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Make it happen.

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Abstract

In most studies on hospital merger effects, the unit of observation is the merged hospital, whereas the observed price is the weighted average across hospital products and across payers. However, little is known about whether price effects vary between hospital locations, products and payers. We expand existing bargaining models to allow for heterogeneous price effects and use a difference-in-difference model in which price changes at the merging hospitals are compared to price changes at comparison hospitals. We find evidence of heterogeneous price effects across health insurers, hospital products and hospital locations. These findings have implications for ex ante merger scrutiny.

1. Introduction

An increasing number of empirical studies have been conducted concerning the price effects of hospital mergers. In general, the aim of these studies is to test the effectiveness of antitrust policy. In competitive markets, the aim of preventive merger control is to prohibit anticompetitive consolidation. To determine whether a merger between two or more firms will result in anticompetitive price increases and/or quality decreases, antitrust authorities need to carry out a prospective review of the merger. However, merger reviews in the healthcare sector encounter specific difficulties because there are unique factors that render the most commonly used tests for measuring geographic markets less reliable in healthcare than in other sectors (Elzinga & Swisher, 2011). Retrospective studies are aimed at providing a better understanding of the effects of mergers, which, in turn may improve future antitrust policy.

The majority of the studies on retrospective merger analyses indicate a positive correlation between hospital mergers and prices (see e.g. Gaynor & Town, 2012; Vogt & Town, 2006; Gaynor & Vogt, 2000 for reviews). In most of these studies, the unit of observation is the merged hospital, whereas the observed price is the weighted average across different hospital products and across different payers. However, little is known about whether price effects vary between different hospital locations, different products and different payers. Because merged hospitals often continue to operate at different locations, produce multiple products and negotiate prices with a range of payers, an interesting question is whether these differences matter. If it turns out that they do matter, this may have important implications for ex ante merger scrutiny by antitrust authorities.

This article considers the question of whether the price effects of a hospital merger vary between locations, products and third-party payers (i.e. health insurers). By means of a hospital-insurer bargaining model, we show that the price effects of a hospital merger may vary and that the differences between locations, products and insurers may influence the outcome of hospital-insurer price setting differently. We show that the price effects differ between locations, products and insurers depending on: (I) the degree of substitution between the merging hospitals for different products, (II) the relative bargaining ability of hospitals and insurers and (III) the pre-merger price-cost margins. We then use a unique national dataset on hospital-insurer negotiated contract prices for each hospital product in the Netherlands to investigate whether the price effects of a merger between a general acute care hospital (henceforth hospital M1) and a neighboring general acute care hospital that also provides tertiary hospital care (henceforth hospital M2) vary between different hospital locations, different products and different insurers. The merger that we study was consummated in the Netherlands in year *t*[1].

Our article relates to two literatures. Firstly, we build on the literature that structurally estimates multilateral bargaining models of healthcare competition. In general, these models contribute to our understanding of price setting mechanisms in the healthcare industry. This is relevant because standard oligopoly models are not applicable to the hospital industry (Gaynor et al., 2015). Because the current Dutch healthcare system bears evident similarities with the US healthcare system, we are able to build on the models that were developed for the US health market by Gaynor and Town (2012) (hereafter: GT) and Gowrisankaran et al. (2015) (hereafter: GNT). Following these models, we describe a bargaining model in which hospital-product prices are bilaterally negotiated between insurers and hospitals. We show how hospital-insurer negotiations translate into product prices, and by adapting the GT and GNT models for hospital mergers we show that the price effect of a merger between two hospitals may be heterogeneous depending on the degree of substitution between hospitals, the relative bargaining ability of hospitals and insurers and the pre-merger

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1 For reasons of confidentiality, we only report those results that are of direct interest to this article. We anonymize the names of the merged hospitals, rival hospitals and insurers. For the same reason, the merger year is reported as *t* (which was between 2005 and 2012), with the year preceding the merger as *t*-1 and the year following the merger as *t*+1.

price-cost margins of different products at both merging hospitals. The most important contribution of this article to hospital-insurer bargaining models is that we, unlike GT and GNT, endogenize the product price ratio. That is, the models by GT and the GNT both assume that hospitals and health insurers bargain over a single base price per hospital, holding product-price ratios of each hospital fixed. This means that in both benchmark models each hospital entering a network always provides all treatments. Our model, in contrast, allows for the situation in which a hospital may be contracted only for a subset of treatments. In section 2, we explain that this assumption better matches current practice where contracts between hospitals and insurers can be concluded for a subset of treatments.

Secondly, we build on the literature on retrospective analyses of hospital mergers. Since the 1980s, hospital sectors in many OECD countries have become increasingly concentrated as a result of mergers (Gaynor and Town, 2012). Merger activity has fuelled a public and scientific debate about the consequences of mergers and the desirability of further concentration of healthcare sectors. An increasing number of empirical studies have been conducted concerning the price effects of hospital mergers. Most of these studies have shown that although mergers may bring about meaningful reductions in marginal costs and therefore improve welfare overall, mergers between rival hospitals are likely to raise the price of inpatient care in concentrated markets (Gaynor and Town, 2012). We build on these studies, but disaggregate the merger price effect and show that the price effects of a merger between two hospitals may differ between locations, providers and products. With that, we contribute to a better understanding of the effects of mergers, which, in turn may also improve future antitrust policy.

This article is structured as follows. We start with the bargaining model. We then discuss the applicability of this model to the Dutch hospital market (section 3) and describe the merger that we study (section 4). The next sections concern the empirical model (section 5) and the data (section 6). In section 7 we present the results and section 8 discusses the policy implications. Finally, our main findings are summarized in section 9.

2. The model

To explain the possibility of heterogeneous price effects of hospital mergers we consider a game-theoretical model of hospital-insurer bargaining, following the lines suggested by Gaynor and Town (2011) (GT) and Gowrisankaran et al. (2015) (GNT). These papers build on earlier literature analyzing hospital-insurer bargaining, notably Gal-Or (1997); Town and Vistnes (2001); Capps et al. (2003) and Gaynor and Vogt (2003).

To keep our model as simple as possible, we adopt a two-stage set-up following the base model of GNT. In the first stage of this model, health insurers[2] bargain and contract with hospitals on behalf of their insured and in the second stage, each consumer receives a health draw and seeks treatment at the hospital that maximizes his utility. Because the consumer commits to a restricted network of hospitals when he buys health insurance, he has the option of visiting any of the contracted hospitals when he is in need of specific care.

Like in the models by GT and GNT, we simplify some elements of the bargaining game: we condition on the network of the insurer[3] and do not allow consumers to switch insurers in response to a network change. Following GT and GNT, the bargaining solution used in this article is based on the framework that was developed by Horn and Wolinsky (1988). While not imposing a complete non-cooperative structure, this framework nests a non-cooperative Nash equilibrium within a cooperative game theoretical concept of a Nash bargaining solution.

To be able to explain heterogeneous price effects over products, we need to allow for flexibility in the price ratios between different products of the same hospital. Both the GT and the GNT models consider heterogeneous insurers, hospital locations and hospital products. However, they fix all the product-price ratios at the level of the respective disease-weight ratios. The hospitals are constrained to negotiate a base price per hospital location and the prices for different products are computed as a product of the base price and the disease weight[4]. Therefore, in their models a hospital system and an insurer bargain over a single base price per hospital location. Our model deviates from this assumption by freeing the product-price ratios. While in both benchmark models each hospital that enters a network always provides all treatments, our model allows for the situation in which a hospital may be contracted only for a subset of treatments. This also better matches practice where contracts between hospitals and insurers can be concluded for a subset of treatments. For example, in the US, we observe cases in which hospitals shifted resources and activities to central profitable services, while reducing or eliminating some loss making services (i.e. the so-called specialty service lines) (Berenson et al., 2006). This is in line with the anticipated strategy change towards integrated care delivery systems (Porter, 2009). Furthermore, there is an increase in the use of bundled payments, global payments or alternative quality contracts by health insurers (e.g. Chernew et al. 2011; Delbanco, 2014; Song et al. 2014). In these settings, a single payment covers the services that providers deliver to treat a given condition or provide a given treatment. Hence, in these cases,

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2 GNT use the term managed care organization or MCO if they refer to insurers that use provider networks and negotiate prices with providers. We refer to similar organizations, but use the term 'health insurer' instead as this is the more commonly used term in the Netherlands (which is the country in which the merger that we study took place).

3 There is some work on network formation games, with Ho (2009) being the most notable. Ho (2009) estimates the parameters of managed care organization's (MCO) choices of provider network focusing on the role of different networks on downstream MCO competition (Gowrisankaran et al., 2015). Like GT and GNT, we treat the insurers' network structure as given.

4 Each year, the Center for Medicare Services publishes DRG weights. The DRG weights measure the mean resource usage by diagnosis. In the model, they reflect the resource intensity of treatment. Using the DRG weights with a base price does not allow for heterogeneous price effects of mergers.

a price has to be determined for each bundle. Also in the Netherlands, which data we use when estimating the model parameters, hospitals may be contracted only for a subset of services. In the Netherlands, it is usually the insurers that initiate selective contracting of procedures. For example, Dutch health insurers have imposed rules on contracting certain types of operations. These rules say that if a hospital treats less than a certain number of patients in a given year, the hospital will not be contracted for that procedure in the years after. So, for example, one insurer selectively contracts providers of breast cancer surgeries (CZ, 2015), whereas another selectively contracts 15 hospital products (VGZ, 2014). As a result of selective contracting or hospitals' choices, in practice, the full hospital or a subset of procedures in a hospital may be contracted.

Model set-up

Following GT and GNT, we analyze hospital-insurer bargaining in a model with multiple hospitals and health insurers. For ease of comparison, we follow the model notation by GNT. In this model, there is a set of hospitals that is indexed by $j = 1, ..., J$; and a set of health insurance companies indexed by $m = 1, ..., M$. Each consumer buys insurance at a particular health insurer and hence the set of enrollees for a particular health insurer is indexed by $i = 1, ..., I$. With probability fid enrollees may be stricken by illness $d \in \{0, 1, ..., D\}$, where $d = 0$ means no illness.

In our model, we associate each illness with a hospital product[5]. Let Dj denote the list of all products of hospital j. We assume that the range of products may differ between hospitals. As explained in the overview, the assumption that some hospitals only provide a subset of products is in accordance with current practice in many hospital markets. Hospitals (each of which delivers a certain range of products) are subdivided over S systems, which set we denote M_s. Each system $s \in M_s$ is associated with a subset in the hospital-product space of all treatment options (jd) that can be provided by this system, where index j refers to hospitals and index d to products. L_s denotes the list of treatment options (jd) with which hospital j of system s enters the hospital-insurer bargaining game. For the sake of simplicity, we consider the situation in which each system is initially represented by one hospital.

For any consumer i, we denote his health insurer by $m(i)$. Following the base model version of GNT, we assume that $m(i)$ is chosen via long-run employer/health insurer contracts and hence, we assume that $m(i)$ is fixed. This implies that we do not allow consumers to switch insurers in response to a network change[6]. We also treat the network of each health insurer as given. That is, we assume that each health insurer enters the negotiations with some set of hospital systems and bargains with each of these systems over the prices of products. The network of insurer m denoted by N_m defines all hospital-product pairs available to th e enrollees of insurer m. By introducing the notation N_{md} for the subset of hospitals that provide product d in network N_m, we optain the expression: $N_m = \cup_{d \in \{1,...,D\}, j \in N_{md}} (jd)$.

5 Please note that d can also be a cluster of products.

6 GNT also present a modification of their base model to include the possibility that an enrollee may choose between different health insurers. In their posted premium model extension, the framework is as follows: (I) the health insurers set their network, (II) the health insurers post their premiums simultaneously and (III) the enrollees choose their health insurers. The bargaining process of the posted premium model is similar to the base model, except that the threat points are different. Since the results of the base model broadly align with the extended posted premium model, we follow the relatively simpler base model.

