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Research Article

The impact of hospital competition and insurer concentration on health care volume and cost in Dutch hospitals

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Abstract

This study analyses the effect of spatial concentration of general hospitals, the appearance of independent treatment centers (in Dutch: Zelfstandige Behandelcentra: ZBCs) and the concentration of health insurers on production volume and costs since the introduction of market-oriented health care reforms in the Netherlands. We use regression analyses of 1,345,144 patient-level hospital data for fifteen major diagnosis treatment combinations (in Dutch: Diagnose Behandeling Combinaties: DBCs), representing 70% of the managed competition segment (the so-called B-segment).

We find that spatial concentration of hospitals and concentration of insurers do not affect health care production volume. More competitive hospital markets are associated with higher cost of most DBCs studied. Surprisingly, hospitals operating under insurers with high monopsonic power incur higher average DBC-cost than hospitals operating under insurers with more dispersed power. The number of independent treatment centers in the hospital's vicinity is positively related to health care volume and average cost.

Practical relevance

This article provides insights into the workings of management care in the Dutch health care sector. It informs financial managers, supervisory bodies and politicians of the drivers of health care volume and health care costs. This information may enable policy makers and managers to more effectively control health care production and costs.

Keywords

Health care, hospital, costing and pricing of health services, DBC, Independent Treatment Centers (ZBCs)

1. Introduction

In 2005, the Dutch government introduced managed health care competition with limiting conditions for liberalization and strong supervision (Schut and Van de Ven 2005). This type of competition was expected to lead to more transparency, more demand-driven competition, higher quality and more cost containment in the health care sector (Heijink et al. 2013; Heinemann et al. 2013; Ministry of Health 2001). Cost containment was particularly to be achieved by a performance-based reimbursement system for a dedicated part of the total hospital production of elective care products. It involves free negotiations between insurers and hospitals about price, volume and quality. The 'competitive market' part of the hospital production has been expanded from 10% in 2005, 20% in 2008, 34% in 2009 to 70% in 2012 (NZa 2012).

Previous research on the case of the Netherlands has focused on the effect of managed competition on quality (Okma et al. 2011; Van de Ven and Schut 2009). In this paper, we ask how hospitals react to market conditions on the health care supply side and demand side. The supply side of the market is characterized by the number of hospitals offering health care services in the immediate vicinity of the focal hospital. We also look at the impact of nearby alternative suppliers, represented by Independent Treatment Centers (ITCs; in Dutch: Zelfstandige Behandelcentra: ZBCs). The demand side relates to the concentration of health insurance companies and hence their monopsonic power over the focal hospital. We particularly focus on the impact of different market conditions on health care volume and cost (approximated by the number and average cost of activities per patient).

Standard microeconomic theory predicts that under perfect competition a larger supply of goods will in the short term lead to lower production costs and lower prices, or to higher quality offered for the same price. Empirical studies in health care markets, however, do not show a negative but rather a positive correlation between price levels and per capita supply of medical services (Capps et al. 2003). The phenomenon is also referred to as *Medical Arms Race*: hospitals spend more on care activities, technologies, amenities and facilities to attract patients. The medical arms race can only be maintained as long as patients and insurers are prepared to pay for it. This makes it necessary to also focus on the demand side of the managed health care market. Given these contradictory findings, we focus in this paper on the question whether the Dutch managed health care market follows the standard microeconomic theory of a negative correlation between volume and costs (and prices), or whether it adheres more to the medical arms race phenomenon.

2. Previous studies

Most of US studies examining hospital market power focus on the effect of hospital competition on prices and find a positive relation between hospital concentration and prices. This suggests that hospitals' monopoly power leads to higher prices and that increasing price competition leads to lower prices (Lynk 1995; Lynk and Neumann 1999; Melnick et al. 1992; Noether 1988; Melnick and Keeler 2007).

The neighbourhood of Independent Treatment Centers appears to lead to the opposite effect. ITCs are single-specialty stand-alone centers for specialist care that provide elective surgery (for example hip replacements and cataracts) and diagnostic procedures (such as MRI scans). In the last years many such centers have entered hospital markets, such as the Ambulatory Surgery Centers (ASCs) in the US and the Independent Treatment Sector Centers in the UK. In the Netherlands, the government has allowed ITCs to facilitate efficient production, leaving the production of relatively higher cost specialties to hospitals. This means that hospital production will be lower and the average cost per patient will be higher (Carey et al. 2011) in hospitals with neighbouring ITCs. Many studies, however, do not take the number of ITCs into account (Courtemanche and Plotzke 2010).

