MSc. Thesis

Hospital change programs and their effect on hospital expenditures

Health Economics Policy and Law

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Word count – 12.978

Abstract

Dijklander Ziekenhuis and Noordwest Ziekenhuisgroep agreed upon a multi-year contract with Dutch insurer VGZ in 2017 and subsequently started organization-wide change programs to enhance their hospital-efficiency. This study hypothesized that these multi-year contracts and change programs would have a negative effect on the hospitals' expenditures and a positive effect on primary care expenditures due to substitution of care in the hospital referral region. By means of a difference-in-difference analysis, the costs in the period before intervention (2011-2016) and period after intervention (2017-2018) were analysed. The study found no significant difference in costs between the treatment and control hospitals in the pre- and post-period. This indicated that the multi-year contracts and change programs did not lead to lower medical care expenditures and higher primary care expenditures for Dijklander and Noordwest. Using the implications gathered from the theoretical review, this study concludes that the effect of multi-year contracts and change programs should also be measured via a change in other factors, such as quality, treatment volumes, internal costs, organizational willingness to change and the adjustment period. These factors can possibly be studied in future research on the effects of multi-year contracts and change efforts in hospitals.

- Rotterdam, 5th of July 2021 -

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Chapter 1. Introduction

Health care is the second largest sector in the Dutch economy comprising of many different divisions. Specifically looking at the division medical specialist care, 27% of the total Dutch healthcare expenses are allocated to this compartment, amounted to 4,4 billion euros in 2019 [1]. Expectations are that these costs will increase even further in the upcoming years. Hospital expenditures increase due to a variety of reasons such as ageing populations, rise of chronic diseases, new technologies and expanding insurance coverage. We want the population to have access to specialist care, but how do we, as a society, pay for the spending growth while ensuring value for money?

Value for money can be ensured by realizing hospital savings while maintaining or enhancing outcomes and quality. In the Dutch regulated competition system, such a transformation requires commitment and coordination from both the insurer and the provider [2]. Providers can change their work practices, while insurers are able to influence pricing- and investment decisions of these providers. For instance, by offering information and concluding contracts that stimulate value. Enhancing vertical relationships between the insurer and provider can thereby increase provider' efficiency.

Since 2006, multi-year contracts have been one of the innovations that insurers use to influence providers' efficiency [3]. Multi-year contracts give a hospital financial security, provide room for embracing efficient practices and enhance the vertical relationship between provider and insurer. Even though multi-year contracts have large potential, the Dutch Health Authority (hereafter: NZa) has recently shown that only a small percentage of the Dutch hospital contracts contains multi-year agreements to organize care more efficiently [4]. Most contracts are one-year contracts with a focus on turnover ceilings. In these contracts, providers are not incentivized to change something on the long term as their contracts and budgets are only based on the former year. Reason for the relatively low number of long-term arrangements can according to the NZa be assigned to the lack of mutual trust among insurers and hospitals or disagreement on the long-term vision of the provider [3,4].

There is evidence from the U.S. that having a larger focus on organizing care differently in combination with multiple-year contracts, can result in lower health care expenditures, without skimping on the quality [5]. This can only be accomplished when hospitals embrace a change program and put in efforts themselves as well. A change program is a hospital-wide implementation of various initiatives that aim to enhance the hospitals' efficiency [6]. Examples of these initiatives can be to change referral patterns, stimulate lower utilization of supplies and decreasing the number of treatments. The initiatives are focused on either decreasing costs while maintaining quality and outcomes or improving quality while maintaining the same budget [6]. A research

performed by the Centraal Planbureau evaluated the effect of change programs after two Dutch hospitals received a multi-year contract. The study showed that Bernhoven hospital and the Beatrix hospital decreased their volume by implementing change programs and having a multi-year contract with several insurers [7]. No effect in their expenditures was however identified. Both hospitals implemented an organization-wide program called 'Droom' at Bernhoven and 'Kwaliteit als Medicijn' at Beatrix hospital. The programs ensured that the employees in the organization worked towards the common goal of achieving higher quality and lower costs. Furthermore, the programs served as a hospital-wide mission and vision. Bernhoven as an example, implemented 100 initiatives that could improve their care, such as shared decision-making initiatives, improving collaboration with primary care physicians and cultural/organizational transformations [7/8].

This research studies the hypothesis that multi-year contracts in combination with change programs assure lower medical specialist care-expenditures for two Dutch hospitals: Dijklander Ziekenhuis in Hoorn/Purmerend and Noordwest Ziekenhuisgroep in Alkmaar/Den Helder. Subsequently, it is evaluated whether multi-year contracts and change programs also led to higher primary care-expenditures in Dijklander's and Noordwest's hospital's referral regions, as a result of substitution of hospital care to primary care. This second hypothesis is made because substitution of care is a commonly used technique to decrease volume and thereby reduces expenditures. Both Dijklander and Noordwest hospitals agreed upon a multi-year contract with insurer VGZ in 2017 and have implemented change initiatives ever since. This research compares Dijklander and Noordwest to a group of control hospitals that did not have a contract with VGZ.

The societal and scientific relevance of this study is that it allows us to discover whether change programs stimulated by a multi-year contract, result in lower expenditures, in contradiction to the outcomes of Bernhoven and Beatrix hospital. This increases the scientific evidence on this subject. Furthermore, if change programs do work and incentivization via a multi-year contract works, these contracts can be seen as a (partly) possible solution for the ever-growing health care expenditures that cause a heavy financial burden on our society.

1.1. Research objectives

The aim of this study is to evaluate whether the introduction of a multi-year contract and implementation of a change program positively or negatively impacts the hospital expenditures of Noordwest Ziekenhuisgroep and Dijklander Ziekenhuis. The Vektis data set that will be used for this study provides data for the years 2011-2018 and includes the medical expenses occurred in the Dutch health insurance law per postcode area in the Netherlands. Therefore, this research will not draw conclusions on other factors than expenditures, such as costs and treatment volumes. A negative change in expenses in comparison to a group of control hospitals, may indicate that medical expenses for Dijklander and Noordwest declined due to the multi-year contract and

implementation of initiatives. Besides medical expenses, primary expenses are studied. A positive change in primary care expenses in Dijklander and Noordwest's hospital referral regions can indicate that care was shifted from the hospital to the first line. The change in expenses is measured via a difference-in-difference analysis, a method that can assess the causal effect of interventions.

The hypotheses are formulated below:

- 'We hypothesize that multi-year contracts and change programs started in 2017 will lead to lower medical-specialist care expenditures for Noordwest and Dijklander hospitals in comparison to a group of control hospitals during the periods 2017-2018.'
- 'We hypothesize that primary care expenditures in the dominant service area of Noordwest and Dijklander hospitals in the years 2017-2018 increase, in comparison to the control hospitals, as a result of substitution from hospital to primary care.'

1.2. Reader's guide

This study is built up as follows. In chapter 2, the empirical evidence on the effect of multi-year contracts and hospital change efforts are discussed. In this chapter this study also takes a closer look into the change programs of Noordwest and Dijklander. In chapter 3, the choice for treatment and control hospitals is discussed, alongside an explanation of the available Vektis data. Chapter 4 elaborates upon the methodology which describes how a difference-in-difference analysis is used to estimate the effect of multi-year contracts and change programs on expenditures. In chapter 5, the results of this analysis can be found. Chapter 7 concludes this study with a discussion and some final words.

Chapter 2. Theoretical framework

The theoretical framework comprises of two parts. It firstly touches upon what has been written about the subject of this study in the literature. In this empirical part, advantages and disadvantages of multi-year contracts are discussed. Besides, success factors in change implementations, such as cultural and structural development of the organization, are featured. Lastly, the review shortly touches upon the effect of hospital mergers and their effects on hospital efficiency, as both treatment hospitals derived from a merger. In the second part of the framework more information is provided on the treatment hospitals and the agreements they made with Dutch insurer VGZ.

2.1. Empirical evidence

In the past years, a lot of attention has been given to efficiency enhancement practices in hospital operations. While hospitals are dealing with several operational challenges, such as small budgets for investments and finding good personnel, they must work more efficient to keep medical care affordable [9]. Unnecessary care, and thus production volumes, can for instance be reduced by focusing on quality and changing the hospitals' culture and business models [10]. Dutch insurers are increasingly becoming familiar with these effects and started collaborating with providers to decrease volume and expenditures while focusing on quality [2,11]. For instance, via multi-year contracts or by stimulating hospital change programs.

Multi-year contracting is a new contracting form that can enhance efficiency of hospitals [3,12]. In most cases, hospitals receive a global budget for the full contracting period, that is often between 2-5 years [4]. The global budget is a prospective payment for all hospital care in the pre-specified period. The budget includes specific regulations to achieve higher quality and accessibility of care that providers should adapt to. Because of the global budget, providers have stronger incentives to decrease their production by reducing waste and unnecessary care. Furthermore, the global budget does not incentivize providers anymore to produce higher volumes of care to receive more money, which is different from the old payment form 'fee-for-service' [13].

2.1.1. Pros and cons of multi-year contracts

Multi-year contracts have advantages and disadvantages. The advantages are as follows. By offering a multi-year contract with a global budget agreement, the provider has fewer production-based incentives than in a fee-for-service system. A provider receives more incentives to work as efficient as possible to have more money left at the end of the contract. Moreover, multi-year contracts lead to a better vertical relationship between provider and insurer and give providers time and security to earn large investments back [14]. Lastly, an advantage of multi-year contracts is the decrease of transaction costs. The contracts do not need to be revised every single year and are less complicated than 1-year contracts [15]. The Dutch Council for Public Health and Society wrote a letter to the

chamber in 2018 in which they stretched the importance of partnerships between providers and insurers via multi-year contracts. By shifting attention to innovation, prevention and mutual trust, administrative burden could decrease. The letter was supported by the minister of Medical Care [16].

Multi-year contracts also have disadvantages. A disadvantage of the multi-year contract is that its effects crucially depend on the efforts and participation of the hospital. Savings can only be realized when there is mutual trust between the insurer and the hospital. Besides, the healthcare field knows many uncertainties, making it difficult for providers to commit to a multi-year budget [3,12]. If providers commit, they might be incentivized to deliver an insufficient amount of care to save money or patients may be referred to other hospitals, to decrease production volumes and realize savings [17]. Lastly, it is difficult to estimate the global budget beforehand and providers may skimp on quality when not making clear agreements on this topic in the contract.

2.1.2. Empirical evidence on multi-year contracts

Empirical evidence for the working power of multi-year contracts can be found in multiple articles. The article about 'Alternative Quality Contracts' (ACQ) by Song et al. indicates that five-year contracts are contracts in which providers work with a global budget and receive pay-for-performance when realizing a set amount of quality indicators [5]. The researchers indicated savings of 2,8% when comparing the participating hospitals to the control hospitals. Gaspar et al. found for the Netherlands that global budgets have a decreasing impact on the volume of care in the Dutch health care system, but not necessarily on overall expenditures [17]. Furthermore, Cattel & Eijkenaar performed a systematic literature review about global payments. The research concluded that global payments, where providers are incentivized when improving their quality, are initiated in different ways but overall show promising results in terms of efficiency [18]. Quality- and value-based payments were introduced in the Netherlands by insurer Menzis in collaboration with hospital organization Santeon in 2016 and, according to research, reduced unnecessary hospital stays by 30% [19]. Still, these promising outcomes do not mean that every insurer in the Netherlands is using multi-year contracts with a global budget as their main contracting form. Up until 2018 there were 13 multi-year (3-5 year) contracts closed in the Netherlands. Six contracts included a global budget, and eight contracts included a turnover ceiling in which providers could spend a maximum amount of money based on their production. [4].

In the Netherlands, the four largest insurers negotiate about several subjects in their multi-year contracts. These subjects are summarized in *figure 1*. As expected, price and volume are what all four insurers make agreements on. We see that efficiency is also a large pillar. Around 20 agreements within the contracts were based on common goals, outcome, care profiles, networks and substitution of care. This data is based upon a total of 27 multi-year contracts with 60

agreements in 2018 [4]. According to the NZa, Dutch insurers should improve their efforts to make long term agreements based on quality and outcomes. National empirical evidence of the effectiveness of these contracts is however still lacking, especially since this trend is relatively new in the health care industry [4].

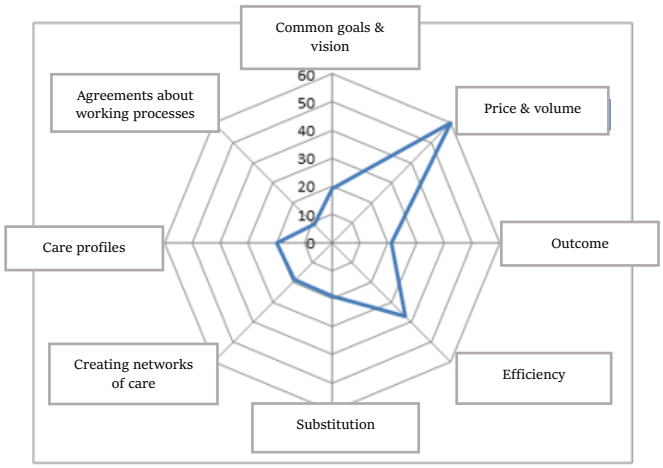


Figure 1 - Agreements in multi-year contracts on eight subjects [4]

2.1.3. Cultural changes in hospitals

Besides multi-year contracts, this study also researches the effect of an efficiency-enhancing change program. Therefore, it is important to denote important pillars that can positively affect the success of a change: organizational culture and structure. In a work culture with a good balance between loyalty, engagement, acceptance and individual initiative, change is more successfully implemented [20,21]. An efficiency-enhancement effort that aims to reduce waste in the ER room will, for example, not be implemented successfully without acceptance from employees working in this ER. Factors that are negatively influencing cultural change efforts are weak leadership and ownership or imposing change by external advisors [22].

Hospital culture does not only influence successful change implementation but can also have a positive effect on quality outcomes. Recently, more empirical evidence about the link between culture and quality has been published [23]. Braithwaite et al. found in their meta-analysis of 62 articles that positive organisational and workplace cultures were consistently associated with enhanced outcomes [24]. When looking at empirical findings in the Netherlands, van Dulmen et al. could not draw causal conclusions on the effect of change programs on quality in Bernhoven and Beatrix hospital [8]. They did, however, find that change programs did not negatively affect quality of the hospitals. Moreover, they stated that the volume-decreases were the indirect effect of a cultural change throughout the organization. People started to continuously ask themselves: ‘is this care necessary?’. Without going through that cultural change, the effects on expenditures in Bernhoven and Beatrix hospital would not have been as large.