Value functions of a health insurer and a hospital system

When falling ill with illness d, the patient seeks treatment at a hospital that gives him the highest utility level. The utility function from the treatment of illness d at hospitals j is given by

$$u_{ijd} = \beta \mathbf{x}_{ijd} + e_{ij}$$

where $\mathbf{x}_{ijd}$ is a vector of hospital and patient characteristics such as travel time, hospital quality, or other characteristics, β is the associated vector of parameters and e_{ij} is an i.i.d. error term that is distributed type 1 extreme value. We assume that getting treated at a hospital does not require an out-of-pocket payment from the patient (see below). The patient with illness d may visit any of the contracted hospitals that provide this treatment in the insurer's network or an outside option. Following GNT, we assume that the outside option is treatment at a hospital located outside the market. The outside option is denoted by $j = 0$, so that the associated characteristics are normalized: $\mathbf{x}_{i0d} = 0$.

Health insurer m provides its enrollees a set of treatment options at hospitals in its network N_m, where each option $(jd) \in N_m$ listed in the insurance policy allows patients access to hospital j for treatment of disease d. Therefore, the utility function of enrollees introduced above results in the following expression for the probability that patient i with disease d chooses hospital j:

$$s_{ijd}\left(N_{m(i)}\right) = \frac{\delta_{ijd}}{\sum_{k \in \{0, N_{m(i),d}\}} \delta_{ikd}}$$

where $\delta_{ijd} = \beta \mathbf{x}_{ijd}, j \in \{0, N_{m(i),d}\}$. The notation $N_{m(i),d}$ denotes the subset of treatment options available to individual i enrolled at insurer m for treatment of illness d. Since the right hand side of equation (2) does not depend on prices and only includes product d, $s_{ijd}(N_{m(i)}) = s_{ijd}(N_{m(i),d})$.

It is important to note that GT and GNT differ in their position towards copayments. GT assumes that enrollees pay a premium to their insurer, which gets them access to the provider network without any additional payments, whereas GNT considers an extension in which they also model out-of-pocket payments (i.e. the negotiated base price multiplied by the coinsurance rate and the resource intensity of the illness). The GT model without copayments is in this respect similar to the GNT model with zero coinsurance rates. Because our empirical analysis focuses on the Netherlands and in the Netherlands, coinsurance as defined by GNT in the hospital sector is nonexistent[7], we follow the approach of GT or, put differently, the approach of GNT with zero coinsurance rates. For our model this means that the utility from treatment does not depend on hospital prices and hence the resulting choice probabilities are also independent of product prices.

The *ex ante* expected utility to patient i from network $N_{m(i)}$ is then:

$$w_i\left(N_{m(i)}\right) = \sum_{d=1}^{D} f_{id} \ln\left(\sum_{j \in \{0, N_{m(i),d}\}} \exp(\delta_{ijd}) \right)$$

Aggregating over the enrollees of insurer m, we obtain:

$$W_m(N_m) = \sum_{i=1}^{I} 1\{m(i) = m\} w_i(N_m)$$

7 Also copayments are very limited. There is a yearly mandatory deductible that the patient pays when he starts using healthcare. However, the deductible is limited to a fixed amount. Since almost all hospital prices are higher than this amount, each patient receiving treatment at any hospital would generally pay the same deductible. Hence, deductibles are expected to hardly affect patient hospital choice.

Denoting the prices that insurer m pays to hospital j for treatment d by p_{mjd}, we obtain the insurer's total cost as follows:

$$TC_m(N_m, \mathbf{p}_m) = \sum_{i=1}^{I} \sum_{d=1}^{D} 1\{m(i) = m\} f_{id} \sum_{j \in \{0, N_{md}\}} p_{mjd} s_{ijd}(N_m)$$

Following GNT, we assume that the health insurer is seeking to maximize the sum of the enrollee surplus (equal to w_i – $premium_m$ for each consumer) and the insurer's profit (equal to $premium_m$ – *expected* $cost_m(i)$ for each consumer) over all enrollees. Under this assumption, the value function of the health insurer is the difference between the *ex ante* expected utility of all the enrollees and the total payment to the hospitals treating these enrollees:

$$V_m(N_m, \mathbf{p}_m) = W_m(N_m) - TC_m(N_m, \mathbf{p}_m)$$

Note that in GNT the health insurer acts as an agent for the employer and, thus, cares equally about both enrollee welfare and insurer profit[8]. With that, it is assumed that the incentives of health insurers and enrollees are perfectly aligned which implies that both terms in equation (5) will have equal weights[9].

Substituting into this expression equations (3) and (4), and rearranging the terms, we derive the same expression in terms of prices and choice probabilities. Since both expected utility and the payment to the hospital are separable in products d, the total value function of a health insurer has an additive structure over the products. This can be seen as follows:

$$V_m(N_m, \mathbf{p}_m) = W_m(N_m) - TC_m(N_m, \mathbf{p}_m)$$

$$= \sum_i 1\{m(i) = m\} \sum_d f_{id} \left(\ln[\sum_{j \in \{0, N_{md}\}} \exp(\delta_{ijd})] - \sum_{j \in \{0, N_{md}\}} p_{mjd} s_{ijd}(N_m) \right)$$

$$= \sum_d \sum_i 1\{m(i) = m\} f_{id} \left(\ln[\sum_{j \in \{0, N_{md}\}} \exp(\delta_{ijd})] - \sum_{j \in \{0, N_{md}\}} p_{mjd} s_{ijd}(N_m) \right)$$

$$= \sum_d W_{md}(N_{md}) - TC_{md}(N_{md}, \mathbf{p}_{md}) = \sum_d V_{md}(N_{md}, \mathbf{p}_{md})$$

where $\mathbf{p}_m$ is the price vector of all product prices negotiated by insurer m, $\mathbf{p}_{md}$ denotes the subvector of product d's prices, N_{md} is the subset of options for product d, $W_{md}(N_{md}) = \sum_i 1\{m(i) = m\} f_{id} \ln[\sum_{j \in \{0, N_{md}\}} \exp(\delta_{ijd})]$ and $TC_{md}(N_{md}, \mathbf{p}_{md}) = \sum_d \sum_i 1\{m(i) = m\}$ $f_{id} \sum_{j \in \{0, N_{md}\}} p_{mjd} s_{ijd}(N_m)$. Since the choice probabilities do not depend on product prices, the enrollee surplus from each product neither depends on prices of other products.

8 This is also a reasonable assumption in the Netherlands, where the provision of basic insurance is subject to strict rules. See section 3 for more details.

9 If we assume stronger power on the enrollee or the health insurer side, we would have to impose a higher weight to the respective term (as discussed in Gowrisankaran et al., 2015 and Gaynor et al., 2015).

Following GT and GNT, we assume profit maximizing hospitals, which is typical in the health economics literature, especially because numerous studies found that the behavior of for-profit and not-for-profit hospitals is similar[10]. The marginal cost of providing product d in hospital j for health insurer m can then be denoted by mc_{mjd}:

$$mc_{mjd} = \gamma v_{mjd} + \epsilon_{mjd}$$

where v_{mjd} denotes a fixed effect, γ is the associated parameter and ϵ_{mjd} is an error term. Because we assume that hospitals are maximizing their profits, we let each hospital system s maximize the total profits earned from the contracts with health insurers:

$$\pi(M_s, N_m, \mathbf{p}_m) = \sum_{m \in M_s} \sum_{(jd) \in L_s} (p_{mjd} - mc_{mjd}) q_{mjd}(N_m)$$

where q_{mjd} denotes the production volumes of the hospitals under hospital-product system s and mc_{mjd} is the marginal cost of treatment d at hospital j for enrollees of insurer m.[11] Because of our assumption on the consumer utility function, the volume delivered by the hospital system only depends on the set of treatment options included in the network and not on the prices of these options. The production quantities of hospital j are then expressed by:

$$q_{mjd}(N_m) = \sum_i 1\{m(i) = m\} f_{id} s_{ijd}(N_m)$$

Bargaining problem

There are $M \times S$ potential contracts. However, in our model, each contract specifies the prices of treatment options that are contracted by the insurer and the hospital system, and not the base prices of the hospitals that enter the system, as in the models by GT and GNT. Following GT and GNT, we assume that bargaining occurs under complete information about the characteristics of enrollees and hospitals and we consider the Nash Bargaining solution price vector that results from the maximization of the product of the exponentiated value functions of both parties from agreement, conditional on all other prices. Based on the theoretical contributions by Binmore et al. (1986), Horn and Wolinsky (1988) and Collard-Wexler et al. (2014), it is assumed that the prices of each contract are negotiated conditional on the prices of all other contracts and that the agents do not change their strategies when they observe the outcome of the contracts that have already been concluded. That is, if one negotiating pair fails, the other pairs will continue the negotiation process conditional on their initial assumptions regarding the pricing outcomes of the other pairs ('passive beliefs'). The introduction of these assumptions corresponds with the models that were developed in the recent literature on hospital-insurer negotiations (in particular, GT and GNT). Here, we additionally assume that both insurers and hospitals appoint their negotiating teams per product. Therefore, bargaining on one product occurs separately from other products.

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10 In this article, we assume that hospitals are profit maximizers, but Lakdawalla and Philipson (2006) and Gaynor et al. (2015) have shown that output maximization can be incorporated in the standard hospital utility function in addition to profit maximization by using perceived marginal costs instead of actual marginal costs.

11 Marginal costs may differ between insurers, for example because of differences in administrative costs. If we assume, however, that marginal costs are the same over insurers, we could drop index m from the notation of marginal costs.

Under these assumptions, the objective of the Nash bargaining problem of health insurer *m* and system *s* is as follows:

$$NB^{m,s}(\mathbf{p}_{m,s}|\mathbf{p}_{m,-s})$$
$$= \left(\sum_{d}[\sum_{(jd)\in L_s} q_{mjd}(N_m)(p_{mjd} - mc_{mjd})]\right)^{b_{s(m)}}$$
$$\times \left(\sum_{d}[V_m(N_m, \mathbf{p}_m) - V_m(N_m \backslash L_s), \mathbf{p}_m)]\right)^{b_{m(s)}}$$

where $b_{s(m)}$ and $b_{m(s)}$ are the bargaining weights of system *s* and health insurer *m* respectively. The weights characterize the bargaining abilities of both negotiating parties. They are normalized to sum up to one. $\mathbf{p}_{m,s}$ and $\mathbf{p}_{m,-s}$ denote the insurer's prices of the treatment options at hospitals that participate in hospital system s and those that do not participate in the system, respectively.

The Nash equilibrium is a vector of prices that maximizes the Nash bargaining value specified above. Each price vector maximizes the value for the negotiating pair, conditional on the other prices:

$$p^*_{mjd} = \underset{p_{mjd}}{\text{argmax}}\, NB^{m,s}(p_{mjd}, \mathbf{p}^*_{m,-(jd)}\, |\mathbf{p}^*_{m,-s})$$

The new notation $\mathbf{p}^*_{m,-(jd)}$ denotes the equilibrium price vector consisting of all negotiated prices between insurer *m* and system *s* except for $\mathbf{p}_{mjd}$.

Although each team negotiates separately, different negotiating teams of the same agent would generally take into account the effect of their decisions on patient flows for other products of the same agent. However, as according to equation (2) patient flows are fully determined by the network structure (i.e., the set of treatment options) and not by prices, the decisions of different product teams of the same agent will not be dependent on each other. This can be seen as follows. Consider that hospital *j* negotiates with insurer *m* over the price of product *d*, conditional on the other prices. We partition the set of all diseases into $\{D', d, D''\}=\{d_1,...,d_D\}$, where $\{D',d\}$ covers the subset of products with which hospital *j* enters the network of insurer *m* and D'' covers the rest. Because *m(i)* is fixed, a hospital system that fails to reach agreement with a particular insurer regarding treatment option *(jd)* cannot capture any profit on this treatment option from the enrollees of this health insurer. Therefore, the disagreement outcome of the hospital system in negotiation over this treatment option will be zero. The payoff structure in bargaining between insurer *m* and hospital *j* over *(jd)* will then be:

$$j^d_{agree} = \pi_{jd}(N_{md}, \mathbf{p}_{md}) + \pi_{j,D'}(N_{mD'}, \mathbf{p}_{mD'})$$

$$j^d_{disagree} = \pi_{jD'}(N_{mD'}, \mathbf{p}_{mD'})$$

$$m^d_{agree} = V_{md}(N_{md}, \mathbf{p}_{md}) + V_{mD'}(N_{mD'}, \mathbf{p}_{mD'}) + V_{mD''}(N_{mD''}, \mathbf{p}_{mD''})$$

$$m^d_{disagree} = V_{md}(N_{md}\ \backslash j, \mathbf{p}_{md}) + V_{mD'}(N_{mD'}, \mathbf{p}_{mD'}) + V_{mD''}(N_{mD''}, \mathbf{p}_{mD''})$$

This payoff structure implies that the difference between the agreement and disagreement payoffs in negotiations on any product *d* only depends on the part related to that particular product. In particular, $j^d_{agree} - j^d_{disagree} = \pi_{jd}(N_{md}, \mathbf{p}_{md})$ and $m^d_{agree} - m^d_{disagree} = V_{md}(N_{md}, \mathbf{p}_{md}) - V_{md}(N_{md}\backslash j, \mathbf{p}_{md})$.

