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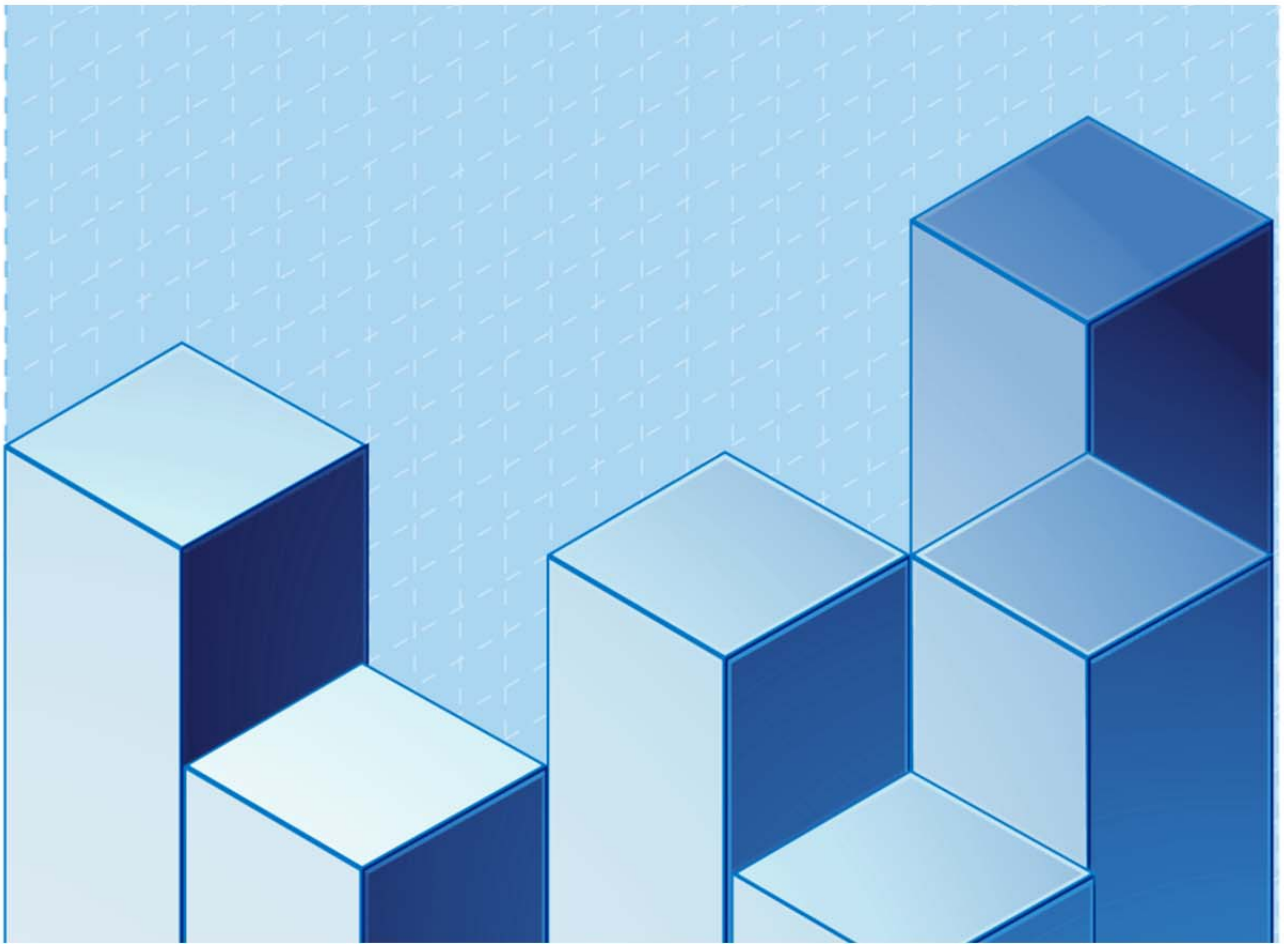

SPINTAN Project: Smart Public intangibles. This project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no: 612774.

Version: March 2016

Published by:

Instituto Valenciano de Investigaciones Económicas, S.A.

C/ Guardia Civil, 22 esc. 2 1º - 46020 Valencia (Spain)

DOI: http://dx.medra.org/10.12842/SPINTAN-WP-09

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HOSPITAL PERFORMANCE AND INTANGIBLE INVESTMENTS: THE IMPACT OF OWN ACCOUNT ORGANIZATIONAL CAPITAL

Erika Schulz*
Laura Beckman*

Abstract

This paper used the employee embedded approach to measure the amount of investments in own account organizational capital as well as the impact of organizational capital on hospital performance in Germany. In hospitals managers of the three main professions: doctors, nurses and economists contribute to building organizational capital. Parts of their working were defined as investments in organizational capital. We find that in our selection of hospitals, one million Euros are invested each year in organizational capital, which is consistent with the findings of CHS (2005, 2009) for the US.

Furthermore, we estimated several models to analyze the impact of organizational capital on hospital performance, using a variety of output indicators. We found significant and positive effects on quality adjusted output measures and labor productivity in all models. This includes the time as well as the wage weighted approach to labor input. As organizational capital is mainly constituted of nursing and medical staffing times and wages, we would thus conclude that investments into these professions have a positive effect on hospital performance.

Additionally, we estimated several quality models to account for the special output of hospitals; patient treatment. For our quality regressions we selected a subgroup of patients with a set of diagnoses as basis for our output measures in order to be able to better compare the quality of treatment between hospitals. In this context positive output measures such as labor productivity might cause deterioration in quality due to higher work load. For this reason we estimated a separate model with the survival rate as the only dependent variable, in order to isolate the quality effect from the quantity effect. Our results show that the positive impact of organizational capital on hospital performance is mainly driven by quantity aspects. However, when talking about intangibles in the public sector, we believe that developing quality indicators would be a valuable contribution of future research.

Key words: Own account organizational capital, hospital performance, Germany

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1 Introduction

Performance or growths of firms are not only driven by capital and labor input, but also by intangibles. Intangible resources are a key factor in creating a competitive advantage and to increase the performance of firms in the private as well as in the public area (López et al. 2002).

Besides IT and R&D, intangible capital encompasses also the knowledge embedded in firm-specific human and structural resources. Important intangibles are human capital, like professional experience and skills, organizational capital, like efficient management of processes, and relational capital, like partnership or (vertical and horizontal) cooperation with other internal or external providers (Zigan et al. 2007).

Corrado, Hulten, Sichel (CHS 2005, 2009), who discussed the impact of intangible capital on the growth of firms in US industries, distinguishes three "economic competencies", namely brand equity, firm specific human capital, and organizational capital. Organizational capital has two components; purchased and own account. The own account organizational capital is the ability to improve the effectiveness of business organization, that is to develop business models and corporate culture (CHS 2005). Whereas the importance of organizational capital is commonly acknowledged, there is a broad discussion whether organizational capital is embodied in employees or in the firm itself and how to measure organizational capital. CHS (2005, 2009) followed the employee embedded approach. They focus on the time (and payroll) managers spent to improve the effectiveness of the organizational structure. Focusing on the tasks related to improve the organization, Squicciarini and Le Mouel (2012) mention that in non-market sectors, such as health care, also other employees beside managers contribute to the building of organizational capital. In German hospitals organizational tasks are divided between doctors, nursing staff and administration staff. All these occupations spend parts of their working time on management tasks related to create organizational capital.

The aim of this paper is firstly to quantify the amount of investments in organizational capital in German hospitals based on the employee embedded approach. In hospitals managers of the three main professions: doctors, nurses and economists (business managers) contribute to building organizational capital.

Secondly, we want to analyze the impact of investments in organizational capital and the respective capital stock on the performance of hospitals using cross section as well as panel regression analyses.

This paper is structured as follows:

Section 2 and 3 discuss the concept of organizational capital, the approaches that are mentioned in the literature and our own methods of measuring organizational capital in German hospitals. Section 4 and 5 give insight into the data used and descriptive statistics on the average organizational capital stock in (German) hospitals. Section 6, 7 and 8 then show the results of our regression analyses. We applied two models and carried out cross sectional regressions, OLS regressions with pooled data (2006-2012), and panel data analyses using random and fixed effects models. In our basic models we used the full-time-staff as input (section 6). Additional we used a wage weighted labor input (section 7). Furthermore, in section 8 we tried to focus more on quality aspects. Thus, we modified our output variable and some control variables. The last section 9 concludes.

2 Organizational capital

In the literature there is a broad consensus that organizational capital (OC) can have a significant impact on the outcome and performance of a firm, but there is no consensus about the definition of organizational capital or the method of measuring it (Tronconi and Marzetti 2011). Also the way to quantify the contribution of organizational capital to the output used differs between the authors (Filia and Boruvkova 2012). Evenson and Westphal (1995) define organizational capital as the knowledge used to combine human skills and physical capital into systems for producing and delivering want-satisfying products. There are two strands to view organizational capital. One strand is to view organization capital as "a firm specific capital good jointly produced with output and embodied in the organization itself" (Atkeson and Kehoe 2002, p. 3). Proponents of this approach include Arrow (1962), Rosen (1972), Tomer (1987), and Ericson and Pakes (1985). Also Lev and Radhakrishnan (2003) follow the firm embodied concept of organizational capital.

The second way to view organizational capital is that this resource is embodied in employees (Jonanovic 1979, Becker 1993, Prescott and Visscher 1980). Black and Lynch (2005) divide organizational capital into three broad components – workforce training, employee voice, and work design - with important links and synergies between each of these components that contribute to the overall value of organizational capital. Organizational changes may require specific workforce training to cope with the new situation. At the same time, organizational capital may interact with human capital and the ability of a firm to undertake organizational changes. Additionally, the spillover effects of specific training are related to the organizational structure of the firm and the human capital. The second component, employee voice, means those organizational structures that give workers input into the decision-making associated with the design of the production process and greater autonomy (for example employee suggestion box in the lunch room, consulting of employees about their views, self-managed teams where production employees work in a semi-autonomous setting). The third component, work design, includes the use of cross-functional processes that result in a more flexible allocation and re-allocation of labor in the firm. This component of organizational capital includes practices like reengineering efforts that may involve changing the occupational structure of the workplace or benchmarking. Baron and Armstrong (2007, p. 14) define organizational capital as *embedded or institutionalized knowledge that may be retained with the help of information technology on readily accessible and easily extended databases.* It can include explicit knowledge that has been recorded on a database or in manuals and standard operating procedures, or tacit knowledge that has been captured, exchanged and, as far as possible, codified. Organizational capital is created by the workforce but it is also the outcome of social capital interactions.

Corrado, Hulten and Sichel (2005, 2009) also followed the employee embedded approach. The authors distinguish three broad groups of intangibles: Computerized information, innovative property and economic competencies. Latter includes knowledge embedded in firm-specific human and structural resources, like organizational structure. Investments in organizational capital have both purchased and own account components. "*The own-account component is represented by the value of executive time spent on improving the effectiveness of business organizations—that is, the time spent on developing business models and corporate cultures."* (CHS 2005, p.29).

According to CHS (2005, 2009) the investment in own-account organizational capital can be estimated as a proportion of the cost and number of persons employed in executive occupations. The authors assume that one-fifth of the managers and executives time (and payroll) is spent on organizational innovation, but they also mentioned that this is an "*admittedly arbitrary choice*". CHS have focused on the impact of intangible capital on

the growth of private business industries in the US. The study of Squicciarini and Le Mouel (2012) shows that in particular in public service industries also other occupations may be engaged in organizational development and change. Thus, beside managers other occupations are relevant for creating organizational capital, too.

Hospitals are very complex organizations. This complexity is influenced by the number of different departments and services provided, each having its own leadership and being quite differentiated. Furthermore, a mix of industrial, scientific and technological procedures is conducted on humans, with a diverse set of cultural, educational and social components intertwined (Santos-Rodrigues et al. 2013). The primary aim of hospitals is to provide health treatments of high quality. The outcome of hospitals is the improved health status of their patients. Hospitals try to provide adequate treatments of high quality in an efficient way. The efficiency of health care provision is influenced by the organization of the processes necessary for the adequate treatment of the patient. In hospitals as professional bureaucracies there is more horizontal than vertical leadership. Teamwork and coordination between medical professions, nursing professions, and economic professions are necessary for an efficient treatment of patients as well as a frictionless coordination of the single tasks. Tacit knowledge plays an important role for an efficient health care provision.

