Does better mean bigger?

A study on the relation between the quality of Dutch hospitals and their market shares

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Abstract

The Netherlands introduced a new system for financing health care in 2006. In this system hospitals compete with each other for patients and contracts with private health insurers. This competition is expected to be both on price and quality. A sign of functioning quality competition is that higher quality hospitals treat more patients than hospitals of lesser quality. This thesis has tested whether this is the case for Dutch hospitals, for hip and knee replacements, carotid interventions and abdominal aortic aneurysms, in one point in time and over time.

A multiple regression was used to test whether better quality hospitals treated more patients in 2019 and vice versa. Using panel data for the period 2016 to 2019, it was tested whether better quality hospitals grow more over time. Multiple quality indicators per procedure were used in the analysis.

Previous research has found that market shares of hospitals of better quality are bigger, this can not be concluded based on the results found in this thesis. No significant results were found for the year 2019. For the years 2016-2019 only three of the used quality indicators (revision rate after a knee replacement, score difference in a patient related outcome measure and complication rate after a carotid intervention) showed a significant effect on the number of treated patients. Meaning that overall no evidence was found of effective quality competition.

Further research should take the limitations of this thesis into account, namely the short time frame, the market fixed effects and the quality indicators. Further research could focus on more procedures or different health care systems. Follow-up research could also examine why Dutch patients are not able or willing to choose their provider based on quality even though the system is made for it.

Contents

Introduction

Rising health care spending and long waiting lists are not uncommon in the health care systems of OECD countries (OECD, 2009; Siciliani, Borowitz & Moran, 2013). Countries have tried to solve these issues in a few different ways. The United Kingdom was especially troubled by long waiting lists, so the reform in 2000 focussed on increasing quality and decreasing waiting times by investing more (Alvarez-Rosete & Mays, 2014). While in Belgium spending was seen as the bigger problem, hospital budgets were introduced to contain the costs (Schokkaert & Van de Voorde, 2005). The Netherlands opted for a more extensive solution, tackling both problems at once. After much debate and research the Dutch government decided to implement a new health insurance law.

The new health insurance law came into effect in the Netherlands in 2006. The Health Insurance Law (*Zorgverzekeringswet*) created a new system of financing medical costs. It shares some characteristics with the German and Swiss system. Like in the German system, solidarity is an important factor in the functioning of the organisation of health care and patients have a choice of health insurer (Busse, Blümel, Knieps & Bärnighausen, 2017). The German system tries to balance the solidarity with increasing competition. As in Switzerland, the new Health Insurance law made buying a health insurance mandatory, with subsidies for those who cannot afford it (De Pietro et al., 2015).

In the new Dutch system, the market for health care consists of three separate markets: a market with health insurers and health care providers, a market with health insurers and patients and a market with health care providers and patients (Van de Ven & Schut, 2008). Health care providers have to compete with each other for contracts with private health insurers and for patients. The goal for the introduced managed competition was better accessibility, better affordability and better-quality care (Kroneman et al., 2016, p. 27).

To achieve better accessibility, better affordability and better-quality care, health care providers are expected to compete on both quality of care and price. Research shows however that quality has so far had a limited role in negotiations with health insurers, focusing more on price and volume (Stolper, Boonen, Schut, Varkevisser, 2019). Due to a large variety of care to negotiate on, it is an extensive task for insurers to gather the knowledge for adequate quality negotiations (Zuiderent-Jerak, Grit, Van der Grinten, 2011). A sign that the quality competition functions is that better quality health care providers attract higher market shares and vice versa. In a well-functioning market with quality competition, higher quality providers will be rewarded by attracting more patients.

This thesis will test whether better performing providers attract higher markets shares, and closely follows the 2016 paper by Chandra, Finkelstein, Sacarny & Syverson who examined the relationship between market power and quality of American hospitals. They showed that higher quality hospitals have higher market shares and grow more over time. They used data from Medicare patients with heart attacks, congestive heart failure, pneumonia and hip and knee replacements. Similar research has also been done on hip replacements in the Netherlands with comparable results (Beukers, Kemp & Varkevisser, 2014).

Publicly available quality data published by *Zorginstituut Nederland* will be used. The data from hip and knee replacements will analysed, as well as abdominal aortic aneurysm and carotid interventions over multiple years. This thesis will add to existing literature by evaluating more conditions in a Dutch setting, also, more recent data is used compared to the 2014 paper by Beukers et al.. The results could be of use for policymakers, hospitals and insurers by providing information on the effect of quality on the flow of patients to different hospitals.

Objective and research question

The aim of this thesis is to test whether hospitals that give higher quality care also give care to more patients. If better quality providers attract a larger market share and grow more over time, it would mean that the quality competition is functioning . Better quality care was one of the goals of the health care reform that started in 2006. This thesis will follow the same strategy as in the 2016 Chandra et al. article, they tried to answer the question whether better quality has a larger market share in one point in time. They also tried to find out whether better quality hospitals gain more market share over time.

