

Impact of Hospital Ownership and Structural Characteristics on Internal Incentive Systems for German Chief Physicians

Fabian Dutschkus

fabian.dutschkus@uni-jena.de

Jena University Hospital

Christian Lukas

Friedrich Schiller University Jena

Research Article

Keywords: Hospital ownership, Physician incentives, Management control, Pay-for-performance

Posted Date: September 28th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10956903/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

Additional Declarations: No competing interests reported.

Impact of Hospital Ownership and Structural Characteristics on Internal Incentive Systems for German Chief Physicians

Fabian Dutschkus*¹ and Christian Lukas²

¹Institute of General Practice and Family Medicine, Jena University Hospital, Friedrich Schiller University Jena, Jena, Germany, fabian.dutschkus@med.uni-jena.de

²Department of Economics and Business Administration, Friedrich Schiller University Jena, Jena, Germany, christian.lukas@uni-jena.de

September 7, 2026

Abstract

Purpose Hospital ownership and other structural characteristics are commonly used as controls in studies of hospital performance and pay-for-performance. However, little is known about whether these characteristics are associated with the internal incentive systems through which hospitals direct chief physicians. This study examines associations between hospital characteristics and the use of compensation-based incentives (CBI) and non-compensation-based incentives (NCBI) for chief physicians in Germany.

Methods We linked a nationwide survey of chief physicians conducted in 2019 to statutory hospital quality reports. The final sample comprised 597 hospital departments. Separate binary probit models assessed associations of hospital ownership, size, university status, outpatient infrastructure, intensive care units, and surgical departments with CBI and NCBI linked to quality performance, inpatient economic performance, and outpatient economic performance.

Results Private hospitals were more likely than charitable and public hospitals to use CBI. Public hospitals were more likely than private hospitals to use NCBI. Charitable hospitals reported less CBI and more NCBI linked to inpatient economic performance and quality performance; public hospitals showed corresponding differences in quality performance. Outpatient infrastructure was associated with NCBI linked to outpatient economic performance. Hospital size, university status, intensive care units, and surgical departments showed selective rather than general associations with the incentive systems and performance dimensions examined.

Conclusion Hospital ownership and selected structural characteristics are associated with internal incentive systems for chief physicians. Studies of hospital performance and pay-for-performance should, where feasible, measure internal incentive arrangements directly rather than rely solely on broad structural characteristics as proxies.

Keywords: Hospital ownership; Physician incentives; Management control; Pay-for-performance

JEL Classification: I11; I18; J33; M52

*Corresponding author

1 Introduction

Not just a few people believe that private for-profit (PfP) hospitals focus more on financial performance than not-for-profit (NfP) hospitals, i.e., public or charitable hospitals, due to owners' vested interests (Eggleston et al., 2008; Kruse et al., 2018). According to Kruse et al. (2018), private hospitals seem to respond more strongly to (financial) incentives than other hospital types. This could suggest that private hospitals rely more heavily on compensation-based incentives than other hospitals. In addition, other structural characteristics might affect the design of incentive systems; for example, one might expect departments with day treatment facilities to be more likely to offer incentives for outpatient procedures.

If a systematic relationship between structural characteristics like provider type or day-care facility and incentive system design exists, observable structural characteristics could be used to control for (some of) the unobservable systematic differences in the choice of performance measures by hospitals. Our research aims to establish, or at least test for, the existence of such a relationship.

The literature on institutional interventions such as pay-for-performance consistently shows heterogeneous effects: from absent or marginal to clearly positive changes in process quality, patient outcomes, or efficiency, depending on design, setting, and outcome domain (Van Herck et al., 2010; Eijkenaar et al., 2013; Mendelson et al., 2017).

A possible reason for these varying effects could be that it is often unclear how hospitals pass on their pay-for-performance incentives to service providers - the treating physicians. If these incentives are passed on at all, this can be done through internal incentive systems, such as compensation-based incentives (CBI) - e.g., bonus payments, target agreements with performance bonuses, and profit-sharing - or non-compensation-based incentives (NCBI)- e.g., budget or staffing targets, accountability for results, or reporting obligations. CBI and NCBI may be linked to quantitative indicators, associated targets, qualitative requirements, or combinations thereof. We refer to these underlying targets and indicators as performance measures.

Most empirical studies on pay-for-performance, however, do not examine the internal incentive systems (CBI or NCBI), including their underlying performance measures, that shape physicians' day-to-day decisions. Instead, they typically control for structural features such as ownership type (PfP vs. public/NfP), hospital size, or academic status, as these are regarded as proxies for different (corporate) objectives and thus different responses to monetary incentives.

As mentioned above, PfP hospitals are expected to use CBI more intensively than NfP hospitals. Larger hospitals are expected to be more difficult to manage than smaller hospitals. The former are associated with better management practices, whereas smaller hospitals can rely more on informal relationships; managerial supervision is easier, and organizational processes and routines are less complex (Lucifora, 2023). Consequently, larger hospitals are expected to use CBI with multiple performance measures (King and Clarkson, 2015). The same reasoning applies to specialised structures such as surgical wards, outpatient clinics, or intensive care units (ICUs). Here, processes are more complex, making CBI more likely. Finally, academic hospitals are associated with excellent clinical quality (Burke et al., 2017; Ayanian and Weissman, 2002). Therefore, one would expect them to use incentives, CBI or NCBI, to achieve their quality objectives (Kupersmith, 2005).

The cited literature suggests a systematic relationship between structural characteristics and the design of internal incentive systems. Studies, however, have shown that, for example, ownership structures have contradictory effects on quality (Eggleston et al., 2008), suggesting substantial variation in the design of internal incentive systems across hospital provider types. Such differences in incentive system design could also help explain why some studies do find differences in outcome measures by provider type (Morris et al., 2017; Wübker and Wuckel, 2019). Here, CBI and NCBI, along with their underlying performance measures, serve as unobserved determinants of hospital outcome measures, contributing to biased or inconclusive results. Accordingly, it remains open and empirically highly relevant whether the size, status, type, and specialized structures of a hospital predict the choice of internal incentive systems and their underlying performance measures.

This paper, therefore, examines whether structural characteristics systematically predict the adoption and design of internal incentive systems for physicians. The core research question is: *Which structural characteristics of hospitals are systematically associated with the adoption of internal incentive and control mechanisms for physicians, and with the performance dimensions to which these mechanisms are linked?* Answering this question reveals whether standard controls for structural characteristics of hospitals adequately proxy for internal incentive system variation and their underlying performance measures—or whether unobserved differences in CBI/NCBI design could be a driver of the heterogeneous intervention effects observed in the literature.

To answer the research question, we use a nationwide survey of chief physicians matched to statutory hospital quality reports to examine whether observable structural characteristics systematically predict the adoption and design of internal incentive systems. Specifically, we estimate separate binary probit models for the use of CBI and NCBI and for the use of incentives linked to inpatient, outpatient, or quality performance dimensions, as functions of hospital ownership, size, university status, and department-specific structures. This design allows us to open the hospital “black box” and link external structural characteristics, which are commonly used as incentives in pay-for-performance and ownership studies (Bjorvatn, 2018; Eggleston et al., 2008; Herrera et al., 2014; Moscelli et al., 2018; Wübker and Wuckel, 2019), to the internal control architectures that actually govern physicians’ behavior.

