ONLINE APPENDIX

Price effects of a hospital merger: 
Heterogeneity across health insurers, hospital products and hospital locations
A. Game-theoretical model of hospital-insurer bargaining

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 (2012) (hereafter: GT) and Gowrisankaran et al. (2015) (hereafter: 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 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.

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 fix all product-price ratios at the level of the respective disease-weight ratios. In their models, hospitals are constrained to negotiate a single base price per hospital location and the prices for different products are computed as a product of the base price and the disease weight\(^1\). Our model deviates from this assumption by freeing the product-price ratios. It thus allows for the situation in which a hospital may be contracted only for a subset of treatments. This better matches practice where contracts between hospitals and insurers can be concluded for a subset of treatments and a price has to be determined for each care bundle (e.g. Chernew et al. 2011; Delbanco, 2014; Song et al., 2014). In the US, for example, 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) and further specialization of the healthcare market because of quality considerations (Ho et al. 2007; Baicker & Levy, 2013). Also in the Netherlands, which data we use when estimating the model parameters, hospitals may be contracted only for a subset of services. Interviews with health insurers and hospital representatives who were involved in contractual negotiations during our study period indicated that especially for high-revenue products insurers and hospitals bargain separate prices. In the Netherlands, it is usually the

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\(^1\) The disease 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.
insurers that initiate selective contracting of procedures. 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 $f_{id}$ 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$^2$. Let $D_j$ denote the list of all products of hospital $j$. We assume that the range of products may differ between hospitals. The set of all hospitals (each of which delivers a certain range of products) is subdivided over $S \leq J$ systems. Here $J$ denotes the number of hospitals, and $S$ denotes the number of hospital systems. $M_s$ will denote the respective set of all systems. 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 (i.e. $S = J$).

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. We also treat the network of each health insurer as given. The network of insurer $m$ denoted by $N_m$ defines all hospital-product pairs available to the enrollees of insurer $m$. By introducing the notation $N_{md}$ for the subset of hospitals that provide product $d$ in network $N_m$, we obtain the expression: $N_m = \bigcup_{d \in \{1, ..., D\}, j \in N_{md}} (jd)$.

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$^2$ $d$ can also be a cluster of products.
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

$$u_{ijd} = \beta x_{ijd} + e_{ij}$$

where $x_{ijd}$ is a vector of hospital and patient characteristics such as travel time, hospital quality, or other characteristics, $\beta$ is the associated vector of parameters and $e_{ij}$ is an i.i.d. error term that is distributed type 1 extreme value. The patient with illness $d$ may visit any of the 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: $x_{i0d} = 0$.

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 $j$:

$$s_{ijd}(N_m(i)) = \frac{\delta_{ijd}}{\sum_{k \in \{0, N_m(i), d\}} \delta_{ikd}}$$

where $\delta_{ijd} = \beta x_{ijd}, j \in \{0, N_m(i), d\}$. 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 $d$, $s_{ijd}(N_m(i)) = s_{ijd}(N_m(i),d)$.

Because our empirical analysis focuses on the Netherlands and in the Netherlands, coinsurance as defined by GNT in the hospital sector is nonexistent, 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:

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

(3)

Aggregating over the enrollees of insurer \( m \), we obtain:

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

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:

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

(4)

Following GNT, we assume that the health insurer is seeking to maximize the sum of the enrollee surplus (equal to \( w_i - \text{premium}_m \) for each consumer) and the insurer's profit (equal to \( \text{premium}_m - \text{expected cost}_m(i) \) for each consumer) over all enrollees. Under this assumption, the value function of the health insurer is the difference between the \textit{ex ante} expected utility of all the enrollees and the total payment to the hospitals treating these enrollees:

\[ V_m(N_m, p_m) = W_m(N_m) - TC_m(N_m, p_m) \]  

(5)

In the model, 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\(^4\).

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:

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\(^4\) 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).
\[ V_m(N_m, \mathbf{p}_m) = W_m(N_m) - TC_m(N_m, \mathbf{p}_m) \]
\[ = \sum_i 1\{m(i) \} \]
\[ = m \} \sum_d f_{id} \left( \ln \left[ \sum_{j \in \{0, N_{md}\}} \exp(\delta_{ijd}) \right] - \sum_{j \in \{0, N_{md}\}} p_{mjd}s_{ijd}(N_m) \right) \]
\[ = \sum_d \sum_i 1\{m(i) = m\} f_{id} \left( \ln \left[ \sum_{j \in \{0, N_{md}\}} \exp(\delta_{ijd}) \right] - \sum_{j \in \{0, N_{md}\}} p_{mjd}s_{ijd}(N_m) \right) \]
\[ = \sum_d W_{md}(N_{md}) - TC_{md}(N_{md}, \mathbf{p}_{md}) = \sum_d V_{md}(N_{md}, \mathbf{p}_{md}) \]

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 also does not depend on prices of other products.