In German hospitals management tasks are divided between doctors, qualified nurses and economic professionals. Thus, all these occupational groups have specific tacit knowledge and are engaged in creating organizational capital. Medical professionals are no longer solely responsible for the provision of adequate medical treatments of high quality but in recent years have also increasingly taken on management tasks (Klinke und Müller 2008). Qualified nurses are responsible for the coordination of nursing care and related tasks (transportation of patients, admission and discharge management, management of food and material supply) and the economic professions in administration are responsible for the economic efficiency of the hospital. The study of Squiccianini and Le Mouel (2012) came to the result that in the health care sector a high proportion of non-managerial organizational occupations exists; in hospitals around 40 % of employees, in non-hospital sector 25 %.

3 Approach to measuring organizational capital

In our paper we follow the employee embedded approach. We calculated the ***investments in organizational capital*** (IOC) in three steps:

- We identified the occupational groups relevant for creating organizational capital
- We used a survey to quantify the time these occupations spend on management tasks
- We calculated the average wage for these occupational groups in each hospital (deflated)

And last but not least we used the 0.2 percent of the salaries of these parts of employment as investments in organizational capital (according to CHS 2005). For this we used Full Time Equivalents (FTE).

Formula to calculate the investments in organizational capital:

$$\mathbf{IOC_{ijt} = 0.2 * wage_{ijt} * FTE_{ijt} * share\ of\ management\ tasks_{j}}$$

IOC_{it} = 0.2 of (wage costs of workers engaged in production of OC deflated by earnings index) multiplied with the (labor input of workers engaged in production of OC) for each hospital i in year t.

Professions engaged in the production of OC are doctors, qualified nurses and part of the administration staff.[1] The management tasks of doctors depend on the qualification level and hierarchical position. In hospitals doctors can be distinguished between leaders of the department, leaders of the ward, and assistant physicians. How much time these occupations spend on management tasks is analyzed in surveys. Klinke and Müller (2008) carried out a survey of doctors (in total 1,950 physicians) in Hessian hospitals, in which they had to indicate the amount of time spent on six different areas of tasks. On average doctors spend 2.1 hours with admin tasks and 1.2 hours writing medical reports. Administration tasks and the writing of medical reports together take up around one third of doctors working time daily. DKI (2010) analyzed the tasks of nursing staff. Nursing services are assigned a number of administrative tasks, which have to do with the organization and coordination of patient treatment. The organization of appointments takes on average 41.6 minutes in internist departments. In addition to this, the organization of therapists (e.g. physiotherapy, ergo therapy), of social services and pastoral services takes up on average 24 minutes per day. Together nursing staff spend around one hours per day for administration tasks, that is 13 %. Both studies focus only on specific occupational groups and the results may not be comparable between the mentioned occupational groups. The survey of time spent for documentation (HIMSS EUROPE 2015) presents results for all occupational groups and distinguishes doctors by hierarchical level. According to the HIMSS survey chief consultant spend 61 % of their daily working time for documentation and management, senior physicians 35 % and assistant physicians (without assistant physicians in further training) around 43 %. Qualified nurses spend 34 % of their time daily working time for these tasks. Administration staffs responsible for economic affairs (management tasks) spend 50 % of their time for management tasks. Thus, we used the HIMSS survey for our analysis. We calculated the investments as followed:

> IOC_{it} = 0.2*(((Doc1*0.61*+Doc2*0.35+Doc3*0.43)*average wage cost of doctors deflated)+((qualified nurses*0.34)* average wage costs of nurses deflated)+((admin*0.2)* average personnel costs of administration staff deflated))

Doc1 are doctors in managerial capacity (chief consultant); Doc2 are assistant medical directors (senior physician); Doc3 are assistant physicians (without physicians in further training). According to the HIMSS survey only a part of the total administration staffs are engaged in management tasks relevant for creating OC. As the hospital statistics provides only information on the total administration staff, we calculated the share of management occupations in total administration staff and multiplied this share with the 50 %. As a result we used 20 % of working time of total administration staff.

Based on the investments in organizational capital we calculated the ***average capital stock (OC)*** for each hospital and each year using the approach of Görzig/Piekkola/Riley (GPR 2011). According to GPR the capital stock of OC can be calculated as follows;

Capital stock at the end of the year is equal the investments in OC of the year plus the capital stock at the beginning of the year reduced by the depreciation rate

$OC_{it} = IOC_{it} + (1-\delta)*OC_{it-1}$. With δ as depreciation rate = 0.4

Their approach to calculate the initial capital stock is

$K_{ø-1} = \hat{I}\ (1-(1-\delta-g)*T)/(1-(1-\delta-g))$ where $\hat{I}$ is an estimated starting value of $I_{ø-1}$

[1] Staff relevant for organizational tasks is also employed in the overall organization of hospital trusts. They are not included in the hospital statistics, but in total it is only a small number of employees.

T can be set by 100; g is the average growth rate of OC in the sample; Î is set as the starting period investment.

4 Data

To calculate the investments in own account organizational capital and to analyze the impact of IOC and OC on hospital performance we used the German Hospital Statistics provided by the Federal Statistical Office of Germany. The hospital statistics provides information on basic data of hospitals, personnel, costs and inpatients at hospital level. We used data for the years 2006 to 2012. The data set is based on a census of all hospitals in Germany carried out each year (on average around 2,000 per year). We select general hospitals and thereof those hospitals with information on the case mix of inpatients, that is hospitals using DRGs or a combination of DRGs and per diem rates as reimbursement system. Additional we exclude hospitals with no mandate for health care provision of the statutory health insurance funds (Krankenhäuser ohne Versorgungsauftrag). The selected hospitals are acute care hospitals.

Additionally we carried out the following data selection:

- As the dataset included many missing values for key variables like personnel, material, patients or costs, we replaced them - where possible - with the average of the previous and following year. Where this was not possible, we replaced missing values with the value of the previous year. If we were not able to fill in missing data, we excluded the observation from our sample, leading to 382 observations being dropped from the sample (2006-2012).
- In addition to missing data, we were also faced with implausible and unreliable data. In line with RWI (2010) we excluded the top and bottom 1 % hospitals of key variables, such as the number of beds, number of inpatients, average lengths of stay, Case Mix Index (CMI), wages (for physicians, nurses and other non-medical staff), and material costs per weighted inpatient, which should improve the comparability of our observations. By this method 1,584 observations were deleted from the sample.
- Furthermore, we excluded all those observations where the average earning of nursing staff was higher than the average earning of physicians or if the number of patients, doctors or nursing staff was equal to zero. However, this only led to less than three observations being deleted from the sample (due to data protection law).
- Finally, to avoid a bias due to very specialist hospitals, we selected only those hospitals with an internist and/or surgical department. This excluded further 751 observations from our sample.
- As the calculation of the organizational capital stock requires data for each year, we only selected those remaining hospitals with information for all seven years, deleting another 1,639 observations

At the end, the sample size is 925 hospitals per year for cross-sectional analyses and 6,475 hospitals for panel data analyses Table 11 in Annex A provides an overview of the development of the number and structure of hospitals included in the sample. In 2012 most of the hospitals were owned by charitable institutions (46 %), 39 % were public hospitals and around 15 % were private hospitals. During the observation period the share of private hospitals increased and the shares of public and charitable hospitals declined. Additional, a moderate trend to larger hospitals can be seen.

5 Investments in organizational capital and organizational capital stock

According to the above mentioned approach we used 20 % of the time and personnel costs of hospital personnel engaged in management activities, i.e. of doctors, qualified nurses and part of administration staff, to calculate investments in OC. As a result, around one million Euro are invested in creating own account OC per year in the hospitals included in the sample (Table 1). The greatest share is created by public hospitals, followed by charitable hospitals. The share of IOC of private hospitals increased during the observation period and amounts to 14 % in 2012 (which is still less than their share in hospitals). The differences in the investments activity by ownership show the amount of investment per inpatient. Public hospitals have on average a higher amount of investments in OC per inpatient than charitable or private hospitals. The investments in OC amount in public hospitals to 89 Euro per inpatient, in charitable hospitals to 84 Euro per inpatient and in private hospitals to 85 Euro per inpatient per year.

Table 1: Investments in OC of German hospitals 2006 to 2012

	Total*	Share bei ownership			Per inpatient per year (in Euro)*			
	million Euro	public	charitable	private	average	public	charitable	private
2006	951	49%	40%	11%	87	91	83	88
2007	969	47%	39%	13%	86	90	82	88
2008	993	47%	40%	13%	86	89	82	87
2009	1,024	47%	40%	13%	87	90	83	88
2010	1,060	47%	40%	13%	88	91	85	89
2011	1,078	46%	40%	13%	87	90	85	87
2012	1,098	46%	41%	14%	87	89	84	85

*)In real terms (2012 = 100).
Source: Federal Statistical Office of Germany; Hospital statistics, micro-data, balanced panel 2006 to 2012.

To prove if the calculated amount of IOC is plausible, we compared our results to the results for the US economy. CHS (2005) estimated an amount of investments in own account organizational capital for the US economy in the period 1998 to 2000 of 210 billion dollars per year. That is around 2.25 % of GDP. As we are not looking at the total economy but on hospitals only, we take the total adjusted costs as proxy for the value added or net product of hospitals. If we assign the 2.25 % of the US example to our sample, the amount of IOC is around one million. Thus, our estimation is in line with the calculation of CHS.

The average capital stock of own account organizational capital is calculated according to the above mentioned approach. The average capital stock of all hospitals included in the sample amounts to 2.6 billion Euro in 2012 (Table 2). During the observation period a markedly increase can be observed. Between 2008 (first year with comparable calculation data) and 2012 the increase is around 30 %. Like the investments in OC, also the average capital stock is highest in public hospitals, around 3.4 million Euro. Charitable hospitals have the lowest capital stock, around 2.5 million Euro.

Table 2: Organizational capital stock 2006 to 2012

	Organizational capital (sum in million)*				Organizational capital (mean in million)*			
	total	public	charitable	private	total	public	charitable	private
2006	1 366	666	542	157	1.48	1.79	1.26	1.29
2007	1 788	848	705	235	1.93	2.33	1.64	1.80
2008	2 066	975	826	266	2.23	2.69	1.90	2.07
2009	2 264	1 061	902	301	2.45	2.95	2.10	2.23
2010	2 418	1 128	967	323	2.61	3.15	2.25	2.36
2011	2 529	1 174	1 015	340	2.73	3.27	2.35	2.52
2012	2 616	1 203	1 052	361	2.83	3.36	2.46	2.58

*)In real terms (2012 = 100).
Source: Federal Statistical Office of Germany; Hospital statistics, micro-data, balanced panel 2006 to 2012.

6 Impact of own account OC on hospital performance

6.1 Model specifications

To analyze the impact of investments in own account OC and the respective average capital stock on hospital performance we applied the following two model specifications:

- Specification **A**: $\mathbf{Ln\ Y_{it} = ln\ L_{it} + ln\ M_{it} + ln\ IOC_{it} + Z_{it} + u_{it}}$
- Specification **D**: $\mathbf{Ln\ Y_{it}/L_{it} = ln\ M_{it}/L_{it} + ln\ IOC_{it}/L_{it} + Z_{it} + u_{it}}$

Output Y:

According to the Eurostat (2001) recommendations the output variable Y_{it} is measured as the sum of hospital activities (cases) weighted with the average of severity of treated patients (hospital specific Case Mix Index - CMI) and quality adjusted using the in-hospital survival rate. The case mix index is calculated on the basis of patients classified by the German-Diagnoses Related Groups (G-DRG).

$\sum_I (patients_i * G\text{-}DRG_i) / \sum patients = CMI$ showing the average severity of hospital cases

Thus our output variable is approximately a cost weighted output index

$Y_{it} = inpatients_{it} * CMI_{it} * survival\ rate_{it}$

i= hospital; t = year

The development of our output variable is shown in Figure 1 in Annex A.

