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The Role of Medical Professionals in Top Management Teams of Healthcare Organisations: An Economic Model

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Abstract. The appropriate role of medical professionals in a hospital's top management team is a controversial issue. Clearly, the medical director plays an important part in balancing medical and financial performance. It is perceived wisdom among medics that the medical director's position should be strong and on an equal footing with the commercial director. Clinicians believe that relegating their representative to a subordinate role would entail financial considerations taking precedence in decision making, leading to cost-cutting and consequent detrimental effects on medical performance. We challenge this view, presenting arguments in favour of detailing the medical director a subordinate role. Using a simple game theory framework, we demonstrate that placing the medical director in a subordinate position may in fact lead to increased resources and superior medical performance, because medical and financial performance are strategic complementarities. We present empirical evidence to support the predictions of our model.

Keywords: Healthcare organization; decision-making process; performance; medical professionals, top management team.

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Introduction

Top management teams in healthcare organizations face unique industry-specific challenges. First, these firms operate within significant institutional constraints that change frequently as part of a sensitive political process. This puts severe limitations on effective management. Second, medical personnel, doctors and nurses, see their role first and foremost as carers. They have significant autonomy and focus on and are led by professional norms and values, a characteristic that can lead to the formation of "tribes" (Shortell, 1991) and a "clash of cultures" (Abernethy and Stoelwinder, 1995) with management. Third, while health care organisations, like most other organisations, are assessed on the key dimensions of financial performance and quality of service, these variables, in contrast to traditional economics, are not linked through price differentiation. The standardisation of services for compensation purposes means that it is rarely possible to demand higher prices for better service. Management's main lever to increase margins is to cut costs, often with a detrimental effect on quality.

The composition and working practices of the top management team (TMT) are critically important to meeting the managerial challenges of health care organisations. Who should be part of the leadership team and how the team should operate are key questions and the subject of ongoing debate. "*In the past, physician participation was limited to service as presidents of the medical staff and on medical staff committees. Some years back, healthcare organizations began to token physicians on the board; ... Allowing board membership for physicians is good, but the board must adopt policies related to physicians that go beyond board membership*" (Middleton, 2005, p. 17). In a cursory poll we asked 82 doctors in two hospitals which form of hospital leadership they would prefer: (i) a single executive manager, supported by a medic; or (ii) both a manager and a medic of equal seniority and power. Perhaps unsurprisingly, 75 doctors out of the 82 questioned preferred the second option. Doctors seem to attribute reduced resources, and the reduced medical performance they imply, to weak medical representation in the TMT.

The purpose of this paper is to analyse whether this claim can be maintained. In fact, we put forward arguments that support a contrary position. Starting from the assumption that some form of medical representation in a hospital TMT is desirable, we argue that a subordinate, supportive and information-providing role for the medic in the TMT may well lead to higher medical performance and indeed a higher resource level per medic than "equal footing" representation.

To avoid confusion, it is important to clarify the term medical professional at the outset of the paper. We use this term to describe a practising medic, or the representative of practising medics, in the TMT (medical director). In our terminology, an executive manager who was formerly a medic or has some form of medical training is not a medical professional. We focus on the roles managers and professionals play, not on their educational background. Practising medics and managers have a different mindset, as summarised in Table 1.

Doctor	Manager
Decision making in the interest of individuals	Decision making in the interest of the organization
Accountable to profession (peers)	Accountable to multiple stakeholders
Decisions led by professional rules and norms	Decisions led by organizational goals
Normative and autonomous decisions	Group decisions, political environment, bargaining, compromise

Table 1: Clinical versus managerial role

We begin this paper by reviewing the arguments in the literature that support representation of medical professionals in a hospital TMT. Assuming that medics are represented, we focus on their roles within TMTs. We define two different decision-making models and develop related hypotheses concerning the resulting organisational performance. The first model is an “equal footing” model and assumes that managers and medics have equally important but competing objectives, and make decisions in a competitive manner. In the second model, the manager makes the decision alone but takes professional expertise and response into account. To analyse our hypotheses, we develop simple economic models. The theoretical results are supported by an empirical analysis. The paper ends with a discussion of the results and their managerial implications.