Following GT and GNT, we assume profit maximizing hospitals\(^5\). The marginal cost of providing product \( d \) in hospital \( j \) for health insurer \( m \) can then be denoted by \( mc_{mjd} \):\(^6\)

\[ mc_{mjd} = \gamma v_{mjd} + \epsilon_{mjd} \quad (6) \]

where \( v_{mjd} \) denotes a fixed effect, \( \gamma \) is the associated parameter and \( \epsilon_{mjd} \) 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:

\[ \pi(M_s, N_m, \mathbf{p}_m) = \sum_{m \in M_s} \sum_{(jd) \in L_s} (p_{mjd} - mc_{mjd}) q_{mjd}(N_m) \quad (7) \]

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\(^5\) 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.
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 $m$. 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:

$$q_{mjd}(N_m) = \sum_i \{m(i) = m\} f_{id} s_{ijd}(N_m) \quad (8)$$

Bargaining problem

There are $M \times S$ potential contracts. 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 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). To allow for heterogeneous price effects, we assume that bargaining on one (cluster of) product(s) occurs separately from other (clusters of) products.

The objective of the Nash bargaining problem of health insurer $m$ and system $s$ is then as follows:

$$NB_{m,s}^m(p_{m,s} | p_{m,-s})$$

$$= \left( \sum_d \left[ \sum_{(jd) \in L_s} q_{mjd}(N_m)(p_{mjd} - mc_{mjd}) \right] \right)^{b_{s(m)}}$$

$$\times \left( \sum_d \left[ V_m(N_m, p_m) - V_m(N_m \setminus L_s, p_m) \right] \right)^{b_{m(s)}}$$

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.
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. $p_{m,s}$ and $p_{m,-s}$ 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. Each price vector maximizes the value for the negotiating pair, conditional on the other prices:

$$p^*_{mjd} = \arg\max_{p_{mjd}} NB^{m,s}(p_{mjd}, p^*_{m,-(jd)}, p^*_{m,-s})$$

(9)

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

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 and not by prices, the decisions of different product teams of the same agent will not be dependent on each other.

The payoff structure leads to the following Nash bargaining problem with respect to $p_{mjd}$:

$$\max_{p_{mjd}|N_{md}p_{m,-jd}} (j^d_{agree} - j^d_{disagree})^{b_{s(m)}} (m^d_{agree} - m^d_{disagree})^{b_{m(s)}}$$

Where the terms in brackets stand for the respective payoffs of hospital $j$ and insurer $m$, and $p_{m,-jd}$ 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 is considered in GNT and GT.
From the first order condition (FOC) of this problem, we derive the expression for product prices\(^7\):

\[
p_{mdj} = b_{s(m)} \frac{W_{md}(Nm) - W_{md}(Nm j)}{q_{mdj}} + b_{m(s)} m_{c_mj} + b_{s(m)} \sum_{k \neq j} [p_{mkd} d_{mkd}]
\]

where \(d_{mkd} = \frac{q_{mkd}(Nm j) - q_{mkd}(Nm d)}{q_{mdj}}\). 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 \(d_{mkd}\) 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 \(p_{mdj}\) 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.

**Merger analysis**

The merger analysis considered in our article adopts a method proposed by GT. Because our empirical application deals with the situation in which hospitals continue to charge different prices after they merged, 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.

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 \(j\):

\[
(j + k)^d_{agree} = [p_{mdj} - m_{c_{mdj}}]q_{mdj}(Nm_d) + [p_{mkd} - m_{c_{mkd}}]q_{mkd}(Nm_d)
\]

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\(^7\) Using \(j^d_{agree} - j^d_{disagree} = \pi_{jd}(Nm_d, p_{md})\) and \(m^d_{agree} - m^d_{disagree} = V_{md}(Nm_d, p_{md}) - V_{md}(Nm_d \setminus p_{md})\).
\[(j + k)^d_{\text{disagree}} = [p_{mkd} - mc_{mkd}] q_{mkd}(N_{md} \setminus j)\]
\[m^d_{\text{agree}} = W_{md}(N_{md}) - p_{mj} q_{mj}(N_{md}) - \sum_{l \neq j} p_{mdl} q_{mdl}(N_{md})\]
\[m^d_{\text{disagree}} = W_{md}(N_{md} \setminus j) - \sum_{l \neq j} p_{ml} q_{ml}(N_{md} \setminus j)\]

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, \(p^{(j+k)}_{mj}\), as follows:

\[
p^{(j+k)}_{mj} = \frac{W_{md}(N_{md}) - W_{md}(N_{md} \setminus j)}{q_{mj}} + b(m) m c_{mj} + \frac{p_{mkd} d_{mk}^{jk}}{q_{mj}} + b(m) \sum_{l \neq j} [p_{ml} d_{ml}^{jl}]
\]

Taking the difference between this price and the initial price level of hospital \(j\), we obtain the expression for price change due to merger:

\[
p^{(j+k)}_{mj} - p_{mj} = b(m) (p_{mkd} - mc_{mkd}) d_{mk}^{jk}
\]  
(10)

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)\(^8\) 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. 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\(^9\), 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)\(^8\), the price change caused by merger is proportional to the difference between the

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\(^8\) Please note that we refer to this equation as equation (1) in the main paper.