Input

We used the production factors labor and material and additional the calculated investments in own account organizational capital respectively the average own account capital stock:

- *Labor* (L): We used the total number of full-time staff
- *Material* (M): In Germany the investments in hospitals are the responsibility of the Länder. Private hospitals can apply for a grant. The hospital statistic provides no information on the investments in hospitals. Only information on the costs for material is available. Thus we used the (deflated) material costs.
- *Investments in OC and OC:* We used the above mentioned method to calculate investments in own account organizational capital (IOC) respectively the average organizational capital stock (OC).

Annex A shows the development of full-time employees and the ratio of patients to full-time staff over time (Figure 2 and Figure 3). Table 12 shows the development of material costs 2006 to 2012.

Control variables:

Based on a literature review we included the following control variables in our estimation:

- *Ownership of hospitals.*
  Tiemann, Schreyögg, Busse (2011) discussed the impact of hospital ownership on hospital efficiency based on a review of empirical studies and an own estimation for German hospitals. Based on theoretical approaches (like public choice theory or agency theory) private hospitals are expected to be more efficient than public or charitable hospitals. However, empirical studies for Germany found no clear evidence for higher efficiency of private owned hospitals (Augurzky et al. 2012). Werblow et al. (2010) found that private for profit hospitals are significantly more efficient than public or charitable once. Tiemann and Schreyögg (2009) found clear evidence that public hospitals have a substantially higher efficiency. Even though the empirical evidence is inconclusive, we still included the ownership of hospitals to control for any such impacts on our quality adjusted hospital outcome.
- *Number of beds*
  We included the number of beds to control for hospital size. Smaller hospitals are in general more specialized and they may be less efficient. Large hospitals may have economies of scale, for example the occupation rate of large scale equipment. As there is only marginal price competition among German hospitals, they can increase their efficiency due to the reduction in costs per patient. Thus, larger hospitals may realize economies of scale and be more efficient.
- *Share females*
  We included the share of females as females show another spectrum of diseases than men, in particular birth giving females require on average less treatment measures. Another point is that a higher share of females could involve higher efficiency because in gynaecological department treatments and surgeries are highly standardized (Frohloff 2007).
- *Share 75+*
  Elderly need on average more and additional (palliative) treatments and they have a higher average length of stay. Higher ratio of elderly patients should increase inefficiency values because of adverse side-effects and multi-morbidity (Frohloff 2007)
- *OP ratio*
  The share of patients with an operation is expected to have two contrary effects: On the one side surgeries are cost intensive and they need more/additional resources, like a surgery room with the

required equipment. One the other side a higher surgery rate should decrease inefficiency because of learning by doing (Frohloff 2007)

- *Measure of deprivation*:
  As research shows a significant impact of social determinants on a person's health status, we included GDP/capita as a measure of deprivation in order to control for different health characteristics in the population.
- *University hospital*:
  To control for the resources spent for teaching and research and thus, to increase the comparability of the regression results we included the dummy university hospital (in line with RWI 2010). That is also to control for the different staff composition.
- *Average length of stay*:
  The Case Mix Index used to calculate the output variable indirectly includes the average length of stay since the index is build up from the DRG-mix of hospitals. We included the length of stay also as control variable to control for the realized length of stay and thus for the use of resources. Additional, the shorter the length of stay the higher is the coordination effort.
- *Share of qualified nurses in nursing staff (FTE):*
  Qualified nurses are essential for the coordination of medical and nursing tasks and they are the largest group with managerial functions. Thus we included the share of qualified nurses in total nurses as control.

In a preliminary specification we included additional controls, but they showed no significant influence:

- To control for competition we included the so called Herfindahl-Hirschmann-Index. This indicator is defined as share of treated patients in hospital A in total treated patients of all hospitals in one region (catchman area). The values of HHI are between zero and one (monopoly). Bloom, Propper, Seiler, Van Reenen (2010) show in their study carried out for hospitals in UK, that higher competition leads to higher efficiency. However, our results for Germany show no significant influence of HHI on hospital outcome. That is in line with the study of Herr (2012).
- To control for the density of population in the hospitals region we included an indicator named "Rural area". It is expected that a higher density is an advantage. But our analyses showed no significant influence.

We carried out cross sectional analyses for each year, regressions with pooled data and panel analyses using random effects and fixed effects models.

6.2 Results Model A

Cross sectional regression (investments in OC)

The regressions show a highly significant positive impact of investments in OC on hospital performance measured as 'quasi' cost weighted output index (Table 3). Specification A has a high explanatory power with an R^2 of 0.97. The input factors labor and material costs are significantly positive.[2] Larger hospitals perform significantly better but the coefficient is low. In line with the study of Werblow et al. (2010) our cross-sectional

[2] According to R.A. Fisher an impact will be classified as significant if p value is less or equal 5% (Stigler 2008). Lover significant levels are classified as highly significant if p<= 1% and extreme highly significant if p<=0.1% (Döring 2006, Perezgonzalez 2015).

analysis shows a significant impact of ownership on hospital efficiency. However the differences between public, charitable and private hospitals are small. Due to their different spectrum of tasks, university hospitals have a significant negative effect on hospitals outcome. The operation rate has a significant positive and the lengths of stay a significant negative impact on hospitals performance, but both coefficients are relatively small. Contrary to the expectations the share of females, the share of elderly patients (75+) and the share of qualified nurses in total nursing staff have no significant impact on the output. The GDP per inhabitant has a significant, but very low coefficient term.

We carried out cross-sectional analyses for the years 2006 to 2011, too (see Annex B Table 16). As the regressions show similar results, we don't discuss them here. But we can conclude that the positive impact of investments in OC is stable over the observation period.

Table 3: Model A – cross sectional and panel data analyses

	Investments in organizational capital				Average organizational capital stock			
	Cross Section 2012	Pooled	Panel Random Effects	Panel Fixed Effects	Cross Section 2012	Pooled	Panel Random Effects	Panel Fixed Effects
(Inv)OrgCapital (log)	0.265***	0.205***	0.245***	0.227***	0.157***	0.135***	0.212***	0.190***
labour (log)	0.264***	0.279***	0.297***	0.272***	0.353***	0.336***	0.341***	0.346***
material costs (log)	0.340***	0.365***	0.261***	0.201***	0.354***	0.373***	0.263***	0.214***
sizecat	0.046***	0.048***	0.057***	0.056***	0.049***	0.050***	0.057***	0.060***
charitable	0.0116136	0.003	0.002	0.008	0.014	0.004	0.004	0.005
private	0.062***	0.049***	0.036***	0.028*	0.059***	0.047***	0.037***	0.026*
university hospital	-0.204**	-0.146***	-0.087	-	-0.223***	-0.160***	-0.119*	-
share females	-0.055035	-0.141	-0.165***	-0.175**	-0.50	-0.144	-0.142***	-0.165**
share 75+	0.0383843	0.045	-0.183***	-0.443***	0.049	0.050	-0.170***	-0.467***
op rate	0.082***	0.052*	0.018	-0.009	0.085***	0.052*	0.018	-0.008
mean length of stay	-0.024***	-0.025***	-0.021***	-0.010***	-0.025***	-0.025***	-0.020***	-0.009***
share qualified nurses	-0.0432691	-0.067	-0.048	-0.042	0.034	-0.018	0.027	0.058*
GDP/capita	-0.002**	-0.001**	-0.000	-0.000	-0.002***	-0.001**	-0.000	-0.000
2006	-	0.074***	0.050***	0.014*	-	0.161***	0.189***	0.143***
2007	-	0.066***	0.048***	0.019***	-	0.097***	0.099***	0.068***
2008	-	0.050***	0.038***	0.015**	-	0.074***	0.078***	0.054***
2009	-	0.032***	0.026***	0.010*	-	0.045***	0.048***	0.032***
2010	-	0.021***	0.018***	0.008	-	0.029***	0.030***	0.020***
2011	-	0.013***	0.012***	0.007*	-	0.017***	0.017***	0.012***
_const	-1.573***	-1.195***	-0.176	1.203***	-1.086***	-0.888**	-0.282	0.784**
number of observations	925	6475	6475	6475	925	6475	6475	6475
R^2	0.969	0.968	0.967	0.962	0.969	0.968	0.966	0.961

*** = p <= 0,001; ** = p <= 0,01; * = p <= 0,05.
Source: Federal Statistical Office of Germany; Hospital statistics, micro-data, balanced panel 2006 to 2012.

OLS regressions with pooled data (investments in OC)

We carried out OLS regression using pooled data to get an idea if the sample size matters. Since we have a panel dataset, our observations cannot be assumed to be independent. As a consequence the errors may be

auto correlated and while the OLS estimate is still unbiased, the OLS standard errors and test statistics are no longer valid. For this reason we used robust standard errors that are clustered around the hospital ID for our pooled analysis. We also included time dummies to control for time variations.

The results using pooled data are similar to the cross sectional results. The coefficient of investments is a little bit lower, but still highly significant. The impact of labor, material costs and hospital size is higher and also of high significance. The time dummies are significant, but at low levels.

Panel data analyses: random and fixed effects (investments in OC)

We further carried out panel data analyses using random and fixed effects models. The panel data structure of the hospital statistics allows us to differentiate between error terms that are time independent and those that vary over time.

$\varepsilon_{it} = \alpha_i + u_{it}$

where u_{it} is assumed to be homoscedastic and not correlated over time and α_i is time invariant and homoscedastic over individuals. In this case OLS standard errors are misleading and inefficient because they do not exploit the correlation over time in ε_{it}. If we assume that α_i is uncorrelated with the explanatory variables, we can use the Random Effects Model, which is typically more efficient than OLS.

However, we think there are good reasons to believe that the unobserved heterogeneity in α_i is correlated with one or more of the explanatory variables. In this case both OLS and Random Effects estimators would be biased. The Fixed Effects Model is able to address this problem by performing the regression on deviations from the individual means. This essentially implies that we eliminate the individual effects α_i (within transformation). To test whether we can assume α_i and the explanatory variables (x_{it}) to be uncorrelated and thus, which model is appropriate to use, we run a Hausman Test. This test compares the consistency between the estimated coefficients of the Random and the Fixed Effects model, where the Fixed Effects Model is known to be consistent. Under the null hypothesis that α_i and x_{it} are uncorrelated, both estimators should be consistent but the Random Effects estimator is more efficient. However, the Hausman test indicates a significant difference between the two estimators (p-value = 0.000), implying that the RE model is not consistent and the FE model should be preferred.

The Fixed Effect Model has an explanatory value (R squared) of over 96 % for investment in OC, with investments in OC having a highly significant and positive effect on hospital output. Accordingly a one percent increase in the Investment in OC leads to a 0.227 percent increase in the hospital output indicator. This is slightly smaller than in the Cross Section and slightly bigger than in the pooled data analysis, but still consistent in direction and magnitude. The labor input and material costs have a similar impact on the output indicator. For our control variables we used levels instead of logs. So, for example, if a hospital moved up into the next higher size category, this would result in a 5.6 % increase of the output indicator. Looking on the other controls, besides mean length of stay, also the share of females and the share of elderly patients (75+) have now – contrary to the cross section and pooled data analyses – a highly significant and negative impact. In particular, high shares of elderly patients lead to a markedly reduction in hospital output. That is in line with the expectations that high shares of elderly increase the inefficiency due to adverse side-effects and multi-morbidity. Regarding the control variables, the dummy variable “university” was omitted; due to the fact that there is too little within variation (hospitals rarely/never change their status).

Average organizational capital stock as input

The models using the average organizational capital stock as input show in general similar results. Compared to the analyses using the investments in OC, the capital stock shows in all models (cross sectional, pooled data, random and fixed effects models) a lower, but still highly significant impact on hospital outcome. The coefficient of the input factors labor and material costs are slightly bigger and of high significance.

6.3 Results Model D

Are there different results if we focus on labor productivity instead of a cost weighted output index as output measure?