Therefore, the following question will be tried to be answered:
Are Dutch hospitals with better quality for hip replacements, knee replacements, abdominal aortic aneurysm and carotid interventions larger and do they grow more over time?

In the next chapters an answer to this question will be sought after. In the theoretical framework an overview of the relevant existing literature will be given as well as an outline of the Dutch healthcare market. In the research methods section an elaboration is given on the data and variables and the used methods will be explained. The results will be presented and explained in the 'Results' section. Afterwards, the main findings will be linked to previous research in the discussion. In addition, the limitations and strengths of this thesis will be addressed. Recommendations for further researched will also be made in this section. Finally, an answer to the research question will be given in the conclusion.

Theoretical framework

Since the health care system reform in 2006 every Dutch citizen is obligated to buy a standardised basic health insurance with one of the private health insurance companies (Van de Ven & Schut, 2008). There is a mandatory yearly deductible for most types of care, the height of the deductible is set yearly, in 2021 it is €385 (Rijksoverheid, 2021). This is below the average price of most hip and knee replacements (NZa, 2019a; NZa, 2019b), the cost of treatment for the patient is therefore independent of the choice of provider. This means that a patient's choice of hospital will be based on characteristics other than price.

The insurance companies sign contracts with health care providers, they can choose with whom they sign and the conditions of the contract (Van de Ven & Schut, 2008). If insurers decide to use their ability to selectively contract, i.e. not signing with every provider, they could steer patients to hospitals of better quality or better efficiency. Insurers, however, are reluctant to use selective contracting (Bes, Wendel, Curfs, Groenewegen & De Jong, 2013). Only four out of 55 insurance packages in 2020 used selective contracting, together they covered 3,5% of total insured (NZa, 2020; Van Ark, 2020). Therefore, selective contracting currently does not play a major role in the flow of patients.

Patients can access quality data on websites like *ziekenhuischeck.nl* and *zorgkaartnederland.nl* and rankings like the yearly *AD* ranking. The national newspaper *AD* publishes a ranking of hospitals based on 35 characteristics (Van Lare & De Vreede, 2018). This is done for the hospital as a whole, not per procedure or department. The data used in this thesis are also used on *ziekenhuischeck.nl* and *zorgkaartnederland.nl*. Based on the information gathered from these sources patients can make a decision on where they want to receive treatment. Most patients, however, follow the advice of their general practitioner (GP) when it comes to choosing a provider (Reitsma, Brabers, Masman & De Jong, 2012). This does not mean the choice could not be based on quality differences, GP's may inform themselves through these websites or related channels and may give advice accordingly.

Previous research

Research has shown that patients are willing to travel past the nearest provider under the right circumstances. A 2017 systematic review of 26 studies, from various countries where patients have some freedom of choice, found that patients are willing to travel, this increased mobility is positively associated with lower waiting times and indicators of better quality (Aggarwal, Lewis, Mason, Sullivan & Van der Meulen, 2017). They found that older patients and patients with a lower socio-economic status are less likely to travel. Shalowitz, Nivasch, Burger & Schapira (2018) found in a discrete choice experiment of patients from Pennsylvania, USA that 4 in 5 patients were willing to travel 80 kilometres for a better survival rate of ovarian cancer ($\leq$6%). They found no socio-economic differences between the patients willing to travel and those that were not. Another systematic review found that decision making also relies on other factors than distance and rational information on risk, like age and years of formal education of the patients, but also a better self-rating of the patient's health (Bühn, Holstiege & Pieper, 2020).

There are also several Dutch studies finding similar results. These studies have found that patients are willing to bypass the nearest hospital for a hospital with a better reputation, better quality or shorter waiting times and if it means bypassing a university hospital (Varkevisser & Van der Geest, 2007; Varkevisser, Van der Geest & Schut, 2010; Varkevisser, Van der Geest & Schut, 2012). In a study about hospital choice for hip replacements, travel time was found as the most important determinant, with hospital quality ratings and waiting times also having a significant impact (Beukers et al., 2014). They used insurance claims from 2008-2010.

This thesis focusses on the effect of quality on market share. Research has also been done on the reverse, the impact of competition on quality. The evidence on the influence of competition on the quality of care is mixed. Propper, Burgess & Green (2004) found that hospitals in areas in the UK with more competition had higher mortality rates, although the effect was small. In a market with fixed prices however, Cooper, Gibbons, Jones & McGuire (2011) found that hospitals in areas with more competition had lower mortality rates. Research from the Netherlands confirms that result. It has been found that hospitals in more competitive markets have better quality scores (Croes, Krabbe-Alkemade & Mikkers, 2018). Roos et al. (2020) also found no evidence of reduced quality after price deregulation in the Netherlands. Gaynor, Ho and Town (2015) conclude that the effect of competition depends on characteristics of the market and the observability of quality.