2.1.4. Organizational structure

The hospital's organizational structure can also positively affect the success of an efficiency-enhancing change. Structural change had a positive impact on Bernhoven hospital when they started working in four different care models and medical specialists got a dual role in which they were still doctor but also became responsible for management activities [8]. Furthermore, medical specialists were no longer self-employed but started working in salaried service.

In recent decades, more hospitals have started shifting their organisation towards a more patient-centred set-up. By doing this, the process is built around the patient and his or her illness, rather than around the many independent departments [25]. Even though, changing towards a new structure takes much time, the results have shown higher efficiency outcomes. Besides efficiency improvements, a process-focused structure leads to less hierarchal differences, more independence and decision-making power for employees and integration of responsibilities [26]. Alongside structural changes, evidence is also available for the payment incentives that doctors receive. As discussed, physicians are more incentivized to supply more health care when they receive a payment per service. Therefore, it is wise to start looking beyond fee-for-service incentives to pay physicians in hospitals [13].

2.1.5. Hospital concentration

As both Noordwest and Dijklander derived from mergers, the effect of hospital concentration on efficiency is shortly covered in this last part of the review. In the report 'price and volume effects of hospital mergers' the Dutch competition authority (ACM) investigates the effects of mergers in the period 2007-2014. In their results they indicate that mergers led to a rise in prices of healthcare services but did not lead to a large volume change. The ACM's report did not conclude upon costs developments and long-term effects of the mergers in the Netherlands between the period 2007-2014 [27].

When looking at other empirical evidence, it is found that Harris, Ozgen and Ozean, who look at mergers in the USA in the early 1990s, do find a positive efficiency score effect but this result is not significant [28]. Kjekshus & Hagen who look at 17 merged hospitals in Norway find a significant negative effect on cost-efficiency and Tijani-Eniola finds mixed results for the effect of hospital mergers on efficiency as "there is no predictable effect that hospital mergers will definitely have" [29,30]. According to her article, the impact of a merger depends on the hospital-region, quality indicators and the market share of all parties. Moreover, the impact also depends on the intentions of the concentrating hospitals. Were they merging to save costs, or did they want to be able to offer a wider range of services or become more appealing to new patients? All in all, it can be concluded that the empirical evidence on hospital mergers does not give a definite answer of its effect on efficiency. Their effect majorly depends on several factors.

2.2. Change programs in Dijklander and Noordwest

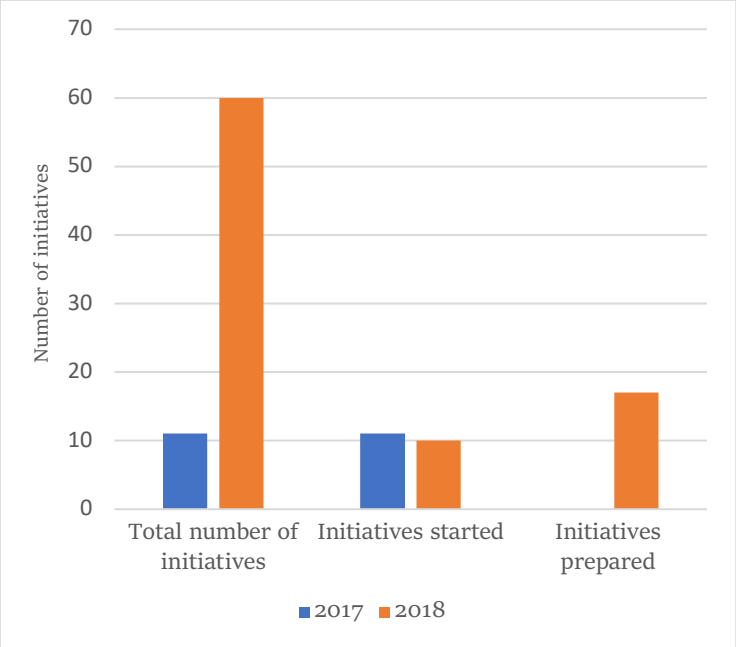
Both hospitals in the analysis, Dijklander and Noordwest, have a multi-year agreement with insurer VGZ. VGZ is the second largest insurer in the Netherlands with a market share of 24,3% in 2021 [31]. VGZ signed multi-year contracts with 9 hospitals in the Netherlands in 2016 with the goal to improve and innovate current healthcare practices [11]. Relationships between the insurer and affiliated providers strengthened as they started working towards a common goal. The providers received the opportunity to implement innovating practices and ideas for better care delivery and VGZ facilitated the efficiency-enhancement process with financial resources. VGZ will benefit as their insured population costs them less money due to more efficient work practices by the hospitals.

2.2.1. Dijklander Ziekenhuis

Dijklander offers care for the North-Holland market regions Waterland and West-Friesland and has around 3000 employees, 270 medical specialists and approximately 438 beds in 2019 [32]. Dijklander has two main locations in Hoorn and Purmerend. The hospitals merged in the year 2017, the same year in which their 5-year contract with VGZ started. The main goal of the merger was to be able to continuously offer high-quality medical specialist care in their operating region. The 5-year contract with VGZ is part of Zinnige Zorg, which is also part of Dijklander's organizational strategy. The aspects they focus most on to achieve sensible care are avoiding (more expensive) care, shifting care from secondary to primary care services and replacing care by E-health.

After consultation of the financial annual report, it is found that Dijklander's revenues from providing health services were €289 million in 2017 and €300 million euros in 2018. They closed the financial year 2017 with a result of 1.9 million euros and a negative result of - 1.6 million euros in 2018. Elsevier published a list of the 'Best Hospitals' in the Netherlands in 2018, Dijklander location Purmerend kept their score from 2017 (1/4 points) in 2018. In comparison to 2016, in which they scored 2/4 points, their score decreased. Hoorn's score decreased from 4/4 points in 2016 and 2017, to 3/4 points in 2018. The scores are based on the national mean score of hospitals and mainly focus on quality (covering safety and efficiency) and patient satisfaction [33]. In the AD hospital test, Dijklander Hoorn scores 71,60/100 points in 2018 (place 23/44). Dijklander Purmerend scores 83,58/ 100 in 2018 and ends at place 5/44. The AD test looks at measurable outcome variables, such as readmission rates and number of operations [34].

The annual report of 2017 was consulted to find if Dijklander stated news about their efforts with regards to 'Zinnige Zorg' [35]. They stated that their common goal, together with VGZ, was to realize 100 initiatives in 4 years that enhance efficiency. In 2017, 11 initiatives were introduced in the hospital, which can be seen in *figure 2*. In 2018, 60 new initiatives were started. It was not indicated in the report if the initiatives contributed in terms of quality or expenses of the hospital.



Initiatives 2017:

1. Avoiding unnecessary surgeries in the final stage of life, by discussing treatment wishes in the nursing homes.
2. Avoiding unnecessary admissions vulnerable elderly people by collaborating with long-term care organization 'Omring'.
3. Chemotherapies at home.
4. No admissions in Dijklander after angioplasty in university medical centres.
5. Deployment of pulmonary nurse to control asthma medications.
6. Using referral website 'Zorgdomein' to avoid double diagnostical research.
7. Deployment of a nurse practioner for children with incontinence, instead of medical specialists shortens waiting lists.
8. Pre-hydration treatment for cardiologic surgeries avoids admissions on the day before surgery.
9. New medication for ICU patients assures calmness and faster readmission.
10. Mamma-policlinic and punctions in the echo-room.
11. Decreasing the number of CT myocardial perfusions rest examinations by only performing them when patients get a specific indication.

Figure 2 - Overview number of 'Zinnige Zorg' initiatives Dijklander in 2017 and 2018 (left) and examples of the implemented initiatives in 2017 (right).

2.2.2. Noordwest Ziekenhuisgroep

Noordwest Ziekenhuisgroep operates in the northwest part of the Netherlands. Its two main locations Alkmaar and Den Helder merged in 2015, after already collaborating for 8 years. The merger was required to resolve the financial distress of the hospital in Den Helder. Noordwest hospital group delivers trauma care for the North North-Holland region and is one of the largest hospital organizations in the Netherlands, with approximately 4400 employees, 325 medical specialists and around 824 beds [36]. Starting in 2017, Noordwest signed a 3-year contract with insurer VGZ. In the same year, they also started their organization-wide program 'Noordwest vernieuwt' or 'renews' that aims to improve efficiency and patient/employee satisfaction. The market for both hospital locations is located around Den Helder and Alkmaar. Den Helder also serves as the hospital for the population of the island Texel. In total, Noordwest focuses on a population area of 600.000 inhabitants in their region.

Noordwest is part of a group of 26 top clinical hospitals in the Netherlands. These hospitals collaborate to deliver high quality hospital care and assure education for medical specialists, nurses, and care professionals. Moreover, top clinical hospitals contribute to scientific research and innovations, unlike regular hospitals [36].

The financial annual report of Noordwest was also consulted. Revenues from providing health services were €441 million in 2017 and €460 million euros in 2018. The hospital closed the financial year in 2017 with a positive result of €14.936 euros and closed 2018 with a positive result of €11.766 euros [37]. In 2017, Noordwest Den Helder received the number 1 position in the 'Best Hospital'

test by Elsevier, location Alkmaar scored 4/4 points so also received above average results in the ranking that is primarily based on patient centredness and quality indicators [36].

Noordwest Ziekenhuisgroep states in their annual report of 2017 that the first initiatives as part of 'Zinnige Zorg' were started in 2017 [38,39]. They mention that they are aiming to initiate more practices in the upcoming years that are enhancing efficiency and quality. In the annual report of 2018, some examples of projects that were started were found (*figure 3)*. There is however not much information available on their website with regards to the initiatives started in the years following, nor the effects of the started initiatives.

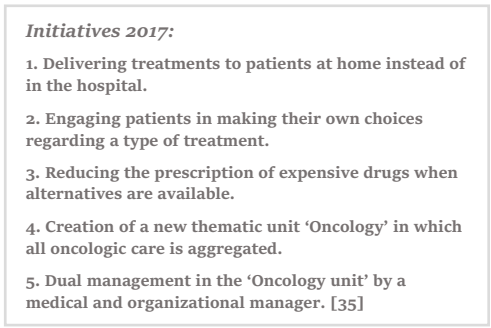


Figure 3 - Initiatives 'Zinnige Zorg' Noordwest 2017

Chapter 3. Data

The data chapter describes how available data was constructed to fit the purpose of answering the research questions. The primary data source used in this study was a dataset from Vektis. Vektis publishes aggregated data from all expenses reimbursed by insurers in the Dutch health insurance law per year. The expenses are broken down per 3-digit postal code, age, gender and cost group. At first, it had to be established what hospitals were included in the analysis. Afterwards, the 3-digit postal codes that belong to these treatment and control hospitals had to be identified. For that reason, we followed several steps, that can be found in *figure 4*. These steps eventually led to the execution of a difference-in-difference analysis, studying the effects in medical specialist care- and primary care expenses.

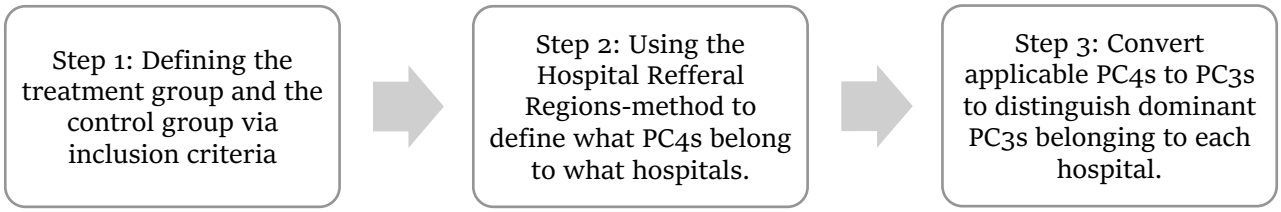


Figure 4 - Three-step data preparation model

3.1. Selection of hospitals

3.1.1. Treatment hospitals

Dijklander Ziekenhuis and Noordwest Ziekenhuisgroep have been chosen as the treatment hospitals. The reasons for choosing these hospitals are outlined below:

1. The hospitals have concluded a multi-year contract ≥3 years with a large insurer. It was decided to look at multi-year contracts of 3 years or more, as there is less freedom for hospitals to transform their activities and practices in a 2-year contract.
2. The hospitals have implemented organizational and cultural changes to enhance their efficiency. As mentioned above, both Noordwest and Dijklander implemented an organization-wide program to enhance their efficiency.
3. It was chosen to specifically look at providers that VGZ had a multi-year contract with, as a follow-up on the previous research about Rivas and Bernhoven.
4. The dominant service area is easy to define. The chosen hospitals are not located in urban areas that have multiple hospitals, which made it easier to identify which hospital a specific 3-digit postal code group prefers to visit.
5. The chosen hospitals are not academic hospitals as these hospitals deal with case-mix differences and perform more complex surgeries, which makes comparison with general hospitals difficult.

3.1.2. Control hospitals

The treatment hospitals Noordwest and Dijklander are compared with a set of control hospitals: hospitals that are comparable to our treatment hospitals. Choosing a control group strengthens the ability to draw conclusions in a study, especially when measuring the effect of a specific intervention [40]. The Netherlands has a total of 69 hospital organizations with 116 locations excluding outpatient clinics. Several criteria were set to define which of these hospitals could be included in the analysis as control group:

1. The hospital must be a general hospital, as Dijklander and Noordwest are also general hospitals. This means that all university medical centres and outpatient clinics were excluded.
2. The dominant service area must be easy to define. Hospitals that were situated in large cities surrounded by other hospitals were excluded.
3. The hospital cannot be part of VGZ program 'Zinnige Zorg', as this will interrupt the ability to measure the effect of the change program and multi-year contract in which VGZ is engaged.

Taking all criteria into account, a total number of 37 hospital organizations and 47 hospitals were included as part of the control group. Please refer to *Appendix 1* to find the overview of all selected control hospitals.