Representation of medical professionals in TMTs

Should medical professionals be included in a hospital TMT and if so, how? Medics are of course at the heart of a hospital’s operation and, as clinical leaders, accept significant professional and ethical responsibilities and are given a large amount of autonomy in their work (Rundall et al., 2004). However, an effective integration of such focused professional staff in an organisational structure to support firm-wide objectives, including economic efficiency, is a significant challenge (Succi and Alexander, 1999).

The behaviour of medical professionals has been the subject of a host of studies. Doctors have a high commitment to professional values and a relatively low commitment to managerial values. Their corporate behaviour is affected by their health care organisation's perceived identity, its construed external image, and the strength of identification with the organisation (Dukerich et al., 2002). Extending the scope of medical work to include management responsibilities leads to role conflict (Comerford and Abernethy, 1999). Indeed, there is some evidence that medics who acquire some management competence tend to use it not primarily to help balance the goals of the firm but rather to secure their professional autonomy and reinforce the nexus between managerial and professional power (Thorne, 2002).

There are two significant strands of literature related to the issue of inclusion of medical professionals in hospital TMTs: general management literature on TMT diversity and its impact on organisational performance; and health care management literature.

Healthcare professionals tend to fall into camps with little interaction: physicians and nurses on one side and managers and administrators on the other. It is tempting to bridge this gap by including representatives of both groups in the TMT. A key advantage of a diverse TMT like this is that it provides access to different sources of information. However, this diverse knowledge has to be effectively employed in the decision making process if it is going to have any effect on organisational performance. Lack of communication and understanding between the two camps can be a significant barrier to capturing the performance-enhancing potential of diversity (see e.g. Reagans and Zuckerman, 2001, Reagans and McEvily 2003).

In order to improve our understanding of the relationship between diversity and performance, researchers have focused on mediating variables, such as change of corporate strategy (Wiersema and Bantel 1992), comprehensiveness and extensiveness (Miller et al., 1998), and propensity to action (Hambrick et al., 1996). However, in terms of the effect of diversity on performance these studies are inconclusive. It has been argued that the link between diversity and performance is highly context-specific (Carpenter 2002). Important factors include organizational culture (Thomas and Ely, 1996), loyalty and competence (Dooley and Fryxell, 1999), debate (Simons et al., 1999), the CEO's collectivistic orientation (Simsek et al, 2005) and behavioural integration (Hambrick 2007). In summary, the general management literature does not provide consistent or conclusive advice on the inclusion of medical professionals in a hospital TMT.

The health care management literature makes a compelling case for an integrated TMT, starting with the pioneering work of Shortell and LoGerfo (1981), who argue that organisational factors such as (i) involvement of the medical staff president with the hospital governing board, (ii) overall physician participation in hospital decision making, (iii) frequency of medical staff committee meetings and (iv) percentage of active staff physicians on contract are positively associated with higher quality-of-care outcomes.

The work of Alexander et al (1993) renewed the interest in TMTs of health care organisations: "(...) *historically, the medical staff has operated somewhat like a wild card in the bureaucratic structure and governance of hospitals, recent trends in the medical care sector point to more formally structured relationships between physicians, hospital boards, and hospital management. Growth in the number of more complex governance structures (…) suggests that physicians will be more likely to act as partners with CEOs and will be financially as well as professionally tied to the fate of these organisations (…). Research is needed on how this nexus of relationships is changing (…).*" (Alexander et al, 1993, p 94)

Weiner et al. (1997) show that the greater the degree of physician involvement in the governance of a hospital, the greater the degree of clinical involvement in quality management processes. The findings of Molinari et al. (1995) suggest that board participation by medical staff enhances operational performance. Comerford and Abernethy (1999) argue that medics' role conflict in the budgeting process is reduced if the process is clearly and transparently linked to organisational goals. It is easier to communicate such a link if a medic is represented in the TMT.

In this paper we will take TMT participation of medical professionals as a given and investigate the relationship between doctor and manager. Our focus is the decision-making *process* and its impact on medical performance. This link is, in our opinion, crucial to the understanding of effective TMTs of health organisations and has not yet been given sufficient attention in the literature.