Table 4: Results Model D – cross sectional and panel analyses

	Investments in organizational capital				Average organizational capital stock			
	Cross Section 2012	Pooled	Panel Random Effects	Panel Fixed Effects	Cross Section 2012	Pooled	Panel Random Effects	Panel Fixed Effects
(Inv)OrgCapital/ labor (log)	0.312***	0.253***	0.308***	0.319***	0.208***	0.186***	0.302***	0.377***
material cost/ labor (log)	0.364***	0.390***	0.301***	0.271***	0.379***	0.399***	0.290***	0.244***
sizecat	0.006**	-0.012***	-0.008***	0.006	-0.004	-0.011***	-0.001	0.030***
charitable	0.016*	0.009	0.014*	0.017	0.020*	0.010	0.015*	0.011
private	0.070***	0.056***	0.048***	0.029*	0.066***	0.054***	0.049***	0.024*
university hospital	-0.313***	-0.272***	-0.281***	-	-0.336***	-0.289***	-0.298***	-
share females	0.054	-0.032	-0.094*	-0.200***	0.064	-0.032	-0.071	-0.178**
share 75+	0.078	0.080	-0.050	-0.342***	0.09	0.085	-0.054	-0.429***
op rate	0.057*	0.028	0.012	-0.002	0.061*	0.028	0.013	-0.003
mean length of stay	-0.023***	-0.023***	-0.021***	-0.016***	-0.023***	-0.024***	-0.020***	-0.013***
share qualified nurses	-0.108*	-0.141*	-0.108***	-0.080*	-0.031	-0.094	-0.027	0.008
GDP/capita	-0.002***	-0.002***	-0.001*	0.000	-0.002***	-0.002***	-0.001*	0.000
2006		0.091***	0.079***	0.066***		0.212***	0.274***	0.307***
2007		0.080***	0.072***	0.062***		0.124***	0.142***	0.148***
2008		0.060***	0.055***	0.049***		0.095***	0.111***	0.116***
2009		0.038***	0.037***	0.033***		0.056***	0.067***	0.069***
2010		0.025***	0.025***	0.023***		0.035***	0.042***	0.042***
2011		0.015***	0.015***	0.014***		0.019***	0.022***	0.021***
_const	-2.757***	-2.475***	-1.982***	-1.775***	-2.365***	-2.243***	-2.204***	-2.451***
number of observations	925	6475	6475	6475	925	6475	6475	6475
R^2	0.528	0.514	0.502	0.39	0.514	0.506	0.474	0.235

*** = p <= 0,001; ** = p <= 0,01; * = p <= 0,05.

Source: Federal Statistical Office of Germany; Hospital statistics, micro-data, balanced panel 2006 to 2012.

In general the answer is: there are no markedly differences in the impact of investments in organizational capital or the average organizational capital stock on hospital performance measured as labor productivity compared to the model specification A (Table 4). But some differences are mentionable:

- The explanatory power is in general lower: using the ratio of investments in OC/labor it is R^2 = 0.528 in the cross sectional regression, R^2 = 0.514 in OLS using pooled data, and R^2 = 0.39 in the panel data fixed effects analysis; using the capital stock it is again lower (0.514, 0.504, and 0.235)
- The coefficient of investments in OC/labor and OC/labor are higher (cross sectional, pooled data and panel data analyses)
- The impact of material costs/labor is higher in the cross section and pooled data regressions, but lower in the panel data models
- Among the controls university hospitals show higher coefficients.

7 Models using a wage weighted labor input

As an extension to the basic models A and D, we carried out regressions with an alternative approach to labor input. So far our regressions only considered labor input as time (full time equivalent) and ignored the costs for this labor (wages). For specification A this only explains the explanatory variables, whereas in specification D it presents an alteration to our performance measure (labor productivity).

We used the following wage weighted labor input:

LaborW= doctors *relwage doctors + nursing staff*relwage nursing staff + medical-technical staff*relwage med-techstaff + functional service staff*relwages funstaff + admin staff*relwage adminstaff + other staff*average relwage other staff

with staff measured as FTE, relwage = relative wage

The relative wage of nurses is set =1 and the relative wages of all other occupational groups is calculated in relation to this wage.

We integrated the labor input in two forms:

- Firstly, as sum of all wage weighted staff
- Secondly, for each occupational group separately.

7.1 Results Model A – wage weighted labor

Table 5 shows the results for wage weighted labor input as sum of all staff for the model specification A. The sample size is lower than in the above mentioned analyses due to missing or zero coding of wages. The sample size is 888 hospitals per year, in total 6,216 hospitals. The explanatory power is still high, R^2 is 0.97 (cross section and pooled) and 0.96 (panel fixed effects).

In general, the model A using wage weighted labor shows similar results as the basic model A, in particular in view of the highly significant impact of investments in OC and average capital stock, of wage weighted labor, material costs, hospital size and average length of stay. Nevertheless, some differences can be observed:

- The coefficients of investments in OC and average capital stock are always (cross-sectional, pooled, panel data) higher than in the basic model A.

- In the cross-sectional analysis the regression coefficient of wage weighted labor is higher than of not weighted labor input; the pooled data regression and the panel analyses show the contrary effect.
- The coefficients of material costs are always lower.
- The share of females as well as the share of elderly patients shows always a higher, but still negative coefficient.

Table 5: Model A - wage weighted labor

	Model A with wage weighted labor							
	Investments in organizational capital				Average organizational capital stock			
	Cross Section 2012	Pooled	Panel Random Effects	Panel Fixed Effects	Cross Section 2012	Pooled	Panel Random Effects	Panel Fixed Effects
(Inv)OrgCapital (log)	0.277***	0.248***	0.286***	0.256***	0.203***	0.186***	0.258***	0.217***
wage weighted labor (log)	0.273***	0.264***	0.254***	0.224***	0.341***	0.316***	0.294***	0.293***
material costs (log)	0.298***	0.329***	0.253***	0.197***	0.302***	0.333***	0.252***	0.211***
sizecat	0.053***	0.051***	0.057***	0.055***	0.055***	0.054***	0.059***	0.062***
charitable	0.003	0.001	-0.004	0.003	0.004	0.001	-0.002	-0.001
private	0.039**	0.026*	0.020*	0.022	0.032*	0.021	0.019*	0.018
university hospital	-0.171**	-0.104*	-0.043	-	-0.184**	-0.109*	-0.073	-
share females	-0.193*	-0.256***	-0.229***	-0.247***	-0.193*	-0.260***	-0.212***	-0.231***
share 75+	0.106	0.106	-0.193***	-0.470***	0.12	0.108	-0.173***	-0.501***
op rate	0.077*	0.051	0.029*	0.001	0.083*	0.053	0.029*	0.003
mean length of stay	-0.026***	-0.027***	-0.021***	-0.007**	-0.026***	-0.027***	-020***	-0.006*
share qualified nurses	-0.031	-0.030	-0.084**	-0.104***	0.023	0.016	-0.008	0.000
GDP/capita	-0.001*	-0.001*	-0.000	-0.000	-0.001*	-0.001	-0.000	-0.000
2006	-	0.091***	0.064***	0.022***	-	0.214***	0.236***	0.171***
2007	-	0.080***	0.059***	0.025***	-	0.125***	0.123***	0.081***
2008	-	0.060***	0.045***	0.018***	-	0.095***	0.095***	0.063***
2009	-	0.040***	0.030***	0.011*	-	0.060***	0.058***	0.036***
2010	-	0.026***	0.021***	0.008	-	0.038***	0.036***	0.021***
2011	-	0.016***	0.013***	0.007*	-	0.021***	0.020***	0.013***
_const	-1.129**	-1.145***	-0.318*	1.225***	-0.832*	-0.893**	-0.498**	0.779**
number of observations	888	6216	6216	6216	888	6216	6216	6216
R^2	0.969	0.968	0.967	0.962	0.969	0.968	0.966	0.961
*** = p <= 0,001; ** = p <= 0,01; * = p <= 0,05.								
Source: Federal Statistical Office of Germany; Hospital statistics, micro-data, balanced panel 2006 to 2012.								

7.2 Results Model D – wage weighted labor

Also model D using wage weighted labor input shows in general similar results as the basic model D. The weighting of labor input increases the impact of investments in organizational capital/weighted labor and average capital stock/weighted labor compared to the basic model D. The impact of material costs/weighted labor is lower; except in the fixed effects analysis.

The explanatory power is again lower. In the models using investments in OC as input it ranges from R^2 = 0.37 (fixed effects) to 0.47 (pooled data); using the average capital stock as input it ranges from R^2 = 0.2 (fixed

effects) to 0.46 (pooled data). Thus, in particular the fixed effects models have a relatively small explanatory power.

Table 6: Model D - Wage weighted labor

	Model D with wage weighted labor							
	Investments in organizational capital				Average organizational capital stock			
	Cross Section 2012	Pooled	Panel Random Effects	Panel Fixed Effects	Cross Section 2012	Pooled	Panel Random Effects	Panel Fixed Effects
(Inv)Org Capital stock/ weighted labor (log)	0.346***	0.320***	0.381***	0.395***	0.267***	0.257***	0.372***	0.437***
material cost/ weighted labor (log)	0.324***	0.352***	0.294***	0.275***	0.328***	0.356***	0.280***	0.245***
sizecat	-0.006*	-0.012***	-0.010***	-0.000	-0.004	-0.011***	-0.001	0.028***
charitable	0.009	0.006	0.009	0.015	0.011	0.007	0.010	0.006
private	0.042**	0.027*	0.026**	0.022	0.033*	0.022	0.024**	0.016
university hospital	-0.294***	-0.227***	-0.234***	-	-0.311***	-0.236***	-0.253***	-
share females	-0.089	-0.166*	-0.178***	-0.245***	-0.088	-0.169*	-0.162***	-0.237***
share 75+	0.173*	0.161	-0.024	-0.360***	0.193**	0.164	-0.021	-0.459***
op rate	0.039	0.024	0.021	0.010	0.046	0.027	0.022	0.010
mean length of stay	-0.024***	-0.025***	-0.021***	-0.013***	-0.024***	-0.025***	-0.019***	-0.010***
share qualified nurses	-0.101	-0.110	-0.155***	-0.162***	-0.042	-0.063	-0.069*	-0.058
GDP/capita	-0.002***	-0.001**	-0.001*	0.000	-0.002***	-0.001**	-0.000*	-0.000
2006	-	0.113***	0.100***	0.085***	-	0.284***	0.343***	0.363***
2007	-	0.098***	0.088***	0.077***	-	0.161***	0.176***	0.174***
2008	-	0.073***	0.067***	0.058***	-	0.123***	0.136***	0.136***
2009	-	0.048***	0.044***	0.038***	-	0.076***	0.083***	0.080***
2010	-	0.031***	0.029***	0.025***	-	0.047***	0.050***	0.046***
2011	-	0.018***	0.017***	0.015***	-	0.025***	0.026***	0.024***
_const	-2.605***	-2.625***	-2.435***	-2.347***	-2.347***	-2.455***	-2.685***	-2.941***
number of observations	888	6216	6216	6216	888	6216	6216	6216
R^2	0.456	0.471	0.461	0.367	0.447	0.46	0.431	0.201
*** = p <= 0,001; ** = p <= 0,01; * = p <= 0,05.								
Source: Federal Statistical Office of Germany; Hospital statistics, micro-data, balanced panel 2006 to 2012.								

7.3 Wage weighted labor – single occupational groups

In the basic model as well as in the wage weighted labor model we used the aggregate sum of all professions. In this part we want to analyze the impact of different occupational groups on hospital output using model specification A. We differentiate between doctors, nurses, medical technical service, functional service, administration staff and other personnel. Doctors account for 17.6 % of hospital staff. Nurses are the largest professional group in hospitals accounting for 38 % of total full-time staff in our sample. The medical technical service encompasses staff in pharmacies, laboratories, radiological department (incl. EKG, EEG; EMG), physiotherapy including massage and bath therapy. They account for around 14 % of full-time staff. Staff in functional service encompasses nursing (care) staff in operating rooms, anesthesia services, ambulances, poly-clinics, blood transfusion services, functional diagnostics, endoscopy and other clinical social-care staff. It accounts for 13 % of full-time staff (in our sample). Administration staff account for around 7 % of full-time staff. The whole staff is relevant for hospital outcome, but some groups are more directly involved in patient treatments such as doctors, nurses, medical technical staff and functional services. Thus, we expect a significant impact on hospital outcome from these occupational groups.