Hence, only these terms will be relevant for the derivation of the price p_{mjd}. Note that bargaining over this price only occurs if the sum of the payoffs is positive: $j_{agree}^{d} - j_{disagree}^{d} + m_{agree}^{d} - m_{disagree}^{d} > 0$, therefore each 'link' *(jd)* included in the network must satisfy:

$$\pi_{jd}(N_{md}, \mathbf{p}_{md}) + V_{md}(N_{md}, \mathbf{p}_{md}) - V_{md}(N_{md} \backslash j, \mathbf{p}_{md})$$
$$= W_{md}(N_{md}) - W_{md}(N_{md} \backslash j) - mc_{mjd} q_{mjd}(N_{md})$$
$$- \sum_{l \neq j, l \in \{0, N_{md}\}} p_{mjd}(N_{md}) \left(q_{mld}(N_{md} \backslash j) - q_{mld}(N_{md}) \right) > 0$$

Hence, hospital j will produce product d only if this condition is satisfied. The payoff structure outlined above leads to the following Nash bargaining problem with respect to p_{mjd}:

$$\max_{p_{mjd} | N_{md}, \mathbf{p}_{m,-j,d}} \left(j_{agree}^{d} - j_{disagree}^{d} \right)^{b_{s(m)}} \left(m_{agree}^{d} - m_{disagree}^{d} \right)^{b_{m(s)}}$$

where $\mathbf{p}_{m,-j,d}$ corresponds to the price vector of contract prices of hospitals other than j in the subset of treatments options N_{md}. The same type of Nash bargaining problem as described above is considered in GNT and GT, with the difference that their problem is formulated for a hospital's base price, keeping a product weights fixed in accordance to the disease weights of different diagnoses.

From the first order condition (FOC) of this problem, we derive the expression for product prices:

$$p_{mjd} = b_{s(m)} \frac{W_{md}(N_{md}) - W_{md}(N_{md} \backslash j)}{q_{mjd}} + b_{m(s)} mc_{mjd} + b_{s(m)} \sum_{k \neq j} [p_{mkd} d_{md}^{jk}]$$

where $d_{md}^{jk} = \frac{q_{mkd}(N_{md} \backslash j) - q_{mkd}(N_{md})}{q_{mjd}}$. The numerator of this ratio shows how many patients of insurer m with illness d will flow to hospital k if hospital j no longer treats this illness, and therefore d_{md}^{jk} defines the disease-specific diversion share of patients with illness d from hospital j to hospital k. A higher value of the diversion share suggests a higher degree of substitution between two hospitals in treating this illness.

The expression for p_{mjd} suggests that a product price of a hospital is increasing in the hospital's marginal costs of this product, the product prices of other hospitals, and net value that the inclusion of treatment option *(jd)* brings to the insurer's network. In addition to these factors, negotiated prices also depend on the bargaining abilities/weights of the hospital and the insurer. Differences in these parameters can explain the presence of price differences between health insurers, hospital locations and hospital products.

Merger analysis

The merger analysis considered in our article adopts a method proposed by GT. The method by GT allows us to derive the expressions of product price changes in a closed form, which simplifies the price comparison across products and players. GT consider two alternative approaches to model a hospital merger of hospitals j and k. In the first approach, it is assumed that after the merger, these hospitals still negotiate prices per hospital, but take into account the impact of disagreement on the flow of patients to each other. In the second approach it is assumed that hospitals negotiate jointly and will charge the same price after the merger. Because our empirical application deals with the situation in which hospitals continue to charge different prices after they merged, we follow the first approach. Please note that because in our model the patient flows of different products are independent of each other, the problem can be split and analyzed separately for each product.

Drawing from GT, we analyze the situation in which two hospitals that enter the same network are merging and consider the bargaining problem for product d after their merger has taken place (assuming that the network covers treatment options of d at both hospitals). If each of the merged hospitals negotiates its own price of the product, but accounts for the effect on the other's patient flow, we obtain the following expressions for the agreement and disagreement payoffs in the bargaining problem of hospital j:

$$(j+k)^d_{agree} = [p_{mjd} - mc_{mjd}]q_{mjd}(N_{md}) + [p_{mkd} - mc_{mkd}]q_{mkd}(N_{md})$$

$$(j+k)^d_{disagree} = [p_{mkd} - mc_{mkd}]q_{mkd}(N_{md} \backslash j)$$

$$m^d_{agree} = W_{md}(N_{md}) - p_{mjd}q_{mjd}(N_{md}) - \sum_{l \neq j} p_{mld}q_{mld}(N_{md})$$

$$m^d_{disagree} = W_{md}(N_{md} \backslash j) - \sum_{l \neq j} p_{mld}q_{mld}(N_{md} \backslash j)$$

Writing down the Nash bargaining solution for this game and transforming the FOC of this problem, we derive the price of hospital j's product d after the merger, $p^{(j+k)}_{mjd}$, as follows:

$$p^{(j+k)}_{mjd} = b_{s(m)} \frac{W_{md}(N_{md}) - W_{md}(N_{md} \backslash j)}{q_{mjd}} + b_{m(s)} mc_{mjd} + \frac{p_{mkd} d^{jk}_{md}}{q_{mjd}} + b_{s(m)} \sum_{l \neq j} [p_{mld} d^{jl}_{md}]$$

If we then take the difference between this price and the initial price level of hospital j, we obtain the expression for price change due to merger (given that the marginal costs are not affected by the merger):

$$p^{(j+k)}_{mjd} - p_{mjd} = b_{m(s)}(p_{mkd} - mc_{mkd}) d^{jk}_{md}$$

The same type of derivations can be done for hospital k, with indices k and j changing places.

Heterogeneous price effects of hospital mergers

There are a few important conclusions that can be drawn from equation (10) with respect to the price effect of a hospital merger. The first important finding is that product d's price change after the merger in each hospital is increasing in the diversion share between these hospitals. Since the diversion share reflects the degree of substitution between the hospitals, this result tells us that a merger will increase the product's price more if the hospitals that partner in the merger are close substitutes with respect to that product. Therefore, if substitution between hospitals is stronger for one product than for another product[12], the price increase after the merger will be higher for the first product and hence hospital mergers may lead to heterogeneous price effects across different products and different locations.

The second most important conclusion that follows from our model is that, according to equation (10), the price change caused by merger is proportional to the difference between the price and the marginal cost of the other hospital (i.e. the merger partner). Therefore, these differences also contribute to explaining the heterogeneity of price changes after the merger for different products

12 The substitution rates may differ across products, for example, because for some hospital products patients' willingness to travel might be higher, there is more intense competition with nearby hospitals over those products or the transparency of different product markets differs.

and locations. Merging with a hospital whose price of product d is higher, whereas the marginal cost are lower, would result in a greater price increase (other things being equal).

Finally, we observe, perhaps at first sight somewhat contra-intuitively, that a price increase caused by merger is proportional to the bargaining ability $b_{m(s)}$ of the insurer. Thus, a health insurer with greater bargaining ability against hospital system s is confronted with a higher price increase after the merger. This result suggests that, although a greater relative bargaining ability of the insurer in comparison to hospitals provides the insurer with more leverage against these hospitals, this leverage advantage is reduced after the merger of the hospitals.

3. The Dutch hospital market

In this article, we estimate the price changes of a merger between two Dutch hospitals. From the viewpoint of the bilateral bargaining model, the current Dutch healthcare system bears important similarities with the US healthcare system. In recent decades, the Netherlands, like several other OECD countries, has embraced a market-oriented approach to healthcare. After decades of strict governmental supply-side regulation, the Dutch healthcare system is currently undergoing a transition towards regulated (or 'managed') competition (Van de Ven & Schut, 2009; Van de Ven & Schut, 2008; Schut & Van de Ven, 2005). The main goal of the market-oriented healthcare reforms is to increase the efficiency of the system and its responsiveness to patients' needs, whereas maintaining universal access to care (Schut & Van de Ven, 2005).

Of particular importance to this article are the introduction of the Health Insurance Act (HIA) in 2006 and the introduction of hospital-insurer bargaining in 2005. Under the HIA, all Dutch citizens are obliged to buy standardized individual basic health insurance from a private insurer. The standardized basic benefits package specified in the HIA is fairly comprehensive and includes hospital care, GP services, prescription drugs and maternity care. Having bought an insurance policy, the enrollee gets access to all hospitals of the contracted network without co-payments. As described in section 2, there is an annual deductible per adult individual, although most hospital product prices are higher than the fixed amount that is set by the deductible[13] and hence the deductible does not play a role in patients' hospital choices. Dutch health insurers are furthermore required to offer all applicants standardized coverage at a community-rated premium, the insurers have to offer all basic health insurance policies to all applicants (i.e. a guaranteed issue requirement) and consumers are free to choose their health insurer during an annual enrolment period. Risk equalization across insurers takes place to ensure a level playing field for health insurers and to prevent risk selection. The insurers' market shares are relatively stable[14].

In 2005, a product classification system for hospital and medical specialist care was introduced. Each activity and/or service provided by a hospital, including outpatient care, which is associated with a patient's demand for care, is referred to as a Diagnosis and Treatment Combination (DTC)[15]. Following the introduction of the DTC system, the scope for free negotiations of prices between hospitals and health insurance companies has gradually increased from 10% of hospital revenue in 2005, to 20% in 2008, to 34% in 2009 and to 70% in 2012. For the remaining part, hospital prices are still regulated. For products and services included in the free-pricing segment, each hospital typically renegotiates the terms of its contracts with health insurers on an annual basis. Dutch health insurers are allowed to engage in selective contracting with healthcare providers. As explained in section 2, there are several cases in which the insurer contracts only a subset of treatments in hospitals.

The two-stage model that underlies the bargaining theory developed above reflects how Dutch health insurers and hospitals negotiate over the products in the free-pricing segment: consumers buy health insurance from health insurers and health insurers bargain and contract with hospitals on behalf of those that they insure. In the early years of the reform selective contracting was limitedly used, but over the years, the number of health insurers offering contracts with restricted

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13 Just 11% of all patients received treatments that cost less than 165 euro in 2011. The prices of the products that we consider in our article all exceed the deductible during the study period.

14 For example, the switching rate between health insurance companies in the Netherlands was 6% in 2012.

15 The DTC system is based on the concept of Diagnosis-Related Groups but constitutes a newly developed classification system. The Dutch system originally contained 29,000 DTCs. In 2007, a project was initiated to decrease the number of DTCs to about 3,000. This was known as the 'DOT revision' and was implemented in January 2012.

provider networks has increased. Furthermore, the available evidence on the nature of hospital-insurer negotiations in the Netherlands suggests that until 2012, hospital-insurer bargaining focused on price, rather than on quality of volume of care (Ruwaard et al., 2014; Meijer et al., 2010; NZa, 2009). The introduction of the HIA has led to strong price competition between health insurers and health insurers have put increasing pressure on hospitals to charge lower prices (Schut & Van de Ven, 2011). It seems as if the threat of selective contracting, rather than its actual use, may already have had an impact on hospital-insurer bargaining.

4. The merger

Dutch local and regional hospital markets are highly concentrated[16] and mergers represent the largest change in the Dutch hospital industry nowadays as no hospitals have entered or exited the market since 2005. Between 2005 and 2012, 17 mergers involving 34 hospitals were cleared by the Authority for Consumers and Markets (ACM)[17] (www.acm.nl), among which the merger that we study in this article. All mergers took place between neighboring hospitals.