Two frameworks of integrated decision making

There are two principal ways to integrate medical professionals in a hospital's TMT: (i) managers and medics on an equal footing; or (ii) medics in a subordinate role. The first model maintains the traditional autonomy model of professional organisations. "*One policy is to establish a chief medical officer at the vice president level who works with the* *management staff on an ongoing basis regarding medical matters but who can also participate in other management functions (...) the executive in charge of clinical quality and safety should be a physician*” (Middleton 2005, p. 17,18). In this model, the decision-making process is based on a strict separation of the professional and administrative and commercial divisions. Managers and medics are on an equal footing. One can expect a clash of cultures in budgeting and other commercial decision-making situations. The visible tip of the iceberg is the battle between the managing director and the medical director. Competition prevails over collaboration. Indeed, Alexander et al. (1993) demonstrate that a larger number of medical representatives on the board can lead to instability, e.g., increased CEO turnover.

The second decision framework integrates the medical professional in a more hierarchical way, as illustrated in Eeckloo et al. (2004), with reference to the situation in Belgium: “*(...),each hospital has a general manager (CEO), who is appointed by the hospital board and is directly and exclusively responsible to it. His/her tasks include day-to-day management of the hospital. The CEO co-operates closely with those responsible for the medical, nursing, paramedical, administrative and technical departments. Together they constitute the executive management.*“ (p.6). There is a single decision maker in this model but the medical profession has a clear voice. The diversity of the information is maintained but the hierarchical structure removes the potentially wasteful competitive battle of the first model.

What can be said about the performance implications of the two models? Abernethy and Stoelwinder (1995) argue that involving medical professionals in commercial decision making generates a role conflict that has a detrimental effect on medical performance: “*Conflict between professional and bureaucratic norms and values is reduced when professionals with a high professional orientation do not operate in a control environment where output controls dominate and restrict them in their self-regulatory activities.(…) Further, the findings provide strong support that creating an environment which reduces role conflict has significant and positive effects on an individual’s job satisfaction and overall subunit performance.*” (p. 13) This is an argument in favour of the hierarchical model, where medics are less involved and less responsible for commercial decision making. The potential for role conflict is reduced because the medical professionals are not forced to shift their orientation from professional values and norms towards the goals and objectives of the organisation as a whole. The argument is supported by the general management literature. The decision-making process in the equal footing model may well lead to reduced network density (Reagans and Zuckerman 2001), with a detrimental effect on performance, due to ineffective use of the diverse information available.

This contrasts the poll results we mentioned earlier, reflecting a somewhat naïve view that putting a medic in a subordinate role will lead to increased weight being placed on financial and efficiency considerations, contributing to lower resource endowment and therefore lower medical performance. Our aim in this paper is to use an economic model to illustrate why the subordinate TMT structure may, contrary to these assumptions, can lead to higher resource endowment and increased medical performance. In the next section, we develop and analyse the model, and follow it with an empirical study that supports the model predictions.

The model

How is performance defined in the context of a health organization? Given the usual dual goal structure, with both financial and clinical performance objectives, the use of a single combined performance metric is problematic. We will therefore treat the two key aspects of medical and financial performance separately.

We formulate the mathematical model within a game-theoretical framework based on utility maximisation. We assume that the manager chooses the resource endowment per medic $c \geq 0$ to maximise her utility function u_M, while the medical professional controls a medical performance variable $q \geq 0$ to maximises his utility function u_P. We think of medical performance q as a volume-metric, such as the number of cases treated, case-mix adjusted if necessary. The medic is professionally motivated to treat as many patients as possible. However, he also understands that the treatment of too many patients, with the same level of resource endowment, will eventually have a detrimental effect on the quality of his work. If, however, the manager were willing to provide more resources, this should have a positive effect on quality and entice him to increase medical performance. This tension between volume, quality and resource endowment can be captured by quality-adjusting the medical performance q, as in the following utility function:

$$u_P(c,q) = q(\alpha_0 - \alpha_1 q + \alpha_2 c), \quad \alpha_1, \alpha_2 \geq 0 \qquad (1)$$

This utility assumes, for simplicity, a linear quality adjustment term $\alpha_0 - \alpha_1 q + \alpha_2 c$ that decreases with volume and increases with resource endowment. The general model analysed later will refrain from the linearity assumption.

Model (1) is a sensible reflection of the behaviour of medical professionals, see for example Landon (2004): "*Clearly, physicians are motivated by economic rewards and respond to financial incentives. Physicians, however, by and large also want to provide care of high quality and in accordance with evidence-based best practices and local norms*" (p. 71). Similar quadratic utilities, albeit with a different interpretation of variables, have been used for physicians in recent healthcare literature (Benstetter and Wambach, 2006).