Table 7: Model A - wage weighted labor single occupations

	Model Specification A							
	Investments in organizational capital				Average organizational capital stock			
	Cross Section 2012	Pooled	Panel Random Effects	Panel Fixed Effects	Cross Section 2012	Pooled	Panel Random Effects	Panel Fixed Effects
(Inv)OrgCapital (log)	0.265***	0.238***	0.278***	0.247***	0.181***	0.166***	0.236***	0.195***
doctors (log)	0.092***	0.073**	0.099***	0.093***	0.119***	0.090***	0.119***	0.122***
nurses(log)	0.134***	0.127***	0.108***	0.107***	0.183***	0.169***	0.159***	0.173***
medical technical service (log)	0.003	0.010	0.012	0.010	0.002	0.009	0.005	0.006
functional service (log)	0.057***	0.042**	0.066***	0.056***	0.054***	0.042**	0.054***	0.047***
admin (log)	0.009	0.009	-0.006	-0.006	0.014	0.014	-0.000	-0.001
other personnel (log)	0.001	0.015	-0.001	-0.004	0.005	0.017*	-0.002	-0.007
material costs (log)	0.280***	0.324***	0.231***	0.182***	0.285***	0.328***	0.231***	0.194***
sizecat	0.051***	0.050***	0.055***	0.054***	0.053***	0.052***	0.057***	0.059***
charitable	-0.000	-0.001	-0.003	0.007	-0.000	-0.002	-0.003	0.005
private	0.029*	0.025*	0.014	0.021	0.023	0.021	0.013	0.019
university hospital	-0.125*	-0.076	-0.004	-	-0.132*	-0.077	-0.024	-
share females	-0.274**	-0.303***	-0.277***	-0.240***	-0.268**	-0.304***	-0.253***	-0.224***
share 75+	0,000	0.073	-0.197***	-0.428***	0.066	0.073	-0.179***	-0.458***
op rate	0.05	0.035	0.016	-0.001	0.061	0.043	0.021	0.002
mean length of stay	-0.024***	-0.025***	-0.018***	-0.007**	-0.024***	-0.025***	-0.018***	-0.006*
share qualified nurses	-0.024	-0.025	-0.078**	-0.092**	0.040	0.029	0.007	0.017
GDP/capita	-0.001	-0.001	0.000	-0.000	-0.001	-0.001	0.000	0.000
2006	-	0.089***	0.075***	0.037***	-	0.199***	0.232***	0.172***
2007	-	0.078***	0.067***	0.037***	-	0.118***	0.126***	0.089***
2008	-	0.059***	0.052***	0.028***	-	0.090***	0.098***	0.069***
2009	-	0.039***	0.037***	0.020***	-	0.057***	0.063***	0.044***
2010	-	0.026***	0.025***	0.014**	-	0.036***	0.040***	0.027***
2011	-	0.015***	0.014***	0.009**	-	0.020***	0.020***	0.015***
_const	-0.362	-0.565	0.398*	1.709***	0.098	-0.171	0.373*	1.516***
number of observations	888	6216	6216	6216	888	6216	6216	6216
R^2	0.97	0.968	0.967	0.963	0.969	0.968	0.966	0.962
*** = p <= 0,001; ** = p <= 0,01; * = p <= 0,05.								
Source: Federal Statistical Office of Germany; Hospital statistics, micro-data, balanced panel 2006 to 2012.								

Table 7 shows the impact of individual professional groups on the output measure of specification A. We see significant effects for physicians, nurses and functional services with the largest estimated effect for nurses, followed by doctors. The coefficients of functional staff are lower but still highly significant, whereas the medical technical staff has no significant effect on hospital outcome. Thus, the regressions show the expected impact of patient centered staff on hospital outcome. Focusing on single occupational groups reduces the coefficients of investments in OC and average organizational capital stock compared to the model A using the total wage weighted staff. But the impact is still high and also of high significance.

8 QUALITY: Models with modified output specification

Hospitals are not comparable to regular firms, as high pressure on staff (i.e. increased productivity) can have adverse effects on the quality of the service provided. We therefore decided to focus more on quality performance of hospitals and to extend our models in this direction.

Nimptsch and Mansky (2012) analyzed the disease-specific patterns of hospital care using the German Inpatient Quality Indicators (G-IQI). The G-IQI focuses on the in-hospital mortality rates for specific diseases. The authors argue that the difference of the hospital specific standardized mortality rate to the nationwide standardized mortality rate may be seen as an indicator for the quality of management and treatment. The G-IQI catalog encompasses standardized mortality rates for such diseases which can be reduced due to better management und processes (Mansky et al. 2013). We selected seven indicators representing diseases which need an urgent or special and efficient treatment to avoid in-hospital mortality. The idea is that hospitals with a good organization are more able to react in time and are more flexible if unpredictable occurrences appear.

We selected inpatient with the following diseases (ICD10 classification):

CHF = I11 Hypertensive heart disease

AMI = I21-I25 Ischaemic heart disease without Angina pectoris

I50 = I50 Cardiac failure

I63 = I63 Ischaemic stroke

STR = I64 Stroke

GIH = I67 Other cerebrovascular diseases

PNE = J12-J18 Pneumonia

Additionally, we added some quality specific control variables. We included five new variables, of which three variables identify some kind of workload;

- Patient_nurse = ratio of number of patients to full-time nursing staff (Braun et al. 2010)
- Occup = bed occupancy rate, calculated as the total number of days patients stayed in the hospital, divided by the number of beds times 365 days(Kuntz et al. 2014)
- Intensive = share of patients receiving intensive care in total inpatients

and two variables identifying the role of part-time work and team mix for the quality of care provision

- Share_fte = ratio of full-time nursing staff to head counted nursing staff as an proxy for additional organizational effort due to higher shares of part-time workers.
- Nurses_doctors = ratio of full-time nursing staff to full-time doctors as a proxy for team mix (Bundesärztekammer 2010, DKI 2008, DKI 2010)

Kuntz et al. (2014) carried out a study analyzing the impact of safety tipping points on in-hospital mortality. They argue “that safety tipping points occur when managerial escalation policies are exhausted and workload variability buffers are depleted. Front-line clinical staff is forced to ration resources and, at the same time, becomes more error-prone as a result of elevated stress hormone levels” (p. 754). They focused on the occupancy rate of hospital beds and the mortality during the first seven days following admission of patients in selected diseases in German hospitals. They estimate a mortality tipping point at an occupancy level of 92.5 %.

Following this idea the occupancy rate is a proxy for workload and stress of staff. Also the ratio of patients to nurses is seen as a proxy for workload and stress of nursing staff.

We applied two models:

Model Q1:

Similar to the models A and D, the number of survival adjusted inpatients in the mentioned diseases is used as an alternative output measure.

Inpatients with the mentioned diseases account for around 8 % of total inpatients, but for more than a quarter of all in-hospital death (Annex A Table 14). A good organization, measured as high investments in organizational capital or a high capital stock, may be able to avoid deaths to a higher degree than other hospitals.

Our output variable is $\mathbf{Y = \sum_d (inp_d * survival\ rate_d)}$ **with d = single diagnosis**

As the CMI is only available at hospital level we cannot include a severity weight, so our output variable is no longer a cost weighted output index.

Model Q2:

In this model we focus on the reduction in mortality rates in the above mentioned diseases as a quality indicator (not multiplied with the number of inpatients).

The output variable is the hospital's mortality rate of patients with one of the above diagnoses. To control for the different age-structure of patients we used standardized mortality rates (Varabyova and Schreyögg 2013). We applied the method of *direct standardization to account for variations in the age structure* (Schelhase et al. 2006).

Our output variable is $\mathbf{Y = \sum_d (standardized\ survival\ rate_d)}$ **with d = single diagnosis**

8.1 Results of model Q1

There are some mentionable differences of Q1 compared to the basic model A: in the cross-sectional regression investments in OC is no longer significant (Table 8**¡Error! No se encuentra el origen de la referencia.**). The results for the Panel Data analyses show that IOC and OC have a positive and significant impact on our quality adjusted output measure, both in the specification A and D.

Table 8: Quality model Q1 specification A - cross sectional, pooled and panel data results

	Investments in organizational capital				Average organizational capital stock			
	Cross Section 2012	Pooled	Panel Random Effects	Panel Fixed Effects	Cross Section 2012	Pooled	Panel Random Effects	Panel Fixed Effects
(Inv)Org Capital (log)	0.180	0.284*	0.241***	0.219***	0.241*	0.348***	0.242***	0.247***
labor (log)	0.489***	0.452***	0.450***	0.452***	0.447***	0.412***	0.476***	0.491***
material costs (log)	0.270***	0.181**	0.163***	0.166***	0.262***	0.169*	0.161***	0.171***
sizecat	0.095**	0.104**	0.077***	0.072***	0.093**	0.101**	0.080***	0.077***
charitable	-0.063*	-0.026	-0.050**	-0.042	-0.059	-0.021	-0.049**	-0.044
private	0.042	0.034	-0.025	-0.021	0.041	0.036	-0.024	-0.024
university hospital	-0.242	-0.134	-0.169	-	-0.237	-0.123	-0.223	-
share females	-0.750**	-0.821	-0.880***	-0.854***	-0.746**	-0.838	-0.860***	-0.847***
share 75+	4.106***	4.374***	3.325***	2.819***	4.127***	3.384***	3.349***	2.804***
op rate	-1.130***	-1.155***	-0.215***	-0.127***	-1.120***	-1.142***	-0.215***	-0.124***
mean length of stay	-0.138***	-0.145***	-0.067***	-0.044***	-0.138***	-0.144***	-0.068***	-0.045***
intensive	0.473*	0.517	-0.048	-0.098	0.457*	0.498	-0.059	-0.101
share_fte	-0.098	0.086	0.049	0.063	-0.099	0.078	0.06	0.074
patient_nurse	0.007***	0.008***	0.007***	0.006***	0.007***	0.008	0.006***	0.006***
nurse_doctor	0.170***	0.154***	0.038***	0.027***	0.173***	0.157***	0.040***	0.026***
occup	0.885***	1.056***	0.481***	0.393***	0.907***	1.066***	0.511***	0.423***
GDP/capita	-0.000	-0.002*	0.001*	0.001**	-0.000	-0.002*	0.001*	0.001**
2006	-	0.264***	0.182***	0.143***	-	0.495***	0.344***	0.314***
2007	-	0.213***	0.155***	0.122***	-	0.299***	0.215***	0.190***
2008	-	0.143***	0.111***	0.087***	-	0.210***	0.159***	0.140***
2009	-	0.104***	0.094***	0.075***	-	0.141***	0.121***	0.106***
2010	-	0.084***	0.073***	0.058***	-	0.104***	0.087***	0.074***
2011	-	0.047***	0.035***	0.027***	-	0.054***	0.041***	0.034***
_const	-4.592***	-4.512***	-3.289***	3.009***	-5.290***	-5.272***	-3.688***	-3.969***
number of observations	888	6216	6216	6216	888	6216	6216	6216
R^2	0.775	0.741	0.7000	0.682	0.776	0.742	0.700	0.676
*** = p <= 0,001; ** = p <= 0,01; * = p <= 0,05.								
Source: Federal Statistical Office of Germany; Hospital statistics, micro-data, balanced panel 2006 to 2012.								

The magnitude is similar to the estimated coefficients of the basic model. While the results are also very similar for the impact of material costs, the estimated coefficients for the labor input have more than doubled, indicating that staffing is a key factor for quality in hospitals. The overall model has a slightly lower but still high explanatory power, with 67.4 % of variation in specification A and 35.5 % of variation in specification D explained by our model.