\(^9\) 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.
price and the marginal cost of the other hospital. Merging with a hospital whose price of product $d$ is higher, whereas the marginal cost are lower, would result in a greater price increase ($cp$).

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. 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.
B. Price effect of the merger aggregated over products using the per hospital-product revenue in t-1 as a weighting factor

In the article, we first calculated an average price per product for each hospital-insurer pair. Second, 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. Third, 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. In this appendix we estimated the models using the per hospital-product revenue in t-1 as a weighting factor for the aggregation over products (second step).

Table 1 — Merger effect for hip and knee replacements and cataract surgery stepwise disaggregation

|                     | Hospitals M1 & M2 | Hospital M1 | Hospital M2 |
|---------------------|-------------------|-------------|-------------|
| **Panel A. Aggregated over insurers & products** |                   |             |             |
| (intercept)         | 8.795***          | 8.795***    | 8.795***    |
|                     | (0.028)           | (0.028)     | (0.028)     |
| Post merger price change in the common trend (\(\lambda\)) | 0.008            | 0.008       | 0.008       |
|                     | (0.008)           | (0.008)     | (0.008)     |
| Post merger price change | -0.012           | 0.050       | -0.051      |
|                     | (0.057)           | (0.057)     | (0.057)     |
| Observations (number of hospitals) | 54               | 54          | 54          |
| R-Squared           | 0.929             | 0.937       | 0.927       |
| Adjusted R-Squared  | 0.854             | 0.871       | 0.851       |

| **Panel B. Hip replacements: aggregated over insurers** |                   |             |             |
| (intercept)         | 9.130***          | 9.130***    | 9.130***    |
|                     | (0.027)           | (0.026)     | (0.026)     |
| Post merger price change in the common trend (\(\lambda\)) | 0.014*            | 0.014*      | 0.014*      |
|                     | (0.007)           | (0.007)     | (0.007)     |
| Post merger price change | 0.005            | 0.090*      | -0.035      |
|                     | (0.053)           | (0.053)     | (0.053)     |
| Observations (number of hospitals) | 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***          | 9.311***    | 9.311***    |
|                     | (0.031)           | (0.031)     | (0.031)     |
| Post merger price change in the common trend (\(\lambda\)) | 0.003            | 0.004       | 0.004       |
|                     | (0.008)           | (0.008)     | (0.008)     |
| Post merger price change | -0.021           | 0.021       | -0.064      |
|                     | (0.063)           | (0.062)     | (0.062)     |
| Observations (number of hospitals) | 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*** | 7.249*** | 7.249*** |
                                 | (0.029)  | (0.028)  | (0.028)  |
Post merger price change in the common trend ($\lambda$) | -0.015** | -0.015** | -0.015** |
                                 | (0.007)  | (0.007)  | (0.007)  |
Post merger price change         | -0.038   | 0.027    | -0.049   |
                                 | (0.057)  | (0.057)  | (0.057)  |

Observations (number of hospitals) | 57 | 63 | 63 |
R-Squared                         | 0.693 | 0.697 | 0.697 |
Adjusted R-Squared                | 0.371 | 0.378 | 0.378 |

**Panel E. Per insurer: aggregated over products**

(intercept)                      | 8.795*** | 8.795*** | 8.795*** |
                                 | (0.028)  | (0.028)  | (0.028)  |
Post-merger price change in the common trend ($\lambda$) | 0.008   | 0.008   | 0.008   |
                                 | (0.008)  | (0.008)  | (0.008)  |
Post-merger price change insurer 1 | -0.001  | 0.072    | -0.051   |
                                 | (0.057)  | (0.057)  | (0.057)  |
Post-merger price change insurer 2 | -0.001  | 0.050    | -0.029   |
                                 | (0.057)  | (0.057)  | (0.057)  |
Post-merger price change insurer 3 | -0.093  | -0.146** | -0.066   |
                                 | (0.057)  | (0.057)  | (0.057)  |
Post-merger price change insurer 4 | 0.059   | 0.107*   | -0.017   |
                                 | (0.057)  | (0.057)  | (0.057)  |
Post-merger price change insurer 5 | -0.004  | 0.106*   | -0.047   |
                                 | (0.057)  | (0.057)  | (0.057)  |

Observations (number of hospitals) | 54 | 53 | 53 |
R-Squared                         | 0.942 | 0.967 | 0.930 |
Adjusted R-Squared                | 0.872 | 0.927 | 0.844 |

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.

* 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.

The results do not substantially deviate from the results that were found in the paper.
C. The disaggregated difference-in-differences model with hospital-specific covariates

In the article, we report the results of the disaggregated difference-in-differences model excluding any hospital-specific covariates. In this appendix, we report the estimates of the difference-in-differences model including the hospital-specific covariates (table 2). We included the following hospital-specific covariates: (i) VOLUME; that is, the standardized number of patients in each hospital, (ii) MALE; that is, the percentage males in each hospital, (iii) SESSCORE; that is, the average standardized socio-economic status (SES) of the patients in each hospital (based on the patients’ zip codes), (iv) AGE; that is, the average age of the patients in each hospital and (v) MARKETSHARE; that is, the weighted average market share of each hospital.