3.2. Hospital referral region construction

The available dataset from Vektis only provides aggregated data per 3-digit postal code level and not per type of hospital. Therefore, the 3-digit postal codes that belonged to the hospitals part of this study first had to be indicated. The Hospital Referral Regions (hereafter: HRR) method was used to indicate the postal codes. In this method, hospitals are divided into markets in which they are the dominant service provider, to be able to distinguish which patients are going to which hospital [41]. The HRRs of the treatment hospitals are graphically demonstrated in *figure 5*. It is assumed that all people living in the HRR of a hospital, will choose this hospital as their dominant provider.

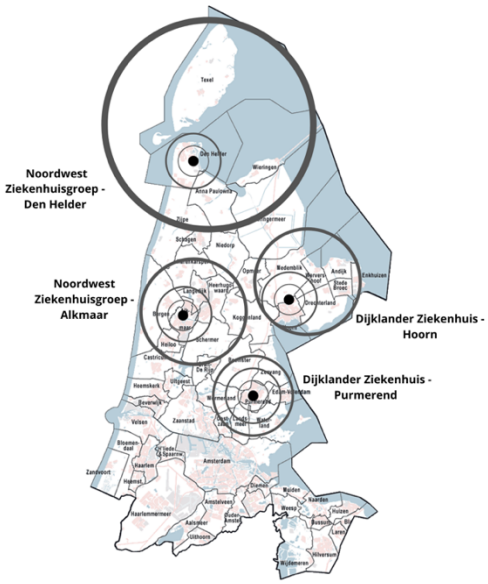


Figure 5 - Graphical demonstration HRRs treatment hospitals

The HRR-method first determines the hospital region by assigning a postal code to the hospital [42]. Secondly, the postal codes that do not fall within a specific hospital region are assigned to the 'dominant hospital', the hospital that has the shortest travel time for a patient [43, 44]. A 4-digit postal code falls within a HRR when the hospital is closest with a 5-minute margin, up to maximum 30 minutes travel distance, when travelling by car. The 4-digit postal codes that do not have a dominant hospital were not taken into consideration in the analysis. The data was collected from the websites postcodeafstanden.nl and GoogleMaps and was calculated and compared via Microsoft Excel.

As the Vektis data only provided hospital expenditure data on 3-digit postal codes, the next step was to convert the 4-digit postal codes to the applicable 3-digit postal codes. A 3-digit postal code was selected to be part of a hospital's dominant region when >50% of the inhabitants of the 4-digit postal code had this hospital as their dominant provider. As an example: 3-digit postal code 174 has 6 4-digits postal codes included (1741,1742,1744,1746,1747,1749) with a total of 32.350 inhabitants. But 4-digits postal codes 1746, 1747 and 1749 (total inhabitants: 11.515) are the only postal codes that fall within Noordwest Alkmaar's HRR with ≤30 minutes travel time. We calculate: 11.515 / 32.350 = 0,36. 0,36 < 0,50 and conclude that 3-digit code 174 is not included as part of Alkmaar's HRR. Please refer to *Appendix 2* to find all dominant 3-digit postal codes for the treatment and control hospitals.

3.3. Variables

After distinguishing the HRRs for all treatment and control hospitals, the dataset could be constructed in a way that it would allow for answering the research questions. A total of 423.325 observations were considered. 669.526 observations were removed from the dataset: observations from all 3-digit postal codes that did not belong to the 51 hospitals in the analysis. Initially, each observation entailed the year, PC3, age, gender, number of insured years and the corresponding medical expenditures. The type of hospital was added to each observation manually.

The first row of the dataset can be found in *table 1*. This row tells us that in 2011, there are 129,4 male insured years in the age category 0 in 3-digit postal code 121, which lays in the HRR of Ter Gooi Hilversum (type of hospital). These 129,4 insured years occurred medical specialist expenses of in total €763.359 and primary care expenses of €21.658 in total in 2011.

Year	PC3	Type of hospital	Age	Gender	Number of insured years	Medical specialist care expenses	Primary care expenses
2011	121	Ter Gooi Hilversum	0	Male	129,42	€763.359	€21.658

Table 1 - Row dataset

The expenses for medical specialist care per person include the total accumulated amount of Diagnosis Treatment Combinations (hereafter: DBCs) paid by the health insurers. If lower medical

specialist care (hereafter: MSC) expenses are found for 3-digits falling under a specific provider, this can be caused by lower DBC-prices or a lower treatment volume. The treatment hospitals have set contract prices for 3 (Noordwest) or 5 (Dijklander) years meaning that their prices most probably remained constant in the post-period. However, this is unclear for the pre-period prices of the treatment hospitals and for the prices of control hospitals. Besides MSC-expenses, the total primary care (hereafter: GP) expenses included several different cost categories that were added up, creating a new variable. All cost-categories that were not related to medical specialist or primary care were deleted from the dataset as they were not associated to the research questions.

The HRRs differ in size of population. For that reason, this study mainly focused on the mean MSC- and GP-expenses and not on the total expenditures. The mean variable was measured by dividing the total MSC-expenses by the number of insured years per 3-digit postal code. The same was done to retrieve the mean GP-expenses. When making calculations with means, the number of insured years was used as the weighting variable, to avoid using 'means of means'.

3.4. Software and external data sources

Two software programs were used to perform this study: Excel and Stata. Excel was used to make the calculations for the HRR-method, with the retrieved information from Postcodeafstanden.nl and GoogleMaps. Postcodeafstanden.nl helped to indicate what 4-digit postal codes were situated in each 3-digit area. Via GoogleMaps travel distances by car could be calculated. Stata/MP 16.1 was used to analyse the dataset from Vektis.

3.5. Descriptive statistics

The descriptive statistics give insight into the dataset and the composition of demographics and expenditures between treatment and control hospitals.

3.5.1. Demographic variables

It is important to include differences in age and gender in the analysis. A difference in mean MSC- and GP-expenses might occur when the treatment group has a higher number of older aged people in their population, and thus automatically stumbles upon higher expenses than the control group. It should be avoided that a difference in demographics is confused with an effect of the intervention. The treatment and control hospitals show rather small differences in their demographic. Therefore, no large difference in mean MSC- and GP-expenses is expected after controlling for these factors.

In both the treatment and control group, percentages male/female are the same: 49,80% is male and 50,20% is female. As seen in *figure 6*, differences in the age group composition are small. It can be identified that the treatment hospitals have a higher proportion of people older than 75 when we compare them to the control hospitals and the overall average for the Netherlands. As an example, the group aged between 76-80 that belongs to the control hospitals has a proportion of 5,29% in comparison to 5,49% for the treatment hospitals: a difference of 0,20%.

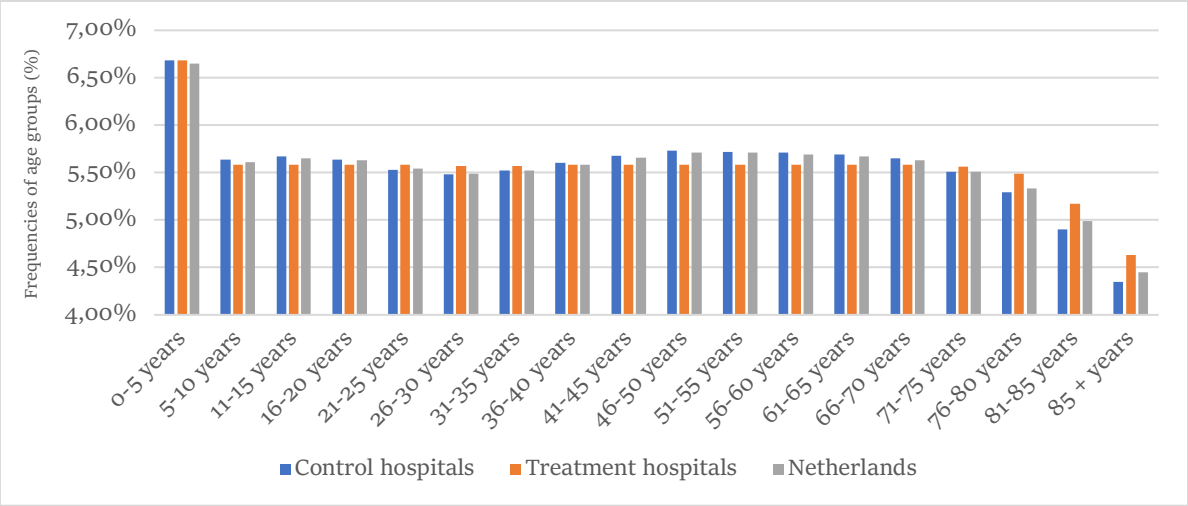


Figure 6 - Age group composition

3.5.2. Medical specialist care expenditures

Total and mean MSC-expenses for the years 2011-2018 are assessed firstly. When assessing the total MSC-expenses for the treatment hospitals, large differences are indicated. Especially Noordwest Alkmaar occurs higher total expenses in comparison to Noordwest Den Helder, Dijklander Hoorn and Dijklander Purmerend. These differences are most probably caused by the fact that Alkmaar's has more densely populated HRRs or has more dominant 3-digit postal codes assigned to them. For this reason, mean expenses will be the focus in the remainder of this study.

Figure 7 displays the raw mean MSC-expenses for the treatment and control group in each year. The mean expenses in 2018 were €1392 for the treatment hospitals and €1409 for control hospitals. Furthermore, the expenses of control hospitals were higher than expenses of treatment hospitals between the years 2013-2018. Without controlling for any variables, both trends seem to be somewhat parallel for the years 2013- 2017. The difference between both groups becomes smaller in the year 2018, in which the expenses for the treatment group are increasing more than the control group. This is the opposite result of what was expected in the first hypothesis, but this outcome is not decisive as some specific variables first need to be controlled for.

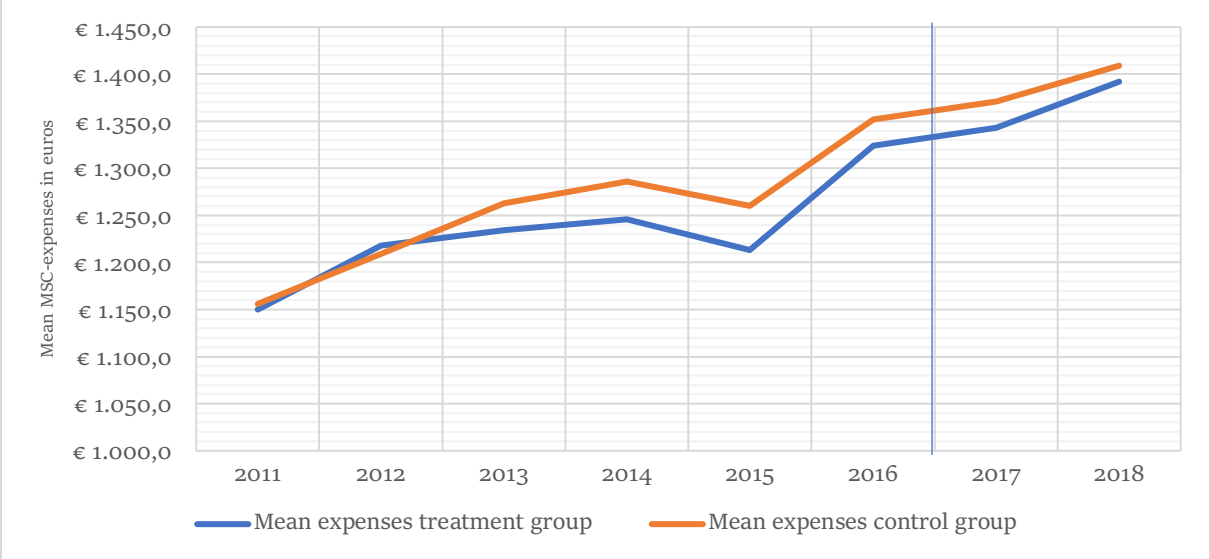


Figure 7 - Mean MSC-expenses

Plotting all MSC-expenditure trends per individual control hospital, we get the figure below (*figure 8)*. All hospitals have difference mean MSC-expenses, but most expenses of hospitals were centred between €1100 and €1400 for the years 2011-2018. Solely looking at the figure, we see a large variety between mean MSC-expenses of two different hospital locations in our treatment group, and overall large variety between all hospitals in the analysis. As an example, Noordwest Alkmaar had much lower mean expenditures than Noordwest Den Helder. Especially Dijklander Hoorn had low mean expenses in comparison to the control hospitals and other treatment hospitals. Lastly, a downward trend in the MSC-expenses in the year 2015 can be indicated, in both *figure 7* and *8*, for both control and treatment hospitals.