The system of patient-driven competition, where purchasers operate under non-binding or soft budget constraints, has led to great inefficiencies and overconsumption of health care in the US (Enthoven 1978). Concentration of payers as in the US Preferred Provider Organizations or Health Maintenance Organizations under harder budget constraints leads to monopsony power enabling providers to obtain lower prices (Feldman and Wholey 2001; Staten et al. 1988). Price reductions appear to be larger in a more concentrated insurer market (Melnick et al. 1992), indicating payers may be successful in playing hospitals off against each other. The one study analyzing the impact of insurer monopsony power on prices in the market competitive segment in the Netherlands finds a negative relationship between the insurer market share and the hospital price–cost margin (Halbersma et al. 2011), indicating a price reducing effect when the insurer market is more concentrated.

In general, to date, most studies use hospital-level data and only few studies have used micro-costing data at the level of treatments, also referred to as episode level-data (Barnett et al. 2003; Carey 2000; Grieve et al. 2005). Most research relies on proxies for costs, like charges and length of stay, both of which have severe drawbacks (Botz et al. 2006; Evans et al. 2007; Martin and Smith 1996; Schreyögg et al. 2011). Previous research on the Dutch situation has focused on inpatient treatments or on one specialty/surgery only (Heijink et al. 2013). We contribute to the existing literature on the introduction of managed competition by analyzing the change in overall production in The Netherlands, taking into account local variations in the spatial concentration of hospitals, insurers and ITCs simultaneously. Most prior literature analyzed the impact of market competition on inpatient health care. We extend the focus by analyzing the influence of managed competition on inpatient and outpatient production separately.

We more specifically expect that an increase in production and associated costs from managed competition will vary across hospitals and DBCs, depending on the local market structure. Increased competition between hospitals is expected to lead to higher DBC volume and average costs (the medical arms race argument), more ITCs in the proximity of hospitals will lower volume and increase average costs, and higher monopsony power of insurance companies will lead to lower volume and lower average costs.

We use a large dataset of 1,345,144 patient files for fifteen Diagnosis Treatment Combinations (DBCs), representing approximately 70% of the managed competition segment, generally referred to as the so-called B-segment. We also take the heretofore neglected entrance of ITCs into account as potential influencer of hospital production and cost. Thus, we aim to provide a much more detailed assessment of the effects of the reforms introduced in the Netherlands.

3. Research method

3.1 Data selection

The introduction of managed competition in 2005 coincided with a new registration system of DBC production, making it impossible to compare production and costs before and after market reform as a natural experiment.

However, we expect market conditions not to have an immediate effect, but to take some time before affecting hospital performance. We therefore concentrate on the period shortly after introduction, covering the period 2005 to 2008. Our analysis is a multi-year analysis of the impact of differences in market conditions on hospital production volume and average costs. Price information is not publicly available, so we use an approximation of average cost instead.

From the segment of managed competition, we selected fifteen DBCs, jointly representing around 70% of the costs in the market-based payment system. Table 1 gives an overview of the selected DBCs with their diagnosis and DBC code.

Table 1. DBCs used in the sample, representing 70% of the health care costs in the B-segment.

Diagnose	Name	DBC code
Cataract	Cataract (daycare)	11 554 32
Arthrosis	Arthrosis (total hip)	11 1701 223
	Arthrosis (total knee)	11 1801 223
	Arthrosis knee (daycare)	11 1801 212
Adenoid	Adenoid (daycare)	11 52 212
	Adenoid (inpatient care)	11 52 213
Inguinal hernia	Inguinal hernia (surgery and daycare)	11 121 202
	Inguinal hernia (surgery and inpatient care)	11 121 203
Varices	Varices dermatology	11 24 41
	Varices surgery (daycare)	11 423 202
Diabetes	Diabetes (first treatment, without complications)	11 221 1101
	Diabetes (first treatment with complications)	11 222 1101
	Diabetes (following treatment without complications)	21 221 1101
	Diabetes (following treatment with complications)	21 222 1101
Hernia	Hernia (low back pain)	11 1203 111

Production of the fifteen DBCs over the period 2005 – 2008 comprises 1,559,351 patient files from 81 general hospitals, ranging from small regional hospitals to top-clinical large hospitals. The dataset does not include university and specialty hospitals. Registered hospital activity consists of outpatients' visits, daycare, diagnostic activities (such as x-rays and lab activities) and nursing days. Additionally, information on patient and health insurer characteristics is available. We checked and validated the data on several aspects for completeness and correctness. We excluded extreme outliers from the database (Palmer and Reid 2001), leading to a reduction of 13.7% of the total number of observations. Our validated database consists of 1,345,144 patient files.