The merger that we study was consummated in year *t* (which was between 2005 and 2012). The merger was notified to the ACM prior to taking place[18]. Following the notification, the ACM carried out a general review of the proposed merger in which they made prospective inferences regarding the expected anticompetitive effects of the merger on the market. In the Netherlands, a merger requires a license when there is reason to assume that 'a dominant position that appreciably restricts competition on the Dutch market or a part thereof could arise or be strengthened as a result of the said concentration' (Mededingingswet, Section 37.2). The merger that we study did not require a license and was cleared after the first general review. The decision to clear the merger evoked critical acclaim by health economists, however, who argued that the prospective merger analysis by the antitrust authority had been lacking and that it was likely that the merger had created a dominant position for the two hospitals involved (Varkevisser & Schut, 2008). Hence, this merger makes an interesting case for further retrospective studies.

The locations

The merger involved a general acute care hospital (hospital M1) and a neighboring general acute care hospital that also provides tertiary hospital care (hospital M2). Hospital M1 is located in an isolated geographical area, whereas hospital M2 is located in a more densely populated region with several other hospitals nearby. The distance between hospitals M1 and M2 is about 50 kilometers[19]. According to the ACM, the merging hospitals were subject to competition from five other hospitals before the merger took place. Prior to the merger, hospital M2 was the largest competitor to hospital M1 and therefore posed a major constraint on hospital M1's prices, whereas hospital M2 had multiple competitors. After the merger, hospital M1 was expected to experience competitive pressure from only one rival hospital, whereas hospital M2 was expected to experience notable competitive pressure from five other hospitals[20]. The differences in competitive pressure in the markets of hospitals M1 and M2 may result in heterogeneous price effects of the merger (see section 2). To find out whether the merging hospitals exploited this opportunity, we disaggregated the merger effect for each of the two merging hospital locations.

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16 In 2006, the average HHI of Dutch hospitals equaled 2.350 (Halbersma et al., 2010) and since then no hospitals entered or exited the hospital market. Only mergers have decreased the number of hospitals.

17 The Authority for Consumers and Markets is the Dutch antitrust agency. The legal predecessor of the Authority for Consumers and Markets, the Netherlands Competition Authority, has carried out the review of some of these mergers. For reasons of clarity, however, we ascribe the decisions made by the Netherlands Competition Authority to its legal successor, which has been in charge since April 1, 2013: the Authority for Consumers and Markets.

18 According to most antitrust laws, mergers must be reported to an antitrust authority prior to consummation (see 15 USC §18A for the US and the competition laws of the EU Member States or EC: 2004 for the European Union's rules on prior merger notification). The Dutch antitrust law is no exception (Mededingingswet, section 37.2).

19 1 kilometer is approximately 0.621 miles

20 None of these rivals provides tertiary hospital care.

The products

In this article, we estimated the impact of the merger in three separate product markets that jointly make up 47.5 percent of the merged hospital's turnover in the segment for which Dutch insurers and hospitals were allowed to freely negotiate prices at the time of the merger. We looked at hip replacements, knee replacements and cataract surgery. Most hospitals provide these services. In year *t*, 95% of all Dutch hospitals (n=97) and 2.7% of all Dutch Independent Treatment Centers (ITCs)[21] (n=73) provided hip replacements, 95% (hospitals) and 7% (ITCs) provided knee replacements and 96% (hospitals) and 15% (ITCs) provided cataract surgery. These products were also provided by hospitals M1 and M2 and all five rivals in year *t*. At time of the merger, there were no ITCs in the regional market that offered any of the hospital products considered. Table 1 presents descriptive statistics on the patients for each product in hospitals M1 and M2 and four rivals[22] before and after the merger.

After merger, the hospitals had an opportunity to concentrate care in one of the two hospital locations. This does not seem to have occurred, however. Even though it follows from table 1 that hospital M2 provided many more hip replacements in year *t*+1 than in *t*-1, the provision of hip replacements in hospital M1 did not change significantly. The hospitals therefore do not seem to have concentrated care in hospital M2 after the merger. Rather, it seems that hospital M2 is, post-merger, better able to attract patients in need of hip replacements because the number of hip replacements performed in rival hospitals decreased slightly whereas the total number of patients in the market did not change significantly.

In hospital M1, the average age of patients undergoing knee replacements dropped between *t*-1 and *t*+1. Again, this does not seem to be an attempt to change patient flows in the merged hospitals, as the mean age of patients undergoing knee replacement surgery in hospital M2 did not change. However, according to hospital M1's website, the hospital has been testing out an innovative procedure for knee replacements since year t for which only patients under 60 years old are eligible. This is likely unrelated to the merger, but could potentially explain the decrease in the patients' average age observed in the data.

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21 ITCs are comparable to freestanding Ambulatory Surgery Centers (ASCs) that operate in the US and UK healthcare markets (see e.g. Gaynor & Town, 2012; Carey et al., 2011). Independent Treatment Centers (ITCs) are typically much smaller than general hospitals and only compete on a narrow range of specialties. Their market share is relatively small, but their influence has increased because they usually offer elective care treatments, focus on the free-pricing segment and have rapidly grown in number and size (NZa, 2012; NZa, 2009). The joint market share of all ITCs increased from 1.5 percent (2005) to 4 percent (2007) of the free-pricing segment's total returns (NZa, 2009) and from 1 percent (2007) to 2.3 per cent (2010) of total medical specialist care (NZa, 2012).

22 We excluded all hospitals that had more than 15% missing prices for either hip or knee replacements or cataract surgeries in the period *t*-2 to *t*+2. The fifth rival hospital was therefore excluded from the analysis. See section 5 for more information on the exclusion criteria.

Table 1 **Descriptive statistics**

	Hip replacements		Knee replacements		Cataract surgery	
	t - 1	*t* + 1	*t* - 1	*t* + 1	*t* - 1	*t* + 1
Panel A. Hospital M1						
Volume	174	175	223	293	387	361
Gender (% male)	0.28	0.38	0.34	0.43	0.38	0.35
Patients' average age	68	68	64	56	72	73
Patients' average SES score	0.05	-0.14	0.15	0	0.09	-0.06
Panel B. Hospital M2						
Volume	390	511	271	299	2144	2113
Gender (% male)	0.34	0.35	0.34	0.32	0.41	0.40
Patients' average age	68	70	69	69	72	73
Patients' average SES score	0.31	0.42	0.39	0.48	0.35	0.42
Panel C. Rival 1						
Volume	165	154	164	135	1026	1045
Gender (% male)	0.27	0.36	0.27	0.29	0.41	0.37
Patients' average age	70	71	71	69	75	75
Patients' average SES score	-0.22	-0.05	-0.06	-0.09	-0.09	-0.02
Panel D. Rival 2						
Volume	237	195	162	162	881	1088
Gender (% male)	0.32	0.34	0.32	0.38	0.43	0.41
Patients' average age	70	68	68	68	73	72
Patients' average SES score	0.15	0.12	0.15	0.28	0.22	0.26
Panel E. Rival 3						
Volume	136	114	146	118	650	972
Gender (% male)	0.34	0.28	0.40	0.29	0.38	0.42
Patients' average age	70	62	70	70	75	74
Patients' average SES score	-0.83	-0.88	-0.76	-0.69	-1.01	-0.96
Panel F. Rival 4						
Volume	169	155	101	151	855	763
Gender (% male)	0.34	0.26	0.38	0.35	0.43	0.44
Patients' average age	69	73	70	71	75	75
Patients' average SES score	0.24	0.46	0.09	0.36	0.17	0.4
Panel G. Other hospitals						
Volume	231 (14)	234 (15)	196 (12)	199 (12)	1590 (146)	1545 (137)
Gender (% male)	0.33	0.34	0.32	0.33	0.39	0.41
Patients' average age	69 (0.37)	69 (0.25)	69 (0.27)	69 (0.26)	73 (0.32)	73 (0.29)
Patients' average SES score	-0.04 (0.05)	-0.18 (0.08)	0 (0.05)	-0.11 (0.07)	0.01 (0.05)	-0.09 (0.07)

Notes: The standard errors are in parentheses. We excluded all hospitals that had more than 15% missing prices for either hip or knee replacements or cataract surgeries in the period *t*-2 to *t*+2. The fifth rival hospital was therefore excluded from this analysis. Panel G displays the descriptive statistics of the hospitals other than hospitals M1, M2 and the rival hospitals. Within panel G, 51 hospitals performed hip replacements, 56 hospitals performed knee replacements and 57 hospitals performed cataract surgeries. The rows on volume only report cases which have a valid gender, age and SES-score.

The health insurers

At the time of the merger, at least five health insurers were active in the region[23]. Four of these were independent health insurers, whereas the fifth was in fact a joint purchasing organization representing the majority of smaller health insurers. For reasons of clarity, we will henceforth treat this purchasing entity as a health insurer. All five health insurers are active on the national insurance market. According to table 1, the volume of patients has not changed significantly across hospitals, indicating that health insurers did not shift enrollees away from the merged hospitals to rival hospitals in *t*+1.

Table 2 shows the insurers' market share for each product and for each hospital in years *t*-1 and *t*+1. The market shares have not changed significantly over the years.

Table 2 **Health insurers' market share per product per hospital in *t*-1 and *t*+1**

	Market share insurer 1		Market share insurer 2		Market share insurer 3		Market share insurer 4		Market share insurer 5	
	t-1	*t*+1	*t*-1	*t*+1	*t*-1	*t*+1	*t*-1	*t*+1	*t*-1	*t*+1
Panel A. Hospital M1										
Hip replacements	0.76	0.74	0.05	0.04	0.09	0.13	0.05	0.02	0.05	0.07
Knee replacements	0.69	0.61	0.05	0.06	0.16	0.20	0.06	0.08	0.05	0.06
Cataract surgery	0.84	0.77	0.01	0.03	0.09	0.09	0.04	0.05	0.02	0.06
Panel B. Hospital M2										
Hip replacements	0.62	0.62	0.08	0.06	0.19	0.17	0.04	0.06	0.07	0.08
Knee replacements	0.69	0.62	0.04	0.03	0.17	0.20	0.01	0.06	0.09	0.08
Cataract surgery	0.70	0.71	0.04	0.05	0.16	0.14	0.02	0.03	0.08	0.08

Notes: The health insurers' market shares are based on the number of cases per hospital-insurer-product combination.

Although insurer 1 has the largest market share per product per hospital (its market share ranges from 61% to 84%) it is not the largest health insurer nationally[24]. Regional market shares reflect the continuing effect of the former regional legal monopoly positions of local health insurers (a policy that was abolished in 1992) (Halbersma et al., 2010).

23 In fact, there are six health insurers active in the region. However, for the sixth health insurer, we did not have valid prices in the post-merger year (*t*+1) for the merging hospitals M1 and M2. This health insurer was therefore not included in the difference-and-difference estimates or in any other analysis. The effect of excluding this health insurer for hospital M1 and hospital M2 is most likely negligible, however, because the health insurer only accounts for less than 2% of all hip, knee and cataract patients in hospitals M1 and M2.

24 For reasons of confidentiality, we cannot report the national market shares of the health insurers.

5. Empirical model specification

We use data on hospital-insurer negotiated contract prices in the Netherlands for each of the three hospital products considered, to investigate whether the merger between hospitals M1 and M2 has led to price changes and if so, whether this effect varies between locations, payers and products. There are several ways to calculate price changes post-merger. The first method is to calculate the post-merger price change for each hospital product indexed on, for example, the average price change over all hospitals. However, these price changes would only give us a crude indication of the effect of the merger as it does not take account of changes in prices that would also have occurred if the merger had not taken place.