Quality measures are used to monitor performance and objectively assess healthcare quality. These quality indicators can be categorised in multiple ways. One method of categorising is on structure, process and outcome (Mainz, 2003). Structure indicators include the environment in which the care is given, for example: the type of hospital, the organisational structure, the type of and access to equipment, but also the number of patients. Process indicators focus on the care that is given, e.g., the type of medication, time until treatment and treatment according to guidelines. Outcome indicators describe the result of the given care, this can be results during treatment and end results. Examples are: mortality, difference in quality of life and patient satisfaction. In order for structure and process indicators to be valid, a link between these indicators and an increased likelihood of good outcomes needs to be shown (Mainz, 2003). This thesis primarily uses outcome indicators as a measure of quality, the indicators will be further explained in the methods section. These same outcome measures can be used in value-based reimbursement schemes between insurers and providers (Van Veghel et al, 2018; Vlaanderen et al, 2019).

Research methods

Data

The data used in this thesis are publicly available and obtained from *Zorginstituut Nederland*. They collect yearly quality data from all providers for a list of 42 conditions. Therefore, the data set is a panel dataset. The data set used in this thesis contains quality data on four conditions and 95 providers (hospitals and independent treatment centres). The number of providers is not equal for every condition, additionally the number of years over which data has been collected is not the same for every condition. For hip replacements, knee replacements and abdominal aortic aneurysm (AAA) data will be analysed for the years 2016 through 2019, for carotid interventions the data is available from 2017 onward.

The conditions selected are largely based on the availability of quality data. This varies greatly between all the conditions in the *Zorginstituut* data. The selected conditions have a sufficient number of quality indicators and of treated patients. They also have the additional benefit of being non-emergency treatments, ensuring that patients had a choice of provider. Hip and knee replacements are, in the context of this data set, a total replacement of the joint. A carotid intervention is the treatment of a clogged artery in the neck (the carotid artery), this is often done to treat or prevent a stroke (Mayo Clinic, 2020). This treatment can be by opening the artery and removing the blockage or by placing a small tube in the artery, only the former is included in this data set. An abdominal aortic aneurysm (AAA) is the widening of the artery in the abdomen, large AAA's are treated by placing a small tube in the artery (NHS, 2020). This can either be an emergency procedure in case of a ruptured AAA or an elective surgery, only the latter is included in this data set.

In 2019 over 30.000 hip replacements were performed, over 25.000 knee replacements, 2.500 carotid interventions and almost 2.500 interventions for abdominal aortic aneurysms. All conditions can be treated in academic, tertiary and general hospitals. Hip and knee replacements can also be treated in smaller, specialized clinics. The conditions may therefore be considered common treatments in the Netherlands.

Table 1 shows an overview of the number of patients and providers per procedure per year. For carotid intervention there was no data available for the year 2016. Because the hip and knee replacements can also be performed in independent treatment centres they have a greater number of providers compared to carotid interventions and AAA. Additionally, carotid interventions and AAA are part of a volume demand policy, a hospital is only allowed to perform these procedures if the minimum number of treatments is met. The minimum for carotid interventions and AAA is 20 (De Haas, Heida & Stoop, 2020). The visible decline in the number of providers is due to the closing of some hospitals (e.g. *MC Slotervaart* and *Havenziekenhuis*) and the merger of some hospitals, causing multiple entries for earlier years and only one for later years (e.g. *Franciscus Gasthuis en Vlietland*). There are also providers who failed to hand in their data for a certain year causing gaps in the data set (e.g. *ZGT* and *VU medisch centrum*).

Table 1
Number of patients and providers per procedure

Quality indicators	Year			
	2016	2017	2018	2019
Knee replacements				
- Patients	24.678	24.753	25.618	26.186
- Providers	95	97	93	90
Hip replacements				
- Patients	29.476	30.034	31.751	33.049
- Providers	92	95	91	89
Carotid intervention				
- Patients	-	2.340	2.494	2.446
- Providers	-	53	53	53
AAA				
- Patients	2.727	2.491	2.564	2.461
- Providers	57	58	56	56

Note. Data is derived from the published pivot tables: Open data Ziekenhuizen en zelfstandige behandelcentra/Medisch specialistische zorg. The data for carotid interventions in 2016 was not included in the publications.

Table 2 shows the quality indicators that are used per procedure. The quality indicators can be categorised as outcome measures, with the exception of waiting time. Waiting time is a process measure. The indicators are designed by a committee of professionals from the relevant field.