3.2. Model specification and variable measurement

To identify the impact of hospital and insurer competition on the volume and cost of hospital production in each of the fifteen sample DBCs, we estimate the following linear model:

$$d_{jti} = \alpha + \beta MS_{jt} + \gamma OV_{jt} + \delta Q_{jt} + \zeta P_j + \eta Y_t + \varepsilon_{jti} \quad (1)$$

where d_{jti} is the dependent variable for hospital j at time t for each DBC_i; MS_{jt} is a vector of market structure variables for each hospital, which may vary over time; OV_j is a vector of time dependent organizational characteristics; Q_j contains quality measures; while the vectors P_j and Y are control variables, controlling for each hospital's adherent population and three year dummies. The year dummies pick up common changes in the health care system.

For d_{jt} we use two dependent variables: production volume and average cost. The production volume of each DBC_i is measured by the number of patient files registered, validated and reimbursed. The average cost of DBC_i is calculated by valuing each activity in the patient file at national cost prices for 2005, and divide the total costs of all health care activities by the number of patient files to calculate a total average cost per DBC per hospital per year. The 2005 prices are also used for the valuation of DBCs in the remaining years, thus filtering out price fluctuations. We used the national price list of health care activities because real hospital cost prices are not available. We therefore are unable to detect cost price differences among hospitals. However, what our average cost price does detect is the intensity of care, based on volume and cost of health care activities performed for each DBC.

Hospital and insurer market structures are measured by the Herfindahl-Hirschman Index (HHI). The HHI is defined as the sum of squared market shares of all hospitals serving the same market (Zwanziger and Melnick 1988):

$$HHI_j = \sum_{k=1}^{N_j} S_{jk}^2 = \left(\frac{X_{j1}}{X_{jN}}\right)^2 + \left(\frac{X_{j2}}{X_{jN}}\right)^2 + \left(\frac{X_{j3}}{X_{jN}}\right)^2 + \cdots + \left(\frac{X_{jk}}{X_{jN}}\right)^2 \quad (2)$$

where X_{jk} is the production volume of hospital k of health service j, X_{jN} is the total production of health service j by all hospitals in the relevant market, S_{jk} is the market share of hospital k in its relevant market j and N_j is the number of hospitals operating in that relevant market. To delineate the relevant market area we assume a desirable travel time of 15 minutes (Van der Schee et al. 2005; Varkevisser and Van der Geest 2007). The fixed radius of a hospital to another competitive hospital is thus 30 minutes maximum, with the HHI for hospital concentration based on the number of competitors within a boundary of 30 minutes supplying the same DBC.

The concentration of the insurer market is determined in a similar way, using the HHI on the relative market shares of the insurance companies in financing a specific DBC to a specific hospital. Since the reform in 2005, some concentration on the health insurance market has taken place. Currently, five major health insurance holdings with each a number of insurance brands operate in the Netherlands. In case a health insurer does not belong to one of the five holdings, it is classified in the category "other". We exclude hospitals if more than 10% of the DBCs cannot be identified to a health insurer.

The number of ITCs is taken from surveys from the Dutch Health Authority (NZa) of ITCs having invoiced DBCs to at least one health insurer. Websites and annual reports were reviewed to identify the treatments each ITC offers. For each DBC and each year the number of relevant ITCs is measured, taking into account the 15 minutes radius from each hospital, also including ITCs operating from within the hospital. For instance, when defining the relevant number of ITCs for the DBC 'cataracts', we take into account the number of ITCs providing ophthalmology treatments, while disregarding neighbouring ITCs that do not provide ophthalmology treatments.

We control for a number of organizational characteristics. First, larger hospitals should benefit from economies of scale effects, leading to lower costs; though empirical studies have shown mixed results. One early study found that larger hospitals have modest economics of scale benefits (Carr and Feldstein 1967). However, others suggest that smaller hospitals do not have many additional resources to buffer market demands, and will therefore adjust more quickly than larger hospitals, thus being more efficient (Frech and Danger 1998; Ozcan et al. 1992). More specifically, based on a longitudinal study from 1989–1997, Yafchak (2000) posits that a positive relation between economies of scale and size of hospitals depends on the environment in which hospitals operate and on the reimbursement regulation. Because in the managed competition segment large general hospitals can divide their fixed costs over more production units, we expect large hospitals to benefit from economies of scale. We use the hospital budget, revenues and the number of patient files per DBC of the total managed competition segment as control variables for hospital size.

Second, we control for 'the percentage of physicians with an employee status.' Hospitals whose medical specialists have an employee status may be more successful in cost containment than hospitals with independent physicians (Liu and Mills 2007). Similarly, top clinical hospitals are supposed to have more difficulties adapting to a more competitive environment than general hospitals. Because physicians of top clinical hospitals are responsible for highly specialized and expensive care and for training new doctors, physicians are less productive than in general hospitals who can exclusively focus on care provision (Grosskopf and Gramsch 2004; Reuter and Gaskin 1997). We distinguish between top clinical and general hospitals using a dummy variable. Additionally, some hospitals participated in the early development of the DBC system and as part of a pilot started registration some years before 2005. To exclude any such effects, we include a dummy for these 'front-runner hospitals'.