Although our model focuses on the price effects that follow from the interaction between health insurers and hospitals, large post-merger price increases for merged hospitals in comparison to prices among a control group could be consistent with at least four hypotheses according to the empirical literature (Haas-Wilson & Garmon, 2011; Adams & Noether, 2011): (I) the merger created or enhanced the hospital's power to raise its prices for general acute inpatient services; (II) between the years t-1 and t+1 there was an increase in the product complexity of inpatient cases or an increase in the severity of patients' illness in the merging hospitals relative to non-merging hospitals; (III) between the years t-1 and t+1, the quality of care associated with the products improved at the merging hospitals relative to non-merging hospitals, which increased value and (perhaps) cost and (IV) pre-merger prices at the merging hospitals were lower than the competitive equilibrium prices. In other words, the post-merger price increases at the merged hospital could be an adjustment towards equilibrium (Garmon & Haas-Wilson, 2011). We call this latter phenomenon 'catching up'. When interpreting our results in section 8, we will also reflect on these alternative explanations, arguing that the first explanation is the most likely in our case.

Because we wanted to control for price changes that would have occurred even if the merger had not taken place, we used a difference-in-difference (DID) model in which price changes at the merging hospitals are compared to price changes among a group of comparison hospitals which were unaffected by the merger (i.e. the control group). The identifying assumption of a difference-in-difference estimation is that trends (price trends) would be the same in both groups in the absence of the event (merger). This assumption is referred to as the 'common trend assumption'. Following the suggestion of Angrist and Pischke (2009), we investigated whether the common trend assumption applies by using data on multiple periods.

To examine the effect of aggregating the merger price effect, we estimated difference-in-difference models at various aggregation levels. As a benchmark, we started with the most aggregated model. In other words, we first estimated the price effect for the merged hospital fully aggregated over hospital locations, products and insurers. We then disaggregated this effect stepwise to ultimately arrive at the most differentiated model in which we fully differentiated the merger price effect across hospital locations, products and insurers. Table 3 provides a summary of the different models.

Table 3 **Continuum of aggregated and disaggregated models**

Models	Merger price effect
Baseline model	Fully aggregated over hospital locations, products and insurers
First disaggregated model	Aggregated over hospital products and insurers; disaggregated across locations
Second disaggregated model	Aggregated over hospital locations and insurers; disaggregated across products
Third disaggregated model	Aggregated over insurers; disaggregated across products and locations
Fourth disaggregated model	Aggregated over hospital locations and products; disaggregated across insurers
Fifth disaggregated model	Aggregated over hospital products; disaggregated across insurers and locations
Disaggregated model	Fully disaggregated across hospital locations, products and insurers

We first checked whether the common trend assumption holds. Then, we estimated the most aggregated model:

(1) $$\ln p_{ht} = \alpha + \sum_{j=1}^{H-1} \beta_j D_j + \lambda \cdot D_{t+1} + \delta \cdot D_{t+1} \cdot D_{merged} + \varepsilon_{ht}$$

where p_{ht} was the weighted average hospital negotiated price. $\sum_{j=1}^{H-1} \beta_j D_j$ is the collection of hospital-specific dummy-variables where H is the total number of hospitals, D_{t+1} is one in year t+1 (the post-merger year) and zero in year t-1 (the pre-merger year), D_{merged} is one for the merger hospitals and zero for the control group hospitals, $\lambda \cdot D_{t+1}$ denotes the change in the average price in year t+1 compared to year t-1 and δ is the DID estimator (i.e. the average treatment effect on the treated; see Blundell & Costa Dias, 2009). To account for potential endogeneity of the merging policy, we matched a control group to the event group (i.e. hospitals M1 and M2). In this control group, we included all Dutch hospitals that provided the three products and excluded any other hospitals that also merged between years t-2 and t+2 and Independent Treatment Centers.

To estimate the most aggregated difference-in-difference model we aggregated the patient-level hospital data to an average price per hospital. It is important to note that in the Netherlands, negotiated prices differ between health insurers but not between patients with the same health insurer who are treated in the same hospital. Therefore, we can aggregate the data to hospital-insurer level data without a loss of information. Furthermore, due to aggregation, we do not have to consider the correlation between prices within each hospital-insurer combination, which would otherwise lead to biased standard errors (see for example Thompson, 2011; Donald & Lang, 2007 and Bertrand et al., 2004). Firstly, we calculated an average price per product for each hospital-insurer pair. Secondly, we aggregated these prices over the insurers to an average price for each hospital-product combination, whereby we weighted the prices with the insurer's specific volume shares in year t-1. Thirdly, we aggregated over the products to an average price per hospital, whereby we weighted the hospital-product prices with the market-wide revenue shares for each product in t-1[25]. We calculated an average price for the merged entity M1 + M2, by weighting

25 We also estimated the models using the per hospital-product revenue in t-1 as a weighting factor for the aggregation over products. The results of these models do not differ from the main model and are therefore not included in this article. The results are available from the authors upon request.

the prices for hospitals M1 and M2 with their corresponding revenue shares in year *t*-1. We then removed the aggregations stepwise to show the effect of aggregating over products, locations and insurers until, finally, our results were disaggregated over all three sources of heterogeneity.

We investigated whether our results from the disaggregated model were robust to changes in the control groups by using six different control groups[26]: (1) all Dutch hospitals that provide the product, excluding hospitals that also merged between years *t*-2 and *t*+2 and Independent Treatment Centers; (2) control group 1, excluding all university hospitals; (3) control group 2, excluding rivals of the merged hospitals; (4) control group 3, excluding the hospitals with low market power; (5) control group 3, excluding all hospitals with low health insurers concentration; and (6) control group 3, excluding hospitals of a different size to hospitals M1 and M2. We thus had twelve control groups: six for each hospital. Table 4 summarizes the number of hospitals in the control group.

The reasons behind the various exclusion criteria for the control groups were as follows. Control group 2 excludes all university hospitals because these generally spend more time on research and education and they usually treat patients with more complex problems than general acute care hospitals. This could result in different price trends. Control group 3 excludes the merged hospital's rivals, which were identified as such in the *ex ante* merger review by both the merged hospitals and the ACM. If the merger hospitals exercise their newly acquired market power by raising prices, their rivals may respond by also raising their prices (see e.g. Dafny, 2009; Gaynor & Vogt, 2003). Because of this rival-effect, rivals are excluded from control group 3. Hospitals with limited market power are excluded from control group 4. It is generally assumed that hospitals with a 55 percent market share or higher have significant market power (NZa, 2008; EC, 2004). Both hospital M1 and hospital M2 have a weighted average market share[27] of 55 or higher for all three products. In control group 4, we therefore only take into account those hospitals that also have significant market power. We ranked the hospitals from control group 3 according to their weighted average market share and excluded the hospitals in the bottom quintile. Furthermore, to control for the effect of health insurers' concentration in each hospital in control group 5, we ranked the hospitals according to health insurers' HHI and excluded the hospitals in which the insurers' HHI was in the bottom quintile. Finally, in control group 6, we matched the hospitals that were in control group 3 with the volume of the merged hospitals. Hospital M2 had a much higher volume than hospital M1 and this difference in volume may have reflected different costs per unit product. We therefore matched two groups of equally sized hospitals with hospitals M1 and M2. For hospital M2, we ranked the hospitals by volume per product and excluded the bottom quintile. For hospital M1, we ranked the hospitals by volume for each product and excluded the top quintile (for hip replacements and cataract surgeries) or the bottom quintile (for knee replacements).

26 We also wanted to know whether our disaggregated model was robust to hospital-specific covariates. As a sensitivity check, we therefore also included hospitals-specific covariates in an additional difference-in-difference model (i.e. the number of patients, the percentage of males, the average (standardized) socio-economic status score, the average age of the patients and the weighted market share per hospital). The results using this model did not differ from the other disaggregated model effects and are therefore not included in this article. The results are available from the authors upon request.

27 Measured by the inverse LOgit Competition Index – see section 6 for more information.

Table 4 **Number of hospitals in control groups for hospitals M1 and M2**

	Hospital M1	Hospital M2
Panel A. Hip replacements		
Control group 1	55	55
Control group 2	50	50
Control group 3	46	46
Control group 4	38	38
Control group 5	41	41
Control group 6	36	40
Panel B. Knee replacements		
Control group 1	60	60
Control group 2	56	56
Control group 3	52	52
Control group 4	46	46
Control group 5	44	44
Control group 6	44	44
Panel C. Cataract surgery		
Control group 1	61	61
Control group 2	55	55
Control group 3	51	51
Control group 4	49	49
Control group 5	42	42
Control group 6	36	45

Notes: Control group 1 includes all Dutch hospitals that provide the product, excluding hospitals that also merged between years t-2 and t+2 and Independent Treatment Centers; control group 2 is control group 1 excluding all university hospitals; control group 3 is control group 2 excluding rivals of the merged hospitals; control group 4 is control group 3 excluding the hospitals with low market power; control group 5 is control group 3 excluding all hospitals with low health insurers concentration and control group 6 is control group 3 excluding hospitals of a different size to hospitals M1 and M2.

6. Data

We used a comprehensive nationwide patient-level dataset containing all inpatient and outpatient visits at all hospitals in the Netherlands. For each visit, the patient's zip code, age (year of birth), gender, health insurer, and DTC were observed, as well as the price negotiated for each hospital-insurer-product combination between years *t*-2 and *t*+2. Access to all patient-level data including negotiated prices from all insurers makes our dataset unique. The patient-level data that we used came from the insurers' claims administration and hospital registries, and was provided by the Dutch Healthcare Authority.

We focused on three products for which prices are freely negotiable: hip replacements[28], knee replacements[29] (both orthopedics) and cataract surgery[30] (ophthalmology). In year *t*-1, these product markets jointly accounted for 47.5 percent of turnover in the free-pricing segment at the merging hospitals[31]. We checked for obvious outliers in the negotiated price data by studying the following for each outlier: the average price of the hospital-product combination; the average price of the health insurer-product combination; the price change in the hospital-product combination; the price change in the health insurer-product combination; and the price change in the hospital-insurer-product combination over the years. Only if the price deviated markedly from all the averages excluded the observation from the analysis[32]. In all other cases, we could not detect measurement error with certainty and we kept the prices in the dataset. All hospitals where more than 15% of prices were missing for one or more years between t-2 and t+2 were excluded from the dataset[33].

The pre-merger price was based on data from the year preceding the merger (*t*-1) and the post-merger price was based on data from the year after the merger (*t*+1). We used prices in the years *t*-2 to *t*+2 to determine whether the common trend assumption applied. Table 5 presents summary statistics on the volume and mean prices of the products within hospital M1, hospital M2 and control group 1.

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28 The definition used in the Dutch hospital product classification system is 'joint degeneration of pelvic/hip/upper leg; surgery with clinical admission and joint prosthesis'.

29 The definition used in the Dutch hospital product classification system is 'joint degeneration of knee; surgery with clinical admission and joint prosthesis'.

30 The definition used in the Dutch hospital product classification system is 'cataract; outpatient treatment with intervention'.

31 In hospital M1, hip replacements represented 18 percent, knee replacements represented 27 percent, and cataract surgeries represented 6 percent of the turnover in the competitive segment in year *t*-1. In hospital M2, hip replacements represented 16 percent, knee replacements represented 14 percent, and cataract surgeries represented 14 percent of the turnover in the competitive segment in year *t*-1. By way of comparison: in control group 1, hip replacements represented 15 percent, knee replacements represented 14 percent, and cataract surgeries represented 14 percent of the turnover in the competitive segment in year *t*-1.

32 In total, 73 hip replacements (n=66437 before cleaning), 57 knee replacements (n=61404 before cleaning) and 281 cataract surgeries (n=476205 before cleaning) were excluded from the dataset.

33 For hip replacements, 31 out of 90 hospitals had more than 15% missing prices in one or more years in the period *t*-2 and *t*+2 and were therefore excluded. For knee replacements, 25 out of 89 hospitals had more than 15% missing prices in one or more years in the period *t*-2 to *t*+2 and were therefore excluded. For cataract operations, 25 out of 89 hospitals had more than 15% missing prices in one or more years in the period *t*-2 to *t*+2 and were therefore excluded. The threshold of 15% was arbitrary. As a sensitivity check, we therefore also used other thresholds for the disaggregated model. This had no effect on the overall results or the conclusions of the article. The results are available upon request by the authors.