Table 9: Quality model Q1 specification D– cross-sectional, pooled and panel data results

	Investments in organizational capital				Average organizational capital stock			
	Cross Section 2012	Pooled	Panel Random Effects	Panel Fixed Effects	Cross Section 2012	Pooled	Panel Random Effects	Panel Fixed Effects
(Inv)Org Capital (log)/labor	0.200	0.310**	0.276***	0.261***	0.254*	0.368***	0.292***	0.302***
material costs (log)/labor	0.280***	0.193**	0.181***	0.190***	0.271***	0.179**	0.172***	0.179***
sizecat	0.074***	0.075***	0.037***	0.042***	0.076***	0.077***	0.049***	0.064***
charitable	-0.060	-0.023	-0.044*	-0.039	-0.057	-0.018	-0.044*	-0.043
private	0.045	0.037	-0.022	-0.022	0.043	0.039	-0.023	-0.025
university hospital	-0.280	-0.187	-0.304	-	-0.268	-0.167	-0.336	-
share females	-0.742**	-0.812	-0.877***	-0.864***	-0.740**	-0.830	-0.855***	-0.853***
share 75+	4.138***	4.414***	3.419***	2.866***	4.153***	4.418***	3.425***	2.818***
op rate	-1.140***	-1.166***	-0.216***	-0.123***	-1.127***	-1.151***	-0.216***	-0.122***
mean length of stay	-0.134***	-0.139***	-0.060***	-0.040***	-0.135***	-0.139***	-0.063***	-0.044***
intensive	0.463**	0.507	-0.032	-0.073	0.449*	0.490	-0.048	-0.090
share_fte	-0.090	0.095	0.044	0.056	-0.093	0.085	0.057	0.070
patient_nurse	0.007***	0.008***	0.008***	0.007***	0.007***	0.008***	0.007***	0.007***
nurse_doctor	0.175***	0.161***	0.046***	0.032***	0.177***	0.163***	0.046***	0.028***
occup	0.814***	0.957***	0.372***	0.306***	0.852***	0.985***	0.430***	0.391***
GDP/capita	-0.000	-0.002*	0.000*	0.001*	-0.000	-0.002*	0.001*	0.001*
2006	-	0.269***	0.197***	0.161***	-	0.513***	0.393***	0.362***
2007	-	0.217***	0.166***	0.137***	-	0.307***	0.238***	0.213***
2008	-	0.145***	0.120***	0.098***	-	0.215***	0.176***	0.158***
2009	-	0.105***	0.100***	0.083***	-	0.144***	0.131***	0.116***
2010	-	0.085***	0.076***	0.062***	-	0.105***	0.093***	0.080***
2011	-	0.047***	0.037***	0.030***	-	0.055***	0.043***	0.037***
_const	-5.149***	-5.254***	-4.546***	-4.483***	'-5.723***	-5.902***	-4.900***	-5.029***
number of observations	888	6216	6216	6216	888	6216	6216	6216
R^2	0.481	0.452	0.386	0.359	0.483	0.455	0.389	0.339
*** = p <= 0,001; ** = p <= 0,01; * = p <= 0,05.								
Source: Federal Statistical Office of Germany; Hospital statistics, micro-data, balanced panel 2006 to 2012.								

The share of elderly patients has a highly significant and – contrary to the basic models - positive influence on hospital outcome. The reason for this is the high share of elderly patients with around 50 % of all patients and 82 % of all deaths in the included diagnoses. In total only one quarter of patients is aged 75+ and 62 % of all decedents in hospitals (FSO 2012, diagnosis-statistics). Out of the new included controls, the ratio of patients to nursing staff, the ratio of nurses to doctors and the occupation rate are highly significant. The significant positive effect of the patient to nurse ratio was to be expected for specification D as the output measure is patients per labor input (so somehow a similar variable) and it is rather surprising that this effect is so small given this similarity to the outcome measure. Also the nurse to doctor ratio has a significant positive and larger impact on our output measure in both specifications.

8.2 Results of model Q2

Where all of the previous models tried to bring together quantity (number of patients) and quality (mortality rates) to measure hospital performance, our Q2 model solely focusses on quality (the disease specific mortality rate). The purpose of this is to try and disentangle the joint effect of both quantity and quality output and get a better understanding which part of the effects above are driven by which performance criteria.

Overall this quality model specification has a very low R^2, it explains only 4 to 7 % of the variation in our output variable. Further, Investment in OC is not significant and OC is significant but has a very low impact. In general the random effect results are of higher significance than the fixed effects estimation. This is due to the fact that the RE model considers both, the within and between variation, whereas the fixed effects only considers the within variation. However, while the results of the RE model would be more desirable, the Hausman test shows that the coefficients of these two models are significantly different from each other (p-value of 0.000), strongly indicating that the RE model is inconsistent.

While this model shows almost no significant results, it still helps us interpret the above results in a more differentiated way. Considering that our variables have no significant effect on the quality performance, most of the above effects (Q1 but also all other models) of our explanatory variables can be explained by their effect on the quantity measure of performance (i.e. the number of patients or the labor productivity). This is supported by the estimation results of the basic model without quality adjustment (Annex B Table 17). The results of this quantity regression show an even stronger relationship between organizational capital and output than in the original model.

Data restrictions may play a dominant role, that is to say, the independent variables at hospital level have no direct influence on disease specific mortality. One exception is the patient to nurse ratio, which shows a highly significant and negative impact on disease specific mortality in RE and FE models. While the ratio of patients to nurses has a positive effect in quantity model Q1, the quality model Q2 indicates the negative effect of increasing workload on hospital quality. If we focus on the total in-hospital mortality the effect is nearly the same (see Annex B Table 18).

Table 10: Quality model Q2 – specification A

	Investments in organizational capital				Average organizational capital stock			
	Cross Section 2012	Pooled	Panel Random Effects	Panel Fixed Effects	Cross Section 2012	Pooled	Panel Random Effects	Panel Fixed Effects
(Inv)Org Capital (log)	0.0158*	0.011	0.005	0.001	0.017**	0.012*	0.009**	0.000
labor (log)	-0.015*	-0.011	-0.006	-0.008	-0.016*	-0.012	-0.009*	-0.007
material costs (log)	-0.015***	-0.013***	-0.008***	-0.007**	-0.015***	-0.013***	-0.008***	-0.007**
sizecat	0.007***	0.007***	0.004***	0.002	0.007***	0.007***	0.004***	0.002
charitable	0.002	0.002	0.001	0.003	0.002	0.002	0.002	0.003
private	-0.001	0.002	-0.002	-0.005	-0.001	0.002	-0.001	-0.005
university hospital	0.023*	0.014	0.01	-	0.023*	0.014*	0.010	-
share females	0.011	0.052**	0.051***	0.041**	0.012	0.052**	0.052***	0.041**
share 75+	0.048***	0.057**	0.037***	0.004	0.049***	0.057**	0.038***	0.004
op rate	0.007	0.004	0.007*	0.008*	0.007	0.005	0.007*	0.008*
mean length of stay	-0.001	-0.002*	-0.001	0.001	-0.001	-0.002*	-0.001	0.001
intensive	-0.023*	-0.013	-0.013*	-0.013	-0.024*	-0.013	-0.014*	-0.013
share_fte	0.006	0.001	-0.008	-0.016**	0.005	0.008	-0.008	-0.016**
patient_nurse	-0.000	-0.000	-0.000***	-0.000***	-0.000	-0.000	-0.000***	-0.000***
nurse_doctor	0,000	0,000	0.000	0.001	0.000	0.001	0.000	0.001
occup	0.02	0.029***	0.020***	0.013*	0.023*	0.030***	0.021***	0.013*
GDP/capita	-0.000**	-0.000***	-0.000	-0.000	-0.000**	0.000***	-0.000	-0.000
2006	-	0.014***	0.015***	0.012***	-	0.022***	0.021***	0.012***
2007	-	0.010***	0.011***	0.009***	-	0.013***	0.014***	0.009***
2008	-	0.010***	0.011***	0.009***	-	0.011***	0.012***	0.009***
2009	-	0.010***	0.011***	0.009***	-	0.010***	0.012***	0.009***
2010	-	0.005***	0.006***	0.005***	-	0.006***	0.007***	0.005***
2011	-	0.002***	0.002***	0.002*	-	0.003***	0.003***	0.002*
_const	0.158*	0.148*	0.131***	0.199***	0.129	0.132*	0.094*	0.205***
number of observations	888	6216	6216	6216	888	6216	6216	6216
R^2	0.087	0.113	0.097	0.037	0.091	0.114	0.099	0.037
*** = p <= 0,001; ** = p <= 0,01; * = p <= 0,05.								
Source: Federal Statistical Office of Germany; Hospital statistics, micro-data, balanced panel 2006 to 2012.								

9 Conclusion and discussion

This paper used the employee embedded approach to measure the impact of organizational capital in German hospitals. Parts of the working time of doctors, nurses and administrative staff were defined as investments in organizational capital and the organizational capital stock formed under consideration of capital depreciation. With this approach we find that in our selection of hospitals, one million Euros are invested each year in organizational capital, which is consistent with the findings of CHS (2005, 2009) for the US.

Furthermore, we estimated several models to analyze the impact of own account organizational capital (investment and capital stock) on hospital performance, using a variety of output indicators. We found significant and positive effects on quality adjusted output measures and labor productivity in all models. This includes the time as well as the wage weighted approach to labor input. As organizational capital is mainly constituted of nursing and medical staffing times and wages, we would thus conclude that investments into these professions have a positive effect on hospital performance.

Finally, we estimated several quality models to account for the special output of hospitals; patient treatment. In this context positive output measures such as labor productivity might cause deterioration in quality due to higher work load. For this reason we estimated a separate model with the survival rate as the only dependent variable, in order to isolate the quality effect from the quantity effect. Our results show that the positive impact of organizational capital on hospital performance is mainly driven by quantity aspects, i.e. the number of patients treated. For our quality regressions we selected a subgroup of patients with a set of diagnoses as basis for our output measures in order to be able to better compare the quality of treatment between hospitals. In both models (Q1 and Q2) we face the problem that the dependent variables (survival adjusted inpatients or survival rate) relate only to those patients with one of the specified diagnoses. In comparison, all independent variables relate to the entire hospitals. A differentiation by department or diagnosis is not possible with our data but running the same regressions on the mortality rate of the entire hospital shows that some variables, e.g. the patient to nurse ratio, have opposing effects depending on whether the quality or quantity output measure is chosen.

While this allows a better understanding on the mechanisms at work, it also points to one of the most important blind spots when talking about hospital performance, namely quality. The introduction of the G-DRG system in German acute care hospitals in 2003 based on a voluntary participation and 2004 on a mandatory participation, was mainly aimed at increasing efficiency (Schulz 2012). This quantity focused approach however ignored adverse effects on quality aspects of hospital performance. This is why the current discussion and the focus of health-care policy reforms concentrate on developing standardized quality measures. Unfortunately the hospital statistics has proven to not allow an in depth analysis of quality measures due to missing data (such as waiting times or hygiene standards) and the fact that most data is not available on department level. However, when talking about intangibles in the public sector, we believe that developing quality indicators would be a valuable contribution of future research.

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Annex A: Descriptives

Hospitals – ownership and size

Table 11: Hospitals by ownership and bed-size

	Number of hospitals	Share by ownership			Share by bed-size						
	total	public	charitable	private	< 100 beds	100-149	150-199	200-299	300-399	400-599	600+
2006	925	40%	47%	13%	5%	13%	13%	24%	17%	18%	10%
2007	925	39%	46%	14%	5%	13%	13%	24%	17%	18%	10%
2008	925	39%	47%	14%	5%	14%	12%	24%	17%	18%	10%
2009	925	39%	46%	15%	5%	13%	12%	24%	16%	18%	10%
2010	925	39%	46%	15%	6%	13%	13%	23%	17%	18%	11%
2011	925	39%	47%	15%	6%	13%	13%	22%	17%	19%	11%
2012	925	39%	46%	15%	6%	13%	13%	22%	16%	19%	11%
Total	6,475	39%	47%	14%	5%	13%	13%	24%	17%	18%	10%
Source: Federal Statistical Office of Germany; Hospital statistics, micro-data, balanced panel 2006 to 2012.											

Output

According to Eurostat (2001) "The health output is the quantity of health care received by patients, adjusted to allow for the qualities of services provided, for each type of health care. The quantity of health care received by patients should be measured in terms of complete treatments". To measure complete treatment is difficult, but activities can be used as raw indicator. The activities of hospitals can be measured on the basis of the Diagnosis Related Groups (DRGs) classification. Nearly all general hospitals in Germany are using DRGs for reimbursement. But due to data access restrictions it is not allowed to combine the information on inpatients classified by DRGs with the information of the hospital statistics. One way out is to use the hospital specific (estimated) case mix index (CMI) which represents the average DRG per inpatient of all inpatients treated in the single hospital and combine this index with the number of patients.[3]

According to the Eurostat (2001) recommendations the output indicators have to be quality adjusted. One quality indicator could be the contribution of the treatment to improvements in the health state of the patient. This requires measures of health states of patients before and after treatments. But this may be difficult to measure. Thus, Dawson et al (2005) propose to use the 30-day survival rates after hospitalization or the quality adjusted life years. Another quality indicator may be the reduction in waiting times for elective surgeries in hospitals. The hospital statistics provide information on the in-hospital death rates, but no information on waiting times. Thus, we used the in-hospital survival rate as a raw proxy for quality adjustment.