Hospital quality is measured by two proxies: the percentage of cancelled surgeries and the AD quality score. The AD score is a proxy of overall hospital quality performance and is based on data of an annual survey (AD (Algemeen Dagblad) ranking top 100) between 2006 and 2008.

Socio-economic conditions of the adherent patients are captured by the percentage of immigrants and the percentage of population older than 65 in the market area, as supplied by the Statistics Netherlands office (CBS). A complete list of the variables used can be found in Table 2.

Table 2. Variable list.

Variable	Definition	Source
Dependent variables		
$DBCvolume_{ij}$	Total number of DBC_i in $hospital_j$	DIS *)
$DBCcost_{ij}$	Average costs of DBC_i in $hospital_j$	DIS
Independent variables		
Market variables		
Herfindahl index hospitals	Market concentration hospitals for $hospital_j$	DIS
Herfindahl index insurers	Market concentration insurers for hospital	DIS
Number of ITCs	Number of ITCs providing the same DBC_i as $hospital_j$	NZA
Control variables		
Organizational variables		
Type of hospital	Dummy: 1=top clinical; 0=general hospital	Annual reports
DBC experiment	Dummy: 1=front runner; 0=no front runner	DBC Onderhoud
Budget hospital	Total revenues of $hospital_n$ (in thousands €)	Annual reports
B-segment	Revenues B-segment / Total revenues	DIS
Physicians employed	Percentage of physicians with employee status in $hospital_j$	Annual reports
Quality		
Cancelled surgeries	Percentage cancelled surgeries by $hospital_j$	Ziekenhuizen-transparant
Quality score hospital	AD score for $hospital_j$	Algemeen Dagblad
Population characteristics		
Age > 65 in region	Percentage age > 65 of total population	CBS
Foreigners in region	Percentage foreigners of total population	CBS
Year		
Year 2006	Dummy: 1=2006; 0=other years	
Year 2007	Dummy: 1=2007; 0=other years	
Year 2008	Dummy: 1=2008; 0=other years	

*) DIS: DBC Information System of the Dutch Hospital Association (NVZ)

4. Results

As shown in Table 3, Dutch hospitals vary considerably in size. The smallest general hospitals have annual costs of less than €50 million while larger hospitals (often hospitals offering top level clinical care) have costs of €250 million or more. The average Herfindahl index of hospital concentration is 0.291 (SD 0.262) indicating that the market is relatively concentrated (a low value means that a relatively high number of hospitals serve the relevant market without any hospital taking a large portion of the market). The HHI ranges from 0.04 to 1, so there is much variation in hospital concentration.

There is an increase in the number of independent treatment centers from 37 in 2005 to 89 in 2008. In the period studied, the independent treatment centers had only a relatively small share of the managed competition segment (NZa 2008). However, they may put considerable pressure on negotiations with hospitals in metropolitan regions for specific areas of specialism such as ophthalmology, as the independent treatment centers can produce with much lower overhead costs.

Table 4 depicts the volume and cost changes of the fifteen DBCs in the period 2005–2008. In general, we see a production volume increase for most DBCs, but a remarkable decrease in Diabetes first and following treatments without complications, which could be a result of the introduction of an experiment with bundled payment contracts for integrated diabetes care without complications. This led to a substitution of hospital care to outpatient care for regular diabetes care (Struijs et al. 2009).

Table 3. Descriptives.