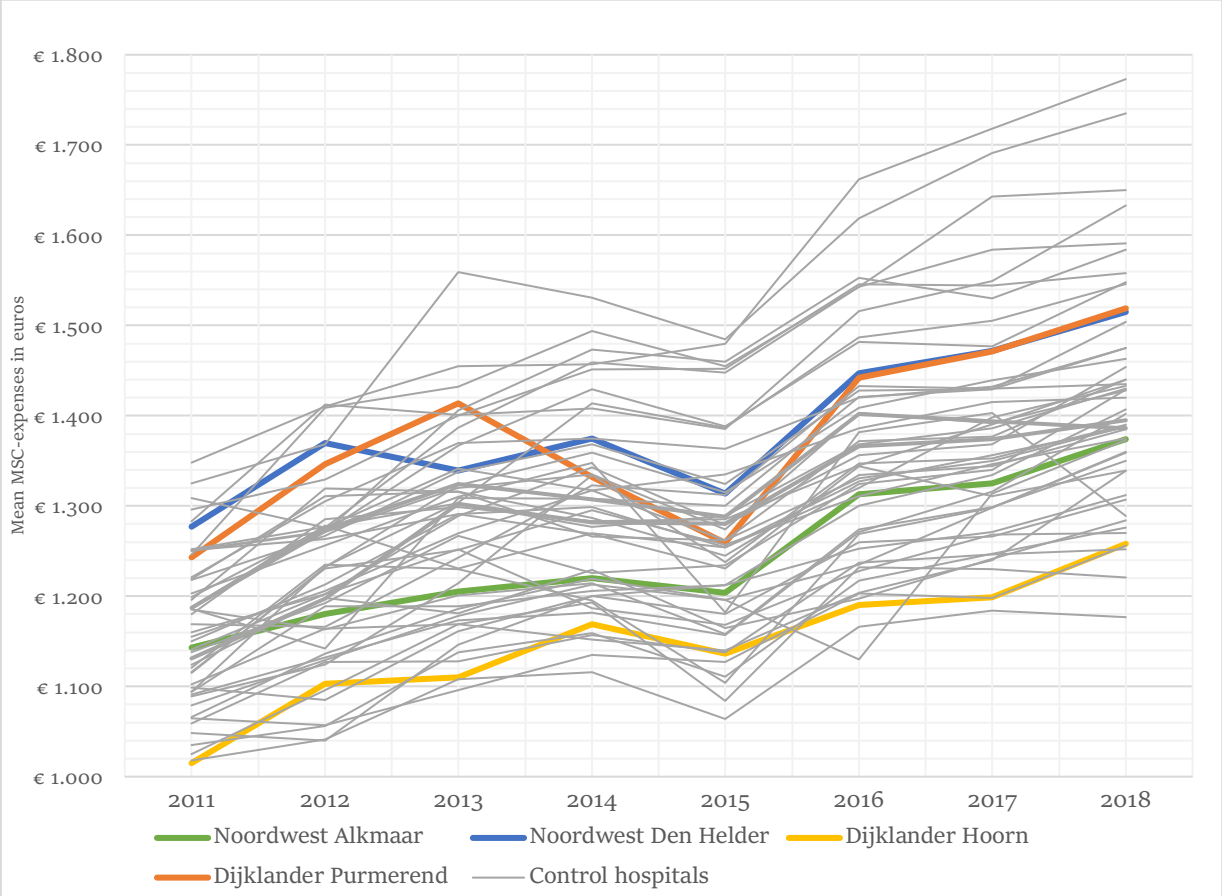


Figure 8 - Mean MSC-expenses

3.5.3. Primary care expenses

In *figure 9,* the mean GP care expenditures have been plotted. Both treatment and control hospitals started with mean GP-expenses of around €140 euros in 2011. This number increased to +/- €200 euros in 2018. A type of parallel trend can be identified between the years 2014-2018. Beforehand it was expected that there was a possibility that care was substituted to primary care by the treatment hospitals. Without controlling for factors such as age and gender, there does not seem to be a large effect indicating substitution of care to the first line in the years 2017 and 2018.

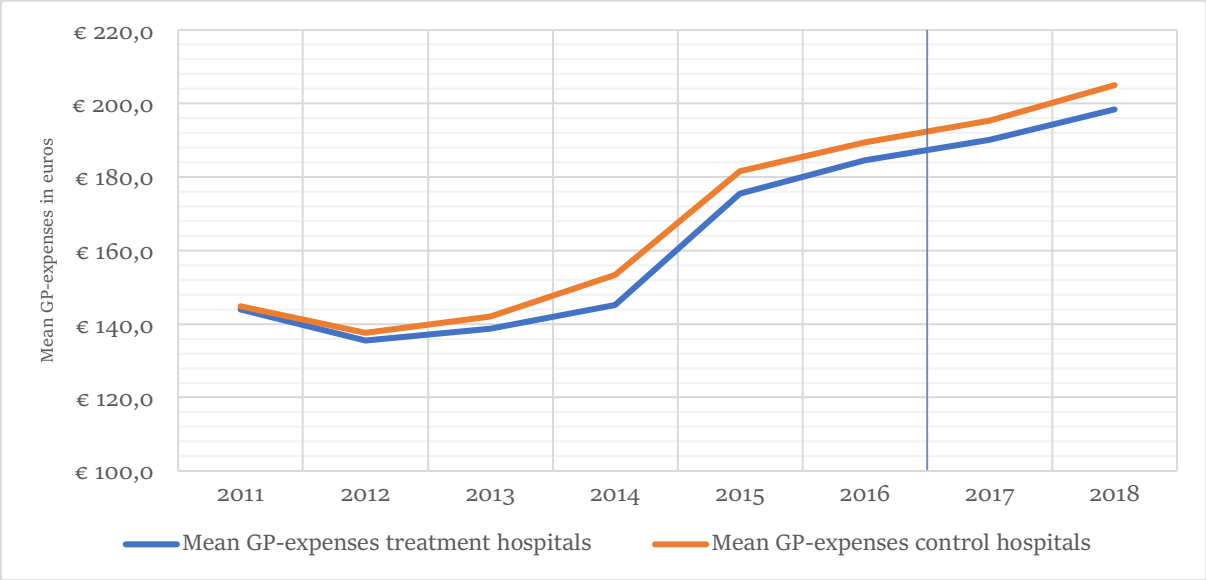


Figure 9 - Mean GP expenses

Chapter 4. Methodology

4.1. Difference-in-difference analysis – explanation

The type of analysis performed is a difference-in-difference (hereafter: DID), a type of analysis that is often used in (public) health studies to assess causal effects of interventions [45]. As mentioned in chapter 3 several steps were followed to distinguish the dominant 3-digit postal codes for each hospital and find a suitable control group. Eventually, a total of 51 hospitals were considered. In the descriptive statistics, the (mean) MSC- and GP-expenses of all people in the dominant 3-digital postal code of the analysis hospitals in the years 2011-2018 were plotted. We did however not control for certain factors that influence expenditures yet outside the control of the treatment and control hospitals.

The DID analysis is used to estimate the effect of multi-year contracts and change programs on expenditures before and after their implementation. It helps to find if the difference in mean MSC- and GP-expenses between treatment- and control group was caused by the intervention whilst controlling for other factors. The hypothetical assumptions are schematically displayed in *figure 10* and *11*. When looking at the *figure 10* below, it is expected that both Noordwest and Dijklander and the control hospitals follow the same trend before 2017 and before implementation of the change program and the multi-year contract. This parallel trend assumption needs to hold to perform a DID [45]. In 2017 and 2018 the expectation was to find a downward effect in the mean MSC-expenses [46]. In *figure 11* the graphical assumption that finds an opposite effect due to substitution of care to the first line can be found.

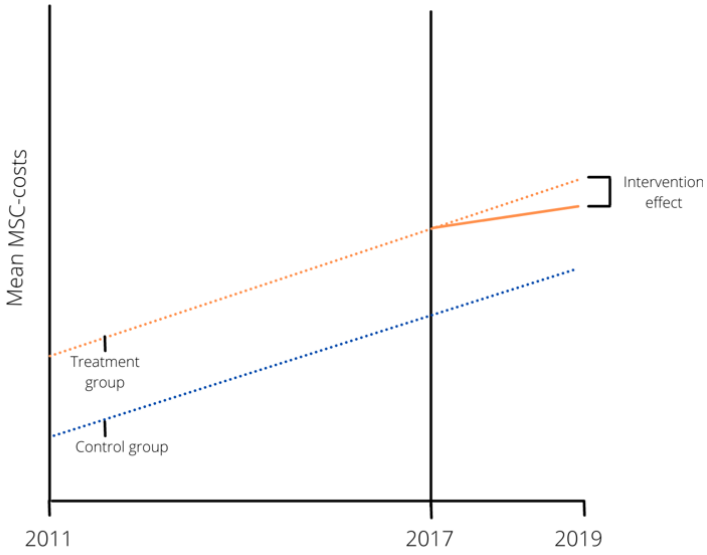


Figure 10 - Schematic reproduction DID MSC-expenses

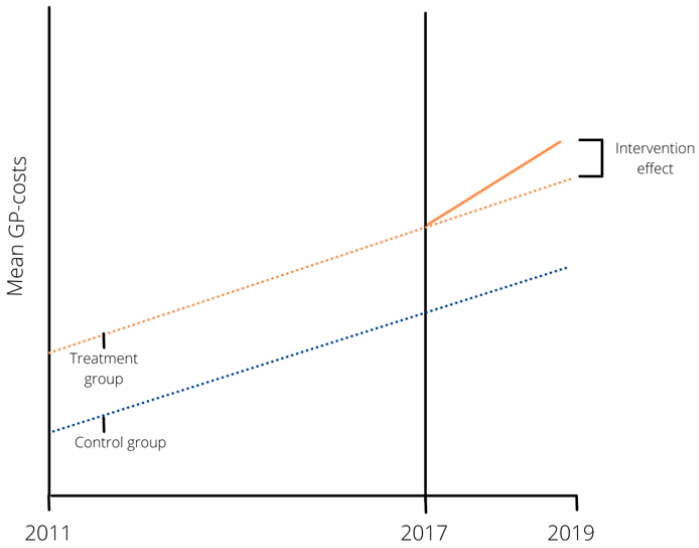


Figure 11 - Schematic reproduction DID GP-expenses

4.2. Difference-in-difference – Medical specialist expenses

4.2.1. Simplified DID test

Firstly, a simplified DID analysis was performed that assesses if there was a significant difference in the mean MSC-expenses between treatment and control hospital, before and after implementation of the intervention. By comparing these 4 groups, this first analysis assesses if the assumed expense-effects that were distinguished in *figures 7 and 9* were significant [47]. In this simplified version, the other factors that might impact the difference in mean MSC- and GP-expenses, such as age and gender, were not controlled for yet. The simplified DID is written down in equation 1 below, in which $\bar{y}$ = mean MSC- or GP-expenses, th = group of treatment hospitals, c = group of control hospitals, post = post-period (2017-2018) and pre = pre-period (2011-2016).

$$DID = \left(\bar{y}_{\text{th, post}} - \bar{y}_{\text{th,pre}}\right) - \left(\bar{y}_{\text{c,post}} - \bar{y}_{\text{c,pre}}\right) \quad (1)$$

4.2.2. Parallel trend assumption

Secondly, it was measured if the parallel trend assumption holds. The parallel trend assumption implies that both treatment and control hospitals follow a similar cost trend in the years before the implementation of the change (2011-2016). This was graphically shown in *figures 10 and 11*. Only when this trend holds, it can be assumed that a change in MSC-expenses in the post-period can be assigned to the intervention. If both trends are fluctuating before implementation of the intervention, it cannot be said with certainty that an effect was caused by the intervention.

If the parallel trend holds, the regression model should indicate that the difference between the expenses of treatment and control hospitals remains zero in the years 2011-2016. Year 2016 is taken out of the model as the reference-year, meaning that 2011 - 2015 turn into our pre-period findings and 2017 and 2018 are the post-period. The parallel trend regression model for MSC-expenses is defined as follows:

$$Y_{rtsa} = \beta_0 + \beta_{2011}D_{th}D_{2011} + \beta_{2012}D_{th}D_{2012} + \beta_{2013}D_{th}D_{2013} + \beta_{2014}D_{th}D_{2014} + \beta_{2015}D_{th}D_{2015} + \beta_{2017}D_{th}D_{2017} + \beta_{2018}D_{th}D_{2018} + \gamma_r + \gamma_t + \gamma_s + \gamma_a + \varepsilon_{rtsa} \quad (2)$$

Y_{rtsa} = Average medical care cost per person in region r, year t, sex s and age groups a.

D_{th} = Dummy variable treatment hospitals (th), in which 1 = 3-digit belongs to intervention group, 0 = 3-digit belongs to control group.

$D_{2017\text{-}2018}$ = Dummy variable, in which 1 = corresponding years 2017-2018, 0 = corresponding years 2011-2016.

γ_r = Fixed effects for differences in 3-digit postal regions, denoted with r.

γ_t = Fixed effects for differences among years, denoted with t.

γ_s = Fixed effects for differences among men and woman, denoted with s.

γ_a = Fixed effects for differences among age groups, denoted with a.

ε_{rtsa} = Error margin assuming mutually independent errors

The null hypothesis, measured at the 5% level, is as follows:

$$H_0 : \beta_{2011}, \beta_{2012}, \beta_{2013}, \beta_{2014}, \beta_{2015} = 0 \quad (3)$$

It should be acknowledged that some factors might influence the difference in MSC-expenses between treatment and control group. For that reason, the fixed effect parameters for region, year, age and sex were included. These effects are called 'fixed' as they have pre-set values: in this case, an individual is for instance either male or female. By including fixed-effect parameters, the aim was to remove all across-group variation. A more precise effect of the intervention can then be measured [48]. Thereby, the study avoids that a pre-period effect is measured that is in fact contributable to a change in age group composition or the region the hospital is located in. This might for instance happen when many older-aged people move to the HRR of a treatment hospital in a specific year, leading to higher MSC-expenses per person in comparison to the previous year. The same situation might occur when more women move to the HRR of a treatment hospital, as women often have higher medical expenses. Lastly, an error term estimator was included to explain how good the independent variables in our regression estimate the dependent variable mean MSC-expenses.

4.2.3. Difference-in-difference estimate

Assuming the parallel trend holds for both Noordwest and Dijklander hospital, it can be tested if the expenditures in the years 2017 (measured by β_{2017}) and 2018 (measured by β_{2018}) significantly decrease or increase. The DID equation for MSC-expenses then becomes:

$$Y_{rtsa} = \beta_0 + \beta_{2017} D_{th} D_{2017} + \beta_{2018} D_{th} D_{2018} + \gamma_r + \gamma_t + \gamma_s + \gamma_a + \varepsilon_{rtsa} \quad (4)$$

4.3. Difference-in-difference – Primary care substitution

A similar analysis for the mean primary care expenses is performed, researching possible substitution of care. The hypothesis is tested by first performing a simplified DID, followed up with the parallel trend assumption. Lastly, the DID is measured. In this case Z_{rtsa} can be defined as the average GP-care expenses per person in region r, year t, sex s and age a. The parallel trend-model becomes:

$$Z_{rtsa} = \beta_0 + \beta_{2011} D_{th} D_{2011} + \beta_{2012} D_{th} D_{2012} + \beta_{2013} D_{th} D_{2013} + \beta_{2014} D_{th} D_{2014} + \beta_{2015} D_{th} D_{2015} + \beta_{2017} D_{th} D_{2017} + \beta_{2018} D_{th} D_{2018} + \gamma_r + \gamma_t + \gamma_s + \gamma_a + \varepsilon_{rtsa} \quad (5)$$

When the parallel trend holds, a DID analysis is performed using the equation below:

$$Z_{rtsa} = \beta_0 + \beta_{2017} D_{th} D_{2017} + \beta_{2018} D_{th} D_{2018} + \gamma_r + \gamma_t + \gamma_s + \gamma_a + \varepsilon_{rtsa} \quad (6)$$

4.4. Validity and reliability

The above-described methodology relies on key assumptions that may impact the validity and reliability of the research.