VOLUME, MALE, AGE and MARKETSHARE were all from the same database. The socio-economic status scores were obtained from the Netherlands Institute for Social Research (SCP). In the literature, SES is consistently found to be related to health outcomes (i.e. patients with a lower SES have worse health outcomes) (see e.g. Cutler et al. 2011). The SES score is the same for all patients in a specific zip code area and is determined by the level of education, income and position on the labor market of residents of that zip code. We standardized the SES scores. A higher SES score means a higher socio-economic status. As we have explained in the article, the weighted average market share is based on the market shares of the hospitals in each zip code. However, some patients had invalid zip codes (i.e. less than 2.5% of the patients had missing values in each year). For each hospital, we used the distribution of valid zip codes to impute the invalid zip codes.

Table 2 — Merger effect for hip and knee replacements and cataract surgery per health insurer in hospitals M1 and M2 including hospital specific covariates

|                        | Hip replacements | Knee replacements | Cataract surgeries |
|------------------------|------------------|-------------------|--------------------|
| **Panel A. Hospital M1** |                  |                   |                    |
| (intercept)            | 9.172***         | 10.169***         | 7.528***           |
|                        | (0.318)          | (0.505)           | (0.699)            |
| Post-merger price change in the common trend ($\lambda$) | 0.016**          | -0.001            | -0.007             |
|                        | (0.008)          | (0.010)           | (0.010)            |
|                                | Hip replacements | Knee replacements | Cataract surgeries |
|--------------------------------|------------------|------------------|--------------------|
| Volume                         | 0.000            | -0.005           | -0.020             |
| (0.018)                        | (0.014)          | (0.018)          |
| Gender (male)                  | 0.096            | -0.105           | -0.269             |
| (0.128)                        | (0.014)          | (0.274)          |
| SES                            | 0.011            | -0.006           | 0.017              |
| (0.011)                        | (0.012)          | (0.011)          |
| Age                            | -0.001           | -0.014           | -0.002             |
| (0.004)                        | (0.007)          | (0.009)          |
| Market share                   | 0.024            | 0.178            | 0.020              |
| (0.132)                        | (0.141)          | (0.092)          |
| Post-merger price change insurer 1 | 0.106*         | -0.019           | 0.033              |
| (0.056)                        | (0.093)          | (0.060)          |
| Post-merger price change insurer 2 | 0.091           | -0.044           | -0.057             |
| (0.056)                        | (0.093)          | (0.060)          |
| Post-merger price change insurer 3 | -0.125**        | -0.221**         | -0.118**           |
| (0.056)                        | (0.093)          | (0.060)          |
| Post-merger price change insurer 4 | 0.149***        | 0.021            | 0.063              |
| (0.056)                        | (0.093)          | (0.060)          |
| Post-merger price change insurer 5 | 0.140**         | 0.012            | 0.055              |
| (0.056)                        | (0.093)          | (0.060)          |
| Observations (number of hospitals) | 57              | 62               | 63                 |
| R-Squared                      | 0.834            | 0.787            | 0.765              |
| Adjusted R-Squared             | 0.593            | 0.487            | 0.436              |

**Panel B. Hospital M2**

|                                | 9.172***         | 10.169***        | 7.528***           |
|--------------------------------|------------------|------------------|--------------------|
| (intercept)                     | (0.318)          | (0.505)          | (0.699)            |
| Post-merger price change in the common trend (λ) | 0.016**         | -0.001           | -0.007             |
| (0.008)                        | (0.010)          | (0.010)          |
| Volume                         | 0.000            | -0.005           | -0.020             |
| (0.018)                        | (0.014)          | (0.018)          |
| Gender (male)                  | 0.096            | -0.105           | -0.269             |
| (0.128)                        | (0.014)          | (0.274)          |
| SES                            | 0.011            | -0.006           | 0.017              |
| (0.011)                        | (0.012)          | (0.011)          |
| Age                            | -0.001           | -0.014           | -0.002             |
| (0.004)                        | (0.007)          | (0.009)          |
| Market share                   | 0.024            | -1.178           | 0.020              |
| (0.132)                        | (0.141)          | (0.092)          |
| Post-merger price change insurer 1 | -0.037*         | -0.059           | -0.085             |
| (0.058)                        | (0.063)          | (0.057)          |
| Post-merger price change insurer 2 | -0.034           | -0.028           | -0.026             |
| (0.058)                        | (0.063)          | (0.057)          |
| Post-merger price change insurer 3 | -0.054           | -0.077           | -0.083             |
| (0.058)                        | (0.063)          | (0.057)          |
| Post-merger price change insurer 4 | -0.026           | -0.009           | -0.020             |
| (0.058)                        | (0.063)          | (0.057)          |
| Post-merger price change insurer 5 | -0.049           | -0.042           | -0.031             |
| (0.058)                        | (0.063)          | (0.057)          |
| Observations (number of hospitals) | 57              | 62               | 63                 |
| R-Squared                      | 0.747            | 0.740            | 0.734              |
| Adjusted R-Squared             | 0.380            | 0.375            | 0.361              |

**Notes:** Models estimated by Ordinary Least Squares (OLS) with standard errors in parentheses under coefficients. In this model, hospitals M1 and M2 are compared to control group 1. The market share is calculated using the inverse LOgit Competition Index (LOCI) developed by Akosa Antwi et al. (2006; 2009). In Gaynor and Town (2012) the application of the method is explained. The SES scores were obtained from the Netherlands Institute for Social Research.