Variables	N	Minimum	Maximum	Mean	Std.Dev
Dummy type of hospital	324	0	1.00	0.71	0.46
Dummy DTC experiment	324	0	1.00	0.37	0.48
Budget hospital (*1000)	324	23,343.00	274,197.00	101,685.00	59,158.00
Revenues B-segment (*1000)	321	1,421.00	52,000.00	12,903.00	9,806.00
Total revenues hospital (*1000)	324	26,903.00	357,623.00	124,000.00	71,460.00
Percentage Segment B (%)	321	2.45	40.37	13.91	8.99
Number of patient files per DTCs	294	336.00	10,395.00	4,336.00	2,071.00
Herfindal index hospital (%)	323	4.05	100.00	29.11	26.19
Herfindal index health insurer (%)	282	18.30	65.40	39.14	10.52
Number of ITCs dermatology	324	0	12.00	2.95	3.15
Number of ITCs surgery	324	0	7.00	2.19	2.02
Number of ITCs otolary ncology	324	0	3.00	0.35	0.73
Number of ITCs internal medicine	324	0	4.00	0.65	1.14
Number of ITCs opthalmology	324	0	9.00	2.11	2.30
Number of ITCs orthopaedics	324	0	40.00	10.97	10.16
Total number of ITCs	324	0	40.00	10.86	10.14
Percentage physicians in service of hospital	196	0	100.00	26.88	19.29
Percentage of 65+ within region	244	0.07	0.22	0.14	0.02
Percentage of foreigners within region	244	0.06	0.47	0.21	0.10
Number of total surgeries in hospital	297	688.00	57,348.00	12,203.00	7,293.00
Percentage cancelled surgeries by hospital	297	0	13.00	1.10	1.07
Number of complaints submitted to Complaints Committee	240	0	222.00	32.40	30.83
Quality score hospitals AD	242	37.97	82.28	63.09	8.42
Number of DTCs Adenoid (daycare)	323	1.00	1,285.00	413.31	253.28
Number of DTCs Adenoid (inpatient care)	323	1.00	493.00	137.67	102.49
Number of DTCs Cataract (daycare)	319	1.00	3,479.00	1,176.16	806.48
Number of DTCs Diabetes first treatment without complications	321	1.00	813.00	89.72	75.30
Number of DTCs Diabetes first treatment with complications	321	1.00	71.00	122.28	104.08
Number of DTCs Diabetes following treatment without complications	321	1.00	1,262.00	342.42	232.76
Number of DTCs Diabetes following treatment with complications	320	1.00	1,549.00	510.14	322.83
Number of DTCs Hernia (low back pain)	323	41.00	1,221.00	394.29	225.80
Number of DTCs Inguinal hernia (daycare)	321	2.00	445.00	147.47	91.71
Number of DTCs Inguinal hernia (inpatient case)	321	1.00	438.00	84.75	62.42
Number of DTCs Total hip replacement	322	1.00	537.00	201.46	114.06
Number of DTCs Knee (daycare)	321	1.00	541.00	85.88	98.45
Number of DTCs Total knee replacement	316	2.00	454.00	152.46	96.29
Number of DTCs Varices dermatology (extended outpatient treatment)	309	1.00	1,630.00	199.99	241.05
Number of DTCs Varices surgery (surgery and daycare)	321	3.00	569.00	144.74	97.86

Table 4. Selected DBCs change in volume and average cost 2005–2008.

DBC name	Volume change 2005–2008 (%)	Cost change 2005–2008 (%)
Adenoid (daycare) – Otolaryngology	11.73%	-1.53%
Adenoid (inpatient care) – Otolaryngology	10.63%	-0.84%
Artrosis (knee daycare) – Orthopedics	29.87%	-5.67%
Artrosis (total hip) – Orthopedics	9.80%	-3.21%
Artrosis (total knee) – Orthopedics	22.33%	-7.56%
Cataract (daycare) – Opthalmology	11.24%	-12.23%
Diabetes (first treatment with complications) – Internal medicine	-11.20%	13.37%
Diabetes (first treatment without complications) – Internal medicine	-46.29%	19.31%
Diabetes (following treatment with complications) – Internal medicine	16.22%	9.15%
Diabetes (following treatment without complications) – Internal medicine	-28.68%	13.57%
Hernia (low back pain) – Neurology	0.35%	11.09%
Inguinal hernia (surgery and daycare) – Surgery	35.49%	2.26%
Inguinal hernia (surgery and inpatient care) – Surgery	-35.76%	4.47%
Varices (extended outpatient treatment) – Dermatology	32.48%	2.35%
Varices (surgery daycare) – Dermatology	32.09%	-13.24%

Also for hernia treatments (inpatient care) there seems to be a substitution from inpatient to daycare.

For seven out of the fifteen DBCs, average costs have decreased, while for eight of the fifteen DBCs average costs have increased. This result shows that the cost reduction objective was not fully met by the introduction of market competition for the sample care products. There is no obvious explanation for the average cost differences. We will try to explain the differences between DBCs in the remainder of the paper by using market structure and objective organizational characteristics as explanatory variables.

Our regression models in Table 5 show that volume in practically all DBCs is positively related to hospital size and percentage of revenues in the managed competition segment. Hospital and insurer market structure do not influence volume much for most DBCs. Hospital market concentration is positively related to production volume in knee replacement and knee daycare. This means that number of knee treatments is higher in areas with lower competition (thus a high Herfindahl index value, indicating only a few hospitals serving the relevant geographical market). Competitive markets (having a low HH-index value) are associated with high production volumes in Diabetes treatments, hernia low back pain treatments and inguinal hernia daycare.

As expected, more ITCs in the hospital's proximity leads to significantly more production volume in predominantly more complicated care, like inpatient care and treatments with complications.

Table 6 shows that larger hospitals incur higher average costs for most B-segment DBCs. This is presumably because larger hospitals treat relatively more severe cases or because larger hospitals incur higher costs of organizational complexity. More competitive health care markets, indicated by a low value of the HH-index, are associated with higher average costs for seven DBCs and with lower average costs for two DBCs. The average costs of all diabetes DBCs are insensitive to market structure. This may be caused by the bundled payment experiment in the diabetes care that was taking place in the period of this study (for an explanation of the bundled payment system please refer to Van der Hijden et al. in this MAB edition).