Firstly, it is important to denote a possible inaccuracy of the selected HRRs. When looking for instance at Dijklander Purmerend, only 1 3-digit postal code was found that has this hospital as their dominant service provider, even though patients from more 3-digit postal codes may visit this hospital. This may lead to take a too narrow estimation of the visiting patients. The other way around, there are possibilities that the estimated patient population is too broad, and fewer people within the 3-digit postcode area will visit their dominant hospital. As the Netherlands has free hospital choice, there might always be chances that people will not visit their dominant hospital for personal reasons. Still, travel time remains the most important predictor for choosing a hospital in the Netherlands [49]. Therefore, it was assumed that the largest amount of people visited the hospital that they had as their dominant service provider as travel time to this hospital was the shortest.

Assuming the correct HRR-region was selected, DID analyses might still deal with various selection biases, such as across time and across group selection bias [50]. Bias across time occurs when a group's composition changes throughout the years, which in our case could happen if many people move from one HRR to another HRR. From 2011 to 2018 in between 1.46-1.79 million Dutch people moved houses on annual basis, most people however continued to live in the same municipality [51]. Hence, this effect seems rather small (<10%).

Moreover, across group bias might occur if the groups substantially differ from each other [50]. In this case, Dijklander and Noordwest may substantially differ from our control hospitals, something that is not caused by a difference in age group, gender, year, region and the intervention. You may for instance think of an epidemic that only took place in Noord-Holland or an emergency situation causing higher mean expenses per 3-digit postal code. We are not aware that a situation like this occurred. Still, selection biases as described above can be overcome by selection of a comparable control group to match with the treatment group that follows the same unobserved trend.

4.5. Robustness assessment

The robustness of this study is assessed by testing the assumptions made. This is done via three different types of assessments.

4.5.1. Fixed-effect analysis with control hospital exclusion

Firstly, it was assumed in the regression that the treatment and control group followed a similar trend in the pre-period 2011-2016, an assumption that is tested via a sensitivity analysis. As 47

control hospitals were included, there was a possibility that some of these individual hospitals were outliers in terms of MSC- and GP-expenses. As discussed in the validity/reliability, it is preferred to match the treatment and control group as much as possible to avoid group bias. Therefore, the sensitivity analysis assesses if the outcomes of the regression model changed if the control hospitals were one-by-one excluded from the regression [52]. A sensitivity analysis compares outcome results while changing input parameters. As hospital organizations can be assumed to follow the same strategies, they were treated as one and the assessment was repeated 37 times. As an example: this means that we do not exclude Spaarne Gasthuis Haarlem and Hoofddorp separately, but exclude them together, treating them as one organization. A notable change in the interaction effect (year*treatment group) betas and p-values is the focus in evaluating the exclusion per hospital.

4.5.2. Fixed-effect analysis with other error term-assumptions

The second assumption tested, is the assumption that errors were mutually independent and did not correlate. In the first parallel trend regression, an estimation with other error terms associated with the variables in the model was not included. Therefore, a new estimation is made, in which it is measured what happens to the model if errors are mutually dependent. There are two ways to model errors: by robust standard errors and via clustering.

With robust standard errors the differences between the outcome and its predicted value in the fixed effects model are estimated [53]. Hereby, unbiased standard errors under heteroscedasticity are derived. We refer to heteroscedasticity when there is variance in the residuals over a range of values. In this case, for instance, it can be assumed that variability in mean MSC-expenses will become larger when people get older. This will subsequently lead to a more widespread number of residuals around higher age groups. With the robust standard error estimation, this variation is considered in the model. Secondly, errors are modelled by allowing the standard error to correlate between clusters, in this case groups of hospitals, and not necessarily between independent observations. Clustering is performed to represent the 51 different types of hospitals that are in the data sample, as the observations are not independent per different person/id but are dependent on their hospital area [53].

4.5.3. Fixed-effect analysis Noordwest/Dijklander separated

Lastly, the robustness is assessed by testing the assumption that both treatment hospitals, Dijklander and Noordwest, follow a similar pre- and post-period cost trend. In the regressions we included both hospitals in the same treatment group, even though both hospitals implemented different initiatives and put in their own individual efforts. As seen in the descriptive statistics, trends per hospital differ a lot from each other. Therefore, the difference between both hospitals is tested in an additional analysis. Hereby, Dijklander is first excluded from the treatment group and afterwards Noordwest is excluded, to assess their individual effects.

Chapter 5. Results

5.1. Medical specialist expenses

5.1.1. Simplified difference-in-difference MSC-expenses

By performing a simplified DID regression it could be estimated if there was a difference in the pre-period and post-period between control and treatment group. In *table 2* below, this shows that both the difference in MSC-expenses before and after implementation are highly significant (***). The treatment hospitals have significantly lower mean MSC-expenses in both periods (+/- -€17,0). It is, however, not found that there is a significant difference between the pre- and post-period in these expenses (p = 0,713).

	Mean MSC- expenses (in €)	Std. Error (in €)	p> [t]
2011-2016			
Control group	€1254,5	€0,2	
Treatment group	€1237,2	€0,6	
Difference (T-C)	-€17,3	€0,7	0,000***
2017-2018			
Control group	€1389,8	€0,4	
Treatment group	€1372,0	€1,2	
Difference (T-C)	-€17,8 (1,4)	€1,4	0,000***
DID	-€0,5		0,713

*Table 2 - Simplified DID analysis MSC-expenses | Number of observations: 423.325 | * = 0,05, ** = 0,01, *** = 0,001 |*

5.1.2. Parallel trend assumption MSC-expenses

Table 3 showcases the fixed effects model in which the four treatment hospitals and all 47 control hospitals were included. The primary focus was on finding the parallel trend to be able to perform a DID regression. The parallel trend was indicated by the year * treatment variable (refer to the blue contour) and shows the difference in MSC-expenses between treatment and control hospitals for every year. In 2011 and 2012, expenses for treatment hospitals are +/- €40,00 euros higher than for control hospitals (€39,6 / €47,0). These effects, and all other interaction-effects are however non-significant, meaning that there is no evidence that the difference between treatment and control hospitals is found to be true. It can be said that the difference is equal to zero for all years 2011-2016. Therefore, the parallel trend was indicated successfully.

When looking at *time fixed effects*, it can be observed from *table 3* that MSC-expenses have increased throughout the years. In 2011 mean MSC-expenses are -€159,1 because of the yearly fixed effect, whereas expenses per patient increase because of the year-effect in 2018 by €49,0. *Gender fixed effects* indicate that women have on average €108,5 lower MSC-expenses than men. For the *age group fixed effects,* the reference group considered is year 0-5. It is found that the ages 5-55 years all have a negative impact on the mean MSC-expenses of a patient. The older people become

the higher mean MSC-expenses per person are. The group of 0-5 is excepted due to high expenses in beginning-of-life years. Fixed effect region, an effect that controls for differences in 3-digit postal code area, is included in the model as panel variable and therefore automatically controlled for [54].

The displayed standard error indicates the average distance between the observed coefficients and the regression line. The smaller the estimated standard error, the more accurate the prediction of the model is. In this case, a relatively high standard error for the interaction effect (26,2) is indicated, making it more difficult to find a significant difference in mean MSC-expenses.

All in all, the regression model is able to subtract significant fixed effects for differences in years, age and gender but is not able to find a significant difference between expenses of treatment and control hospitals. For that reason, it can be inferred that a parallel trend was found for the years 2011-2016 in which the difference in mean MSC-expenses between treatment and control hospital is 0.

Variable	Coefficient (Std. error)	Significance level	Variable	Coefficient (Std. error)	Significance level
Dependent variable *Mean MSC-expenses (in €)*					
Independent variables					
Interaction effect			*Age group*		
2011 * treatment	39,6 (26,2)	0,131	0-5 years	-	-
2012 * treatment	47,0 (26,2)	0,073	6-10 years	-1064,4 (9,7)	0,000 ***
2013 * treatment	-15,6 (26,2)	0,553	11-15 years	-1043,2 (9,6)	0,000 ***
2014 * treatment	-6,5 (26,2)	0,804	16-20 years	-937,7 (9,6)	0,000 ***
2015* treatment	-10,9 (26,2)	0,678	21-25 years	-872,8 (9,7)	0,000 ***
2016 * treatment	-	-	26-30 years	-655,9 (9,7)	0,000 ***
2017* treatment	-18,7 (26,2)	0,474	31-35 years	-603,0 (9,7)	0,000 ***
2018 * treatment	4,2 (26,2)	0,871	36-40 years	-658,2 (9,7)	0,000 ***
Time fixed effects			41-45 years	-623,9 (9,6)	0,000 ***
2011	-159,1 (7,0)	0,000 ***	46-50 years	-460,2 (9,6)	0,000 ***
2012	-126,6 (7,0)	0,000 ***	51-55 years	-224,4 (9,6)	0,000 ***
2013	-65,4 (7,0)	0,000 ***	56-60 years	81,1 (9,6)	0,000 ***
2014	-51,8 (7,0)	0,000 ***	61-65 years	484,9 (9,6)	0,000 ***
2015	-88,1 (7,0)	0,000 ***	66-70 years	955,7 (9,6)	0,000 ***
2016	-	-	71-75 years	1538,1 (9,7)	0,000 ***
2017	9,3 (7,0)	0,185	76-80 years	1976,2 (9,8)	0,000 ***
2018	49,0 (7,0)	0,000 ***	81-85 years	2092,6 (10)	0,000 ***
Gender fixed effects			85 + years	1679,8 (10,4)	0,000 ***
Male	-	-	*Constant*	1539,3 (8,1)	0,000 ***
Female	-108,5 (3,4)	0,000 ***			

*Table 3 - Fixed effects regression model MSC-expenses | Number of observations: 423.325 | F test that all u_i=0: F(301, 414263) = 16.45 | Prob > F = 0.0000 | * = 0,05, ** = 0,01, *** = 0,001 |*

5.1.3. Difference-in-difference estimation MSC-expenses

Assuming the parallel trend holds, the effect of the intervention in the years 2017 and 2018 can be estimated. In *table 4*, the results for MSC-expenses can be found. The fixed effects were included in this regression but not included in the displayed table below since we are mainly interested in the change in expenses. No significant effect is found, meaning that it cannot be concluded that MSC-expenses (positively or negatively) significantly changed for Dijklander and Noordwest in 2017-2018, whilst they agreed upon a multi-year contract and implemented change programs.

Variable	Coefficient (Std. error)	Significance level
Dependent variable		
Mean MSC-expenses (in €)		
Independent variables		
Interaction effect		
2017 * treatment	-€27,6 (20,0)	0,168
2018 * treatment	-€4,6 (20,0)	0,818

*Table 4 - Post-period effect mean MSC-expenses | Number of observations: 423.325 | F test that all u_i=0: F (307, 422995) =17,31| Prob > F = 0.0000 | * = 0,05, ** = 0,01, *** = 0,001 |*

5.2. Primary care expenses

5.2.1. Simplified difference-in-difference GP-expenses

In *table 5* the simplified DID is performed for mean GP-expenses. The opposite result in comparison to mean MSC-expenses is indicated. The GP-expenses in the dominant service area of the treatment hospitals are significantly lower than in the control hospitals for both periods. In this case, we also find a significant effect (***) for the DID: the difference between the two groups and between the two periods are both significant (-€1,9). It is found that GP-expenses for the treatment hospitals decrease faster in the post-period in comparison to the control hospitals, when not controlling for other factors.

Outcome variable	Mean MSC- expenses (in €)	Std. deviation (in €)	P> [t]
2011-2016			
Control group	€157,8	€0,01	
Treatment group	€153,8	€0,04	
Difference (T-C)	-€4,0	€0,04	0,000***
2017-2018			
Control group	€199,8	€0,03	
Treatment group	€193,9	€0,1	
Difference (T-C)	-€5,9	€0,07	0,000***
DID	-€1,9	0,09	0,000***

*Table 5 - Simplified dif-in-dif analysis. Number of observations: 423.325 | * = 0,05, ** = 0,01, *** = 0,001 |*

5.2.2. Parallel trend assumption GP-expenses

Table 6 showcases the fixed effect regression model for mean GP-expenses. A parallel trend is found. The difference between treatment and control group, measured by the interaction effect is rather small in the years that the effect is significant (4,3, 3,1 and -4,3). Comparable to the fixed effect regression model for MSC-expenses, the time fixed effects, age group effects and gender effects are significant. In this case, females occur higher GP-expenses than males, the opposite of what we found for MSC-expenses. The trends of the other fixed effects are in line with the findings from *table 3*.

Variable	Coefficient (Std. error)	Significance level	Variable	Coefficient (Std. error)	Significance level
Dependent variable *Mean GP-expenses (in €)*					
Independent variables					
Interaction effect			*Age group*		
2011 * treatment	4,3 (1,0)	0,000 ***	0-5 years	-	-
2012 * treatment	3,1 (1,0)	0,002 **	6-10 years	-36,1 (0,4)	0,000 ***
2013 * treatment	0,9 (1,0)	0,368	11-15 years	-39,0 (0,4)	0,000 ***
2014 * treatment	-4,3 (1,0)	0,000 ***	16-20 years	-25,2 (0,4)	0,000 ***
2015* treatment	1,2 (1,0)	0,242	21-25 years	-21,0 (0,4)	0,000 ***
2016 * treatment	-	-	26-30 years	-19,3 (0,4)	0,000 ***
2017* treatment	-0,4 (1,0)	0,686	31-35 years	-18,7 (0,4)	0,000 ***
2018 * treatment	-0,4 (1,0)	0,671	36-40 years	-18,6 (0,4)	0,000 ***
Time fixed effects			41-45 years	-16,8 (0,4)	0,000 ***
2011	-48,8 (0,3)	0,000 ***	46-50 years	-11,2 (0,4)	0,000 ***
2012	-56,6 (0,3)	0,000 ***	51-55 years	-1,1 (0,4)	0,003 **
2013	-51,6 (0,3)	0,000 ***	56-60 years	12,0 (0,4)	0,000 ***
2014	-40,8 (0,3)	0,000 ***	61-65 years	30,2 (0,4)	0,000 ***
2015	-9,4 (0,3)	0,000 ***	66-70 years	72,9 (0,4)	0,000 ***
2016	-	-	71-75 years	103,9 (0,4)	0,000 ***
2017	5,8 (0,3)	0,000 ***	76-80 years	157,6 (0,4)	0,000 ***
2018	-0,4 (0,3)	0,000 ***	81-85 years	200,4 (0,4)	0,000 ***
Gender fixed effects			85 + years	263,4 (0,4)	0,000 ***
Male	-	-	*Constant*	169,4	0,000 ***
Female	12,9 (0,1)	0,000 ***		(0,3)	

*Table 6 - Fixed effects regression model GP-expenses | Number of observations: 423.325 | F test that all u_i=0: F(307, 422985) = 127,7 | Prob > F = 0.0000 | * = 0,05, ** = 0,01, *** = 0,001 |*

5.2.3. Difference-in-difference estimation GP-expenses

When looking at *table 7,* the results of the DID for mean GP-expenses are displayed. The expenses for treatment hospitals are €1,3 euros less on average than for control hospitals, this effect is however not significant. It can be derived from the table that there is no significant effect in mean GP-expenses in the years 2017 and 2018 for treatment hospitals due to substituted care.