* For clarity reasons, we do not report the hospital dummies (fixed effects) here.

*** Significant at the 1 percent level.
** Significant at the 5 percent level.
* Significant at the 10 percent level.
We observe that, for each hospital and each product, the estimated merger effect per insurer does not substantially deviate from the estimates from the paper. The coefficients of the covariates are not significantly different from zero in all but one case, which leads us to conclude that adding covariates to the model does not improve the model and is therefore not necessary.
D. Missing value analysis

In the article, we excluded all hospitals with more than 15% missing prices in one or more years between \( t-2 \) and \( t+2 \) from the dataset. The threshold of 15% is, however, arbitrary. As a sensitivity check we therefore also used a 5% threshold. Under this threshold we thus excluded all hospitals with more than 5% missing prices in one or more years between \( t-2 \) and \( t+2 \).

Table 3 — Merger effect for hip and knee replacements and cataract surgery per health insurer in hospitals M1 & M2

| Panel A. Hospital M1 | Hip replacements | Knee replacements | Cataract surgeries |
|----------------------|------------------|-------------------|-------------------|
| (intercept)          | 9.132***         | 9.313***          | 7.254***          |
| (0.028)              | (0.034)          | (0.028)           |
| Post-merger price change in the common trend (\( \lambda \)) | 0.009        | -0.002           | -0.025***         |
| (0.008)              | (0.010)          | (0.008)           |
| Post-merger price change insurer 1 | 0.118**       | 0.055            | 0.047             |
| (0.056)              | (0.068)          | (0.057)           |
| Post-merger price change insurer 2 | 0.104*        | 0.030            | -0.043            |
| (0.056)              | (0.068)          | (0.057)           |
| Post-merger price change insurer 3 | -0.113***     | -0.147**         | -0.104*           |
| (0.056)              | (0.068)          | (0.057)           |
| Post-merger price change insurer 4 | 0.162***      | 0.095            | 0.077             |
| (0.056)              | (0.068)          | (0.057)           |
| Post-merger price change insurer 5 | 0.152***      | 0.086            | 0.069             |
| (0.056)              | (0.068)          | (0.057)           |
| Observations (number of hospitals) | 45             | 44               | 47                |
| R-Squared            | 0.837            | 0.768             | 0.778             |
| Adjusted R-Squared   | 0.628            | 0.467             | 0.496             |

Panel B. Hospital M2

| Panel B. Hospital M2 | Hip replacements | Knee replacements | Cataract surgeries |
|----------------------|------------------|-------------------|-------------------|
| (intercept)          | 9.132***         | 9.313***          | 7.254***          |
| (0.028)              | (0.034)          | (0.028)           |
| Post-merger price change in the common trend (\( \lambda \)) | 0.009        | -0.002           | -0.025***         |
| (0.008)              | (0.010)          | (0.008)           |
| Post-merger price change insurer 1 | -0.027      | -0.061           | -0.041            |
| (0.057)              | (0.068)          | (0.057)           |
| Post-merger price change insurer 2 | -0.024      | -0.029           | -0.066            |
| (0.057)              | (0.068)          | (0.057)           |
| Post-merger price change insurer 3 | -0.044      | -0.078           | -0.064            |
| (0.057)              | (0.068)          | (0.057)           |
| Post-merger price change insurer 4 | -0.016      | -0.010           | -0.000            |
| (0.057)              | (0.068)          | (0.057)           |
| Post-merger price change insurer 5 | -0.039      | -0.044           | -0.012            |
| (0.057)              | (0.068)          | (0.057)           |
| Observations (number of hospitals) | 45             | 44               | 47                |
| R-Squared            | 0.734            | 0.694             | 0.738             |
| Adjusted R-Squared   | 0.391            | 0.298             | 0.403             |

Notes: Models estimated by Ordinary Least Squares (OLS) with standard errors in parentheses under coefficients. In this model, hospitals M1 & M2 are compared to control group 1.

* 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.
The results do not substantially deviate from the results that were found in the paper.
E. Rival analysis

Table 4 presents summary statistics on the market shares of the products within hospital M1, hospital M2 and the rival hospitals of hospitals M1 and M2.