Table 5 **Volume and mean prices for hip and knee replacements and cataract surgery in hospitals M1, M2 and control group 1**

	Hip replacements		Knee replacements		Cataract surgeries	
	t-1	*t*+1	*t*-1	*t*+1	*t*-1	*t*+1
Panel A. Hospital M1						
Volume	172	173	222	282	381	355
Mean price (in €)	9189.58 (348.00)	10188.05 (559.08)	11022.98 (494.94)	11291.41 (651.32)	1405.00 (40.78)	1421.27 (45.08)
Panel B. Hospital M2						
Volume	389	503	271	295	2140	2077
Mean price (in €)	9181.96 (144.25)	8991.34 (109.09)	10959.49 (185.30)	10321.76 (245.90)	1400.10 (20.34)	1313.40 (29.83)
Panel C. Control group 1						
Volume	224	227	189	194	1520	1498
Mean price (in €)	9045.00 (338.64)	9160.96 (620.08)	10592.34 (473.51)	10608.52 (786.32)	1340,94 (72.83)	1349.43 (104.12)

Notes: The hospitals' volume per product in this table slightly deviates from the hospitals' volume per product reported in table 1. In this table we only report the records with a valid price, whereas in table 1 only records with a valid gender, age and SES-score per product per hospital are reported. The mean prices for each hospital are the averaged over all patients. The mean price for control group 1 is the average over the mean prices of the hospitals within control group 1. The standard errors are in parentheses.

Hospitals with limited market power are excluded from control group 4. The weighted average market share that was used to determine the hospitals' market power was based on the LOgit Competition Index (LOCI), developed by Akosa Antwi et al. (2006; 2009). The application of the method is explained in Gaynor and Town (2012) and NZa (2014). Firstly, we calculated the hospitals' market share for each product in each zip code. The market share of hospital j for product d in zip code z is defined as $s_{jd,z} = \frac{q_{jd,z}}{\sum_{j=1}^{J} q_{jd,z}}$, where $q_{jd,z}$ is the total number of patients at hospital j $(j=1,..,J)$ for product d $(d=1,2,3)$ in zip code z $(z=1,...,Z)$. Secondly, for each hospital and product, we calculated a weighted average market share $\bar{s}_{jd} = \sum_{z=1}^{Z} w_{jd,z} s_{jd,z}$, where we weighted each market share with its share in hospital j, i.e. $w_{jd,z} = \frac{q_{jd,z}}{\sum_{z=1}^{Z} q_{jd,z}}$.

The insurer's HHI that was used to construct control group 5 is based on the insurer's market shares for each product and ranged from zero to one[34]. The insurer's HHI for hospital j and product d: insurer's $\mathrm{HHI}_{jd} = \sum_{m=1}^{M} \left(\frac{q_{mjd}}{\sum_{m=1}^{M} q_{mjd}}\right)^2$, where q_{mjd} is the total number of patients of insurer m $(m=1, ...,M)$ in hospital j for product d.

34 Although it is also possible to calculate the hospitals' HHI, we opted for the weighted average market share that was based on the LOgit Competition Index (LOCI) because market delineation is necessary for the hospitals' HHI (in contrast to the insurers' HHI), but the use of market delineation methods in healthcare markets is the subject of increasing criticism (e.g. Elzinga & Swisher, 2011).

7. Empirical results

To gain a picture of the change in the market structure as a result of the merger, we calculated the market share of the combined entity M1 + M2 for each product and compared it to the weighted average of the separate market shares of hospitals M1 and M2. Both calculations were based on the pre-merger market shares (i.e. from year *t*-1)[35]. As expected, the weighted average market shares of the hospitals' products increased as a result of the merger. The increase is from 76.7% to 82.5% for hip replacements, from 78.2% to 85.7% for knee replacements, and from 83.5% to 86.6% for cataract surgeries. In table 6, we present the diversion shares of hospitals M1 and M2 that follow from the bargaining model presented in section 2. Diversion shares reflect the degree of substitution between hospitals. As indicated in section 2, a higher value of the diversion share suggests a higher degree of substitution between two hospitals in treating the same disease.

Table 6 **Diversion shares TO/FROM hospitals M1 and M2 (in *t*-1)**

	Hip replacements		Knee replacements		Cataract surgery	
To \ From	**M1**	**M2**	**M1**	**M2**	**M1**	**M2**
M1	-	0.105	-	0.158	-	0.034
M2	0.735	-	0.663	-	0.850	-

Notes: The diversion shares are calculated using a conditional logit model of hospital choice, following Capps et al. (2003). We used patient-level data from *t*-1 to estimate the model, which included the travel time between the patient's zip code and hospital location, a dummy indicating whether the patient is older or younger than 65, a dummy for the patient's gender and the socio-economic status score for the patient's zip code.

From table 6 it follows that the diversion shares of hospital M1 to hospital M2 are much higher. Hospital M1 is located in a more isolated region with hospital M2 being its strongest competitor pre-merger. As expected, a large share of patients is diverted to hospital M2 once hospital M1 is not available. If the more centrally located hospital M2 would not be available, however, only few patients are expected to be diverted to hospital M1. When comparing the diversion shares over products, we find that the variation in diversion shares across products within each hospital is much smaller than the variation in diversion shares across hospital M1 and M2 for each product.

Table 7 shows the average price increases for hip replacements, knee replacements and cataract surgeries for control group 1 and the merged hospitals M1 and M2, indexed on the average price in control group 1 in year *t*-1.

35 Measured by the inverse LOgit Competition Index – see section 6 for more information.

Table 7 **Price changes of hospitals M1, M2 and the control group pre- and post-merger** **(indexed on the average price in control group 1 in year *t*-1)**

	Hospital					Control group 1				
	t-2	*t*-1	*t*	*t*+1	*t*+2	*t*-2	*t*-1	*t*	*t*+1	*t*+2
Panel A. Hospital M1										
Hip replacements	99	102	110	113	111	99	100	101	101	100
Knee replacements	101	104	105	107	105	99	100	100	99	101
Cataract surgery	101	103	102	104	100	98	100	99	99	95
Panel B. Hospital M2										
Hip replacements	99	102	97	99	99	99	100	101	101	100
Knee replacements	100	103	95	97	97	99	100	100	99	101
Cataract surgery	99	103	94	96	94	98	100	99	99	95

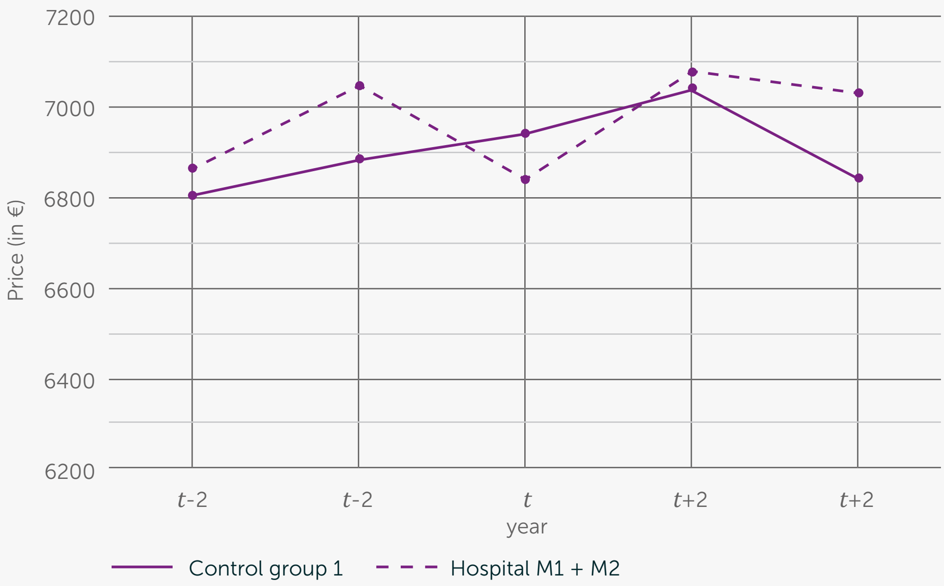
Notes: Indexed on the average price in control group 1 in year *t*-1; that is, the average price in control group 1 in *t*-1 is 100. The price for the control group is averaged over the mean prices of the hospitals in control group 1.

The table suggests that following the merger, both hospital locations charged different prices. As argued in section 4, the differences in competition intensity between the markets of hospitals M1 and M2, may induce the merged hospital to charge different prices. The prices for hip replacements did not change substantially between years *t*-2 and *t*+2 in control group 1. In comparison to the average control group prices in year *t*-1, the prices for hip replacements in hospital M1 increased by 13 percent after the merger (year *t*). This was the most substantial deviation from the average prices of control group 1 for year *t*-1.

As explained in section 5, however, price changes only give us a crude indication of the effect of the merger because they do not control for changes in prices that would have occurred anyway, even if the merger had not taken place. We therefore prefer a more sophisticated model in which price changes at the merging hospitals are compared to price changes at a group of comparison hospitals which were unaffected by the merger (i.e. a difference-in-difference model). As explained in section 5, the common trend assumption on which the DID model is based needed to be checked first. We found that the common trend assumption applied for all specifications. The pre-merger price change in the merged hospital did not deviate substantially from the pre-merger price changes in control group 1. This is also presented graphically in figure 1.[36]

36 We only report the common trend test for the aggregated model, which reveals that at the aggregate level the trend is similar but not the same for both groups. Closer inspection of the trends for specific models reveals that for each of these models, the treatment and control groups follow a common trend, yet these similarities are obfuscated upon aggregation of the trends. This difference between the aggregate trend and the disaggregated trends reconfirms the importance of performing analyses at the disaggregated level. The common trend tests for the disaggregated analyses are available upon request by the authors.

Figure 1 **Average price development in Hospital M1+M2 and control group 1**



Notes: The prices are aggregated over products, insurers and locations. Firstly, we calculated an average price per product for each hospital-insurer pair. Secondly, we aggregated these prices over the insurers to an average price for each hospital-product combination, whereby we weighted the prices with the insurer's specific volume shares in year *t*-1. Thirdly, we aggregated over the products to an average price per hospital, whereby we weighted the hospital-product prices with the market-wide revenue shares for each product in *t*-1. We calculated an average price for the merged entity M1 + M2, by weighting the prices for hospitals M1 and M2 with their corresponding revenue shares in year *t*-1. The average price for control group 1 is the average over the mean prices of the hospitals within control group 1. Control group 1 includes all Dutch hospitals that provide the product, excluding hospitals that also merged between years *t*-2 and *t*+2 and Independent Treatment Centers.

Table 8 presents the results of the difference-in-difference model aggregated over locations, insurers and products.

Table 8 **Merger effect aggregated over all three products, health insurers and hospital locations[A].**

	Hospitals M1 & M2
(intercept)	8.869*** (0.029)
Post-merger price change in the common trend (λ)	0.009 (0.009)
Post-merger price change	-0.017 (0.057)
Observations	54
R-Squared	0.719
Adjusted R-Squared	0.422

Notes: Models estimated by Ordinary Least Squares (OLS) with standard errors in parentheses under coefficients. In this model, hospitals M1 and M2 together are compared to control group 1. Control group 1 includes all Dutch hospitals that provide the product, excluding hospitals that also merged between years t-2 and t+2 and Independent Treatment Centers. We aggregated the patient-level hospital data to a mean price per hospital. Firstly, we calculated an average price per product for each hospital-insurer pair. Secondly, we aggregated these prices over the insurers to an average price for each hospital-product combination, whereby we weighted the prices with the insurer's specific volume shares in year t-1. Thirdly, we aggregated over the products to an average price per hospital, whereby we weighted the hospital-product prices with the market-wide revenue shares for each product in t-1. We calculated an average price for the merged entity M1 + M2, by weighting the prices for hospitals M1 and M2 with their corresponding revenue shares in year t-1.

[A] For clarity reasons, we do not report the hospital dummies here.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

Table 8 shows that no significant merger effect was observed when the result was aggregated over locations, insurers and products.

In table 9, we again show the price effect, aggregated over insurers, products and locations (panel A, column 1) but we then disaggregated the effect by location (panel A, column 2 and 3), by product (panels B to D, column 1), by location and product (panels B to D, columns 2 and 3), by insurer (panel E, column 1), and, finally, by insurer and location (panel E, columns 2 and 3).