Table 2
Quality indicators per procedure

Procedure	Quality indicator	Explanation
Hip and knee replacements	Percentage revisions	The percentage of replacements that a revision in one year
	Percentage of deep post-operation wound infection	The percentage of total patients that have had a deep wound infection 90 days after the surgery
	Score difference PROM	The difference in score pre and post-surgery (three months for hip replacements and six months for knee replacements) in Patient Related Outcome Measures, measured with EQ-5D.
Carotid interventions	Mortality rate	Percentage of patients that died within 30 days of the carotid intervention. Calculated over 3 years and corrected for case-mix
	Complication rate	Percentage of patients with complications within 30 days of the carotid intervention, split in secondary bleedings, injury of the brain nerve and neurological event.

		Calculated over 3 years and corrected for case-mix.
	Waiting time	Percentage of patients who had a waiting time shorter than two weeks after first consult until intervention
Abdominal aortic aneurysm	Mortality rate	Percentage of patients that died within 30 days of the intervention. Calculated over 3 years and corrected for case-mix.
	Complication rate	Percentage of patients that had complications within 30 days of the intervention. Calculated over 3 years and corrected for case-mix.

Note. The explanation for the quality indicators is derived from the indicator sets published along with the pivot tables: Open data Ziekenhuizen en zelfstandige behandelcentra/Medisch specialistische zorg

The Patient Related Outcome Measure (PROM) is measured with the EQ-5D. This is a measure to estimate the health related quality of life, it is a standardised, generic measure applicable to a variety of interventions and populations (EuroQol, 2020). The quality of life score is calculated by converting answers to a short questionnaire to a score. The questionnaire has five dimensions: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. The responses to the dimensions represent the person's health state, with 11111 representing the best possible state and 55555 the worst health state. The health state can than be converted in a utility score, generally from 0 (death) to 1 (perfect health) (EuroQol, 2020).

Methods

As stated before, this thesis uses a similar method to the 2016 Chandra et al. article. In their article they tried to find out if the quality of hospitals influences their size in one point in time and across time, this is called static and dynamic allocation. In the paragraphs below, both of these methods will be explained. The four aforementioned procedures will be analysed. The regressions and panel data analysis are performed in the program STATA.

Static allocation

To find whether there is a correlation between the quality of hospitals and their size (in terms of patients treated) a multiple linear regression will be used. This is termed, similar to Chandra et al. (2016), static allocation, the correlation between hospital quality and hospital size in a point in time, the year 2019. The dependent variable is hospital size and the independent variables are the aforementioned quality indicators.

Following Chandra et al. (2016) the regression equations will be:

$$Yh = \beta_0 + \beta_1 qh + \alpha_M + \varepsilon_h \tag{1}$$

Yh the size of hospital *h*, *qh* is a measure of quality in hospital *h* and α_M are market fixed effects.

A multiple linear regression is used, because this method allows for multiple independent variables that affect the dependent variable. Table 2 shows the independent variables that will be used in the multiple regression. The dependent variable is the size of the hospital in terms of number of patients treated for the condition. A separate multiple linear regression will be done for the chosen procedures to examine if there is a correlation between size of the hospital and the quality indicators.

A positive correlation would mean that a provider of higher quality (according to the quality indicators) also treats more patients. A negative correlation or no correlation would mean that a higher quality hospital does not treat more patients or treat fewer patients than a hospital with lower quality scores. That would be an indication of the presence of forces other than quality competition that drive the allocation of patients (Chandra et al., 2016).

A variable for market fixed effect will be added to the regression. This is done because patients will not be likely to travel too far to a hospital, the distance they are willing to travel is finite (Shalowitz, 2018). Hospitals that are close to each other can be seen as competitors, they try to attract patients from a similar geographical market. When making this division existing regions were used. Hospitals in the Netherlands are appointed to an Education and Training Region (*Onderwijs- en Opleidingsregio's* (OOR)). These eight regions form a network of providers and a university hospital working together on training new healthcare professionals. Because they are working together it can be assumed that their locations are close to each other. These regions were used as market fixed effects, because they are in the same geographical area, and therefore competitors. One change was made while using these existing regions, the two regions for Amsterdam were combined, because the cover a very similar area.

Dynamic allocation

To find whether better quality hospitals grow more over time or if hospitals of lesser quality grow less or shrink a panel data analysis will be performed. This is the termed dynamic allocation, the correlation between quality and size over time. To analyse this there needs to be sufficient data on the number of procedures performed and at least one quality measure in a number of consecutive years. For hip replacements, knee replacements and AAA this is the case for 2019, 2018, 2017 and 2016. Insufficient data was available for carotid intervention for the year 2016. Because the data spans multiple years per provider it is possible to create a panel data set. This can be exploited empirically by estimating the following equation:

$$\Delta Y_h = \beta_0 + \beta_1 qh + \alpha_M + \varepsilon_h \tag{2}$$

The variables are the same as before, with the outcome measure now being the change in size of hospital *h*, to estimate the change over time.