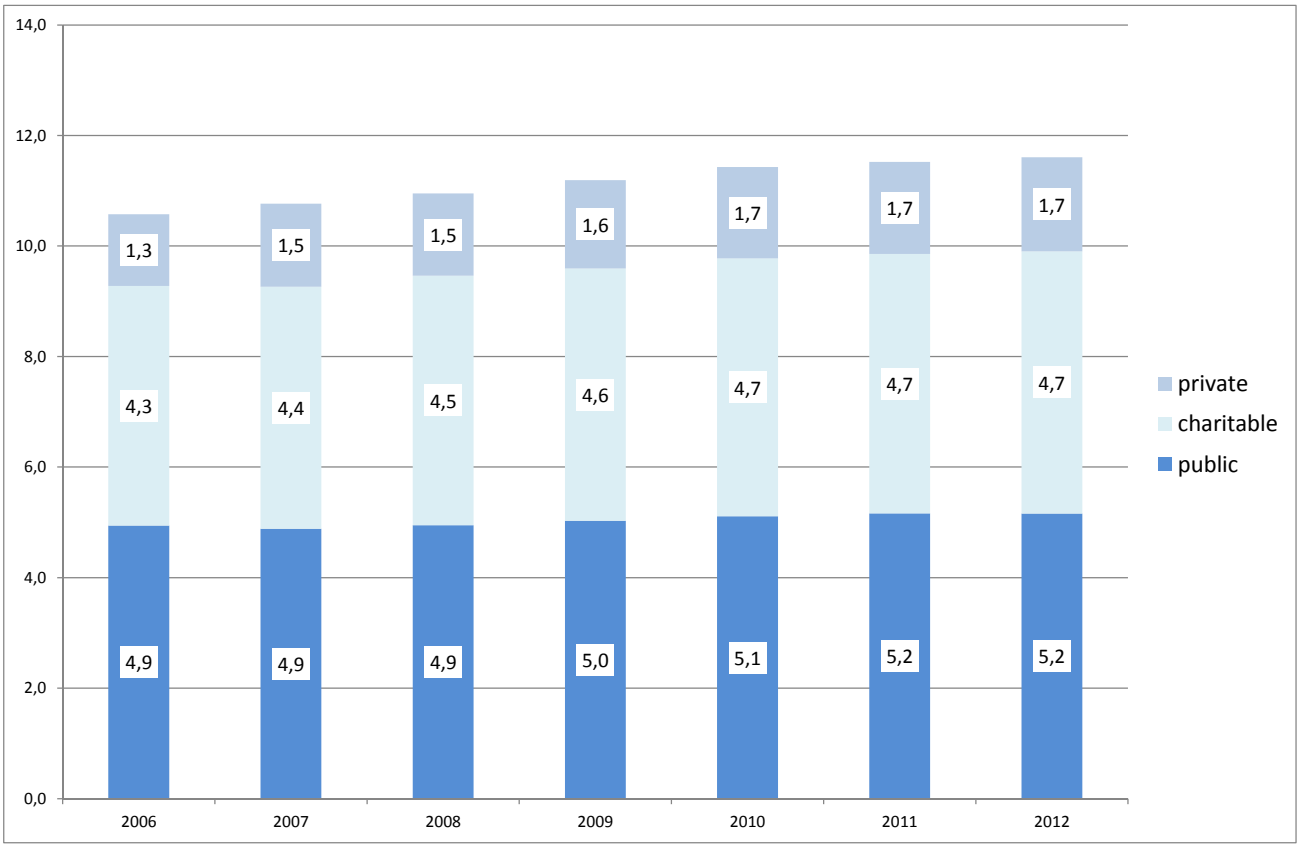
In this study the **output** is measured as

CMI_{ti}*(number of hospital $cases_{ti}$*survival $rate_{ti}$).

[3] The number of patients or hospital cases is not identical with the number of persons as a person can be admitted to a hospital more than once a time during a year.

Between 2006 and 2012 there has been an increase in the number of stationary patients from 10.9 million to 12.7 million cases. Weighted with the CMI and survival adjusted the output increased from 10.6 million in 2006 to 11.6 million in 2012 (Figure 1).

Figure 1: CMI weighted number of hospital cases survival adjusted 2006-2012 (million)



Source: Federal Statistical Office of Germany 2015, Micro data of the hospital statistics; balanced panel data 2006 to 2012

Labor

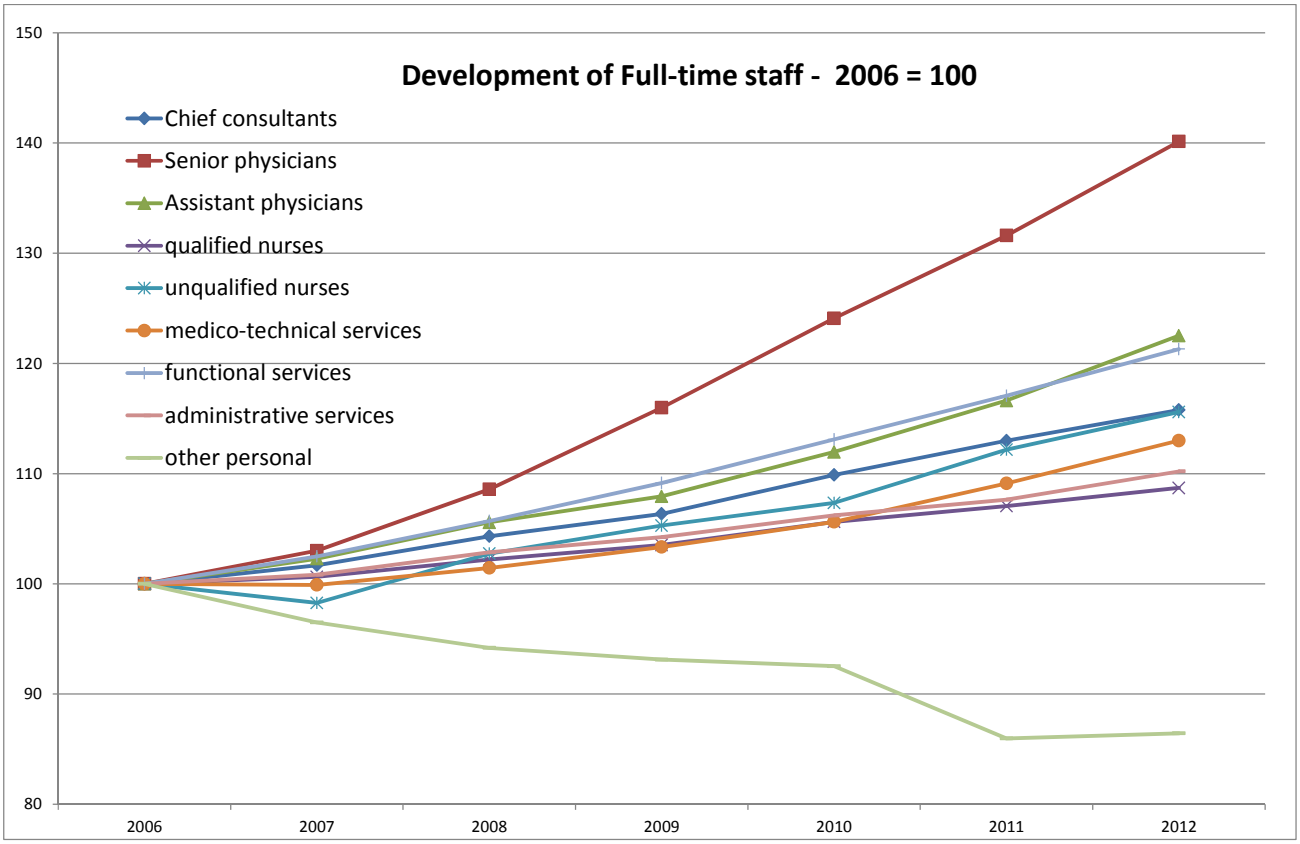
Health care and in particular hospital care is a personnel intensive public service. Employees are important input factors. Additionally, employees carrying out managerial tasks are relevant for the calculation of investments in OC as another input factor.

In 2012 around 468 thousand full-time staff was employed in the 925 hospitals included in our sample that is on average 526 FTE per hospital. Qualified nurses are the largest occupational group with around 167 thousand full-time staff (on average180 per hospital). They were assisted by 18 thousand unqualified nurses (19 per hospital). In total they account for 38 % of total hospital staff. Doctors account for 18 % of hospital staff (87 thousand full-time doctors). Around 8 thousand doctors were chief consultant (on average 8 per hospital), 21 thousand senior physicians (23 per hospital) and 58 thousand assistant physicians (62 per hospital). The time spent for management tasks is different between these professional groups and assistant physicians in further

training are in general not involved in management tasks related to create OC. The medical-technical and functional service staff accounts for 17 % of total hospital staff. Around 33 thousand full-time staff is employed in administration services (7% of total hospital staff). The administrative services encompass also professions not involved in creating OC. Thus only a part of the – on average 36 full-time employees per hospital – are relevant for IOC.

During the observation period (2006 to 2012) the number of hospital full-time staff increased, but the development was different between the occupational groups). A relative high increase can be seen for senior physicians and assistant physicians, while nursing and administration staff shows only a moderate increase. The decline of other personnel is determined by the outsourcing of housekeeping relevant tasks like cleaning or catering services. The different development of medical and nursing staff has the consequence that the share of nursing staff as well as the ratio of nursing staff to doctors declined. In 2006 the nurse-doctor-ratio amounts 2.5, in 2012 only 2.1.

Figure 2: Development of full-time hospital staff 2006-2012 – 2006 = 100



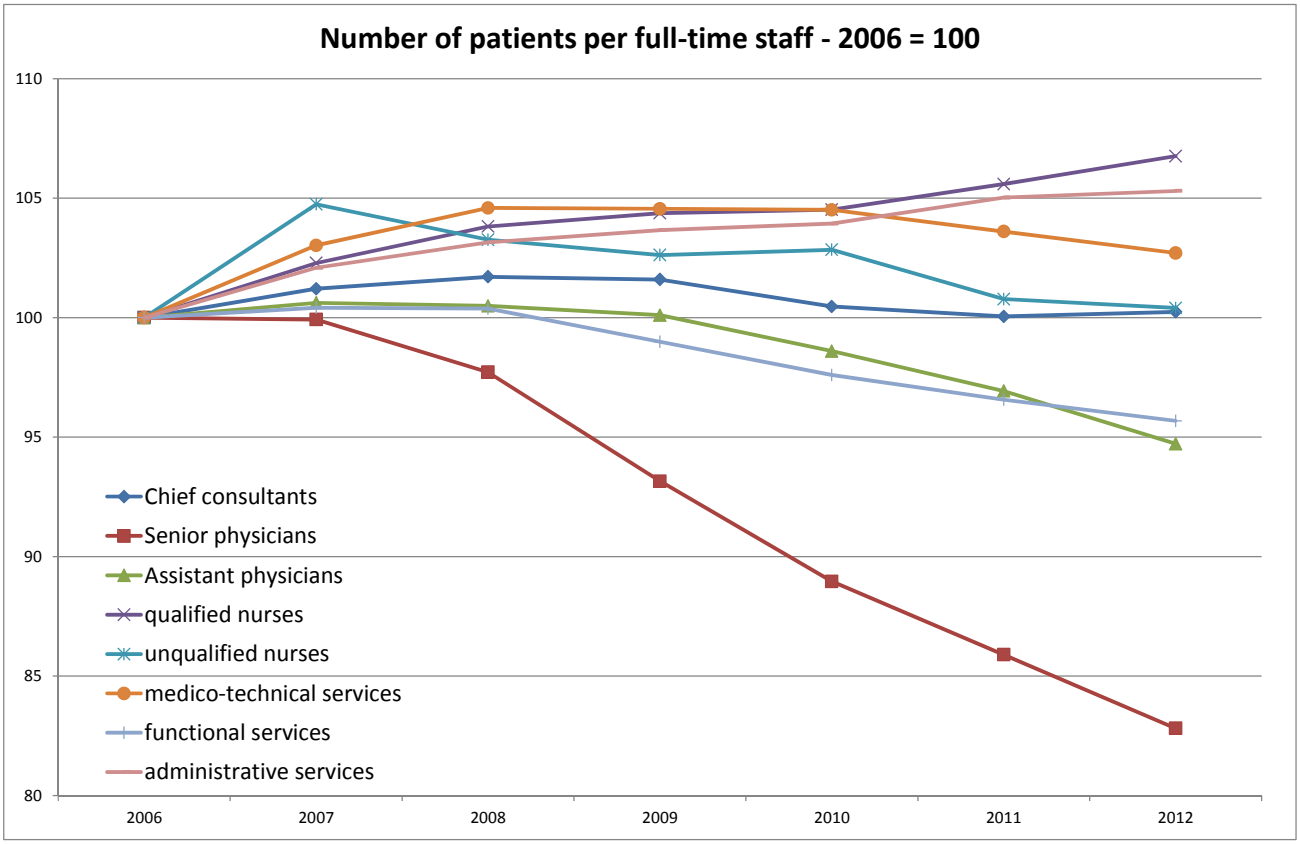
Source: Federal Statistical Office of Germany 2015, Micro-data of the hospital statistic; balanced panel; calculation of DIW Berlin.