Our results show that private for-profit hospitals rely more heavily on CBI for both economic and quality targets, whereas public and charitable hospitals more often use NCBI to pursue similar targets. We also find that outpatient infrastructure is associated with outpatient-oriented performance measures, which are managed using NCBI. Size, ICU, and surgical status, however, play a rather limited role. These findings are consistent with contingency-theoretic views of management control, which posit that control systems must fit organizational context, and they offer a plausible mechanism for the heterogeneous and sometimes contradictory ownership and pay-for-performance effects documented in the literature: differences in internal incentive architectures, rather than ownership or P4P status alone, shape how hospitals translate external financial pressures into clinicians’ day-to-day decision-making.

2 Theoretical framework and research questions

2.1 Theoretical framework

A suitable theoretical starting point for opening the hospital “black box” is contingency theory in research on performance measurement and management control. From this perspective, no single incentive and control system is universally optimal. Rather, the design and use of such systems are expected to fit the organisational context in which a hospital operates. The contingency literature therefore examines how contextual factors—including environmental conditions, organisational structure, size, strategy, and culture—are associated with the design of management control systems (Spanò and Cicellin, 2018).

Applying the contingency perspective to hospitals means that observable structural characteristics may be systematically associated with the internal mechanisms used to translate organisational objectives into the day-to-day behavior and accountability of chief physicians. In this study, we focus on internal incentive and control systems for chief physicians and distinguish between compensation-based incentives (CBI) and non-compensation-based incentives (NCBI). CBI include instruments that link compensation to performance, such as bonus payments, performance-related target agreements, or profit-sharing. NCBI comprise instruments that do not directly alter individual compensation, such as budget or staffing targets, reporting obligations, accountability for results, or resource-allocation decisions.

Both CBI and NCBI may be linked to quantitative indicators, associated targets, qualitative requirements, or combinations thereof. We refer to these underlying targets and indicators as performance measures. The performance measures considered in this study relate to three performance dimensions: quality of care, inpatient services, and outpatient services. CBI and NCBI should therefore not be understood as mutually exclusive alternatives. Hospitals may combine both instruments and link them to more than one performance dimension.

From a contingency-theoretic perspective, structural characteristics of hospitals may be associated with the use of CBI and NCBI for two related reasons. First, they may reflect differences in the organisational objectives hospitals pursue, including financial performance, quality of care, and service provision. Second, they may affect the complexity of coordination, monitoring, and accountability within the hospital. Ownership type, hospital size, university status, outpatient infrastructure, and department-specific structures may therefore be associated with both the adoption of CBI and NCBI and the performance dimensions to which these instruments are linked.

The present study is theory-informed but exploratory. It does not seek to establish causal effects of hospitals’ structural characteristics on incentive-system design. Instead, it examines whether observable hospital characteristics are systematically associated with the use of internal incentive and control systems for chief physicians. The following sections develop the theoretical considerations for the individual structural characteristics and formulate the corresponding research questions.

2.2 Research questions: Hospital ownership and size

Research on the association between hospital ownership and quality of care has produced mixed findings. Empirical studies and reviews suggest that ownership differences depend on institutional context, including the regulatory environment, regional markets, and the period under study (Eggleston et al., 2008; Herrera et al., 2014; Bjorvatn, 2018; Kruse et al., 2018; Moscelli et al., 2018). For example, using an analytical model, Moscelli et al. (2018) show theoretically that the effect of placing greater weight on profit on the quality of care is generally indeterminate. Thus, ownership type alone is unlikely to explain differences in hospital outcomes. One possible reason is that hospitals with different ownership structures may differ in their internal incentive and control systems for pursuing financial and quality-related objectives.

The distinction between PfP and NfP hospitals provides a theoretical basis for such differences. According to Arrow (Arrow, 1963), the non-marketable nature of risk-bearing and the imperfect marketability of information help explain why public and not-for-profit providers play an important role in healthcare markets.¹ Similarly, Hansmann (1979, 1988) and Sloan (2000) argue that, in settings characterized by complex services and substantial information asymmetries, not-for-profit ownership may reduce the risks associated with market contracting.

PfP hospitals and their owners are residual claimants of profits generated by the provision of healthcare services. In contrast, public and charitable hospitals are subject to the non-distribution constraint, which prevents the distribution of residual earnings to owners (Hansmann, 1979). These ownership-specific conditions may be associated with different approaches to directing physician behavior. In particular, PfP hospitals may be more likely to use CBI, because these instruments directly link individual remuneration to organisational performance. Evidence that private hospitals respond more strongly to financial incentives than other hospital types is consistent with this expectation (Kruse et al., 2018).

In contrast, public and charitable hospitals may rely more on NCBI. Such instruments can be used to communicate priorities, allocate resources, establish accountability, and coordinate departmental activities without directly linking individual compensation to measured performance. In the present context, the relevant argument is not that NCBI necessarily operate through a particular psychological mechanism. Rather, they constitute an alternative form of internal control that may be more compatible with the objectives, governance arrangements, and financial constraints of public and charitable providers.

Whether hospitals use CBI or NCBI may depend on ownership type. In addition, ownership type could be associated with the performance dimensions to which these instruments are linked. Public and charitable hospitals are not exempt from economic constraints. In particular, operating deficits and the need for deficit transfers have made financial performance a relevant concern for many municipal hospitals (Curacon GmbH Wirtschaftsprüfungsgesellschaft, 2025). Likewise, charitable hospitals must use their resources efficiently to sustain service provision. Public and charitable hospitals may therefore pursue both quality and economic objectives related to their inpatient services, while relying comparatively more often on NCBI to communicate and implement these objectives.

For PfP hospitals, improvements in inpatient economic performance may directly increase

¹ Information becomes a commodity as soon as uncertainty and risk exist (Arrow, 1963, p. 946).

profits available to owners. As a consequence, PfP hospitals appear more likely to link CBI to inpatient economic performance. At the same time, quality of care remains relevant for all hospital types. Quality may affect reputation, patient demand, regulatory scrutiny, and long-term financial viability. Therefore, any greater use of CBI in private hospitals may not be restricted to inpatient economic performance, but may also extend to quality performance measures.

Taken together, these considerations suggest that ownership type could be associated with both the use of CBI and NCBI and the performance dimensions to which these instruments are linked. We therefore address the following ownership-related research questions:

RQ1: How is hospital ownership associated with the use of compensation-based incentives (CBI) and non-compensation-based incentives (NCBI) for chief physicians?

RQ2: How is hospital ownership associated with the use of CBI and NCBI linked to inpatient economic performance and quality performance?

Hospital size may be associated with the use of internal incentive and control systems because larger hospitals typically contain more departments, specialised units, and employees who must coordinate their activities across multiple organisational interfaces. Examples of these interfaces include wards, operating rooms, diagnostic services, outpatient units, and hospital administration. Greater organizational complexity can make it more difficult to maintain oversight and coordinate activities through informal communication and personal arrangements alone (Starkweather, 1970).

Larger hospitals could use formalised internal incentive and control systems more often than smaller hospitals. Clearly defined objectives, performance measures, reporting routines, and responsibilities can facilitate coordination and monitoring across departments and professional groups. CBI may link remuneration to specified performance measures, whereas NCBI may formalize expectations and accountability through targets, budgets, resource-allocation decisions, or reporting obligations. However, the direction and magnitude of these associations remain empirical questions. Accordingly, we examine the following research question:

RQ3: How is hospital size associated with the use of CBI and NCBI and with the performance dimensions to which these instruments are linked?