A fixed effects model will be used. Fixed effects are characteristics of individuals, or in this case providers, that do not change over time. Examples are gender, location and ethnicity. Characteristics like these are assumed to stay the same over time, but can vary between individuals. These variables are treated as constants, but not every constant that could affect the outcome can be included, because there are simply too many or because it is unmeasurable. An omitted variable bias can be created by these unincluded constants. A fixed effects model tries to account for this. Because a fixed effect model is used, it is not necessary to divide the providers into markets. Providers stay in the same market over the course of the researched period, making the variable for market a fixed effect.

Regression (2) will be done for all four procedures. A positive correlation between growth and the quality indicators indicates that better quality hospitals grow more over time in terms of the number of patients for the procedure. A negative correlation or no correlation would mean that this is not the case or even that lower quality hospitals grow more over time.

Descriptive statistics

Table 3 shows some descriptive statistics to give an overview of the data. Visible are the means and range for the quality indicators for each procedure, they are split in only the year 2019 (static allocation) and the years 2016 through 2019 (dynamic allocation).

Table 3

Descriptive statistics of the quality indicators

Procedures	2019		2016-2019	
	Mean	Range	Mean	Range
Knee replacements				
% revisions	0.35	0-2.49	1.14	0-19.22
% infections	0.60	0-4.29	0.56	0-4.29
Score difference PROM	0.20	-.1-.45	0.20[a]	-.1-.45[a]
Hip replacements				
% revisions	1.62	0-4.04	1.76	0-8.28
% infections	0.89	0-5.88	0.97	0-8.57
Score difference PROM	0.25	.08-.49	0.25	-.31-.56
Carotid interventions				
%mortality	0.99	0-3.8	1.04	0-5.2
%complication				
Bleed	3.63	0.8-11.7	3.8	0-13.1
Brain injury	1.74	0-6.45	2.13	0-7.6
Neurological event	3.12	0-8.06	3.36	0-8.06
%waiting time <2 weeks	85.85	62.5-100	84.76	50-100
Abdominal aortic aneurysm				
%mortality	1.75	0-12.3	1.7	0-12.3
%complication	18.49	2.5-40.1	19.48	2.3-49.7
%reintervention	4.04	0-10.6	4.05	0-11.2
%readmission	5.66	0-13.2	5.9	0-16.39

Note.
[a] The difference in PROM score for knee replacements is only available for 2017-2019

Table 3 shows that complications after an AAA are quite common, especially compared to the hip and knee replacements. Apparently, an AAA surgery is riskier than the other procedures. Another observation in the distribution of mortality rate for AAA procedures is that the number of hospitals with a mortality rate of zero dropped every year, but 2019 does have the second highest average rate of the four years, after 2016.

All inputs of zero for any of the quality indicators were checked on whether it was an error in input or if it was a plausible result. If it was deemed a possible error if, for example, there was a complication rate of zero with the number of patients also zero, the observation was set to missing. This was most prevalent in the PROMs. In additions to the score difference, providers also had to report the number of patients that filled in the PROM before and after the procedure. This way multiple data errors could be detected in the PROM indicator, a score of zero was set to missing if there were also zero patients who filled out the PROMs.

Furthermore, there were four providers for knee replacements that reported a negative score difference in the PROMs. This means that on average the self-reported health related quality of life as measured by the EQ-5D was worse six months after the knee replacement than before. There were no obvious similarities between these four providers found that could explain these scores.

Another observation for the descriptive statistics for the hip and knee replacements, it was quite common for the infection rate after knee replacements to be zero when the revision rate was also zero. This was also to be expected since infection is the most common reason for a revision (Postler, Lützner, Beyer, Tille & Lützner, 2018)

Results

Static allocation

Table 4 presents the results of the static allocation analyses, the estimates are the result of regression (1). They show the effect of an increase of one unit in the quality indicator on the number of treated patients for the year 2019. For example, a rise of one percentage point in the mortality rate for AAA would result in a decrease of treated patients of 0.66. Following the article by Chandra et al. (2016), the regression was done separately for each indicator, to show the individual effect. Because a variable was added for market, this is the result of a hospital within its market.