Table 9 **Merger effect for hip and knee replacements and cataract surgery stepwise disaggregation**[A]

	Hospitals M1 & M2	Hospital M1	Hospital M2
Panel A. Aggregated over insurers & products			
(intercept)	8.869*** (0.029)	8.869*** (0.029)	8.869*** (0.029)
Post-merger price change in the common trend (λ)	0.009 (0.009)	0.008 (0.008)	0.008 (0.008)
Post-merger price change	-0.017 (0.057)	0.053 (0.057)	-0.053 (0.057)
Observations	54	54	54
R-Squared	0.719	0.725	0.720
Adjusted R-Squared	0.422	0.434	0.423
Panel B. Hip replacements: aggregated over insurers			
(intercept)	9.130*** (0.027)	9.130*** (0.026)	9.130*** (0.026)
Post-merger price change in the common trend (λ)	0.014* (0.007)	0.014* (0.007)	0.014* (0.007)
Post-merger price change	0.005 (0.053)	0.090* (0.053)	-0.035 (0.053)
Observations	57	57	57
R-Squared	0.733	0.745	0.734
Adjusted R-Squared	0.452	0.476	0.453
Panel C. Knee replacements: aggregated over insurers			
(intercept)	9.311*** (0.031)	9.311*** (0.031)	9.311*** (0.031)
Post-merger price change in the common trend (λ)	0.003 (0.008)	0.004 (0.008)	0.004 (0.008)
Post-merger price change	-0.021 (0.063)	0.021 (0.062)	-0.064 (0.062)
Observations	57	62	62
R-Squared	0.708	0.709	0.707
Adjusted R-Squared	0.401	0.403	0.399
Panel D Cataract surgery: aggregated over insurers			
(intercept)	7.249*** (0.029)	7.249*** (0.028)	7.249*** (0.028)
Post-merger price change in the common trend (λ)	-0.015** (0.007)	-0.015** (0.007)	-0.015** (0.007)
Post-merger price change	-0.038 (0.057	0.027 (0.057)	-0.049 (0.057)
Observations	57	63	63
R-Squared	0.693	0.697	0.697
Adjusted R-Squared	0.371	0.378	0.378

	Hospitals M1 & M2	Hospital M1	Hospital M2
Panel E. Per insurer: aggregated over products			
(intercept)	8.869*** (0.029)	8.869*** (0.029)	8.869*** (0.029)
Post-merger price change in the common trend (λ)	0.008 (0.008)	0.008 (0.008)	0.008 (0.008)
Post-merger price change insurer 1	-0.008 (0.057)	0.074 (0.057)	-0.052 (0.057)
Post-merger price change insurer 2	-0.008 (0.057)	0.049 (0.057)	-0.032 (0.057)
Post-merger price change insurer 3	-0.088 (0.057)	-0.137** (0.057)	-0.070 (0.057)
Post-merger price change insurer 4	0.054 (0.057)	0.115 (0.057)	-0.019 (0.057)
Post-merger price change insurer 5	-0.011 (0.057)	0.106* (0.057)	
Observations	54	53	53
R-Squared	0.742	0.796	0.728
Adjusted R-Squared	0.430	0.549	0.398

Notes: Models estimated by Ordinary Least Squares (OLS) with standard errors in parentheses under coefficients. In this model, hospitals M1, M2 and M1 and M2 together are compared to control group 1. Control group 1 includes all Dutch hospitals that provide the product, excluding hospitals that also merged between years *t*-2 and *t*+2 and Independent Treatment Centers. The data for the model in *Panel A, columns 2 & 3* is aggregated over health insurers and products: (I) we calculated an average price per product for each hospital-insurer pair, (II) we aggregated these prices over the insurers to an average price for each hospital-product combination, whereby we weighted the prices with the insurer's specific volume shares in year *t*-1 and (III) we aggregated over the products to an average price per hospital, whereby we weighted the hospital-product prices with the market-wide revenue shares for each product in *t*-1. The data for the model in *Panels B, C & D, columns 2 & 3* is aggregated over health insurers: (I) we calculated an average price per product for each hospital-insurer pair, and (II) we aggregated these prices over the insurers to an average price for each hospital-product combination, whereby we weighted the prices with the insurer's specific volume shares in year *t*-1. The data for the model in *Panel E, column 2 & 3* is aggregated for the control group as in *Panel A*. For the merged hospital entity M1+M2 *(column 1)* the data is aggregated: (I) we calculated an average price per product for each hospital-insurer pair, (II) we aggregated these prices over the insurers to an average price for each hospital-product combination, whereby we weighted the prices with the insurer's specific volume shares in year *t*-1. We calculated an average price for the merged entity M1 + M2, by weighting the prices for hospitals M1 and M2 with their corresponding revenue shares in year *t*-1.

[A] For clarity reasons, we do not report the hospital dummies here.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

If we only disaggregate by location, product or insurer, no significant merger effect is found. However, if we disaggregate by both product and location, we find that the merger led to significantly increased prices for hip replacements in hospital M1, by a total of 9 percentage points. This was the overall price effect of the merger for hip replacements in hospital M1. When the price effect was estimated over hospital locations and products, the effect disappeared. Also, if we disaggregated by insurer and location, we found that the merger only resulted in price changes for specific health insurers and only at hospital M1.

In table 10, we disaggregate the merger effect by location, product and insurer.

Table 10 **Merger effect for hip and knee replacements and cataract surgery per health insurer in hospitals M1 & M2**[A]

	Hip replacements	Knee replacements	Cataract surgeries
Panel A. Hospital M1			
(intercept)	9.130*** (0.026)	9.311*** (0.031)	7.249*** (0.028)
Post-merger price change in the common trend (λ)	0.014* (0.007)	0.004 (0.008)	-0.015** (0.007)
Post-merger price change insurer 1	0.113** (0.053)	0.049 (0.062)	0.037 (0.057)
Post-merger price change insurer 2	0.099* (0.053)	0.024 (0.062)	-0.053 (0.057)
Post-merger price change insurer 3	-0.118** (0.053)	-0.153** (0.062)	-0.114** (0.057)
Post-merger price change insurer 4	0.157*** (0.053)	0.089 (0.062)	0.067 (0.057)
Post-merger price change insurer 5	0.147*** (0.053)	0.080 (0.062)	0.059 (0.057)
Observations	57	62	63
R-Squared	0.828	0.767	0.740
Adjusted R-Squared	0.617	0.487	0.429
Panel B. Hospital M2			
(intercept)	9.130*** (0.026)	9.311*** (0.031)	7.249*** (0.028)
Post-merger price change in the common trend (λ)	0.014* (0.007)	0.004 (0.008)	-0.015** (0.007)
Post-merger price change insurer 1	-0.032 (0.053)	-0.066 (0.062)	-0.051 (0.057)
Post-merger price change insurer 2	-0.029 (0.053)	-0.035 (0.062)	-0.016 (0.057)
Post-merger price change insurer 3	-0.049 (0.053)	-0.084 (0.062)	-0.074 (0.057)
Post-merger price change insurer 4	-0.021 (0.053)	-0.016 (0.062)	-0.010 (0.057)
Post-merger price change insurer 5	-0.044 (0.053)	-0.049 (0.062)	-0.022 (0.057)
Observations	57	62	63
R-Squared	0.738	0.716	0.706
Adjusted R-Squared	0.417	0.375	0.354

Notes: Models estimated by Ordinary Least Squares (OLS) with standard errors in parentheses under coefficients. In this model, hospital M1 and M2 are compared to control group 1 which includes all hospitals excluding other merging hospitals and Independent Treatment Centers. The data for this model is aggregated for the *control group* as follows: (I) we calculated an average price per product for each hospital-insurer pair, (II) we aggregated these prices over the insurers to an average price for each hospital-product combination, whereby we weighted the prices with the insurer's specific volume shares in year *t*-1. For the *merging hospitals* the data is aggregated as follows: an average price per product for each hospital-insurer pair.

[A] For clarity reasons, we do not report the hospital dummies here.
*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.

In section 4 we explained that we disaggregated the post-merger price change for each hospital location to see whether the merging hospital differentiated an potential price increase after merger across locations. Table 7 suggested that the hospitals had done so and when we use the difference-in-difference approach we also found that the post-merger increase in prices for hip replacements in hospital M1 varied significantly from the control group, whereas the prices for hip replacements in hospital M2 were unaffected by the merger. Apparently, the merged hospital differentiated its prices across locations.

We also disaggregated the effect of the merger for each product. We found that the price effects of the merger varied significantly between hospital products. Specifically, the merger resulted in higher prices for hip replacements in hospital M1, whereas the prices for knee replacements and cataract care in hospitals M1 and M2 remained unaffected.

Finally, we disaggregated the post-merger price changes for each hospital-insurer combination. For four out of five health insurers that negotiated prices with hospital M1, the post-merger price increases for hip replacements were on average 13 percentage points higher than for the control groups. The merger's price effect varied between health insurers from -12 to 16 percentage points relative to the control groups. Also, the largest health insurer – insurer 1, which represented 76 percent of hospital M1's patients – was unable to negotiate lower prices: the prices it paid for hip replacements rose by 11 percentage points as a result of the merger. In contrast, one of the four other much smaller health insurers – insurer 3, which represented only 11 percent of hospital M1's patients – was able to negotiate prices that were much lower than the control groups. These results were robust between the control groups. It is therefore less likely that the merger effect estimated was driven by unobserved characteristics in the control group[37].

Hence, what we can deduce from these tables is that aggregating the merger effect over locations, products and insurers masked considerable variations between locations, products and insurers. In other words, failing to disaggregate would prevent us from detecting the price effects of a hospital merger.

37 These findings are not reported in the article, but are available upon request by the authors.

8. Discussion

The main finding of our study is that a merger between two hospitals in overlapping geographical markets generated heterogeneous prices effects at the two different hospital locations, for different hospital products and for different health insurers. The theoretical model that was presented in section 2 explains why this might be the case.

Different price effects for different products

Firstly, when we compare the price effects of a hospital merger on hip replacements, knee replacements and cataract surgery, we find a significant increase in the post-merger price of hip replacements but not of the other two products. This result was robust across all control groups and model specifications. In section 5, we explained that large post-merger price increases for the merged hospitals in comparison to prices among a control group could be consistent with at least four hypotheses. By a close consideration of the market under study, we can rule out the possibility that the increase in the post-merger price of hip replacements can be explained by a catching-up effect, or by an increase in quality or case mix severity. This because the pre-merger prices of hip replacements in hospital M1 were no lower than the prices at the comparison hospitals, as table 5 shows. Also, the pre-merger price for hip replacements at hospital M1 corresponds to the pre-merger price for hip replacements at hospital M2. According to the 'learning about demand' explanation, following a merger, a hospital is able to observe the prices paid to one of its former competitors, revealing potentially important information about the willingness of health insurers to pay for hospital services (see Adams & Noether, 2011). This explanation, however, cannot apply here as the pre-merger prices are similar. Furthermore, it is unlikely that the quality of care for hip replacements increased in hospital M1 following the merger. Although the hospital advertised quality increases in other procedures during the study period, this did not include the quality of its hip replacements. Furthermore, if it were the case that hospital M1 increased its quality because it learned from hospital M2 following the merger, we would expect prices to converge between the locations, but this did not happen. Also, an increase in quality that would justify such a large price increase (9 percentage points on average) would most likely also have an effect on patient volume at the expense of patient numbers at hospital M2 or rival hospitals, but this did not occur either. Therefore, we find it unlikely that an increase in quality between t-1 and t+1 can account for the price increase for hip replacements in hospital M1. From table 1 it also follows that the demographic characteristics of the patients at hospital M1 did not change much following the merger. The number of males increased slightly, but as the number of males increased in almost all hospitals, this cannot explain the increase in the prices for hip replacements at hospital M1. Also, it is more likely that if the patients' case mix had increased post-merger, more complex cases would have gone to hospital M2 rather than to hospital M1 because hospital M2 is a larger general hospital that also provides tertiary care. In view of this, the most plausible explanation out of the four possible explanations that follow from the literature is that the merger enhanced the market power of the hospitals.