University hospitals differ from other hospitals because they combine patient care, teaching, and research. Due to their academic mission, specialized service portfolios, and societal roles, university hospitals face particular quality expectations from the public, which implies greater reputational pressure. These characteristics may increase the organisational salience of quality performance objectives and the use of CBI or NCBI linked to quality performance (Ayanian and Weissman, 2002; Burke et al., 2017; Kupersmith, 2005; Mueller et al., 2013).

At the same time, university hospitals often provide highly specialised, emergency, and resource-intensive services. At least some of these services are less profitable and require cross-subsidisation through other hospital activities (Tsang, 2025). This service portfolio may increase the relevance of inpatient economic performance. However, the direction of an association between university status and incentives linked to inpatient economic performance is unclear. University hospitals could use more such incentives because of their financial and coordination

requirements, or fewer because professional norms, academic self-governance, and hospital-wide governance arrangements partly substitute for department-level incentive instruments. Accordingly, we examine the following research question:

RQ4: How is university status associated with the use of CBI and NCBI and with the performance dimensions to which these instruments are linked?

2.3 Research questions: Department-specific structures

Department-specific structures likely affect the performance dimensions that are particularly relevant for internal incentive and control systems. From a contingency-theoretic perspective, hospitals with different service portfolios, capacity requirements, and reimbursement conditions will differ in the performance measures to which they link CBI and NCBI.

Hospitals with outpatient infrastructure, such as outpatient departments or day clinics, provide services that are structurally organised outside conventional inpatient care. The availability of this infrastructure may increase the strategic relevance of outpatient service provision and, consequently, the relevance of outpatient performance measures for internal incentive and control systems. In the German context, outpatient hospital services are subject to reimbursement arrangements that potentially differ from those for inpatient DRG-funded care. This reasoning leads to the following research question:

RQ5: How is outpatient infrastructure associated with the use of CBI and NCBI linked to outpatient economic performance?

ICUs are characterised by resource-intensive treatment, high fixed costs associated with standby capacity, and complex coordination requirements. Under DRG-based reimbursement, the costs of intensive care are not always fully reflected in average payments, particularly for cost-intensive cases and high-cost outliers (Ettelt and Nolte, 2012; McLaughlin et al., 2009; Neilson et al., 2004). These financial and operational conditions may increase the relevance of performance measures focused on efficient resource use and the coordination of patient care.

In particular, hospitals with ICUs might place greater emphasis on process measures, such as improving patient admission, as well as on performance measures for inpatient services and targets for material and personnel costs. Accordingly, we address the following research question:

RQ6: How is ICU status associated with the use of CBI and NCBI linked to inpatient economic performance and quality performance?

Surgical departments commonly perform procedures for which treatment volume, scheduling, case selection, and patient throughput pose particular challenges for departmental management. As a consequence, inpatient performance measures, including case volumes, revenues, capacity utilisation, and resource use, become essential for effective management. This reasoning leads to the following research question:

RQ7: How is the presence of a surgical department associated with the use of CBI and NCBI linked to inpatient economic performance?

Table 1 summarises the theoretical considerations and research questions guiding the empirical analysis.

Table 1: Theoretical overview of structural hospital characteristics, internal incentive systems, and research questions

Structural characteristic	Theoretical rationale	Incentive outcomes of interest	RQ
Hospital ownership	Ownership is associated with differences in organizational objectives, governance arrangements, and financial incentives. Private for-profit hospitals may be more likely to use compensation-based incentives, whereas public and charitable hospitals may rely relatively more on non-compensation-based incentives.	Use of CBI and NCBI; CBI and NCBI linked to inpatient economic performance and quality performance.	RQ1–RQ2
Hospital size	Larger hospitals have more departments, specialised units, and coordination interfaces. Greater organizational complexity may be associated with more formalised incentive and control arrangements.	Use of CBI and NCBI; CBI and NCBI linked to quality performance, inpatient economic performance, and outpatient economic performance.	RQ3
University status	The combination of care, teaching, and research, together with specialised service provision and reputational requirements, may be associated with the performance orientation of internal incentive systems.	Use of CBI and NCBI; CBI and NCBI linked to quality performance, inpatient economic performance, and outpatient economic performance.	RQ4
Outpatient infrastructure	Outpatient departments and day clinics may increase the organizational and economic relevance of outpatient service provision.	CBI and NCBI linked to outpatient economic performance.	RQ5
Intensive care unit	Resource-intensive treatment, standby capacity, and coordination requirements may increase the relevance of resource use, inpatient economic performance, and quality performance.	CBI and NCBI linked to inpatient economic performance and quality performance.	RQ6
Surgical department	Treatment volume, scheduling, capacity utilisation, and patient throughput may increase the relevance of inpatient economic performance.	CBI and NCBI linked to inpatient economic performance.	RQ7

Note: CBI = compensation-based incentives; NCBI = non-compensation-based incentives. The table summarises theory-informed areas of analytical interest. It does not imply causal effects or confirmatory directional hypotheses.

3 Data and methodology

3.1 Sample

The survey took place in 2019. We obtained a complete sampling frame from the 2016 hospital quality reports (14,402 departments), the most recent reports available at the time of the survey. The reports were extracted into a database despite minor duplicates and inconsistencies due to affiliated hospitals, multi-department management, and data quality issues (cf. Kraska et al. (2017); Ji et al. (2024)). After cleaning (missing/invalid emails, duplicates), 11,092 invitations were sent via Unipark, yielding 8,754 deliveries, 2,049 responses (23.4%), and 1,045 usable physician questionnaires from single-department CPs.

These questionnaires were matched to the 2019 statutory quality reports (published in 2021), again using department-level data. The matching procedure required exact name matches between the CP listed in the 2019 quality report and the contact details taken from the 2016 reports. This implies that the CPs in our sample were in charge of the same department across the 2016–2019 period, which supports the assumption that the incentive arrangements and accountability structures captured in the survey were stable and aligned with the structural measures in the 2019 reports.

The strict matching process resulted in 617 linked observations. We further excluded departments classified as “other specialist departments,” as well as psychiatry, psychosomatic medicine, and psychotherapy departments, due to their distinct coding rules and unclear service scope. The final sample consists of 597 observations. Although this corresponds to a relatively low response rate of 6.8% among successfully delivered invitations, the sample size clearly exceeds the median of 125 in the 130 survey studies analyzed by Van der Stede et al. (2005). Moreover, as shown in the Online Appendix (Section 7.1), the matched sample is representative of the underlying target population along several key dimensions, mitigating concerns about non-response bias.

3.2 Performance measures

To operationalise the performance dimensions introduced in the theoretical framework, the survey distinguishes multiple performance-measure categories, some of which correspond to those outlined in the standard contract for clinical directors/chief physicians issued by the German Hospital Federation. For the empirical analysis, we grouped these categories into three broader performance dimensions that map onto the core performance dimensions of chief physicians: quality performance, inpatient economic performance, and outpatient economic performance.

Table 2 presents the performance-measure categories and their assignment to the respective performance dimensions. The grouping is intended to simplify the analysis and interpretation while retaining the distinction between the substantive performance dimensions to which CBI and NCBI may be linked.²

² Several performance-measure categories are excluded from the grouping because hospitals use them only to a limited extent (“preparation of expert opinions”, “implementing new treatment methods”, “providing non-medical services”, “drug testing etc.”, “additional medical services”, “outpatient procedures”) or because their objective is unclear (“other performance-oriented arrangements”). The exclusion of these categories reflects their limited relevance to the three performance dimensions considered in the analysis.