Variable	Coefficient (Std. error)	Significance level
Dependent variable		
Mean GP-expenses (in €)		
Independent variables		
Interaction effect		
2017 * treatment	-€1,3 (0,2)	0,135
2018 * treatment	-€1,3 (0,2)	0,129

*Table 7 - Post-period effect mean GP-expenses | Number of observations: 423.325 | F test that all u_i=0: F (307, 422995) = 107,38 | Prob > F = 0.0000 | * = 0,05, ** = 0,01, *** = 0,001 |*

5.3. Robustness assessment

5.3.1. Fixed effect analysis with control hospital exclusion

As discussed in the methodology, a sensitivity analysis that finds possible outliers in our group of control hospitals was performed to assess robustness. By excluding every control hospital organization one-by-one, it could be indicated if there were no large outlying control hospitals that impacted the outcomes majorly.

In *table 8* the results of the sensitivity analysis can be found. The outliers were identified by looking at the largest and smallest number in every column with the interaction term (year * treatment hospital). The fixed effects year, age, gender, and region were included in the regression, but left out of the model displayed below since they are not differing substantively per excluded hospital. Moreover, the main interest within this analysis was on the effect of the intervention, and not on the other parameters. *Table 8* showcases the interaction effect of mean MSC-expenses when comparing the treatment hospital to the control hospitals in the years 2011 to 2018. Row 0 shows the outcomes that were already displayed in *table 3* fixed effect regression model mean MSC-expenses. In the rows below, a hospital organization is excluded every time. The outliers that differed the most from row 0 were indicated in blue (upper coefficient) and grey (lower coefficient) for each treatment* year interaction term.

When for instance looking at Treant Groep, we can see that if you leave these 3 hospitals (Emmen, Hoogeveen and Stadskanaal) out of the analysis, the difference in mean MSC-expenses in 2011 between treatment and control group becomes smaller (€31,9 < €39,6). The effect is however not significant, meaning that the difference between treatment and control group equals 0. When excluding hospital Sionsberg, Dokkum, from the analysis, we find that the expenses for the treatment hospitals are €42,5 higher than for control hospitals in 2011, at a 0,05-significance level. The other years are however all insignificant (2012-2018). With the exclusion of Sionsberg, the largest change in the sensitivity analysis is indicated. All in all, the exclusion of control hospitals did not lead to large differences in the interaction effect and therefore it is concluded that there were no distinctive outliers indicated.

No.	Hospital(s) excluded	2011 * T	2012 * T	2013 * T	2014 * T	2015 * T	2016 * T	2017 * T	2018 * T
0	No hospitals excluded	39,6	47	-15,6	-6,5	-10,9	-	-18,7	4,2
1	Treant Groep	31,9	42,6	-19,2	-6,2	-12	-	-13,5	9
2	Wilhelminaziekenhuis Assen	39,6	46,2	-16,4	-7,2	-11	-	-19	4,2
3	Hardenberg Saxenburgh	40,3	47,8	-14,1	-7,1	-11,7	-	-20,3	2,5
4	Isala Zwolle/Meppel	36,7	47,6	-22,5	-11,3	-12,8	-	-24,9	-0,4
5	Deventer ziekenhuis	38	45,6	-16,4	-5,5	-11,3	-	-18,9	4,3
6	ZGT Almelo	39,3	47,5	-15,4	-6,9	-10,3	-	-18,4	5,2
7	Heerenveen Tjongerschans	39,6	46,7	-14,7	-6,5	-11	-	-19,5	4,8
8	Nij Smellinghe Drachten	38,7	43,5	-19	-8,2	-12,2	-	-18,7	3,9
9	Sionsberg Dokkum	42,5 *	47,9	-16	-8,2	-13,3	-	-17,9	5,3
10	MCL Leeuwarden	38,2	44,6	-17,2	-7	-9,4	-	-19	5,3
11	Antonius Sneek/Emmeloord	39,7	46,1	-16	-8,4	-12	-	-19	2,3
12	Flevoziekenhuis Lelystad	40,2	44,3	-18,4	-7,8	-13,6	-	-19,6	1
13	St Jansdal Harderwijk/Almere	40,7	45,3	-17,3	-6,9	-14,2	-	-18,6	0,3
14	Gelre Zutphen/Apeldoorn	38,1	44,4	-16,2	-6,7	-10,2	-	-19,3	3,1
15	Gelderse Vallei Ede	40,7	43,7	-19,4	-8,6	-11,6	-	-19,1	3,1
16	Rijnstate Arnhem	40,1	47,9	-16,1	-8,6	-11	-	-18,2	3,4
17	Slingeland Doetinchem	40	45,2	-16,9	-6,6	-12,2	-	-19,3	2,4
18	Koningin Beatrix Winterswijk	40,4	45,4	-18,7	-8	-11,5	-	-17,8	4,4
19	Rivierenland Tiel	38,4	43,2	-16,3	-8,1	-11,2	-	-19,5	1,4
20	Meander Amersfoort	39,8	46,1	-18,2	-8,3	-10,3	-	-19,7	3,4
21	Spaarne Haarlem/Hoofddorp	40,5	46	-16	-7,6	-12	-	-18	3,3
22	Rode Kruis Beverwijk	40,6	46,7	-15,9	-7,9	-12,1	-	-19,3	2,7
23	Ter Gooi Hilversum/Blaricum	40,3	43,7	-18,9	-8,9	-11,6	-	-19,5	3,1
24	Langeland Zoetermeer	39,4	44,7	-17,8	-8,2	-11,6	-	-18,3	3,8
25	Reinier de Graaf Delft	39,8	43,7	-18,4	-8,5	-12,1	-	-18,4	3,8
26	Spijkenisse MC	39,5	43	-18	-6,6	-11,4	-	-18,3	4,1
27	Dirksland Betsheda	40,1	44,2	-18	-7,9	-11,2	-	-18,6	4,2
28	Admiraal de Ruyter Zeeland	35,5	35	-22,9	-10,4	-10,7	-	-18,1	5,8
29	Zorgsaam Terneuzen	41,8	46,3	-15,7	-7,5	-10,5	-	-18,2	5,1
30	Bravis Bergen op Zoom	38	40,6	-21,2	-9,1	-11,9	-	-18,3	3,2
31	Amphia Ziekenhuis Breda	39,2	43,8	-18,2	-7,7	-11,5	-	-18,7	3,9
32	Jeroen Bosch Ziekenhuis	39,6	50,8	-13,7	-2,6	-8,7	-	-16,7	4,4
33	Elkerliek Ziekenhuis Helmond	39,3	43,9	-16	-6,9	-11,2	-	-18,7	4,9
34	Viecuri Venlo/Venray	37,6	43,5	-17	-5,6	-10,5	-	-21,1	2,1
35	St. Jans Gasthuis Weert	39,5	46,7	-16,1	-6,8	-10,9	-	-18,7	3,7
36	Laurentius Roermond	39,5	46,1	-16	-6,1	-10	-	-18,5	4,2
37	Zuyderland Heerlen/ Sittard	37,3	47,9	-18,2	-10	-13,6	-	-18,3	6,8

*Table 8 - Sensitivity Analysis | * = 0,05, ** = 0,01, *** = 0,001| BLUE = Upper coefficient | GREY = Lower coefficient |*

5.3.2. Fixed-effect analysis with other error term-assumptions

The main regression for MSC-expenses assumes that all error terms were mutually independent. This robustness analysis tests what happens to the analysis when we, firstly, assume robust standard errors and, secondly, cluster errors per type of hospitals. These tests will give us different fixed-effect regression model outcomes. The outcomes of this analysis can be found in *appendix 3*. The coefficients of the interaction effect (betas) remained the same when comparing them to the original fixed-effect analysis where mutual independent errors were assumed. Time, age group and gender fixed effects were included in the analysis but excluded in the table in the appendix, as these effects remained statistically significant and were not the main interest of this analysis.

As expected, differences were indicated in the standard error and p-values. The model-based standard error in *table 3* of 26,2 for the year*interaction effect (main regression MSC-expenses) was larger than the standard error found for the robust/cluster check, which lays between 12,5 and 20,9. Furthermore, the robust/cluster model finds lower p-values for all years. Especially relevant are years 2011 and 2012 that have now become (lightly and moderately) significant which tells us that the MSC-expenses in treatment hospitals were significantly higher (40 and 47 euros) than control hospitals in 2011 and 2012. Due to the fluctuation of the significance, a parallel trend could not be subtracted from these models. Please find the analysis with other error-term assumptions in *appendix 3*.

5.3.3. Fixed-effect analysis Noordwest/Dijklander separated

In *appendix 4,* the outcomes for separately assessing Noordwest and Dijklander can be found. Again, time, age group and gender fixed effects remained statistically significant and were included in the analysis but excluded in the displayed table. The coefficients for the interaction effect showed some differences in the coefficients, but not in the p-values, as they all remain insignificant for all years. Therefore, when assessing Noordwest and Dijklander separately, the difference in MSC-expenses remained zero for all years. When assessing the expenses by clustering the errors on type of hospital (*table 12)*, instead of via independent observations, it was found that both Noordwest and Dijklander separately had significantly higher expenses (+/- €40,00) in 2011 than the set of 47 control hospitals. In the years following, both hospitals follow a different trend. Dijklander has significantly different expenses (higher or lower) than the control hospitals in 2012 and 2014. Noordwest has significantly different expenses (higher or lower) than the control hospitals in years 2013, 2015 and 2016.

The different trends of Dijklander and Noordwest indicated no parallel trend when separately assessing them and allowing for clustering errors between hospitals. Therefore, a DID could not be performed. Please find the separated fixed-effects model for Dijklander and Noordwest in *appendix 4*.

Chapter 6. Discussion

The discussion serves to illustrate the main findings and their implications with regards to the literature. Moreover, strengths and limitations of the research are discussed.

6.1. Main findings

This study hypothesized that multi-year contracts and change programs, which started in 2017, led to lower medical-specialist care expenditures for Noordwest and Dijklander hospitals. It was subsequently hypothesized that general-practioner expenses for the hospital referral regions of the treatment hospitals increased, due to substitution of care. The MSC-expenses and GP-expenses of the two treatment hospitals were compared to a group of 47 control hospitals in a DID analysis.

The model finds a parallel trend in the pre-period years 2011-2016 for both MSC-expenses and GP-expenses, an assumption that needs to hold to perform the DID analysis. This means that there was no difference in mean MSC-expenses and GP-expenses between the treatment and control group in the years 2011-2016. Following up, the DID estimated the effect of the intervention in the post-period 2017-2018. The DID analysis showed us that both MSC-expenses and GP-expenses for the treatment and control hospitals did not significantly differ from each other in the post-period. This indicated that no effect on MSC- and GP-expenses of the multi-year contract and change programs was found.

Additional robustness analyses reinforced these findings. The sensitivity analysis, in which control hospitals were one-by-one subtracted from the analysis, did not show large differences in the outcomes. This signalized that the DID results were not disturbed by an 'outlying' control hospital and showed that the control and treatment group were compatible. Following, the assumption that errors were mutually independent was assessed by performing robust standard errors and clustering the errors on type of hospitals. Coefficients in the fixed effect regression model remained the same for all years. Smaller standard errors were found for all years and lower p-values were found for almost all years, but these findings still led to a rejection of the parallel trend as the effects (2011-2018) were not significant. Therefore, a DID analysis could not be performed.

Lastly, a separated analysis for Noordwest and Dijklander was performed, testing the assumption that the treatment hospitals followed a similar trend. This showed that there was no parallel trend if the hospitals were separately assessed. When allowing for clustering errors between the hospitals the trends of both treatment hospitals started fluctuating. Even though some years showed significant effects the parallel trend was still rejected. When assessing Dijklander and Noordwest separately, a DID could again not be performed. Therefore, the sensitivity analysis did not find evidence for rejecting the main findings of the study.

All in all, the hypotheses stating that MSC-expenses decreased, and GP-expenses increased did not hold. No effect of the multi-year contracts and change programs implemented by Dijklander and Noordwest was indicated. There might me several reasons to explain this outcome.

An effect in terms of MSC-expenses and GP-expenses may not have been found due to a lack of participation from the treatment hospitals' side. As touched upon in the literature, the effect of a multi-year contract crucially depends on the efforts and participation of a hospital [3]. The hospital can commit to a change successfully via cultural and structural adaptation. Even though it was found that Dijklander and Noordwest implemented several initiatives in collaboration with insurer VGZ, these changes and efforts do not seem to be part of a larger organisation-wide commitment [33,36,37]. There was not much information online about the initiatives and this study did not come across 'success stories' or 'best practices' shared by the hospitals about their cost-saving practices. Therefore, a small assumption could already be made beforehand: the hospitals would have most probably shared the results of their initiatives online if they were positively contributing to their efficiency. That did not happen and might have been a predictor for the outcomes. Bernhoven and Rivas have shown to have gone through a cultural and structural change in which the organizations fully committed to enhancing their efficiency and quality [7,8]. The fact that this was not observed at Dijklander and Noordwest may have also shown in the effects of the implemented initiatives.