Table 4 — Market shares for hip and knee replacements and cataract surgery in hospitals M1, M2 and rivals

|                | Hip replacements | Knee replacements | Cataract surgeries |
|----------------|------------------|-------------------|-------------------|
|                | \( t\)           | \( t+1\)          | \( t\)           | \( t+1\)          | \( t\)           | \( t+1\)          |
| Hospital M1    | 0.11             | 0.11              | 0.16             | 0.21              | 0.05             | 0.05              |
| Hospital M2    | 0.25             | 0.33              | 0.20             | 0.21              | 0.29             | 0.28              |
| Rival 1        | 0.10             | 0.10              | 0.12             | 0.10              | 0.14             | 0.14              |
| Rival 2        | 0.15             | 0.13              | 0.12             | 0.11              | 0.11             | 0.14              |
| Rival 3        | 0.09             | 0.07              | 0.11             | 0.08              | 0.09             | 0.13              |
| Rival 4        | 0.11             | 0.10              | 0.07             | 0.11              | 0.11             | 0.10              |
| Rival 5        | 0.20             | 0.16              | 0.21             | 0.18              | 0.21             | 0.16              |

Notes: According to the ACM, the merging hospitals were subject to competition from five other hospitals before the merger took place. We report the market shares per hospital and per product for hospitals M1, M2 and the five rivals. We used the volume per product to calculate the market shares.

The table shows that hospital M2 was able to increase the volume of patients for hip replacements at the expense of its rivals, even though its price did not change. Given that the overall cost of producing hip replacements is the same at all locations and did not change due to the merger the hospital was able to maximize its profits because of its price discrimination through a market separation strategy.

The table also shows that hospital M1 does not experience fiercer competition with the closest rival on the knee replacement and cataract surgery markets before or after merger. In fact, its market share on the market for cataract surgeries is much lower than its market share in the market for hip replacements.
Table 5 presents the diversion shares from hospitals M1 and M2 to their rivals.

| From / to | Hip replacements | Knee replacements | Cataract surgery |
|-----------|------------------|-------------------|------------------|
|           | M1               | M2                | M1               | M2                | M1               | M2                |
| Rival 1   | 0.190            | 0.270             | 0.223            | 0.257             | 0.109            | 0.254             |
| Rival 2   | 0.004            | 0.091             | 0.006            | 0.105             | 0.002            | 0.108             |
| Rival 3   | 0.001            | 0.022             | 0.002            | 0.029             | 0.000            | 0.018             |
| Rival 4   | 0.014            | 0.238             | 0.015            | 0.161             | 0.009            | 0.202             |
| Rival 5   | 0.012            | 0.115             | 0.013            | 0.100             | 0.008            | 0.135             |

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.

Table 5 shows that, 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. The differences in competitive pressure in the markets of hospitals M1 and M2 may result in heterogeneous price effects of the merger.
F. Price effect of the merger (dis)aggregated over products, insurers and locations

In the paper, to examine the effect of aggregating the merger price effect, we estimated difference-in-differences models at various aggregation levels. As a benchmark, we started with the most aggregated model, which is the price effect for the merged hospital fully aggregated over hospital locations, products and insurers (Table 5 – main text). We then disaggregated the 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 6 – main text). The results of the stepwise disaggregation are presented below. Table 6 presents the stepwise disaggregation. In table 7, the price effect is shown, aggregated over insurers, products and locations (panel A, column 1), disaggregated 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).

| Model                               | 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 |
Table 7 — Merger effect for hip and knee replacements and cataract surgery stepwise disaggregation*  

| Panel | Description | 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 (number of hospitals) | 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 (number of hospitals) | 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 (number of hospitals) | 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 (number of hospitals) | 57 | 63 | 63 |
| | R-Squared | 0.693 | 0.697 | 0.697 |
| | Adjusted R-Squared | 0.371 | 0.378 | 0.378 |
| 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) -0.046 (0.057) |
|                   | Hospitals M1 & M2 | Hospital M1 | Hospital M2 |
|------------------|------------------|-------------|-------------|
| 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.

*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.
G. Control group analysis

In the article, we explained that we estimated the model using six different control groups: (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.

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\(^{10}\) 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

\(^{10}\) Measured by the inverse LOgit Competition Index – see section 6 main article for more information
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).

In the article, however, we only reported the results of the merger in comparison to control group 1. Here, we also present the results of the merger in comparison to control groups 2 – 6. Table 8 presents the results for hospital M1 and Table 9 presents the results for hospital M2.

### Table 8 — Merger effect for hip and knee replacements and cataract surgery per health insurer in hospital M1

| Panel A. Hip replacements | Control group 1 | Control group 2 | Control group 3 | Control group 4 | Control group 5 | Control group 6 |
|---------------------------|----------------|----------------|----------------|----------------|----------------|----------------|
| (intercept)               | 9.130***       | 9.131***       | 9.132***       | 9.134***       | 9.134***       | 9.133***       |
|                           | (0.026)        | (0.026)        | (0.027)        | (0.029)        | (0.028)        | (0.029)        |
| Post-merger price         | 0.014*         | 0.011          | 0.010          | 0.005          | 0.006          | 0.008          |
| change in the common trend (λ) | (0.007) | (0.007) | (0.008) | (0.009) | (0.009) | (0.010) |
| Post-merger price change insurer 1 | 0.113** | 0.116** | 0.117** | 0.123** | 0.121** | 0.119* |
|                           | (0.053)        | (0.053)        | (0.054)        | (0.058)        | (0.056)        | (0.059)        |
| Post-merger price change insurer 2 | 0.099* | 0.101* | 0.103* | 0.108* | 0.107* | 0.105* |
|                           | (0.053)        | (0.053)        | (0.054)        | (0.058)        | (0.056)        | (0.059)        |
| Post-merger price change insurer 3 | -0.118** | -0.115** | -0.114** | -0.108* | -0.109* | -0.111* |
|                           | (0.053)        | (0.053)        | (0.054)        | (0.058)        | (0.056)        | (0.059)        |
| Post-merger price change insurer 4 | 0.157*** | 0.160*** | 0.161*** | 0.167*** | 0.165*** | 0.162*** |
|                           | (0.053)        | (0.053)        | (0.054)        | (0.058)        | (0.056)        | (0.059)        |
| Post-merger price change insurer 5 | 0.147*** | 0.150*** | 0.151*** | 0.157** | 0.156*** | 0.154** |
|                           | (0.053)        | (0.053)        | (0.054)        | (0.058)        | (0.056)        | (0.059)        |
| Observations              | 57             | 52             | 48             | 40             | 43             | 38             |
| R-Squared                 | 0.828          | 0.834          | 0.836          | 0.840          | 0.843          | 0.840          |
| Adjusted R-Squared        | 0.617          | 0.627          | 0.629          | 0.628          | 0.638          | 0.626          |