Table 2: Performance-measure categories and performance dimensions

Performance-measure category	Performance dimensions
Quality measures (means and results of quality assurance) Process measures (e.g., improvement of patient admission)	Quality performance
Performance measures for inpatient services Target figures for material and personnel costs	Inpatient economic performance
Outpatient services	Outpatient economic performance

Note: Performance-measure categories were grouped for the empirical analysis. Performance dimensions to which CBI and NCBI may be linked are listed in the right column.

Quality performance. Performance measures related to quality assurance cover outcome-oriented quality indicators and process-oriented measures. Process measures capture, for example, adherence to established clinical pathways or care protocols. Evidence indicates that compliance with evidence-based practices and treatment recommendations reduces in-hospital complications (Rotter et al., 2012), suggesting that improvements in process measures tend to translate into better outcome quality. For this reason, these measures are grouped together as quality performance.

Inpatient economic performance. Performance measures linked to inpatient services, including indicators of inpatient revenues (such as revenues, case mix index, and case volumes) and target figures for material and personnel costs at the departmental level—are grouped into inpatient economic performance. These measures reflect the hospital’s inpatient service delivery and determine the department’s contribution margin and financial performance from inpatient care. In most hospitals, inpatient revenues constitute the primary revenue stream; accordingly, a strong focus on these measures is central to the hospital’s economic success, which justifies their classification as inpatient economic performance.

Outpatient economic performance. The performance-measure category "Outpatient services" captures targets and indicators related to outpatient care provided by the department, such as outpatient case volumes, outpatient revenues, or efficiency indicators in outpatient treatment. Given that these measures directly relate to the quantity and economic performance of outpatient services rather than inpatient care or general quality assurance, they are grouped into a separate category labeled outpatient economic performance.

For each chief physician, we record whether compensation-based incentives (CBI) or non-compensation-based incentives (NCBI) are linked to quality performance, inpatient economic performance, or outpatient economic performance. Following Ioannou et al. (2016), we code each combination of incentive type (CBI or NCBI) and performance dimension as a binary variable.³

³ The survey also elicited the relative weights attached to individual performance measures and the share of variable compensation. However, because $n = 342$ (57%) reported slider values that did not sum to 100 percent, these additional data were not used to construct intensity-based outcome measures.

3.3 Structural variables

Hospital ownership. Hospitals were classified according to ownership as private for-profit (PfP), public, or charitable. Public and charitable hospitals are treated as not-for-profit (NfP) providers in the theoretical framework. Ownership was represented by two dummy variables, *Charitable hospital* and *Public hospital*, with PfP hospitals serving as the reference category.

Hospital size. Hospital size was classified according to the number of beds. Hospitals with more than 400 beds were classified as large hospitals, hospitals with fewer than 120 beds as small hospitals, and all remaining hospitals as medium-sized hospitals. We included dummy variables for *Small hospital* and *Medium-sized hospital*, with large hospitals serving as the reference category. This classification reflects differences in organizational size and complexity that may be associated with the use of internal incentive and control systems (Starkweather, 1970).

Outpatient infrastructure. Hospitals with outpatient infrastructure may differ from other hospitals in their service portfolio, revenue structure, and strategic priorities within DRG-based reimbursement systems. The dummy variable *Outpatient infrastructure* indicates whether day-treatment cases or outpatient procedures were reported. It is included to examine whether the presence of outpatient infrastructure is associated with the use of CBI and NCBI linked to outpatient economic performance.

University status. University hospitals combine patient care, teaching, and research and may differ structurally from other hospitals in their service portfolio, governance arrangements, and performance objectives. Their academic mission is associated with high public and professional expectations regarding quality of care and accountability (Mueller et al., 2013). In addition, university hospitals frequently provide highly specialised and emergency services that could require cross-subsidisation through other hospital activities (Zenty et al., 2014). The binary variable *University* indicates university status and is included to examine whether this status is associated with the use of CBI and NCBI and with the performance dimensions to which these instruments are linked.

Department-specific structures. Intensive care units differ from other departments because they provide resource-intensive care and require standby capacity, leading to substantial cost and financing pressures under DRG-based reimbursement (Ettelt and Nolte, 2012; McLaughlin et al., 2009; Neilson et al., 2004). The binary variable *Intensive Care Unit* indicates whether the hospital has an ICU and is included to examine whether ICU status is associated with the use of CBI and NCBI linked to quality performance and inpatient economic performance.

Surgical departments commonly provide procedures for which treatment volume, operating-room capacity, scheduling, and patient throughput are relevant to departmental management. The binary variable *Surgery* indicates whether the hospital has a surgical department and is included to examine whether surgical department status is associated with the use of CBI and NCBI linked to inpatient economic performance.

3.4 Model

To examine whether structural hospital characteristics are associated with the use and performance orientation of internal incentive and control systems for chief physicians, we estimate separate binary probit models of the following form:

$$\Pr(Y_{ij} = 1) = \Phi(\beta_0 + \beta_1 \text{Hospital Size}_{ij} + \beta_2 \text{Ownership}_{ij} + \beta_3 \text{University Status}_{ij} + \beta_4 \text{Outpatient Infrastructure}_{ij} + \beta_5 \text{Surgery}_{ij} + \beta_6 \text{ICU}_{ij}), \quad (1)$$

where Y_{ij} denotes the respective binary incentive outcome for department i in hospital j . We estimate separate models for the use of CBI and NCBI, and for the absence of both incentive types. In addition, we estimate separate models for each combination of incentive type and performance dimension: quality performance, inpatient economic performance, and outpatient economic performance.

Hospital size is represented by dummy variables for small and medium-sized hospitals, with large hospitals as the reference group. Ownership is represented by dummy variables for charitable and public hospitals, with private for-profit hospitals as the reference category. University status, outpatient infrastructure, surgery, and intensive care unit status are included as binary covariates.

Standard errors are clustered at the hospital level to account for within-hospital dependence. We report probit coefficients, cluster-robust standard errors, test statistics, and p -values.

To assess potential multicollinearity among the categorical predictors, we calculated pairwise Cramér’s V coefficients (Cramér, 1971). Following Cohen’s general effect-size conventions (small: 0.1, medium: 0.3, large: 0.5; Cohen, 1988), the observed pairwise associations were small. All coefficients were below 0.25 (Table 3), suggesting that strong pairwise associations among the included hospital characteristics are unlikely. We therefore included all hospital-level covariates simultaneously in the multivariable models.

Table 3: Cramér’s V association matrix for hospital characteristics.

		1	2	3	4	5	6
1	Hospital size	1.00	0.18	0.20	0.12	0.05	0.02
2	Hospital ownership	0.18	1.00	0.24	0.08	0.07	0.05
3	University status	0.20	0.24	1.00	0.05	0.07	0.01
4	Outpatient infrastructure	0.12	0.08	0.05	1.00	0.21	0.16
5	Surgery department	0.05	0.07	0.07	0.21	1.00	0.06
6	Intensive care unit	0.02	0.05	0.01	0.16	0.06	1.00

We estimate separate probit models to obtain outcome-specific and readily interpretable estimates for each incentive type and performance dimension. CBI and NCBI are not mutually exclusive, and the corresponding outcomes may be correlated because of unobserved hospital- or department-level characteristics. The separate models do not estimate these cross-outcome residual correlations explicitly.