Moreover, the effects of the multi-year contract and change programs may simply not have been visible yet. As shown in *figure 2* Dijklander hospital implemented most of their initiatives (60/100) in 2018 only, which might explain why there is no effect visible yet in the years 2017-2018. Furthermore, investment costs of implementing initiatives can be a reason for not indicating a change in MSC- and GP-expenses [11]. The hospitals were most probably required to invest efforts into some projects first before they could start working more efficiently and effects became visible in their expenditures. Via multi-year contracts, insurers offer the financial resources to invest in efficiency-enhancing initiatives, from which it can be assumed implementation of an initiative will firstly cost money before the benefits will become observable. Since the multi-year contracts of Dijklander and Noordwest did not even expire yet in 2018, the two-year measurement period of 2017-2018 may have been too short to measure effects.

Finally, both hospitals might have been more focused on improving their quality or decreasing their internal costs, rather than decreasing their expenditures. As discussed earlier, expenditures are a combination of price * volume. The subject of costs was not touched upon in this thesis, even though the hospitals might have been more focused on (for instance) decreasing their labour, building, and cleaning costs, rather than their volumes and prices. Besides costs, changes in quality were limitedly measured. Efficiency is a two-factor concept comprising of costs and quality:

quality is either improved while remaining the same costs, or costs decrease while remaining the same quality [6]. The available dataset did not provide the possibility to indicate the change in costs and quality between the pre- and post-period years. Therefore, this subject was shortly touched upon in chapter 2. For Dijklander, the quality scores received from the Elsevier publication in 2017 and 2018 did not improve in comparison to 2016. Furthermore, their annual result changed from a positive to negative number. Noordwest's quality scores remained the same and their annual results decreased slightly. For both treatment hospitals this did not indicate that a large change was made to improve quality or decrease internal costs. Still, a change in quality or costs, while remaining expenditures constant, could be an explanation for not finding an effect of the interventions. This assumption needs additional testing in a follow-up study.

6.2. Strengths of the study

To our knowledge, this is the first study that assessed the impact of multi-year contracts and change programs on the expenditures of Noordwest and Dijklander. Thereby, the study contributed to the existing empirical evidence on the effects on expenditures of these interventions. The outcomes of this research, in which no change in expenditures was indicated, align with earlier studies [7,17,18]. The largest effects in these studies were found in a change in volumes and not specifically throughout the expenditures. The alignment with other studies is one of the strengths of this study and contributes to forming an encompassing view on the study's subject.

Following up, doing multiple analyses ensured that the overall conclusions drawn were correct. The study performed a simplified DID analysis and a fixed effect DID analysis for both MSC- and GP-expenses and three robustness checks for MSC-expenses. None of these analyses showed a significant effect in expenses which indicated a consistent outcome. Moreover, this research has shown the importance of controlling for fixed effects, as a significant effect was found in the simplified DID for GP-expenses but was not found when controlling for these effects in the fixed effect regression. The consistency of the results and adding the fixed effects to the analysis, have strengthened the study outcomes.

6.3. Limitations of the study

This paper saw some limitations that possibly effected the outcomes. Firstly, the post-measuring period was short and only consisted of 2 years (2017 and 2018). Due to a lack of available data, years later than 2018 could not be measured. As mentioned above, both Dijklander and Noordwest might have still been in the transition towards working according to the 'Zinnige Zorg' principles or had adjustment problems. A change takes time, especially changes that acquire cultural and structural changes within the organization.

Secondly, the effect of DBC-prices and treatment volumes could not be assessed separately which exposed a limitation in explaining our outcomes. The change in average expenses was measured per person, calculated by the accumulated amount of DBCs paid by the health insurers. It was assumed that the prices for DBCs of treatment hospitals remained the same during the post-period due to the set budget within the multi-year contract. A change in mean expenses could for that reason be attributed to a higher or lower treatment volume. There was however uncertainty about the difference in DBC-prices for the treatment hospitals between the pre- and post-period. Furthermore, this study did not retrieve information about the contracts of the control hospitals, causing uncertainty how their DBC-pricing and volumes separately changed. Especially since DBC-pricing between different hospitals can vary a lot [55]. To properly know the size and nature of the effect in costs the prices and volumes had to be measured separately.

Thirdly, this study came across difficulties in finding a parallel trend due to uncertainties with regards to large changes that happened to the treatment hospitals in the pre-period 2011-2015. The effect of mergers was touched upon before, which according to the literature does not have a positive nor negative effect on costs of hospitals. Still mergers, or other large unforeseen changes that occurred to the treatment hospitals and not to the control hospitals, could have exposed challenges to finding a parallel trend in the pre-period. Without the parallel trend the DID could not be estimated, exposing a limitation. Especially when estimating the other error-term assumptions-model a very fluctuating trend was found, which might have been caused by uncertainties in the pre-period.

6.4. Concluding remarks

This study was able to construct a model that found a solid answer to the question if the hospitals' expenses were impacted by the intervention: there was no effect indicated in the mean MSC-expenses and GP-expenses of the treatment hospitals. As already depicted above, the effects of the interventions are not only visible in hospital's expenditures. They also depend on changes in quality, internal costs, treatment volume, engagement in changing the organization's cultural behaviours and structural practices. Furthermore, adjustment problems, the duration of the transition period and external factors play an important role. These factors should all be kept in mind when making a comprehensive conclusion on the effect of multi-year contracts and change programs.

Future research can contribute to the empirical evidence by investigating the other factors that play a role in assessing the effect of multi-year contracts and change programs at Dijklander and Noordwest hospitals. Furthermore, future researchers can perform the same study with different hospitals, that implemented comparable interventions, to gather more evidence on this topic in the literature. When gathering more evidence, insurers and providers can learn more about the successful interventions that can be implemented to enhance hospital' efficiency.

References

1. Centraal Planbureau. Zorguitgaven stegen in 2019 met 5,2 procent. 2020. Available from: https://cpb.nl/
2. Bijlsma M, Meijer A, Shestalova V. Vertical relationships between health insurers and healthcare providers. CPB Document no. 167. 2008. ISBN 978-90-5833-370-4/ Available from: https://www.researchgate.net/publication/23564502
3. Ruwaard S, Struijs JN. Meerjarige contracten in de zorg: stand van zaken anno 2018. Rijksinstituut voor Volksgezondheid & Milieu; 2018. Available from: https://rivm.nl/
4. Nederlandse Zorgautoriteit. Monitor inhoud contracten medisch-specialistische zorg 2018. Rijksoverheid. 2019. Available from: https://nza.nl/
5. Song Z, Safran DG, Landon BE, Landrum MB, He Y, Mechanic RE, Day MP, Chernew ME. The 'Alternative Quality Contract,' based on a global budget, lowered medical spending and improved quality. Health Affairs (Millwood). 2012 Aug;31(8):1885-94. Available from: https://doi.org/10.1377/hlthaff.2012.0327
6. Nigam A, Huising R, Golden BR. Improving hospital efficiency: a process model of organizational change commitments. Med care res & rev. 2014; 7(1). Available from: https://doi-org.eur.idm.oclc.org/10.1177%2F1077558713504464
7. Diepstraten M, Douven R, Kopanyi-Peuker A, Wijnker G. Casestudie Beatrixziekenhuis en Bernhoven. CPB Achtergronddocument. Available from: https://cpb.nl/
8. Dulmen S, Stadhouders N, Westert G, Wackers E, Jeurissen P. Op weg naar hoge kwaliteit en lage kosten in de medisch specialistische zorg. Evaluatie veranderpogramma's Rivas Zorggroep en Bernhoven. 2020. Available from: https://betaalbaarheidvandezorg.nl
9. van Poucke A, Ikkersheim D, Prins M, de Vries A. Ombuigen of barsten: uitdagingen voor de Nederlandse ziekenhuissector. KPMG Health Check. 2019. Available from: https://assets.kpmg/content/dam/kpmg/nl/pdf/2019/sector/ombuigen-of-barsten.pdf
10. van Leersum N, Bennemeer P, Otten M, Visser S, Klink A, Kremer JAM. Cure for increasing health care costs: The Bernhoven case as driver of new standards of appropriate care. Health Policy. 2019 Mar 1;123(3):306-311. Available from: https://doi.org/10.1016/j.healthpol.2019.01.002
11. Coöperatie VGZ. Maatschappelijk jaarverslag 2016. 2017. Available from: https://vgz.nl
12. Chernew ME, Mechanic RE, Landon BE, Safran, DG. Private-payer innovation in Massachusetts: the alternative quality contract. Health Affairs. 2011;30(1). Available from: https://doi-org.eur.idm.oclc.org/10.1377/hlthaff.2010.0980

13. Clemens J, Gottlieb JD. Do physicians' financial incentives affect medical treatment and patient health? Am Econ Rev. 2014;104(4):1320-1349. Available from: www.jstor.org/stable/42920741.
14. Eijkenaar F, Schut E. Uitkomstbekostiging in de zorg: een (on)begaanbare weg? Erasmus Universiteit Rotterdam. 2015. Available from: https://eur.nl
15. MacKay A. Contract duration and the costs of market transactions. Harvard Business Review Working Paper 18-058. 2020. Available from: http://dx.doi.org/10.2139/ssrn.3096534
16. Bruins B. Brief van de Minister voor Medische Zorg – Herziening zorgstelsel. Tweede Kamer der Staten-Generaal, kamerdossier 29689. 2018. Available from: www.rijksoverheid.nl/
17. Gaspar K, Portrait FRM, van der Heijden E, Koolman X. Global budget versus cost ceiling: a natural experiment in hospital payment reform in the Netherlands. Eur J Health Econ. 2019 Sep 16;21(1):105-114. Available from: https://doi.org/10.1007/s10198-019-01114-6
18. Cattel D, Eijkenaar F. Value-based provider payment initiatives combining global payments with quality incentives: a systematic review. Med Car Research & Review. 2019. Available from: https://doi-org.eur.idm.oclc.org/10.1177%2F1077558719856775
19. Boston Consultancy Group. How Dutch hospitals make value-based healthcare work. 2018. Available from: https://www.bcg.com/publications/2018/how-dutch-hospitals-make-value-based-health-care-work
20. André B, Sjøvold E. What characterizes the work culture at a hospital unit that successfully implements change - A correlation study. BMC Health Serv Res. 2017; 17. Available from: https://doi.org/10.1186/s12913-017-2436-4
21. Craig LE, Churilov L, Olenko L, Cadilhac A, Grimley R, Dale S, Martinez-Garduno C, McInnes E, Considine J, Grimshaw JM, Middleton S. Testing a systematic approach to identify and prioritise barriers to successful implementation of a complex healthcare intervention. BMC Med Res Methodol. 2017; 17,24. Available from: https://doi.org/10.1186/s12874-017-0298-4
22. Scott T, Mannion R, Davies HTO, Marshall MN. Implementing culture change in health care: theory and practice. Int J Qual Health Care. 2003; Vol 15(2) 111-118. Available from: https://doi.org/10.1093/intqhc/mzg021
23. Mannion R, Davies H. Understanding organisational culture for healthcare quality improvement. BMJ Open. 2018; 363. Available from: https://doi-org.eur.idm.oclc.org/10.1136/bmj.k4907
24. Braithwaite J, Herkes J, Ludlow K, Testa L, Lamprell G. Association between organisational and workplace cultures, and patient outcomes: systematic review. BMJ Open. 2017; 17. Available from: http://dx.doi.org/10.1136/bmjopen-2017-017708

25. Fiorio CV, Gorli M, Verzillo S. Evaluating organizational change in health care: the patient-centered hospital model. BMC Health Serv Res. 2018; Vol 18(1):95. Available from: https://doi.org/10.1186/s12913-018-2877-4
26. Vos L, Chalmers SE, Dückers MLA, Groenewegen PP, Wagner C, van Merode GG. Towards an organisation-wide process-oriented organisation of care: a literature review. Implementation sci. 2011; Vol 6, 8. Available from: https://doi.org/10.1186/1748-5908-6-8
27. Autoriteit Consument & Markt. Prijs- en volume-effecten van ziekenhuisfusies. 2017. Zaaknummer ACM/170/009041. Available from: https://www.acm.nl/sites/default/files/documents/2017-12/rapport-effecten-van-ziekenhuisfusies-prijs-en-volume-aangepaste-versie-2017-12-07.pdf
28. Harris J, Osgen H, Ozcan Y. Do mergers enhance the performance of hospital efficiency? J Oper Res Soc 2000; Vol 51:80 1-11. Available via: https://doi.org.eur.idm.oclc.org/10. 2307/253961
29. Kjekshus L, Hagen T. Do hospital mergers increase hospital efficiency? Evidence from a National Health Service country. J Health Serv Res & Policy 2007; Vol 12:4 230-235. Available via: https://www.jstor.org/stable/26751042
30. Tijani-Eniola O. Hospital mergers: Mixed impact on price, quality of patient care and hospital performance. Int J Sc Res Pub 2015; Vol 6;1. Available from: http://www.ijsrp.org/research-paper-0116/ijsrp-p4955.pdf
31. Zorgwijzer. Cijfers zorgverzekering. 2021. Available from: https://www.zorgwijzer.nl/faq/cijfers-zorgverzekering
32. Dijklander Ziekenhuis 2021. Available from: https://dijklanderziekenhuis.nl/
33. Van Leeuwen A. Waarheen voor de beste zorg? 2018. Elsevier Weekblad. Available from: https://www.ewmagazine.nl/onderzoek/achtergrond/2018/11/waarheen-voor-de-beste-zorg-656385/
34. Algemeen Dagblad. Hoe scoort het ziekenhuis bij jou in de buurt? Bekijk het hier. 2018. Available from: https://www.ad.nl/binnenland/hoe-scoort-het-ziekenhuis-bij-jou-in-de-buurt-bekijk-het-hier~a83840957/
35. Jaarverslag Waterlandziekenhuis Westfriesgasthuis. In het ziekenhuis. 2017. Available from: https://www.wlzwfgjaarverslag.nl/2017/in-het-ziekenhuis-2/
36. Noordwest Ziekenhuis 2021. Available from: https://noordwest.nl/
37. Jaarverslag Stichting Noordwest Ziekenhuisgroep. 2017. Available from: https://www.nwz.nl/Portals/14/Bijlagen/Over_ons/Organisatie/Jaarverslag/Jaarverslag_2017_Noordwest_Ziekenhuisgroep.pdf