This result lends some support to our expectation. Hospitals in highly competitive regions appear to incur higher average costs than hospitals in concentrated regions for most B-segment DBCs. This may indicate that hospitals in competitive markets provide more health care activities or spend more on amenities to attract patients. The average costs of virtually all DBCs are also negatively related to the number of patients treated (see variable "number of patient files per DBC"), indicating an economies of scale advantage for almost all sample DBCs.

The insurer market structure also does seem to have an impact on average cost, but this influence is opposite to what we expected. Hospitals operating under a concentrated insurer market are funded by a group of insurer companies dominated by one or only a few insurer companies which are able to exercise monopsony power. A more concentrated market is indicated by a higher value of the HH-index. We have measured insurer market concentration for each DBC separately. Table 6 shows that for 12 out of the 15 DBCs more monopsony power is associated with higher average DBC cost. This means that hospitals operating in a concentrated insurer market incur generally higher costs than hospitals operating in a less concentrated insurer market. Insurer groups with less monopsonic power seem to be better capable of containing costs than insurer groups with high monopsonic power.

Our finding coincides with the NZa general conclusion that Dutch insurance companies do not effectively use their monopsony power to control costs (NZa 2011). A possible explanation for this finding is that insurers with high monopsonic power may not be able to effectively pressure the hospital because executing the threat of ending financial support could lead to closure of the hospital. Monopsonic insurers may also have long-lasting relations with the hospital, causing insurers to become more committed and thus less critical to the hospital (NZa 2008). Alternatively, under conditions of low insurers concentration, more insurers are involved in the negotiation process which may lead to the availability and exchange of more information about cost and possibilities to economize.

Table 5. Regression analysis of *DBC volume* as dependent variable.

	Adenoid -daycare	Adenoid -inpatient care	Cataract -daycare	Diabetes first treatment without complications	Diabetes first treatment with complications	Diabetes following treatment without complications	Diabetes following treatment with complications	Hernia Low back pain	Inguinal hernia -daycare	Inguinal hernia -inpatient care	Varices dermatology	Varices surgery -daycare	Artrosis total hip replacement	Artrosis total knee replacement	Knee -daycare
Market variables															
Herfindahl index hospitals -%	-0.047	0.063	0.096	-0.057	-0.045	-0.090*	-0.066	-0.163***	-0.149**	0.087	-0.050	0.022	-0.046	0.106*	0.220***
Herfindahl index health insurer -%	-0.090*	-0.086	-0.004	0.084	-0.052	0.251***	0.184***	-0.007	-0.110**	0.066	-0.070	-0.074	-0.144***	-0.137**	0.069
Number of ICTs	0.062	0.110**	0.034	0.026	0.119**	0.115**	0.156***	0.083	-0.139**	0.069	-0.043	0.157**	-0.010	0.140*	0.429***
Organizational variables															
Type of hospital -dummy	0.067	0.139**	0.035	-0.139*	-0.053	-0.099	-0.001	-0.112*	-0.075	-0.045	-0.008	-0.002	0.060	0.008	0.146**
DBC experiment -dummy	0.025	0.099**	0.059	0.010	-0.015	0.012	0.001	0.131	-0.033	0.028	0.002	-0.002	0.058	0.026	0.087
Budget hospital -*1000	0.666***	0.767***	0.727***	0.431***	0.455***	0.554***	0.670***	0.526***	0.700***	0.601***	0.596***	0.607***	0.837***	0.693***	0.632***
B-segment -%	0.274**	0.548***	0.516***	0.169	0.227*	0.375***	0.422***	0.176	0.320***	0.285**	0.153	0.381***	0.526***	0.458***	0.634***
Phycisians in service of hospital -%	-0.070	-0.084*	-0.104**	-0.006	0.021	-0.092*	-0.016	-0.029	0.010	-0.088**	-0.072	-0.019	-0.122***	-0.050	0.074
Quality															
Cancelled surgeries	-0.010	-0.020	-0.091*	-0.022	-0.042	-0.068	-0.093*	-0.057	-0.102**	-0.089*	-0.090*	-0.129**	-0.170***	-0.153***	-0.053
Quality score hospitals	-0.011	-0.058	0.126***	-0.126**	-0.119**	-0.068	-0.008	-0.009	0.011	-0.137***	-0.101**	0.006	0.006	-0.043	-0.082
Population															
Age > 65 within region	-0.131**	0.004	-0.047	0.012	0.020	-0.065	0.074	0.040	-0.079	0.051	0.054	-0.036	0.049	0.059	-0.008
Foreigners within region	-0.154***	-0.094*	0.106**	0.005	0.040	-0.110**	-0.053	-0.010	-0.120**	-0.096*	-0.058	-0.099*	-0.137***	-0.058	-0.126**
Year 2006	0.039	-0.024	-0.032	-0.269***	-0.170***	-0.081	-.003	-0.119**	0.010	-0.162***	-0.019	-0.072	-0.082**	-0.005	-0.110*
Year 2007	0.079	-0.065	0.068	-0.398***	-0.234***	0.189***	0.013	-0.078	0.132**	-0.297***	-0.035	0.009	-0.030	0.051	-0.089
Year 2008	-0.178	-0.472***	-0.415***	-0.492***	-0.287**	-0.517***	-0.272**	-0.160	-0.091	-0.528***	-0.032	-0.191	-0.398***	-0.287***	-0.556***
F-statistics	13.170***	12.147***	14.919***	11.847***	7.441***	12.775***	12.893***	18.224***	14.348***	11.895***	9.681***	11.164***	24.812***	13.095***	7.281***
Adj. R square	0.361	0.341	0.393	0.335	0.230	0.354	0.356	0.444	0.383	0.336	0.287	0.321	0.525	0.360	0.226