Qualified nurses are engaged in the coordination of nursing tasks and the coordination between the medical and nursing tasks. A decline in the share of qualified nurses may be an indicator for a reduction in IOC. Furthermore, creation of IOC requires the teamwork between medical staff (doctors) and nursing staff. It may

be that the (occupational/professional) composition of the team plays a role. In this view it is relevant that also the relation of qualified nurses to doctors declined during the observation period.

Fürstenberg et al (2011) relate the number of full-time staff to the number of inpatient cases to derive an indicator for the development of the workload of the different professions. This approach ignores ambulatory and outpatient services as well as the working time beyond the contractually agreed time. Nevertheless, the number of hospital cases per full-time staff gives a raw impression of the changes in work load of specific occupations.

Figure 3: Number of patients per full-time staff by occupations - 2006 = 100



Source: Federal Statistical Office of Germany 2015, Micro-data of the hospital statistic; balanced panel; calculation of DIW Berlin.

Material

The hospital statistics provides only data on costs. We used the material costs as these costs are directly related to the number of patients treated. We deflated the material costs with the consumer price index. During the observation period the material costs per patients increased markedly, by 16 %.

Table 12: Material costs per patient 2006 - 2012

In Euro (deflated)	2006	2007	2008	2009	2010	2011	2012
Material costs per weighted inpatient (CPI adjusted)	1244	1287	1333	1390	1415	1434	1449
Source: Federal Statistical Office of Germany; Hospital statistics, micro-data, balanced panel 2006 to 2012.							

Control variables

Table 13: Control variables: development between 2006 and 2012

	Mean value per hospital included in the sample						
	2006	2007	2008	2009	2010	2011	2012
Share of female patients in per cent	53.46	53.45	53.23	52.96	52.87	52.69	52.53
Share of elderly patients (75+) in per cent	22.88	23.61	24.06	24.35	24.63	25.44	26.27
Share of hospital cases with operations in per cent	31.45	31.00	30.26	28.69	29.49	28.86	28.54
Share of qualified nurses in total nursing staff in per cent	90.24	90.32	90.18	90.18	90.21	89.95	89.90
Mean length of stay in days	7.94	7.80	7.61	7.45	7.31	7.14	7.01
Source: Federal Statistical Office of Germany; Hospital statistics, micro-data, balanced panel 2006 to 2012.							

Variables quality models

Table 14: Model Q1 –share of patients and share of deaths in selected diagnoses

	2006	2007	2008	2009	2010	2011	2012
Share of patients in selected diagnoses in total patients	8.03%	8.03%	7.95%	7.98%	7.96%	7.99%	7.93%
Share of deaths in selected diagnoses in total in-hospital deat	27.78%	27.59%	27.46%	27.59%	26.66%	26.31%	26.35%
Source: Federal Statistical Office of Germany; Hospital statistics, micro-data, balanced panel 2006 to 2012.							

Table 15: Model Q1 – death rates in selected diagnoses

Disease specific in-hospital mortality rate (ICD10)	2006	2007	2008	2009	2010	2011	2012
CHF = I11 Hypertensive heart disease	0.61%	0.71%	0.50%	0.35%	0.34%	0.32%	0.25%
AMI = I21-I25 Ischaemic heart disease without Angina pectoris	6.30%	6.36%	6.31%	6.38%	5.86%	5.60%	5.46%
I50 = I50 Cardiac failure	11.00%	10.70%	10.39%	10.35%	10.01%	9.72%	9.47%
I63 = I63 Ischaemic stroke	8.49%	8.27%	8.09%	7.86%	7.58%	7.24%	7.18%
STR = I64 Stroke	14.84%	13.92%	14.16%	13.48%	13.77%	12.88%	12.42%
GIH = I67 Other cerebrovascular diseases	2.62%	2.34%	2.12%	2.16%	2.30%	2.10%	2.01%
PNE = J12-J18 Pneumonia	10.69%	10.45%	11.09%	11.11%	10.45%	9.93%	10.24%
Selected diseases together	8.55%	8.41%	8.45%	8.49%	8.06%	7.75%	7.68%
Average mortality rate of all inpatients	2.47%	2.45%	2.45%	2.46%	2.41%	2.35%	2.31%
Source: Federal Statistical Office of Germany; Hospital statistics, micro-data, balanced panel 2006 to 2012.							

Annex B: Additional Regressions

Table 16: Basic Model A - cross-sectional results 2006 to 2012

	Investments in organizational capital						
	2006	2007	2008	2009	2010	2011	2012
(Inv)Org Capital (log)	.173***	.160***	.227***	.206***	.208***	.220***	0.265***
labor (log)	.290***	.289***	.251***	.258***	.279***	.287***	0.264***
material costs (log)	.361***	.357***	.371***	.379***	.364***	.360***	0.340***
sizecat	.052***	.061***	.045***	.049***	.048***	.041***	0.046***
charitable	.001	.002	-.000	-.004	-.003	.006	0.012
private	.031*	.035**	.032*	.050***	.064***	.061***	0.062***
uni	-.081	-.098	-.149*	-.124*	-.151*	-.171**	-0.204**
sharefem	-.270***	-.283***	-.143	-.108	-.068	-.087	-0.055
share75	.112266	.029	.042	.011	.075	.059	0.038
oprate	.047	.031	.037	.016	.048	.054	0.082***
meanlos	-.026***	-.027***	-.023***	-.023***	-.025***	-.024***	-0.024***
share_qualnurse	-.041	.007	-.090	-.092	-.098	-.008	-0.043
GDP/capita	.000	-.000	.000	.001	.000	.000	-0.002**
_cons	-.729*	-.505	-1.399***	-1.394***	-1.282***	-1.504***	-1.573***
number of observations	925	925	925	925	925	925	925
R^2	0.966	0.9689	0.9684	0.9702	0.9675	0.9691	0.969
*** = p <= 0,001; ** = p <= 0,01; * = p <= 0,05.							
Source: Federal Statistical Office of Germany; Hospital statistics, micro-data, balanced panel 2006 to 2012.							

Table 17: Q1 – Model A – without survival adjustments

	Investments in organizational capital				Average organizational capital stock			
	Cross Section 2012	Pooled	Panel Random Effects	Panel Fixed Effects	Cross Section 2012	Pooled	Panel Random Effects	Panel Fixed Effects
(Inv)Org Capital (log)	0.199	0.293**	0.241***	0.219***	0.259*	0.358***	0.245***	0.247***
labor (log)	0.469***	0.439***	0.446***	0.448***	0.429***	0.400***	0.472***	0.487***
material costs (log)	0.250***	0.164*	0.154***	0.156***	0.243***	0.152*	0.151***	0.162***
sizecat	0.103***	0.111***	0.079***	0.074***	0.101***	0.109***	0.082***	0.079***
charitable	-0.061*	-0.024	-0.048**	-0.040	-0.058	-0.019	-0.047**	-0.042
private	0.038	0.035	-0.030	-0.027	0.037	0.037	-0.029	-0.030
university hospital	-0.214	-0.119	-0.165	-	-0.209	-0.107	-0.220	-
share females	-0.672*	-0.700	-0.779***	-0.770***	-0.669*	-0.717	-0.760***	-0.764***
share 75+	4.238***	4.521***	3.401***	2.881***	4.259***	4.531***	3.426***	2.867***
op rate	-1.110***	-1.133***	-0.203***	-0.119***	-1.098***	-1.120***	-0.203***	-0.117***
mean length of stay	-0.138***	-0.145***	-0.066***	-0.043***	-0.138***	-0.145***	-0.067***	-0.044***
intensive	0.435*	0.495	-0.059	-0.105	0.419*	0.476	-0.069	-0.108
share_fte	-0.102	0.089	0.038	0.05	-0.103	0.081	0.049	0.061
patient_nurse (100)	0.007***	0.008***	0.006***	0.006***	0.007***	0.008***	0.006***	0.006***
nurse_doctor	0.168***	0.153***	0.039***	0.029***	0.172***	0.157***	0.041***	0.029***
occup	0.905***	1.081***	0.493***	0.405***	0.930***	1.092***	0.522***	0.434***
GDP/capita (1.000)	-0.000	-0.002*	0.001**	0.001**	-0.000	-0.002*	0.001*	0.001***
2006	-	0.276***	0.192***	0.152***	-	0.514***	0.357***	0.324***
2007	-	0.222***	0.163***	0.130***	-	0.310***	0.224***	0.197***
2008	-	0.152***	0.120***	0.095***	-	0.221***	0.169***	0.148***
2009	-	0.114***	0.103***	0.084***	-	0.152***	0.130***	0.114***
2010	-	0.090***	0.078***	0.063***	-	0.110***	0.093***	0.079***
2011	-	0.049***	0.036***	0.029***	-	0.057***	0.043***	0.036***
_const	-4.417	-4.333***	-3.111***	-2.802***	-5.1225***	-5.102***	-3.536***	-3.767***
number of observation	888	6216	6216	6216	888	6216	6216	6216
R^2	0.778	0.746	0.704	0.685	0.779	0.748	0.704	0.679
*** = p <= 0,001; ** = p <= 0,01; * = p <= 0,05.								
Source: Federal Statistical Office of Germany; Hospital statistics, micro-data, balanced panel 2006 to 2012.								

Table 18: Q2 model – modified – all in-hospital deaths

	Investments in organizational capital			
	Cross Section 2012	Pooled	Panel Random Effects	Panel Fixed Effects
(Inv)Org Capital (log)	.0007	.0013	.0001	-.0008
labor (log)	-.0019	-.0015	-.0000	-.0007
material costs (log)	.0002	-.0002	-.0006	-.0010*
sizecat	.001**	.0013*	.0005**	.0002
charitable	-.0008	-.0005	-.001**	-.0010*
private	.0001	.0002	-.0005	-.0004
uni	-.0001	-.0009	-.0008	-
sharefem	-.0026	.0026	.0037	.0055*
share75	.015***	.0266***	.0157***	.0098**
oprate	-.012***	-.0120***	-.0029***	-.0013
meanlos	-.001***	-.0006*	.0002*	.0006***
intensive	-.0054	-.0022	.0013	.0017
share_fte	-.0016	.0018	.0004	.0003
patient_nurse	-.0001***	-.0001	-.0000***	-.0000***
nurse_doctor	.0004	.0012	.0002	.0001
occup	.0052	.0080**	.0035***	.0019
GDP/capita	-.0000*	-.0000**	-.0000	-.0000
2006		.0052***	.0045***	.0037***
2007		.0041***	.0037***	.0030***
2008		.0034***	.0033***	.0027***
2009		.0027***	.0027***	.0024***
2010		.0019***	.0020***	.0017***
2011		.0009***	.0008***	.001***
2012		-	-	-
_cons	.0267	.0080	.0214**	.0443***

*** = p <= 0,001; ** = p <= 0,01; * = p <= 0,05.

Source: Federal Statistical Office of Germany; Hospital statistics, micro-data, balanced panel 2006 to 2012.