Table 4: Descriptive use of CBI and NCBI by hospital characteristics

Characteristic & Category	N	CBI	NCBI	Neither CBI nor NCBI	CBI linked to Outpatient	CBI linked to Inpatient	Quality	NCBI linked to Outpatient	NCBI linked to Inpatient	Quality
Hospital Size										
Large	373	69.2%	86.1%	4.6%	23.6%	40.8%	43.2%	21.4%	62.7%	24.9%
Medium	205	64.9%	83.4%	3.4%	24.4%	29.8%	29.3%	19.5%	66.8%	27.8%
Small	19	57.9%	73.7%	10.5%	31.6%	26.3%	15.8%	15.8%	73.7%	31.6%
Hospital ownership										
Private	128	79.7%	79.7%	3.9%	20.3%	45.3%	56.2%	16.4%	57.0%	15.6%
Charitable	189	61.4%	83.6%	6.9%	27.5%	23.8%	25.4%	20.1%	70.4%	29.1%
Public	280	65.7%	87.9%	2.9%	23.6%	41.1%	37.1%	22.9%	63.9%	28.9%
University status										
No	554	66.2%	85.2%	4.5%	24.9%	34.8%	35.7%	19.5%	65.9%	27.1%
Yes	43	81.4%	79.1%	2.3%	14.0%	58.1%	60.5%	34.9%	46.5%	14.0%
Outpatient infrastructure										
No	215	68.8%	86.0%	3.3%	23.3%	37.2%	40.0%	14.9%	65.1%	26.5%
Yes	382	66.5%	84.0%	5.0%	24.6%	36.1%	36.1%	23.8%	64.1%	25.9%
Surgery										
No	448	68.3%	86.4%	3.6%	25.2%	37.2%	40.0%	21.4%	65.8%	26.1%
Yes	149	64.4%	79.9%	6.7%	20.8%	32.2%	32.2%	18.1%	60.4%	26.2%
Intensive Care Unit										
No	515	67.5%	84.4%	4.2%	24.5%	36.5%	37.7%	21.2%	63.7%	26.1%
Yes	46	65.2%	89.1%	6.5%	19.6%	37.0%	34.8%	13.0%	73.9%	26.1%

4 Results

The descriptive patterns reported in Table 4 provide an initial overview of the use of CBI and NCBI across hospital characteristics. Private hospitals reported a higher prevalence of CBI than charitable and public hospitals, whereas charitable and public hospitals reported a higher prevalence of NCBI. Descriptive differences by hospital size, university status, outpatient infrastructure, surgical departments, and ICU status were generally less pronounced, although some variation across performance dimensions was apparent.

RQ1: Hospital ownership and incentive types (CBI and NCBI). Table 5 shows that charitable and public hospitals were less likely than private hospitals to report the use of CBI. The coefficients for charitable and public hospitals were negative and statistically distinguishable from zero (-0.537 and -0.494 , respectively; both $p < 0.01$). This pattern is consistent with the descriptive statistics, in which 79.7% of private hospitals reported CBI, compared with 61.4% of charitable hospitals and 65.7% of public hospitals (Table 4).

For NCBI, public hospitals were more likely than private hospitals to report their use (0.366 , $p < 0.05$). The corresponding coefficient for charitable hospitals was positive but not statistically distinguishable from zero. Descriptively, NCBI were reported by 79.7% of private hospitals, 83.6% of charitable hospitals, and 87.9% of public hospitals. Thus, ownership was associated with the use of both incentive types, particularly with a lower reported use of CBI in charitable and public hospitals and a higher reported use of NCBI in public hospitals.

RQ2: Hospital ownership and performance dimensions. The models for CBI linked to performance dimensions show that charitable hospitals were less likely than private hospitals to use CBI linked to inpatient economic performance (-0.578 , $p < 0.01$) and quality performance (-0.815 , $p < 0.001$) (Table 6). Public hospitals were also less likely than private hospitals to use CBI linked to quality performance (-0.635 , $p < 0.01$). The coefficient for CBI, linked to inpatient economic performance, was negative for public hospitals but not statistically distinguishable from zero.

For NCBI, charitable hospitals were more likely than private hospitals to use NCBI linked to inpatient economic performance (0.370 , $p < 0.05$) and quality performance (0.458 , $p < 0.05$).

Table 5: Regression results: CBI, NCBI, and neither incentive type

	<i>Dependent variable:</i>		
	CBI	NCBI	Neither CBI nor NCBI
	(1)	(2)	(3)
Small-size Hospital†	−0.441 (0.302)	−0.388 (0.326)	0.426 (0.390)
Middle-size Hospital†	−0.068 (0.139)	−0.104 (0.144)	−0.224 (0.224)
Charitable Hospitals‡	−0.537** (0.191)	0.150 (0.169)	0.263 (0.258)
Public Hospitals‡	−0.494** (0.187)	0.366* (0.163)	−0.145 (0.268)
University status	0.464 (0.255)	−0.435 (0.246)	−0.149 (0.457)
Outpatient infrastructure	−0.067 (0.111)	−0.063 (0.151)	0.240 (0.228)
Surgery	−0.051 (0.126)	−0.252 (0.148)	0.247 (0.225)
Intensive Care Unit	−0.098 (0.209)	0.152 (0.264)	0.402 (0.312)
Constant	0.934*** (0.182)	1.004*** (0.156)	−1.967*** (0.220)
Observations	597	597	597
Log Likelihood	−366.915	−248.225	−101.657
Null Deviance (df = 596)	754.332	509.717	213.810

Note:

*p<0.05; **p<0.01; ***p<0.001

†: The reference group is "large-size hospital" ,

‡: The reference group is "private hospital"

Table 6: Regression results: CBI linked to performance dimensions

	<i>Dependent variable:</i>		
	CBI linked to		
	Outpatient	Inpatient	Quality
	econ. perf.	econ. perf.	perf.
	(1)	(2)	(3)
Small-size Hospital†	0.282 (0.324)	−0.459 (0.294)	−1.064* (0.422)
Middle-size Hospital†	−0.019 (0.127)	−0.197 (0.142)	−0.313* (0.144)
Charitable Hospitals‡	0.242 (0.166)	−0.578** (0.188)	−0.815*** (0.196)
Public Hospitals‡	0.158 (0.170)	−0.196 (0.183)	−0.635** (0.196)
University status	−0.415 (0.220)	0.407 (0.260)	0.516 (0.305)
Outpatient infrastructure	0.085 (0.120)	−0.031 (0.104)	−0.111 (0.118)
Surgery	−0.199 (0.143)	−0.092 (0.125)	−0.099 (0.135)
Intensive Care Unit	−0.155 (0.219)	−0.031 (0.211)	−0.132 (0.244)
Constant	−0.829*** (0.171)	0.011 (0.174)	0.424* (0.191)
Observations	597	597	597
Log Likelihood	−325.648	−376.305	−366.811
Null Deviance (df = 596)	659.645	783.657	790.034

Note:

*p<0.05; **p<0.01; ***p<0.001

†: The reference group is "large-size hospital" ,

‡: The reference group is "private hospital"