Table 4

Results of the static allocation

Knee replacements			Hip replacements		
Revisions	Infection	PROM	Revisions	Infection	PROM
22.41	-35.44	300.96	11.93	-36.15	15.68
(.537)	(.100)	(.362)	(.601)	(.175)	(.978)

Carotid interventions				
Mortality	Bleed	Brain injury	Neurological event	Waiting time
-0.81	-1.88	-0.54	1.15	0.03
(.789)	(.189)	(.791)	(.431)	(.937)

Abdominal aortic aneurysm			
Mortality	Complication	Reintervention	Readmission
-0.66	-0.34	0.30	0.56
(.647)	(.926)	(.763)	(.573)

Note. p-values are added in parentheses

* means that the coefficient is significant at a 5% level

When investigating table 4 it becomes clear that none of the indicators have a statistically significant effect on the number of patients treated. This means that when the value of the quality indicator changes, the number of patients that the provider treats does not change significantly accordingly. In addition, some of the indicators show a counterintuitive effect on the number of patients. For example, according to table 4, a one percentage point rise in revisions after a knee replacement would result in 22 more patients. The average number of patients per provider in 2019 was 291, 22 more patients would mean a 7.7% increase. The opposite would be more in line with expectations, less patients for providers with worse quality scores.

Following Chandra et al. (2016) regression (1) was also done with all quality indicators in one analysis for each of the conditions. This did not result in many noteworthy outcomes, there was one indicator that had a significant result at a 10% level. This was infection rate of knee replacements (β= -37.88, p=.078). None of the indicators for the other conditions showed a significant result.

For hip and knee replacements data were available on the PROM prescores, the average score of the treated patients on the EQ-5D before the procedure was done. This is can be an indicator of the patients mix of the provider. If the prescore is relatively low, this can mean that these patients suffer from comorbidities or are in generally poorer health. This could have an effect on the quality indicators.

The regression was done again with the PROM baseline added in the regression. The results are shown in table 5.

Table 5

Static allocation results with PROM base line added in the regression

Knee replacements			Hip replacements		
Revisions	Infections	PROM	Revisions	Infections	PROM
19.03 (.620)	-37.63 (.066)	35.96 (.903)	19.38 (.382)	-15.92 (.639)	258.91 (.653)

Note. p-values are added in parentheses

* means that the coefficient is significant at a 5% level

None of the indicators were significant at a 5% level after adding the prescore in the regression. The infection rate of knee replacements is significant at a 10% level. This means that for every percentage point rise in infection rate the number of patients drops with 37, which would mean a reduction of 12.9%.

Dynamic allocation

Table 6 presents the results of the dynamic allocation. The coefficients are the result of regression (2). Again, the regression was done for each quality indicators separately.

Table 6

Results of the dynamic allocation

Knee replacements			Hip replacements		
Revisions	Infection	PROM	Revisions	Infection	PROM
-5.49 (.010*)	-4.85 (.343)	-21.10 (.765)	0.38 (.928)	-4.79 (.327)	194.99 (.007*)

Carotid interventions				
Mortality	Bleed	Brain injury	Neurological event	Waiting time
-0.84 (.562)	0.55 (.421)	1.21 (.069)	1.96 (.012*)	-0.08 (.478)

Abdominal aortic aneurysm			
Mortality	Complication	Reintervention	Readmission
-0.34 (.525)	0.004 (.981)	-0.06 (.885)	-0.05 (.867)

Note. p-values are added in parentheses

* means that the coefficient is significant at a 5% level

As visible in table 6, three of the results are significant at a 5% level. The result for percentage receiving a revision within a year of the knee replacement means that every percentage point rise in revisions results in five fewer patients. The same is true for the PROM's for hip replacements, 1 point higher in the EQ-5D score after the replacement results in 195 more patients, which is equal to a 52.5% increase in patients. This number is very high, this is because a 1 point rise in EQ-5D score is practically not achievable. EQ-5D scores are generally between 0 and 1, with 0 being dead and 1 being perfect health (Devlin, Parkin & Janssen, 2020). Value below 0 is possible for health states worse than death. A rise from 0 to 1 is unlikely to happen after a hip replacement. As was also the case with the static allocation, some of the results are not logical. For example, the result for neurological event after a carotid intervention. It means that a one percentage point rise in neurological events after a carotid intervention results in two more patients. It would be expected that a higher complication rate would result in fewer patients, not more. This result means that hospitals with a higher complication rate attract more patients, if there was sufficient quality competition, a higher complication rate would result in a decreasing number of patients.

As with the static allocation, the dynamic allocation was also done with the PROM prescore added in the analysis. Because the PROM scores were not available for the year 2016 for knee replacements, the panel data analysis on knee replacements could only be done for 2017-2019. The analysis for hip replacements is for 2016-2019. The results are visible in table 7.