### Panel B. Knee replacements

| Panel A. Knee replacements | Control group 1 | Control group 2 | Control group 3 | Control group 4 | Control group 5 | Control group 6 |
|---------------------------|----------------|----------------|----------------|----------------|----------------|----------------|
| (intercept)               | 9.311***       | 9.312***       | 9.312***       | 9.314***       | 9.313***       | 9.338***       |
|                           | (0.031)        | (0.031)        | (0.032)        | (0.033)        | (0.032)        | (0.033)        |
| Post-merger price         | 0.004          | 0.000          | -0.000         | -0.003         | -0.002         | -0.002         |
| change in the common trend (λ) | (0.006) | (0.008) | (0.009) | (0.010) | (0.010) | (0.010) |
| Post-merger price change insurer 1 | 0.049 | 0.053 | 0.053 | 0.055 | 0.054 | 0.055 |
|                           | (0.062)        | (0.063)        | (0.064)        | (0.067)        | (0.064)        | (0.065)        |
| Post-merger price change insurer 2 | 0.024 | 0.028 | 0.028 | 0.030 | 0.029 | 0.030 |
|                           | (0.062)        | (0.063)        | (0.064)        | (0.067)        | (0.064)        | (0.065)        |
| Control group 1 | Control group 2 | Control group 3 | Control group 4 | Control group 5 | Control group 6 |
|----------------|----------------|----------------|----------------|----------------|----------------|
| Post-merger price | -0.153** | -0.150** | -0.149** | -0.147** | -0.148** | -0.147** |
| change insurer 3 | (0.062) | (0.063) | (0.064) | (0.067) | (0.064) | (0.065) |
| Post-merger price | 0.089 | 0.093 | 0.093 | 0.096 | 0.094 | 0.095 |
| change insurer 4 | (0.062) | (0.063) | (0.064) | (0.067) | (0.064) | (0.065) |
| Post-merger price | 0.080 | 0.083 | 0.084 | 0.086 | 0.085 | 0.086 |
| change insurer 5 | (0.062) | (0.062) | (0.064) | (0.067) | (0.064) | (0.065) |
| Observations | 62 | 58 | 54 | 48 | 46 | 46 |
| R-Squared | 0.767 | 0.764 | 0.768 | 0.771 | 0.781 | 0.776 |
| Adjusted R-Squared | 0.487 | 0.477 | 0.481 | 0.481 | 0.502 | 0.489 |

**Panel C. Cataract surgery**

| (intercept) | 7.249*** | 7.251*** | 7.251*** | 7.251*** | 7.256*** | 7.255*** |
|-------------|---------|---------|---------|---------|---------|---------|
| Post-merger price | -0.015** | -0.018** | -0.018** | -0.018** | -0.029*** | -0.026** |
| change in the common trend (λ) | (0.007) | (0.008) | (0.008) | (0.009) | (0.009) | (0.010) |
| Post-merger price | 0.037 | 0.041 | 0.041 | 0.040 | 0.051 | 0.048 |
| change insurer 1 | (0.057) | (0.059) | (0.061) | (0.062) | (0.058) | (0.062) |
| Post-merger price | -0.053 | -0.049 | -0.049 | -0.049 | -0.039 | -0.041 |
| change insurer 2 | (0.057) | (0.059) | (0.061) | (0.062) | (0.058) | (0.062) |
| Post-merger price | -0.114** | -0.111* | -0.110* | -0.111* | -0.100* | -0.103 |
| change insurer 3 | (0.057) | (0.059) | (0.061) | (0.062) | (0.058) | (0.062) |
| Post-merger price | 0.067 | 0.070 | 0.070 | 0.070 | 0.081 | 0.078 |
| change insurer 4 | (0.057) | (0.059) | (0.061) | (0.062) | (0.058) | (0.062) |
| Post-merger price | 0.059 | 0.062 | 0.063 | 0.062 | 0.073 | 0.070 |
| change insurer 5 | (0.057) | (0.059) | (0.061) | (0.062) | (0.058) | (0.062) |
| Observations | 63 | 57 | 53 | 51 | 44 | 38 |
| R-Squared | 0.740 | 0.735 | 0.736 | 0.736 | 0.784 | 0.768 |
| Adjusted R-Squared | 0.429 | 0.411 | 0.410 | 0.405 | 0.504 | 0.456 |

Notes: Models estimated by Ordinary Least Squares (OLS) with standard errors in parentheses under coefficients.