Table 7: Regression results: NCBI linked to performance dimensions

	<i>Dependent variable:</i>		
	NCBI linked to		
	Outpatient	Inpatient	Quality
	econ. perf.	econ. perf.	perf.
	(1)	(2)	(3)
Small-size Hospital†	0.012 (0.376)	0.365 (0.339)	0.315 (0.318)
Middle-size Hospital†	-0.012 (0.130)	0.052 (0.119)	0.054 (0.140)
Charitable Hospitals‡	0.154 (0.173)	0.370* (0.154)	0.458* (0.189)
Public Hospitals‡	0.162 (0.161)	0.254 (0.148)	0.525** (0.189)
University status	0.411* (0.201)	-0.486* (0.207)	-0.511* (0.247)
Outpatient infrastructure	0.331* (0.134)	0.046 (0.116)	-0.021 (0.118)
Surgery	-0.185 (0.134)	-0.191 (0.127)	-0.029 (0.127)
Intensive Care Unit	-0.263 (0.242)	0.298 (0.219)	-0.017 (0.216)
Constant	-1.139*** (0.185)	0.144 (0.152)	-1.019*** (0.188)
Observations	597	597	597
Log Likelihood	-295.845	-379.700	-334.813
Null Deviance (df = 596)	607.327	776.759	685.856

Note:

*p<0.05; **p<0.01; ***p<0.001

†: The reference group is "large-size hospital" ,

‡: The reference group is "private hospital"

Public hospitals were more likely to use NCBI linked to quality performance (0.525, $p < 0.01$); the coefficient for inpatient economic performance was positive but not statistically distinguishable from zero (Table 7). No ownership-related coefficients were statistically distinguishable from zero for CBI or NCBI linked to outpatient economic performance. Overall, the ownership patterns were most pronounced for CBI and NCBI linked to quality performance and, for charitable hospitals, to inpatient economic performance.

RQ3: Hospital size, incentive types, and performance dimensions. Hospital size was not strongly associated with the overall use of CBI or NCBI. Compared with large hospitals, neither small nor medium-sized hospitals showed coefficients statistically distinguishable from zero in the overall CBI and NCBI models (Table 5). In line with that finding, the descriptive statistics showed only moderate variation in overall CBI and NCBI use across hospital-size categories.

Hospital size, however, was associated with CBI linked to quality performance. Small and medium-sized hospitals were less likely than large hospitals to use CBI linked to quality performance (-1.064 , $p < 0.05$ and -0.313 , $p < 0.05$, respectively; Table 6). No other size-related coefficients for CBI or NCBI linked to the three performance dimensions were statistically distinguishable from zero. Thus, the estimates indicate a size-related pattern specifically for CBI linked to quality performance, rather than a general association between hospital size and the use of CBI or NCBI.

RQ4: University status, incentive types, and performance dimensions. University status was not clearly associated with the overall use of CBI or NCBI (Table 5). However, university hospitals showed differences in NCBI linked to specific performance dimensions. Compared with non-university hospitals, university hospitals were more likely to report NCBI linked to outpatient economic performance (0.411, $p < 0.05$) and less likely to report NCBI linked to inpatient economic performance (-0.486 , $p < 0.05$) and quality performance (-0.511 , $p < 0.05$) (Table 7).

No coefficient for CBI linked to any of the three performance dimensions was statistically distinguishable from zero. The relatively small number of university hospitals in the sample ($n = 43$) should be taken into account when interpreting these estimates. Overall, university status was associated with the performance orientation of NCBI, but not with the overall use of CBI or NCBI or with CBI linked to the performance dimensions examined.

RQ5: Outpatient infrastructure and outpatient economic performance. Outpatient infrastructure was associated with NCBI linked to outpatient economic performance. Hospitals with day-treatment cases or outpatient procedures were more likely to report NCBI linked to outpatient economic performance (0.331, $p < 0.05$; Table 7). The corresponding coefficient for CBI linked to outpatient economic performance was not statistically distinguishable from zero (Table 6).

The descriptive results show a similar pattern: 23.8% of hospitals with outpatient infrastructure reported NCBI linked to outpatient economic performance, compared with 14.9% of hospitals without outpatient infrastructure (Table 4). Thus, outpatient infrastructure was associated with NCBI, but not CBI, linked to outpatient economic performance.

RQ6: ICU status, incentive types, and performance dimensions. ICU status was not strongly associated with the overall use of CBI or NCBI (Table 5). None of the coefficients for CBI or NCBI linked to inpatient economic performance or quality performance was statistically distinguishable from zero (Tables 6 and 7). Descriptive differences between hospitals with and without an ICU were also limited. Thus, the estimates provide no statistically precise evidence of an association between ICU status and the incentive outcomes examined.

RQ7: Surgical departments and inpatient economic performance. The presence of a surgical department was not clearly associated with the overall use of CBI or NCBI. It was also not associated with CBI or NCBI linked to inpatient economic performance; the respective coefficients were not statistically distinguishable from zero (Tables 5–7). Accordingly, the descriptive statistics showed only limited differences between hospitals with and without surgical departments. Therefore, there is no statistically precise evidence of an association between surgical department status and the incentive outcomes examined.

5 Discussion

This study examined whether observable structural characteristics of hospitals are systematically associated with internal incentive and control systems for chief physicians. The findings suggest that hospital ownership is most consistently associated with the use and performance orientation of CBI and NCBI. In addition, outpatient infrastructure is associated with NCBI linked to outpatient economic performance. The observed patterns for hospital size, university status, ICU status, and surgical department status are more selective. Overall, the findings are compatible with a contingency-theoretic perspective in which internal incentive and control arrangements may differ across organizational contexts rather than following a single uniform model (Spanò and Cicellin, 2018; Van Herck et al., 2010).

The ownership-related findings suggest that private, public, and charitable hospitals differ not only in the overall use of incentive instruments but also in the types of instruments used for inpatient economic and quality performance. Private hospitals reported a greater use of CBI, whereas public and charitable hospitals reported a comparatively greater use of NCBI for selected performance dimensions. This pattern is consistent with the theoretical distinction between private for-profit providers, whose owners are residual claimants of profits, and public or charitable providers, which are subject to the non-distribution constraint (Hansmann, 1979; Sloan, 2000). The findings do not establish that ownership itself causes differences in the use of incentives. Rather, ownership may capture a broader set of organizational, governance, and financial characteristics that are not observed in the data.

The findings, therefore, add to the literature on hospital ownership and performance. Previous research has often focused on differences in efficiency or quality of care between ownership types and has produced mixed results (Eggleston et al., 2008; Bjorvatn, 2018; Kruse et al., 2018; Moscelli et al., 2018; Wübker and Wuckel, 2019). Our results suggest that ownership-related differences may also be evident in internal incentive and control arrangements. They further do not support a simple contrast in which private hospitals pursue economic objectives while public and charitable hospitals primarily pursue quality objectives. Instead, the observed patterns indi-

cate that inpatient economic performance and quality performance are relevant across ownership types, while the reported instrument types differ.

Hospital size was not generally associated with the use of CBI or NCBI. The association between larger size and CBI linked to quality performance may indicate that hospitals with more extensive organizational structures use quality measures as CBI more often. However, the broader pattern does not suggest that hospital size alone is a sufficient proxy for the use or performance orientation of internal incentive and control systems. This is relevant because size is frequently included as a standard structural control in hospital performance research.