***=significant at 1% level, **=significant at 5% level, *=significant at 10% level; n=324.

Table 6. Regression analysis of *DBC average cost* as dependent variable.

	Adenoid (daycare)	Adenoid (inpatient care)	Cataract (daycare)	Diabetes first treatment without complications	Diabetes first treatment with complications	Diabetes following treatment without complications	Diabetes following treatment with complications	Hernia Low back pain	Inguinal hernia (daycare)	Inguinal hernia (inpatient care)	Varices dermatology	Varices surgery (daycare)	Artrosis total hip replacement	Artrosis total knee replacement	Knee (daycare)
Market variables															
Herfindahl index hospitals (%)	-0.237***	0.009	-0.278***	0.089	0.055	0.016	0.059	-0.127*	-0.229***	0.049	-0.179**	-0.251***	0.139**	0.134*	-0.141*
Herfindahl index health insurer (%)	0.016	0.109*	0.075	0.153**	0.125**	0.128**	0.110*	-0.027	0.148**	0.193***	0.181***	0.137**	0.153**	0.205***	0.114*
Number of ICTs	-0.135**	0.071	-0.075	0.062	0.035	0.125**	0.147**	0.031	0.094	0.208***	-0.130*	0.092	0.275***	0.287***	0.164*
Organizational variables															
Type of hospital (dummy)	0.161**	-0.028	0.152*	-0.135*	-0.194***	-0.186**	-0.140*	0.051	0.041	-0.098	0.096	-0.026	0.057	-0.038	-0.060
DBC experiment (dummy)	-0.037	-0.106*	-0.009	0.024	0.010	-0.040	-0.037	0.082	-0.073	-0.094*	0.130**	-0.046	-0.130**	-0.124**	-0.023
Budget hospital (*1000)	0.324***	0.218**	0.282***	0.036	0.007	0.003	0.199**	0.125	0.171*	0.163*	0.192**	0.057	0.444***	0.273***	0.072
B-segment (%)	0.128	0.231	0.183	-0.087	0.047	-0.005	0.125	0.113	0.195	0.204	0.150	0.211	0.321**	0.312**	0.177
Phycisians in service of hospital (%)	-0.022	-0.044	-0.080	-0.092*	-0.038	0.022	0.032	0.015	0.028	0.034	-0.060	0.094*	-0.035	-0.017	0.036
Number of DBCs	-0.403***	-0.121*	-0.168**	-0.259***	-0.139**	-0.101	-0.114*	-0.228***	-0.135*	-0.250***	-0.283***	-0.113*	-0.467***	-0.389***	0.022
Quality															
Cancelled surgeries	-0.024	0.014	-0.026	0.061	0.091*	0.024	-0.018	-0.028	0.007	-0.007	-0.050	0.058	-0.035	-0.046	0.099*
Quality score hospitals	0.020	0.048	-0.015	-0.102*	-0.041	-0.012	-0.046	0.052	-0.042	-0.001	0.012	-0.052	-0.035	-0.064	-0.055
Population															
Age > 65 within region	0.007	0.034	0.043	0.007	0.001	0.054	0.079	-0.046	0.020	0.072	0.027	-0.001	0.032	0.041	0.016
Foreigners within region	0.016	0.107	-0.007	0.319***	0.244***	0.258***	0.281***	-0.151**	-0.117*	0.043	-0.001	-0.128*	0.020	0.072	-0.218***
Year 2006	-0.099	-0.109	0.022	0.329***	0.562	0.227***	0.201***	0.201***	-0.012	-0.087	-0.091	-0.085	-0.109*	-0.105	0.16
Year 2007	-0.150**	-0.166**	-0.049	0.317***	0.535	0.291***	0.259***	0.318***	-0.049	-0.184***	0.014	-0.176**	-0.197***	-0.197***	-0.209***
Year 2008	-0.152	-0.241	-0.317*	0.269*	0.109	0.361**	0.205	0.197	-0.156	-0.218	-0.084	-0.409**	-0.353**	-0.391**	-0.457***
F-statistics	4.152***	1.616	2.670***	7.805***	6.933***	5.479***	5.789***	3.666***	1.634*	2.642***	2.968***	2.495***	5.130***	4.907***	4.013***
Adj. R square	0.135	0.030	0.076	0.252	0.227	0.182	0.192	0.117	0.030	0.075	0.089	0,069	0.170	0.162	0.130