However, this raises the question of why the price rise only occurred for hip replacements and not for knee replacements and cataract surgery. It is possible that this was due to a different level of competition intensity for these products. Indeed it followed from the theoretical framework that product d's price change after the merger in each hospital is increasing in the diversion share between these hospitals, as well as the price-cost margin of the partnering hospital. We found that the diversion shares in hospital M1 of hip replacements were no higher than the diversion shares of other products. In fact, the diversion share of cataract surgeries is higher, whereas the price change for cataract surgeries in hospital M1 after merger is not significant. Hence, based on the conclusions from the theoretical model, the difference in product-price effects after merger must be explained by other factors, i.e. the pre-merger price-cost margins of hospital M2. Unfortunately, we have no information on the product's price-cost margins of hospitals in this market. However, because the pre-merger prices for hip replacements in hospitals M1 and

M2 were remarkably similar according to table 5, the theory suggests that the pre-merger cost of hip replacements at hospital M2 were lower than the pre-merger cost of hip replacements at hospital M1.

Nevertheless, the finding that price effects are heterogeneous across hospitals' top-revenue products highlights the importance of using a more disaggregated approach rather than the more aggregated approach, when defining product markets. In practice, it is often assumed that the merger price effect will be the same for all hospital products because acute care, inpatient services can be considered as a single and thus homogeneous hospital product in cases of hospital mergers. Typically, antitrust agencies use a cluster approach to define hospital product markets and most empirical studies follow this approach and look at the aggregated price effects of hospital mergers. Also, the bargaining models that were developed to reflect hospital-insurer bargaining assume that a hospital system and an insurer bargain over a single base price per hospital location. In section 2, we already noted that freeing the product price ratios would more closely correspond to hospital-insurer bargaining in practice. The hospital market is highly complex due to the multiplicity of services offered and the heterogeneity of consumers and therefore many different hospital products exist. Sacher and Silvia (1998) show that using the standard inpatient cluster may mask considerable variability in the concentration statistics across the inpatient categories that make up an overall cluster. They argue that disaggregation can provide a better understanding of the potential competition effects of a merger in a range of market configurations. A similar point is made by Hentschker et al. (2014).

Also, from the theoretical model it followed that price effects after merger may differ between hospital products. For that reason, when we estimated the model parameters, we also disaggregated the effects of the merger by product markets. Like Sacher and Silvia (1998), we find that disaggregation can provide a fuller understanding of the potential competitive effects of the merger. However, if potential competitive effects are not homogeneous over product markets this may have important implications for future antitrust scrutiny. If the rules for market definition that are formulated in the EC merger guidelines (EC, 1997)[38], as well as in the US merger guidelines (FTC, 2010)[39], were applied strictly, hundreds or maybe thousands of separate hospital product markets would have to be distinguished because many hospital products and services are not demand or supply substitutes as prescribed by these rules. Clearly this would not be a feasible strategy in cases of hospital mergers. Hence, only a certain level of disaggregation would be warranted. Although our theoretical model defines each product d as a treatment of one illness, d may also be understood as a product cluster combining several illnesses based on revenue or volume or specialism or otherwise. Hence, the model conclusions also hold for the situation in which some clustering (aggregation) is applied in order to reduce the number of product dimensions in the analysis or because this more closely corresponds with practice. Sacher and Silvia (1998) show that even a very limited disaggregation of the standard inpatient cluster can lead to a more accurate merger analysis. Zwanziger et al. (1994), too, propose a manageable disaggregation of the standard clusters. Because it is unclear how often antitrust outcomes would be affected by using a different level of aggregation (Sacher & Silvia, 1998), we suggest using both the clustered approach as well as a limited disaggregated approach when defining product markets in the case of hospital mergers. One feasible approach may then be similar to our approach in which at least the top 3 or top 5 of the highest revenue products affected by the merger are analyzed separately. If the initial disaggregated approach gives rise to suspicions, the analysis can be further disaggregated[40].

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38 According to the EC (1997) Commission Notice, 'A relevant product market comprises all those products and/or services which are regarded as interchangeable or substitutable by the consumer, by reason of the products' characteristics, their prices and their intended use'.

39 According to the FTC (2010) Merger Guidelines: 'Market definition focuses solely on demand substitution factors, i.e. on consumers' ability and willingness to substitute away from one product to another in response to a price increase or a corresponding non-price change such as a reduction in product quality or service'.

If antitrust authorities indeed decide to conduct disaggregated analyses, it is an interesting question how an antitrust authority should deal with differences in merger outcomes between products. It is unlikely that the antitrust authority will block a merger if the prospective analysis indicates that the prices for one product will increase, whereas the prices of other products will not be affected. Rather, finding different effects across products may lead to interventions that are specifically addressed only to the product that is found to be affected by the merger. For example, antitrust authorities may impose remedies requiring the divestiture of a specific product, imposing the obligation to support new entrants (like ITCs) or introducing a price ceiling on particular products at one or more hospital locations.

Different price effects at different locations

Secondly, the merged hospital raised its price for hip replacements significantly at one location (hospital M1), but not at the other (hospital M2). To establish whether the merging hospitals experienced different price changes after merger, we aggregated the post-merger price change according to hospital location. It followed from the theoretical model that price changes caused by merger are proportional to the merging hospitals' diversion shares and the initial price-cost margins of the merger partner. To date, however, most studies have not controlled for this potential source of heterogeneity. Only Tenn (2011) examines and finds evidence of differential pricing strategies after merger.

In our case study, the merging hospitals' diversion shares were different due to their geographic location. Hospital M1 is located in a more geographically isolated area. Hospital M2 was the strongest competitor to hospital M1 and therefore posed a major constraint on hospital M1's prices prior to the merger. Hospital M2, however, faced additional competition from other hospitals. This difference manifests itself in higher diversion shares for hospital M1 than for hospital M2 before merger (table 6). After the merger, the two hospitals were likely able to internalize this constraint, leading to higher prices at hospital M1. They were able to do this without being penalized by rivals because hospital M1 experienced competitive pressure from only one rival hospital after the merger. By contrast, hospital M2 still experienced significant competitive pressure from five other hospitals after the merger. In this setting, differentiating prices according to the location may be a profitable strategy for the merged hospital: hospital M1 was in a position to raise its prices whereas maintaining a steady flow of patients, whereas hospital M2 maintained its prices at the pre-merger level in order to prevent losing patients to a rival hospital. Our results are consistent with this line of reasoning: the price change after merger was higher for hospital M1 whose diversion shares to hospital M2 were much higher than the diversions shares from hospital M2 to hospital M1.

By means of our empirical analysis we showed that it needs to be recognized that a merger between a rather isolated hospital location and its closest substitute creates opportunities for post-merger price increases that may be overlooked when not taking the disaggregate approach. Our findings suggests that the competition intensity that merging locations experience before and after merger may differ considerably between locations even if the merger entails two neighboring hospitals. Because this difference may result in a heterogeneous merger effects across locations, antitrust agencies should take the difference between locations into account. Given that these hospitals initially function as separate entities, the data that would be needed for the analysis at the location level should be available. However, then the question remains how antitrust authorities should deal with differences in merger outcomes between locations. We discussed product-specific remedies in the previous paragraph. Likewise, antitrust authorities may think about location-specific remedies in case they predict the merger effect to be differentiated

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40 In practice, antitrust authorities occasionally take potential differences between products into account. For example, in one case the UK Competition Commission performed a detailed analysis of the appropriate product markets (CC, 2013) and in the *FTC v. ProMedica Health System case*, the US antitrust authority paid special attention to the inpatient obstetrical services in addition to general acute-care inpatient services (FTC, 2012).

across locations. Like product-specific remedies, location-specific remedies might entail structural remedies or behavioral remedies that are only aimed at the location(s) that is (are) affected by merger[41].

Different price effects for different insurers

The theoretical model that we presented in this article showed that the price change caused by merger may differ between health insurers. In our empirical analysis we disaggregated the overall results for each hospital-insurer combination which revealed that there is considerable heterogeneity across health insurers in the change in the post-merger negotiated prices. For four out of five health insurers that negotiated prices with hospital M1, the post-merger price increases for hip replacements were on average 13 percentage points higher than the control group. The merger's price effect varied between health insurers from -12 to 16 percentage points relative to the control group. This finding corresponds to the results from an earlier retrospective study from the US (Thompson, 2011), which indicated that two health insurers experienced price increases due to the hospital merger under study, whereas a third insurer experienced a price decrease and a fourth experienced no price effect from the merger.

The theoretical model suggests that the insurer-specific price differences may arise due to differences in the insurers' bargaining abilities. In particular, a health insurer with more bargaining weight or ability is confronted with a higher price increase after the merger.

The source of bargaining ability of health insurers is the topic of many studies. The evidence suggests that idiosyncratic effects such as bargaining skills of the individuals at the negotiating table might have a sizeable impact on the market outcomes (Halbersma et al., 2010; Grennan, 2014). Thompson (2012) furthermore suggests that the differences between insurers may be attributed to variations in the types of plans that the insurers offer and the services that they provide. Hence, although the bargaining model gives us some ideas on the source of heterogeneity in the post-merger price effects across health insurers, it remains largely unclear why such large differences exist across insurers within markets and why some health insurers experience price increases whereas others experience price decreases after merger. Because this is an issue that has been indicated a few times in research on hospital mergers (Thompson, 2012; Gaynor & Town, 2012), we suggest that further research on hospital-insurer bargaining should aim to establish the source of bargaining ability of health insurers in relation to hospital mergers.

From a policy perspective, the fact that post-merger price effects are not homogeneous across insurers within markets is an interesting finding, however. It is furthermore interesting to note that the heterogeneities are this large. In ex ante merger reviews in the Netherlands, the Authority for Consumers and Markets (ACM) asks representatives of large health insurers in the region about their expectations regarding competitive effects of the merger. In fact, in the guidelines for assessing mergers and collaborations in healthcare, issued in 2013, the ACM says: 'When assessing a concentration's implications, the arguments put forward by insurers and patient organizations will be central.' (ACM, 2013). Like in most prospective merger cases, the representatives of the two largest health insurers in the region indicated that they did not anticipate negative competitive effects from the consolidation that we studied; and partly because of that reason the merger was cleared. However, the retrospective analysis indicates that the health insurers that believed to be able to counteract post-merger price increases were not both able to do that. We therefore suggest that a more critical assessment of health insurers' bargaining ability in merger cases is warranted.

41 Occasionally, antitrust authorities have opted for imposing remedies at the entire location level. Divestitures of hospital locations were, for example, ordered by the US antitrust authority in the *FTC v. ProMedica Health System case* (FTC, 2012) and by the German antitrust authority in the *Asklepios/LBK Hamburg* case (Bundeskartellamt, 2005), whereas in the *Evanston Northwestern/Highland Park Hospital* case the US antitrust authority imposed a firewall so that the two firms had to negotiate separately with insurers after merger (FTC, 2008). See Gowrisankaran et al. (2015) for a critical review of the latter remedy.

9. Conclusion

In this study, we expanded existing bargaining models to allow for heterogeneous product-price effects and used a difference-in-difference model in which price changes at the merging hospitals are compared to price changes at a group of comparison hospitals. The main finding of our study is that the merger led to heterogeneous prices effects for different health insurers, hospital products and hospital locations and that these differences depend on (I) the degree of substitution between hospitals, which may also vary over products, (II) the relative bargaining ability of hospitals and insurers and (III) the pre-merger price-cost margins of different products delivered by these hospitals.

The theoretical model provided us with valuable insights on the sources of heterogeneity, whereas our detailed empirical analysis of a hospital merger improved our understanding of the magnitude of differences. The analysis, however, also gives rise to three areas for future research. Firstly, it would be interesting to replicate this study for different hospital mergers to find out which of our findings persist. Secondly, more insight into the sources of insurers' bargaining ability would be valuable. Thirdly, analysis of pre-merger price-cost margins will improve our understanding of heterogeneous post-merger price effects across products.

Nevertheless, the fact that price effects of a merger are heterogeneous across products, locations and insurers signals important conclusions for ex ante merger scrutiny. Firstly, it highlights the importance of using a disaggregated approach rather than the current cluster approach when defining product markets. Secondly, it suggests that future prospective merger analyses should take potential differences across hospital locations into account. Finally, it asks for a critical assessment of health insurers' bargaining ability in merger cases.

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