University status was associated with the performance orientation of NCBI but not with a general tendency to use more or fewer incentive instruments. The observed pattern is consistent with the possibility that university hospitals differ from other hospitals in how non-compensation-based instruments are linked to outpatient economic performance, inpatient economic performance, and quality performance. Since the analysis includes all university hospitals in Germany, this pattern is not attributable to incomplete coverage of this hospital type. Nonetheless, it should be interpreted as an association between university status and the observed use of NCBI, rather than as evidence about the organizational mechanisms underlying the pattern.

The association between outpatient infrastructure and NCBI linked to outpatient economic performance is consistent with the idea that hospitals with outpatient service capacity attach particular importance to this performance dimension in their internal control arrangements. The absence of a corresponding pattern for CBI suggests that outpatient infrastructure is not uniformly associated with all types of incentive instruments. Because the data do not capture the detailed content, intensity, or consequences of individual incentive arrangements, the result does not identify the specific mechanisms through which outpatient economic performance is addressed.

For ICU status and surgical department status, the analyses did not reveal systematic associations with the incentive outcomes examined. Rather than treating these findings as evidence that intensive care and surgery are irrelevant to a hospital's incentive and control system, they indicate that the structural indicators available in this study are not systematically associated with the broad incentive outcomes measured here. More differentiated measures of ICU-related resource use, process management, surgical case mix, elective capacity, and the exact performance measures contained in chief-physician contracts may reveal patterns that cannot be identified with the present data.

Strengths and limitations: A strength of this study is the linkage of a nationwide survey of chief physicians with statutory hospital quality reports. This linkage makes it possible to examine internal incentive and control arrangements together with observable hospital and department characteristics. In addition, the analysis distinguishes between compensation-based and non-compensation-based incentives and between quality performance, inpatient economic performance, and outpatient economic performance. This provides a more differentiated picture than analyses that treat physician incentives or hospital ownership as homogeneous constructs.

Several limitations should be considered. First, the cross-sectional observational design permits the identification of associations but does not establish causal effects of hospital characteristics on the use or design of incentive systems. Second, CBI and NCBI may be jointly determined

by unobserved organizational characteristics. Although standard errors are clustered at the hospital level, the separate probit models do not explicitly estimate residual correlations across incentive outcomes. A multivariate probit specification could address this issue, but modelling all incentive-type and performance-dimension combinations jointly would require estimating a high-dimensional correlation structure that is difficult to support with the available sample size and outcome frequencies.

Third, the binary outcome variables do not capture the intensity, detailed configuration, or contractual consequences of incentive mechanisms; the available information on incentive weights could not be used reliably because of internally inconsistent slider responses. More fine-grained differences in internal incentive and control arrangements may therefore remain unobserved.

Fourth, the performance-measure categories are aggregated into broad performance dimensions. This aggregation improves interpretability but may conceal associations with particular measures, such as specific process measures, case volumes, or cost targets.

Finally, the study is based on a voluntary survey and a strict longitudinal matching procedure. Although comparisons with the target population support representativeness with respect to observed characteristics, selective participation and matching may limit generalisability to hospitals or departments that differ in unobserved characteristics.

6 Conclusion

This study shows that observable hospital characteristics, particularly hospital ownership, are associated with the reported use and performance orientation of internal incentive and control systems for chief physicians. Private hospitals more frequently reported CBI, whereas public and charitable hospitals more frequently reported NCBI for selected performance dimensions. Outpatient infrastructure was associated with NCBI linked to outpatient economic performance, while the remaining structural characteristics showed more selective or no clear patterns.

These findings are relevant for research evaluating pay-for-performance programmes and hospital ownership. Structural characteristics such as ownership, size, university status, and department-specific structures may not fully capture the internal mechanisms through which hospitals communicate and implement economic and quality objectives. Future evaluations should therefore measure internal CBI and NCBI arrangements directly where feasible, rather than relying exclusively on broad structural characteristics as proxies.

Declarations

There are no conflicts of interest. No funds, grants, or other support was received. The authors have no relevant financial or non-financial interests to disclose.

References

Arrow, K. J. (1963). Uncertainty and the welfare economics of medical care. *The American Economic Review*, 53(5):941–973.

- Ayanian, J. Z. and Weissman, J. S. (2002). Teaching hospitals and quality of care: A review of the literature. *The Milbank Quarterly*, 80(3):417–447.
- Bjorvatn, A. (2018). Private or public hospital ownership: Does it really matter? *Social Science & Medicine*, 196:166–174.
- Bundesministerium der Justiz und für Verbraucherschutz (10.02.2020). Sozialgesetzbuch Fünftes Buch: SGB V.
- Burke, L. G., Frakt, A. B., Khullar, D., Orav, E. J., and Jha, A. K. (2017). Association between teaching status and mortality in us hospitals. *JAMA*, 317(20):2105–2113.
- Cohen, J. (1988). *Statistical power analysis for the behavioral sciences*. Erlbaum, Hillsdale, NJ, 2. ed. edition.
- Cramér, H. (1971). *Mathematical methods of statistics*, volume 9 of *Princeton mathematical series*. Princeton Univ. Press, Princeton, 12. print edition.
- Curacon GmbH Wirtschaftsprüfungsgesellschaft (2025). Curacon-studie: Defizitausgleich für kommunale krankenhäuser in milliarden-höhe für 2024. <https://www.bdpk.de/service/studien-und-gutachten/2025/standard-titel-1>. Bundesverband Deutscher Privatkliniken e. V. (BDPK), Zugriff am 03. Juni 2026.
- Eggleston, K., Shen, Y.-C., Lau, J., Schmid, C. H., and Chan, J. (2008). Hospital ownership and quality of care: what explains the different results in the literature? *Health Economics*, 17(12):1345–1362.
- Eijkenaar, F., Emmert, M., Scheppach, M., and Schöffski, O. (2013). Effects of pay for performance in health care: A systematic review of systematic reviews. *Health policy (Amsterdam, Netherlands)*, 110(2-3):115–130.
- Ettelt, S. and Nolte, E. (2012). Funding intensive care – approaches in systems using diagnosis-related groups. *RAND Health Quarterly*, 1(4):7.
- Hansmann, H. (1988). Ownership of the firm. *Journal of Law, Economics, & Organization*, 4(2):267–304.
- Hansmann, H. B. (1979). The role of nonprofit enterprise. *Yale Law Journal*, 89:835–902.
- Herrera, C. A., Rada, G., Kuhn-Barrientos, L., and Barrios, X. (2014). Does ownership matter? an overview of systematic reviews of the performance of private for-profit, private not-for-profit and public healthcare providers. *PLOS ONE*, 9(12):1–18.
- Ioannou, I., Li, S. X., and Serafeim, G. (2016). The effect of target difficulty on target completion: The case of reducing carbon emissions. *The Accounting Review*, 91(5):1467–1492.
- Ji, L., Geraedts, M., and de Cruppé, W. (2024). A theoretical framework for linking hospitals longitudinally: demonstrated using german hospital quality reports 2016–2020. *BMC Medical Research Methodology*, 24(1):212.