Table 7

Results of the dynamic allocation with PROM baseline added in the regression

Knee replacements			Hip replacements		
Revisions	Infections	PROM	Revisions	Infections	PROM
-4.65	-6.39	-19.74	1.42	-14.90	212.99
(.123)	(.251)	(.777)	(.773)	(.020*)	(.006*)

Note. p-values are added in parentheses

* means that the coefficient is significant at a 5% level

A few differences between table 6 and 7 are visible. The revision rate for knee replacements is no longer significant. After doing the analysis for revision rate again without the baseline score and without the year 2016, it was also not significant. Meaning the difference between with and without the prescore is also because 2016 was not added. The infection rate for hip replacement is significant with the PROM baseline added in the regression. This means that for every percentage point rise in infection rate the number of patients decreases with almost 15, or 4%. Interestingly, the baseline score itself was significant for the knee replacements (β= 267.85, p=.002). Meaning that a higher baseline score means more patients. Apparently, attracting a healthier patient-mix coincides with attracting more patients.

Discussion

The results of this thesis suggest that for most analysed procedures more patients do not tend to be allocated to higher quality hospitals. For the static allocation no significant results were found, meaning the hospitals with better quality scores did not treat more patients. For the dynamic allocation three statistically significant results were found, one of them was not a logical result. A higher complication rate after a carotid intervention would logically result in less patients, the opposite was found. This could be because of the higher age of carotid intervention patients, they are most commonly over 65, with an average age of 75.8 years (Voeks et al., 2011; Lichtman et al., 2017). Another explanation could be that risk factors for the need of a carotid intervention, like smoking and high cholesterol, are more prevalent among people with a lower socio-economic status (Mayo Clinic, 2018; Springvloed, Kuipers & Van Laar, 2017; Jenkins & Ofstedal, (2015). Patients who undergo a carotid intervention may not have the capacity to choose their provider based on quality indicators. These are speculations and would need to be further investigated.

The found results are not in line with previous research. Chandra et al. (2016) found that three of their chosen quality indicators had a significant effect on the market shares of American hospitals. They found that readmission rate, survival rate and process of care (whether appropriate care was given) had a significant effect and patient satisfaction did not. They found these results with both the static allocation and the dynamic allocation. Meaning American hospitals with better clinical outcomes and better process of care tend to have a greater market share and grow more over time. The results found in this thesis are not consistent with the conclusions of Chandra et al. (2016). Only one of the results of the dynamic allocation for knee replacements was in line, revision rate was found to have a significant effect. Varkevisser et al. (2012) did similar research on a cardiology procedure in the Netherlands. They found that hospitals with a low readmission rate and a good reputation attract more patients. Although readmission rate was also added in the regression in this thesis for hip and knee replacements, the found result was not the same. Overall the results found in this thesis are not consistent with previous studies, this could be because of the limitations of this study.

Strengths and limitations

A reason why so few of the results are significant could be because the relatively low number of observations. Especially the static allocation analysis has a low number of observations with just over 50 providers included for carotid interventions and AAA. This is mainly because carotid interventions and AAA are part of the minimum volume policy. A higher number is recommended for the used number of independent variables (Knofczynski & Mundfrom, 2008). A small sample size can cause low statistical power, which can decrease the change of finding an effect and also decreases the change of finding a significant result that reflects the true effect (Button et al., 2013). The reason why only a few significant results were found could also be caused by unidentifiable factors.

A fixed effect model attempts to controls for time-invariant characteristics, assuming that they have the same effect over time. A limitation of fixed effect panel analysis is that there could be unmeasured effects that do change over time (Treiman, 2009, p. 370). A fixed-effect estimation also requires sufficient variability in the predictor variables to be reliable (Treiman, 2009, p. 370). In this case there needs to be enough variability in the quality measures to predict the hospital sizes. As shown in table 3 of the descriptive statistics, this is not the case for all quality indicators. Especially the range for the score difference in PROM is small, this is due to the nature if the indicator. Large score differences are not possible, because the PROM score with EQ-5D is mostly between 0 and 1.

All quality variables for hip and knee replacements are considered valid by the committee collecting the data. The registrations for carotid interventions and abdominal aortic aneurysm have passed the phase of creating reliable and valid data (DICA, 2019). Nevertheless, measuring the performance of hospitals is notoriously difficult. Some of the quality indicators of knee and hip replacements are not case-mix corrected, they could therefore give a wrong indication of quality for a hospital. That is why the analyses were also done with the PROM pre-score added in the regression. It is unlikely that this corrected all differences in case-mix. The found results could therefore also be the result of differences in case-mix. Providers who attract healthier or 'easier' patients are more likely to perform better on the quality indicators. The complication and mortality rate for carotid interventions and AAA are case-mix corrected, but the counterintuitive result of the dynamic allocation for carotid interventions may suggest that the case-mix correction is imperfect. All quality indicators of all procedures in this data set are chosen by committees formed by the relevant professions. Meaning the indicators are deemed good enough and relevant for the professionals.

