8.29)
Ophthalmologist 2011	38.14***	5.46
	(8.27)	(8.4)
Ophthalmologist 2008	.64	-5.41
	(32.54)	(25.13)
Ophthalmologist 2009	23.77	18.17
	(33.76)	(26.07)
Ophthalmologist 2010	-52.79	-52.78
	(50.64)	(39.11)
Ophthalmologist 2011	48.45	62.30*
	(38.15)	(29.53)
Waiting time	-44.81**	-42.36***
	(14.42)	(11.17)
N	284	280
adjusted R2	.29	.06

1.) Year dummies are not presented here.
2.)* significant at p<.05; ** significant at p<.01; ***significant at p<.001

Table A2b: predicted demand zip

	All hospitals	Without top performing hospital
Ophthalmologist 2008	54.84*** (10.50)	23.88* (10.58)
Ophthalmologist 2009	59.33*** (11.36)	17.07 (11.9)
Ophthalmologist 2010	41.13*** (9.34)	16.67 (10.41)
Ophthalmologist 2011	36.15*** (9.42)	.72 (10.55)
Ophthalmologist 2008	19.85 (37.08)	14.45 (31.56)
Ophthalmologist 2009	39.68 (38.47)	34.47 (32.74)
Ophthalmologist 2010	-69.43 (57.71)	-70.27 (49.11)
Ophthalmologist 2011	43.43 (43.47)	58.35 (37.09)
Waiting time	-63.46 *** (16.43)	-61.89*** (14.02)
N	284	280
adjusted R2	.28	.09

1.) Year dummies are not presented here.
2.)* significant at p<.05; ** significant at p<.01; ***significant at p<.001

Graph A3: Dropping top performing hospitals one by one

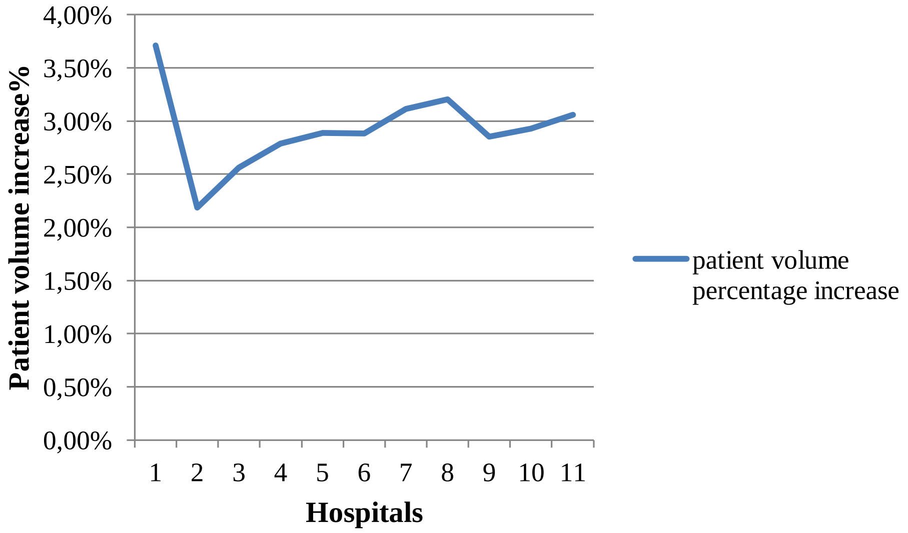


Table A3: Conditional logit

	(1)	(2)
Ophthalmologist	.032***	
	(.000)	
Ophthalmologist 70-80		2.57***
		(.02)
Ophthalmologist 50-60		.81***
		(.04)
Ophthalmologist 30-40		1.03***
		(.02)
Ophthalmologist 20-30		1.10***
		(.01)
Ophthalmologist 10-20		.88***
		(.01)
Distance		
0-20 km	7.47***	7.42***
	(.06)	(.06)
20-40km	4.51***	4.47***
	(.06)	(.06)
40-60km	2.22***	2.22***
	(.06)	(.06)
60-80 km	1.18***	1.21***
	(.06)	(.06)
Waiting time	-.01***	-.01***
	(.001)	(.001)
Log likelihood	-242,203	-241,138
# of observations	2,665,880	2,665,880

1.) Year dummies are not presented here.
2.)* significant at p<.05; ** significant at p<.01; ***significant at p<.001

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