- King, R. and Clarkson, P. (2015). Management control system design, ownership, and performance in professional service organisations. *Accounting, Organizations and Society*, 45:24–39.
- Kraska, R. A., de Cruppe, W., and Geraedts, M. (2017). Probleme bei der verwendung von qualitätsberichtsdaten für die versorgungsforschung. *Gesundheitswesen*, 79(07):542–547.
- Kruse, F. M., Stadhouders, N. W., Adang, E. M., Groenewoud, S., and Jeurissen, P. P. (2018). Do private hospitals outperform public hospitals regarding efficiency, accessibility, and quality of care in the european union? a literature review. *The International Journal of Health Planning and Management*, 33(2):e434–e453.
- Kupersmith, J. (2005). Quality of care in teaching hospitals: A literature review. *Academic Medicine*, 80(5):458–466.
- Lucifora, C. (2023). Management practices in hospitals: A public-private comparison. *PLOS ONE*, 18(2):e0282313.
- McLaughlin, A., Hardt, J., Canavan, J., and Donnelly, M. B. (2009). Diagnosis-related group-based reimbursement is unrealistic for icus. *Critical Care*, 13:P485.
- Mendelson, A., Kondo, K., Damberg, C. L., Low, A., Motúapuaka, M., Freeman, M., O’Neil, M., Relevo, R., and Kansagara, D. (2017). The effects of pay-for-performance programs on health, health care use, and processes of care: A systematic review. *Annals of Internal Medicine*, 166(5):341–353.
- Morris, T., McNamara, K., and Morton, C. H. (2017). Hospital-ownership status and cesareans in the united states: The effect of for-profit hospitals. *Birth*, 44(4):325–330.
- Moscelli, G., Gravelle, H., Siciliani, L., and Gutacker, N. (2018). The effect of hospital ownership on quality of care: evidence from england. *Journal of Economic Behavior & Organization*, 153:322–344.
- Mueller, S. K., Lipsitz, S., and Hicks, L. S. (2013). Impact of hospital teaching intensity on quality of care and patient outcomes. *Medical Care*, 51(7):567–574.
- Neilson, A. R., Moerer, O., Burchardi, H., and Schneider, H. (2004). A new concept for drg-based reimbursement of services in german intensive care units: results of a pilot study. *Intensive Care Medicine*, 30(5):842–847.
- Rotter, T., Kinsman, L., James, E., Machotta, A., Willis, J., Snow, P., and Kugler, J. (2012). The effects of clinical pathways on professional practice, patient outcomes, length of stay, and hospital costs: Cochrane systematic review and meta-analysis. *Evaluation & the Health Professions*, 35(1):3–27. PMID: 21613244.
- Sloan, F. A. (2000). Chapter 21: Not-for-profit ownership and hospital behavior. In Culyer, A. J. and Newhouse, J. P., editors, *Handbook of Health Economics*, volume 1(B), pages 1141–1174. Elsevier.

- Spanò, R. and Cicellin, M. (2018). Performance measurement design: a contingency perspective from the italian regional healthcare services. *Journal of Economic and Administrative Sciences*, 35(1):16–27.
- Starkweather, D. B. (1970). Hospital size, complexity, and formalization. *Health Services Research*, 5(4):330–341.
- Statistisches Bundesamt (2018). Gesundheit, Grunddaten der Krankenhäuser.
- Tsang, A. (2025). An analysis of drg profitability and cross-subsidization in academic medical centers. *American Journal of Healthcare Strategy*, 1(3):15.
- Van der Stede, W. A., Young, S. M., and Chen, C. X. (2005). Assessing the quality of evidence in empirical management accounting research: The case of survey studies. *Accounting, organizations and society*, 30(7-8):655–684.
- Van Herck, P., De Smedt, D., Annemans, L., Remmen, R., Rosenthal, M. B., and Sermeus, W. (2010). Systematic review: Effects, design choices, and context of pay-for-performance in health care. *BMC Health Services Research*, 10(1):247.
- Wübker, A. and Wuckel, C. (2019). The Impact of Private for-Profit Hospital Ownership on Costs and Quality of Care – Evidence from Germany. *CESifo Economic Studies*, 65(4):373–401.
- Zenty, T. F., Bieber, E. J., and Hammack, E. R. (2014). University hospitals: creating the infrastructure for quality and value through accountable care. *Frontiers of Health Services Management*, 30(4):21–33.

7 Online appendix

7.1 Representativeness of the sample

To check the representativeness of our sample, we compare the sample with the population of all departments. For this purpose, the department-specific data of all departments were extracted from the quality reports. All duplicates (caused by incorrect contact details) and departments without main diagnoses, procedures, physicians, nursing staff, and inpatient cases were removed to debug errors in the dataset. This resulted in a dataset comprising a total population of 6,465 departments.

The total population of 6,465 departments includes 189 departments with the designation 'other specialist department' or departments related to psychiatry, psychosomatic medicine, and psychotherapy. As we do in the sample, we also exclude them from the population. Eventually, our data set with the (approximate) population contains 6,276 departments.

Comparing the sample with the population does not yield notable differences for the distribution of departments. In our sample, general surgery represents 17% of the departments, while it represents 17% of the population. We obtain similar shares for other departments as well: internal medicine - 16% in the sample (22% in the population), gynecology and obstetrics - 9% (8%), pediatrics - 9% (5%), and intensive care - 8% (7%). The remaining 41% of departments in the sample are distributed among all existing department categories (except for the removed departments), so each department category exists at least once.⁴

Table 8 shows further descriptive details of departments in the sample in comparison with the approximate population of departments. Again, the figures are comparable.

Table 8: Descriptive Statistics of Hospital Departments

	Sample			Population		
	Mean	Median	Sd.	Mean	Median	Sd.
No. of Cases	1,967	1,670	1,529	2,058	1,737	1,628
No. of Physicians	14	11	10	15	12	13
No. of Nursing Staff	28	21	26	30	23	28
No. of Diagnoses	2,174	1,829	1913	2,231	1,859	1,898
No. of Procedures	6,474	5,124	5,502	7,213	5,432	7,108
No. of Outpatient Procedures	228	45	373	266	42	562
No. of Complications	107	33	261	100	37	222

Our sample consists of 598 chief physicians, 57 of whom are also medical directors. In the sample, 10% of CPs are female, and 90% are male. This is comparable to the gender distribution of CPs in German hospitals (Statistisches Bundesamt, 2018, p.42). Concerning the hospital operator, 47% of the physicians surveyed work in public hospitals, 32% in charitable hospitals,

⁴ The departments are identified by their key number. The assignment of the department key numbers is in accordance with Federal Ministry of Justice and Consumer Protection (Bundesministerium der Justiz und für Verbraucherschutz, 2020, SGB V, § 301 (3), Annex 2). There are various restrictions. At first, only the main categories are chosen, e.g., internal medicine, orthopedics, or neurology. Specifications like internal medicine focused on cardiology, or neurology focused on pediatrics are not considered. If the departments have more than one department key, all keys are registered such that different categories of departments represent these departments.

and 21% in private hospitals. In the population, the shares amount to 29% (public), 34% (charitable), and 37% (private).⁵ While the shares for charitable hospitals are almost identical, the sample contains a higher share of public hospitals and a lower share of private hospitals than the population.

Hospitals can use either CBC or NCBC or both to influence the behavior of CPs; or they refrain from using controls. In our sample, 67% of CPs receive variable pay in addition to their fixed salary. The percentage is very close to the 68% in the population. Accordingly, 33% and 32% do not have variable pay components. Given the very close match between the sample and population (except for the hospital operator), we believe the sample to be representative.

⁵ Statistisches Bundesamt (2018, p. 18)