***=significant at 1% level, **=significant at 5% level, *=significant at 10% level; n=324.

The number of ITCs in the vicinity of the focal hospital has a positive association with average costs for 6 out of the 15 sample DBCs. This result confirms our expectation for almost half of the sample DBCs. Most ITCs provide diagnostic services and basic care to patients with non-complex diseases. When ITCs take some of the less complex patients of the related hospital, this will increase the hospital's average case mix complexity.

5. Conclusions

This study examined the impact of the market structure on hospital production and costs after the introduction of managed competition in the Netherlands in 2005. We investigated three parameters that potentially influence the hospital market: hospital concentration, insurer concentration and the proximity of new providers (ITCs). We investigated whether these market variables have an effect on volume and average costs of 15 DBCs, representing 70% of the management competition segment.

For all general hospitals combined, production has increased in the market competitive system after the introduction of health care reforms. This finding supports our expectation that the introduction of the Dutch managed competition system has led to an increase in hospital production. Regression analysis shows that neither spatial concentration of hospitals nor concentration of insurers is associated with volume of health care production. Hospitals are not increasing production more when the market is concentrated and dominant concentrations of health insurers have not been proven effective in controlling production volume. Apparently, under the new quasi-market system both hospitals and physicians are able to improve income by increasing health care production (Schut and Van de Ven 2011).

Although the average health care production appears to have increased, cost levels have changed differently for the health care products analyzed. Overall, the relationship between volume and costs seems to be negative, but explanations for this effect could be different per diagnosis or even per DBC. Hospital concentration has a significant impact on the reduction of average costs for most of the daycare products and leads to higher cost for hip and knee replacements. This is contrary to the expectation that low hospital concentration leads to lower average costs or hospital production. Our explanation is that competition between hospitals in competitive markets is more patient-driven so that hospitals in competitive markets provide extra services to attract patients.

A high concentration of insurers does not have a clear relationship with volume, but is associated with higher average costs for most of the health care products. This is contrary to our expectation that monopsony power leads to lower average costs. The effect of insurer concentration on costs is more significant than the effect of hospital concentration. It becomes clear that the practice of "selective contracting" is not taking place yet (NZa 2008). To the contrary, insurers with high monopsonic power find themselves trapped in a double-bind relationship. For them, using the threat of retreating their support is not effective because it would jeopardize the future of the hospital and put health care services for their insurance holders at risk. A final conclusion is that more specialized health care centers in the environment of hospitals leads to higher hospital production of more complex and inpatient DBCs and to higher average costs. We think that more ITCs in the hospital's vicinity increases the volume of follow-up treatments in the hospital, leading to higher volume of care and to a more complex case-mix.

There are some limitations to our study; first of all, some limitations are related to the data. The DBC data and care activities, which have been delivered by the Dutch hospitals, constitute an important source of research material. However, the first years of registration of DBCs bear the risk that the production and the activity registration were not complete or not reliable. The dataset was analyzed on completeness, timeliness and correctness of the data. Based on this analysis we consider the data to be useful for further analysis. Also, no other study reported the use of a similar dataset to compare our results. The results can also be influenced by other incentives in the market. Until 2008 medical specialists, who are not in pay of a hospital, were reimbursed by a budget system (lump sum) and maximum hourly tariffs. In 2008, this compensation system was discharged and medical specialists are paid on the basis of the registered DBCs. This may have introduced volume induced incentives that could have influenced the 2008 volumes and cost.

This article is mainly concerned with the effects of market structure differences on health care production and costs. Further research could also focus on the effects on health care quality. The Dutch government has asked the Health Inspectorate to develop quality indicators. We need to wait for reliable quality indicators to see the impact of competition on health care quality (Bijlsma et al. 2010; Heijink et al. 2013). Also, further research is necessary to analyze the different effects of competition on substitution patterns between inpatient and outpatient care.

List of abbreviations

ASC	Ambulatory Surgery Center
CBS	Statistic Netherlands Office
DBC	Diagnosis Treatment Combinations
HHI	Herfindahl-Hirschman Index
ITC	Independent Treatment Center

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