Although the quality indicators were made by a committee of relevant professionals, the question remains if these quality indicators are a good measure of actual quality of care. It is better to use indicators that take the individual patients in to account than to use more crude measures are revision rate of mortality (Gutacker, Siciliani, Moscelli & Gravelle, 2016). Gutacker et al. (2016) found that patients are more responsive to measures like PROM-score increase post procedure than to measures like complication rate. In this thesis only two of the used indicators take the individual patient into account.

Adding the market fixed effects to the regression could have been done in multiple different ways. For this thesis an already existing division was chosen: the Education and Training Regions (OOR). Another option would have been to divide the providers based on provinces or equal population. Both of these options would also have drawbacks. Based on provinces the regions would have had less providers per market, as there are more provinces than training regions. Based on population, the division would not take location enough in to account. Using the Education and Training Regions resulted in some hospitals that were closer to the providers in another regions than they were to providers in their own region. One example is *Gelre Ziekenhuizen* (Apeldoorn). It is a shorter route to go to the nearest hospital (by car) in the East region and the North-East region than it is to go to the nearest hospital in the region to which the *Gelre Ziekenhuizen* belongs (Utrecht). It is 23 kilometres to *Rijnstate* (Arnhem) and 25km to *Deventer Ziekenhuis* (Deventer). This results in the fact that *Gelre Ziekenhuizen* is more likely to compete for patients with hospitals from other regions than with hospitals from its own region. Other examples like this exist. It can be concluded that the Education and Training Regions may not give a representative reflection of a hospital's competitors.

Another limitation of this study is the relatively short time-period that was investigated, only four or in some cases three years were included in the analyses. This may not be a problem, but it could have affected the results. Changes in the quality of hospitals may not have a direct effect on the outcome of the quality indicators. This is especially plausible for the quality indicators of AAA and carotid interventions. Those quality indicators are an average of three years, because they are case-mix corrected. A significant change in the quality of a hospital may only be visible in the quality indicator after two or three years.

Strengths of this thesis are that multiple procedures were included and all providers of the selected procedures. The data is therefore a representative reflection of the Dutch secondary health care market. The selected procedures are all non-emergency procedures, the patients had time to make a rational choice of provider. The use of PROM's is also a strength of this study. The results of this thesis could also be relevant for other procedures, but those procedures must also be elective or non-emergency procedures, examples could be other orthopaedic procedures or non-emergency oncology procedures.

Further research

In further research, the same research strategy could be used to investigate the relation between quality indicators and the number of treated patients for other procedures or in other countries. The health care systems of other countries may have an effect on the results. It is advisable to take the limitations of this research into account, namely the short time span and the market fixed effects. Further research could also add data on the distance from the patient's home to the hospital into account. This could add information on whether patients choose the nearest hospital or if they are bypassing the nearest hospital for better quality.

For policy makers further research is also needed on how to make patients go to hospitals of better quality. The results of this thesis showed that hospitals do not attract more patients when they score better on quality indicators. Additional research is needed to find an effective strategy to make patients more sensitive to quality differences. A reason why they are not sensitive (enough) now could be that they simply go to the nearest hospital, the hospital where they are already known or that they follow the recommendation of their GP. A Dutch survey done in 2019 with 8000 respondents showed that 76% of patients choose at which hospital they wanted to be treated (Patiëntenfederatie Nederland, 2019). The survey also showed that 33% wanted advice and data on which hospital to choose to come from their GP. It could also be that patients are unable to make a decision based on the quality data, because they are not able to find the data or they may not understand what they find. The aforementioned survey also showed that quality was not in the top-5 of most important information for making a decision (Patiëntenfederatie Nederland, 2019). Both instances can be investigated in further research. The research could focus on how GP's refer patients to secondary care or on the side of the patient, how exactly patients make a choice of hospital.

Conclusion

In this thesis the question: *Are Dutch hospitals with better quality for hip replacements, knee replacements, abdominal aortic aneurysm and carotid interventions larger and do they grow more over time?* was tried to be answered. This was done for 2019 and for the years 2016-2019. In the static allocation no significant results were found. This means that better quality hospitals did not treat more patients in 2019 compared to lower quality hospitals. In the dynamic allocation a few significant results were found. Meaning that, for those quality indicators, better quality hospitals did grow more over time or hospitals of lesser quality treated less patients, but this was only the case for revision rate of knee replacements and the PROM-score difference of hip replacements. Overall can be concluded that quality of the hospital does not influence the size of the hospital significantly. This means that patients do not choose their health care provider based on its quality. This is a valuable find for policy makers, because the Dutch health care system supports and assumes competition on quality. This finding shows that competition on quality may not yet be where it is supposed to be.

The results of this thesis are not in line with results of previous studies on the same topic. In other studies it was concluded that higher quality providers treat more patients compared to lower quality providers. Follow-up research in needed to find the reasons behind the found results and if policy makers can make changes to improve the quality competition.

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