38. Jaarverslag Stichting Noordwest Ziekenhuisgroep 2018. Available from: https://www.nwz.nl/Portals/14/Bijlagen/Over_ons/Organisatie/Jaarverslag/Jaarverslag_2018_Noordwest_Ziekenhuisgroep.pdf
39. Jaarverslaggeving 2018. Stichting Noordwest Ziekenhuisgroep. Available from: https://www.nwz.nl/Portals/14/Bijlagen/Over_ons/Organisatie/Jaarverslag/Jaarrekening_2018_Noordwest_Ziekenhuisgroep.pdf
40. Malay S, Chung KC. The choice of controls for providing validity and evidence in clinical research. Plast Reconctr Surg. 2013. Available from: https://dx-doi-org.eur.idm.oclc.org/10.1097%2FPRS.0b013e318262f4c8
41. Hamadi H, Apatu E, Spaulding A. Does hospital ownership influence hospital referral region health rankings in the United States. Int J Health Plan Mngmt. 2018; 33; 168– 180. Available from: https://doi-org.eur.idm.oclc.org/10.1002/hpm.2442
42. Jia P, Wang F, Xierali IM. Evaluating the effectiveness of the Hospital Referral Region (HRR) boundaries: a pilot study in Florida. Annals of GIS. 2020; 26:3, 251-260. Available from: https://doi.org/10.1080/19475683.2020.1798509
43. Diepstraten M, Douven R, Kopanyi-Peuker A, Wijnker G. Casestudie Beatrixziekenhuis en Bernhoven. Achtergronddocument CPB. 2020. Available from: https://cpb.nl/publicaties
44. De Nijs K. Curbing the trend: Estimating hospital-specific expenditure growth through regional variation. Erasmus University Rotterdam Msc Thesis. 2020.
45. Wing C, Simon K, Bello-Gomez RA. Designing difference in difference studies: practices for public health policy research. Annu Rev Public Health. 2018; 39:453-469. Available via: https://doi.org/10.1146/annurev-publhealth-040617-013507
46. Callaway B, Sant'Anna, PHC. Difference-in-differences with multiple time periods. 2019. Available via: http://dx.doi.org.eur.idm.oclc.org/10.2139/ssrn.3148250
47. Lechner M. The estimation of causal effects by difference-in-difference methods. Foundations and trends in econometrics 2010; Vol 4 (3). Available from DOI: 10.1561/0800000014.
48. Allison PD. Fixed effects regression models. Quantitative applications in the social sciences. Sage Publishers 2009. ISBN 978-0-7619-2497-5 (pbk.). Available from: books.google.com
49. Varkevisser M, Geest SA. Why do patients bypass the nearest hospital? An empirical analysis for orthopaedic care and neurosurgery in the Netherlands. Eur J Health Econ 2007; Vol 8 287-295. Available from: https://doi-org.eur.idm.oclc.org/10.1007/s10198-006-0035-0
50. Stuart, EA, Huskamp, HA, Duckworth K et al. Using propensity scores in difference-in-difference models to estimate the effects of a policy change. Health Serv Outcomes Res Method 2014; 14, 166–182. Available from: https://doi-org.eur.idm.oclc.org/10.1007/s10742-014-0123-z

51. Centraal Bureau voor Statistiek. Verhuisde personen; binnen gemeenten, tussen gemeenten, regio. 2020. Available from: https://cbs.nl/
52. Thabane L, Mbuagbaw L, Zhang S et al. A tutorial on sensitivity analyses in clinical trials: the what, why, when and how. BMC Med Res Methodol 2013; Vol 13(92). Accessible from: https://doi.org/10.1186/1471-2288-13-92.
53. Kirkwood BR, Sterne JAC. Essential Medical Statistics. Blackwell Publishing 2003; 2nd Edition. ISBN: 978–0–86542–871–3.
54. Torres-Reyna O. Panel data analysis: Fixed effects and random effects using Stata. Princeton University 2007. Available from: http://dss.princeton.edu/training/
55. Douven R, Burger M, Schut F. Does managed competition constrain hospitals' contract prices? Evidence from the Netherlands. Health Econ Pol Law 2019; Vol 15:3. Available via: https://doi.org/10.1017/S1744133119000215

Appendices

Appendix 1: Overview of selected control hospitals

Treatment hospitals

1. Noordwest Ziekenhuisgroep, Alkmaar
2. Noordwest Ziekenhuisgroep, Den Helder
3. Dijklander Ziekenhuis, Hoorn
4. Dijklander Ziekenhuis, Purmerend

Groningen

5. Treant Zorggroep Refaja, Stadskanaal

Drenthe

6. Treant Zorggroep Scheper, Emmen
7. Treant Zorggroep Bethseda, Hoogeveen
8. Wilhelminaziekenhuis, Assen
9. Isala Ziekenhuis, Meppel
10. Saxenburgh MC, Hardenberg

Overijssel

11. Isala Ziekenhuis, Zwolle
12. Deventer Ziekenhuis
13. ZGT, Almelo

Friesland

14. Tjongerschans Ziekenhuis, Heerenveen
15. Nij Smellinghe, Drachten
16. Sionsberg, Dokkum
17. Medisch Centrum Leeuwarden
18. Antonius Ziekenhuis, Sneek

Flevoland

19. Antonius Ziekenhuis, Emmeloord
20. Flevoziekenhuis Almere
21. St. Jansdal, Lelystad

Gelderland

22. St. Jansdal, Harderwijk
23. Gelre Ziekenhuis, Apeldoorn
24. Gelre Ziekenhuis, Zutphen
25. Ziekenhuis Gelderse Vallei, Ede
26. Rijnstate Ziekenhuis, Arnhem
27. Slingeland Ziekenhuis, Doetinchem
28. SKB, Winterswijk
29. Ziekenhuis Rivierenland, Tiel

Utrecht

30. Meander Ziekenhuis, Amersfoort

Noord-Holland

31. Spaarne Gasthuis, Haarlem
32. Spaarne Gasthuis, Hoofddorp
33. Rode Kruis Ziekenhuis, Beverwijk
34. Ter Gooi Ziekenhuis, Hilversum
35. Ter Gooi Ziekenhuis, Blaricum

Zuid-Holland

36. Langeland Ziekenhuis, Zoetermeer
37. Reinier de Graaf Ziekenhuis, Delft
38. Spijkenisse Medisch Centrum

Zeeland

39. Van Weel-Bethseda, Dirksland
40. Admiraal de Ruyter Ziekenhuis, Goes
41. Zorgsaam Ziekenhuis Terneuzen

Noord-Brabant

42. Bravis Ziekenhuis, Bergen op Zoom
43. Amphia Ziekenhuis, Breda
44. Jeroen Bosch Ziekenhuis, Den Bosch
45. Elkerliek Ziekenhuis, Helmond

Limburg

46. Viecuri Medisch Centrum, Venray
47. Viecuri Medisch Centrum, Venlo
48. St. Jans Gasthuis, Weert
49. Laurentius Ziekenhuis, Roermond
50. Zuyderland Ziekenhuis, Heerlen
51. Zuyderland Ziekenhuis, Sittard-Geleen

Appendix 2: Dominant 3-digit postal codes treatment/ control hospitals.

Hospital	3-digit postal codes	Hospital	3-digit postal codes
Noordwest Alkmaar	148 170 172 181 182 184/187 193	Slingeland Doetinchem	694 700/704 706/708
Noordwest Den Helder	176 178 179	SKB Winterswijk	709/714
Dijklander Hoorn	168 169 171 173 177 147	Ziekenhuis Rivierenland	400/403 411 406 662 418 419
Dijklander Purmerend	144	Meander Amersfoort	381/383 375 376 386 387
Treant Refaja Stadskanaal	950/952 954 955 957/959	Spaarne Haarlem	201/203 205 206
Treant Scheper Emmen	781/785 788 789 776	Spaarne Hoofddorp	213 215
Treant Bethesda Hoogeveen	790/793	Rode Kruis Beverwijk	191 194 195 196 197 198 199
Wilhelminaziekenhuis Assen	940 948 949	Ter Gooi Hilversum	121/124
Isala Meppel	794/796	Ter Gooi Blaricum	126 127 140 141
Hardenberg Saxenburgh MC	773 769 770 777/779	Langeland Zoetermeer	271 272
Isala Zwolle	801/804 772 815 805 809	Reinier de Graaf Delft	261 262
Deventer Ziekenhuis	741/743 812	Spijkenisse Medisch Centrum	318/321
Almelo ZGT	760 761	Van Weel-Bethseda Dirksland	324 325
Tjongerschans Heereveen	841 844/847 849 839	Admiraal de Ruyter Goes	430/438 442/449
Nij Smellinghe Drachten	920/923 928 987	Zorgsaam Terneuzen	450/458
Sionsberg Dokkum	910/914 917 929 985	Bravis Bergen op Zoom	470/472 461 462 466
Medisch Centrum Leeuwarden	883 891/894 900 902 905 907 908	Amphia Breda	481/489 492
Antonius Ziekenhuis Sneek	860/865 870/877 882	Jeroen Bosch Ziekenhuis	521/527 529/533
Antonius Emmeloord	830/832	Elkerliek Helmond	542 570 572/575
Flevoziekenhuis Almere	130/136	Viecuri Venray	580/585
St Jansdal Lelystad	821/824	Viecuri Venlo	591/594 598 599
St Jansdal Harderwijk	384 807 389	St Jans Gasthuis Weert	600 602 603
Gelre Apeldoorn	731/737	Roermond Laurentius	604 606 607 610
Gelre Zutphen	720 723/725 697	Zuyderland Heerlen	641/643 635 631 637 646 647
Gelderse Vallei Ede	671/674 390 670	Zuyderland Sittard-Geleen	612/618
Rijnstate Arnhem	681/684 686 692 688 695		

Table 9 - Dominant 3-digit postal codes

Appendix 3: Variance-covariance estimated fixed-effect model

	Robust			*Cluster*	
Variable	Coefficient (Std. error)	Significance level	Variable	Coefficient (Std. error)	Significance level
Dependent variable					
Mean GP-expenses (in €)					
Independent variables					
Interaction effect			*Interaction effect*		
2011 * treatment	39,6 (18,4)	0,032 *	2011 * treatment	39,6 (12,5)	0,003 **
2012 * treatment	47,0 (17,5)	0,007 **	2012 * treatment	47,0 (18,2)	0,013 *
2013 * treatment	-15,6 (19,4)	0423	2013 * treatment	-15,6 (17,6)	0,380
2014 * treatment	-6,5 (18,4)	0,724	2014 * treatment	-6,5 (20,5)	0,753
2015* treatment	-10,9 (16,5)	0,511	2015* treatment	-10,9 (20,9)	0,604
2016 * treatment	-	-	2016 * treatment	-	-
2017* treatment	-18,7 (16,2)	0,247	2017* treatment	-18,7 (12,2)	0,131
2018 * treatment	4,2 (15,7)	0,787	2018 * treatment	4,2 (11,1)	0,704

*Table 10 - Robust and Cluster check. Number of observations: 423.325 | F(32,307) = 1365.41 | corr(u_i, Xb) = 0.0183 | Prob > F = 0.0000 | * = 0,05, ** = 0,01, *** = 0,001 |*

Appendix 4: Fixed-effect model Noordwest and Dijklander

	Dijklander (without clustering)			*Noordwest (without clustering)*	
Variable	Coefficient (Std. error)	Significance level	Variable	Coefficient (Std. error)	Significance level
Dependent variable					
Mean GP-expenses (in €)					
Independent variables					
Interaction effect			*Interaction effect*		
2011 * treatment	40,5 (41,8)	0,333	2011 * treatment	42,6 (31,8)	0,181
2012 * treatment	68,8 (41,8)	0,100	2012 * treatment	32,7 (31,8)	0,304
2013 * treatment	35,9 (41,7)	0,390	2013 * treatment	-36,9 (31,8)	0,246
2014 * treatment	40,8 (41,7)	0,329	2014 * treatment	-28,2 (31,8)	0,375
2015* treatment	22,3 (41,7)	0,593	2015* treatment	-28,3 (31,8)	0,374
2016 * treatment	-	-	2016 * treatment	-	-
2017* treatment	18,3 (41,7)	0,660	2017* treatment	-31,8 (31,8)	0,315
2018 * treatment	13,5 (41,7)	0,746	2018 * treatment	1,3 (31,8)	0,967

Table 11 - Separated model without clustering. Noordwest | No. of observations: 413266 |F(300, 412933) = 17,06 | corr(u_i, Xb) = 0,0192 | Prob > F = 0,0000 | Dijklander | No. of observations: 404668 | F(294, 404341 = 17,27 | corr(u_i, Xb) = 0,0183 | Prob > F = 0,000

	Dijklander (with clustering)			*Noordwest (with clustering)*	
Variable	Coefficient (Std. error)	Significance level	Variable	Coefficient (Std. error)	Significance level
Dependent variable					
Mean GP-costs (in €)					
Independent variables					
Interaction effect			*Interaction effect*		
2011 * treatment	40,5 (11,7)	0,001 ***	2011 * treatment	42,6 (14,5)	0,005 **
2012 * treatment	68,8 (16,7)	0,000 ***	2012 * treatment	32,7 (16,9)	0,058
2013 * treatment	35,9 (20,7)	0,090	2013 * treatment	-36,9 (12,6)	0,005 **
2014 * treatment	40,8 (13,6)	0,004 **	2014 * treatment	-28,2 (14,9)	0,064
2015* treatment	22,3 (27,4)	0,419	2015* treatment	-28,3 (6,7)	0,000 ***
2016 * treatment	-	-	2016 * treatment	-	-
2017* treatment	18,3 (16,4)	0,268	2017* treatment	-31,8 (6,5)	0,000 ***
2018 * treatment	13,5 (9,0)	0,142	2018 * treatment	1,3 (14,2)	0,927

*Table 12 - Separated model with clustering | Noordwest | No. of observations: 413266 | Dijklander | No. of observations: 404668 | corr(u_i, Xb) = 0 | Std. Error adjusted for 50 clusters in type_hospital | * = 0,05, ** = 0,01, *** = 0,001 |*