*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 9 — Merger effect for hip and knee replacements and cataract surgery per health insurer in hospital M2*
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The estimated merger effect is driven by unobserved characteristics in the control group. It is therefore less likely that the estimated merger effect is driven by unobserved characteristics in the control group.

| Notes: | Models estimated by Ordinary Least Squares (OLS) with standard errors in parentheses under coefficients |
|---|---|
| * 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. |

The tables show that the results are robust across control groups. It is therefore less likely that the estimated merger effect is driven by unobserved characteristics in the control group.

Panel B. Knee replacements

|       | Control group 1 | Control group 2 | Control group 3 | Control group 4 | Control group 5 | Control group 6 |
|-------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| (intercept) | 9.311*** | 9.312*** | 9.312*** | 9.314*** | 9.313*** | 9.338*** |
|          | (0.031) | (0.031) | (0.032) | (0.033) | (0.032) | (0.033) |
| Post-merger price | 0.004 | 0.000 | -0.000 | -0.003 | -0.002 | -0.002 |
| change in the common trend (λ) | (0.008) | (0.008) | (0.009) | (0.010) | (0.010) | (0.010) |
| Post-merger price change insurer 1 | -0.066 | -0.063 | -0.063 | -0.060 | -0.061 | -0.061 |
|          | (0.062) | (0.063) | (0.064) | (0.067) | (0.064) | (0.065) |
| Post-merger price change insurer 2 | -0.035 | -0.031 | -0.031 | -0.029 | -0.030 | -0.029 |
|          | (0.062) | (0.063) | (0.064) | (0.067) | (0.064) | (0.065) |
| Post-merger price change insurer 3 | -0.084 | -0.080 | -0.080 | -0.078 | -0.079 | -0.078 |
|          | (0.062) | (0.063) | (0.064) | (0.067) | (0.064) | (0.065) |
| Post-merger price change insurer 4 | -0.016 | -0.012 | -0.012 | -0.010 | -0.011 | -0.010 |
|          | (0.062) | (0.063) | (0.064) | (0.067) | (0.064) | (0.065) |
| Post-merger price change insurer 5 | -0.049 | -0.046 | -0.045 | -0.043 | -0.044 | -0.044 |
|          | (0.062) | (0.063) | (0.064) | (0.067) | (0.064) | (0.065) |
| Observations | 62 | 58 | 54 | 48 | 46 | 46 |
| R-Squared | 0.716 | 0.706 | 0.708 | 0.708 | 0.713 | 0.707 |
| Adjusted R-Squared | 0.375 | 0.347 | 0.346 | 0.337 | 0.347 | 0.332 |

Panel C. Cataract surgery

|       | Control group 1 | Control group 2 | Control group 3 | Control group 4 | Control group 5 | Control group 6 |
|-------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| (intercept) | 7.249*** | 7.251*** | 7.251*** | 7.251*** | 7.256*** | 7.251*** |
|          | (0.028) | (0.029) | (0.030) | (0.031) | (0.029) | (0.032) |
| Post-merger price change in the common trend (λ) | -0.015** | -0.018** | -0.018*** | -0.018** | -0.029*** | -0.018* |
|          | (0.007) | (0.008) | (0.008) | (0.009) | (0.009) | (0.009) |
| Post-merger price change insurer 1 | -0.051 | -0.048 | -0.048 | -0.048 | -0.037 | -0.047 |
|          | (0.057) | (0.059) | (0.061) | (0.062) | (0.058) | (0.064) |
| Post-merger price change insurer 2 | -0.016 | -0.013 | -0.013 | -0.013 | -0.002 | -0.013 |
|          | (0.057) | (0.059) | (0.061) | (0.062) | (0.058) | (0.064) |
| Post-merger price change insurer 3 | -0.074 | -0.071 | -0.071 | -0.071 | -0.060 | -0.070 |
|          | (0.057) | (0.059) | (0.061) | (0.062) | (0.058) | (0.064) |
| Post-merger price change insurer 4 | -0.010 | -0.007 | -0.007 | -0.007 | 0.004 | -0.007 |
|          | (0.057) | (0.059) | (0.061) | (0.062) | (0.058) | (0.064) |
| Post-merger price change insurer 5 | -0.022 | -0.018 | -0.018 | -0.019 | -0.008 | -0.018 |
|          | (0.057) | (0.059) | (0.061) | (0.062) | (0.058) | (0.064) |
| Observations | 63 | 57 | 53 | 51 | 44 | 47 |
| R-Squared | 0.706 | 0.693 | 0.694 | 0.692 | 0.745 | 0.695 |
| Adjusted R-Squared | 0.354 | 0.319 | 0.315 | 0.366 | 0.415 | 0.306 |
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