A key concern for the manager is efficiency. On the one hand there is a natural inclination to brings costs down by reducing the resource endowment per medic. On the other hand, the medical performance, that is, the number of treated cases, must be taken into account in the manager's objectives. A simple model that balances these goals is the objective to minimise *inefficiency-adjusted costs*. Assuming a linear inefficiency index of the form $\beta_0 - \beta_1 q + \beta_2 c$, with increasing inefficiency with increased cost and decreasing inefficiency with increased medical performance, this results in a utility function of the form

$$u_M(c,q) = -c(\beta_0 - \beta_1 q + \beta_2 c), \quad \beta_1, \beta_2 \geq 0. \qquad (2)$$

Essentially, this objective assumes that the manager regards the hospital's revenues as an exogenous quantity, which is a sensible assumption in some countries, where hospital budgets are predetermined. Other countries are moving or have already moved to pay-for-performance systems. In environments such as these, the manager's behaviour is better modelled as the maximisation of a utility function of the form

$$\tilde{u}_M(c,q) = pq - c*(\beta_0 - \beta_1 q + \beta_2 c), \quad \beta_1, \beta_2 \geq 0 \qquad (3)$$

where p is the hospital's per-unit performance revenue. In this setting, the manager's objective is to maximise surplus, where the costs are inefficiency-adjusted. The inefficiency adjustment models the fact that a small surplus or even a loss is easier to explain to stakeholders if the hospital is comparatively efficient than if it is operating inefficiently.

We have developed the utility models (1), (2), or (3) for illustration and to guide the reader's intuition. Since specific algebraic representations of utilities might be difficult to justify (Conrad and Christianson, 2004) we will develop our results within axiomatic characterisations of the utility functions.

Modelling hierarchy versus equal footing

We consider two standard game-theoretic equilibrium concepts: Nash and leader-follower solutions. The Nash solution is a simultaneous solution (c_N, q_N) of the two utility maximisation problems. Formally,

$$c_N = c*(q_N), \quad q_N = q*(c_N),$$

where $c*(q)$ and $q*(c)$ are the response functions of the manager and medic, respectively, i.e.

$c*(q)$ solves the manager's utility maximisation problem $\max_{c\geq 0} u_M(c,q)$ for given medical performance $q \geq 0$,

$q*(c)$ solves the professional's utility maximisation problem $\max_{q\geq 0} u_P(c,q)$ for given resource endowment $c \geq 0$.

In the Nash context, the manager and the professional are on equal footing and compete against one another. They arrive at a solution where neither can improve their utility unilaterally.

In contrast, the leader-follower solution models a hierarchy with the manager as leader and main decision maker. She takes her decision, taking account of the response of the professional, the follower. The leader-follower solution is defined as (c_S, q_S), where

$$c_S \text{ solves } \max_{c\geq 0} u_M(c, q*(c)), \quad q_S = q*(c_S).$$

The manager as lead decision maker takes the reaction $q*(c)$ of the medical professional, the follower, into account.

Under fairly broad and natural assumptions, it turns out that the leader-follower solution results in higher resource endowment per medic and higher medical performance. We will discuss these assumptions before presenting the result.

The first assumption guarantees that the optimisation problems defining the response functions are well defined.

Assumption 1: The utility functions u_M and u_P are twice differentiable and satisfy $\frac{\partial^2 u_M}{\partial c^2} < 0$, $\frac{\partial^2 u_P}{\partial q^2} < 0$, and the response functions $c^*(q), q^*(c)$ are well-defined, i.e., both optimisation problems have unique optimal solutions.

Next, we require that the manager appreciates higher medical performance at a fixed level of resource endowment.

Assumption 2: $\frac{\partial u_M}{\partial q}(c, q^*(c)) > 0$ for all $c \geq 0$.

The third assumption requires that the medic will improve medical performance if the resource endowment is increased.

Assumption 3: $q^{*\prime} > 0$

The final two assumptions guarantee the existence and uniqueness of a leader-follower and Nash solution. Assumption 4 relates to the convexity of the leader's optimisation problem.

Assumption 4: Let $f(c) = u_M(c, q^*(c))$. Then $f''(c) < 0$ and f decreases for large c.

Economically sensible conditions, in terms of the manager's utility function u_M and the professional's response q^*, which imply Assumption 4 can be found in Appendix 2.

The final assumption guarantees the existence and uniqueness of a Nash solution, assuming Assumptions 1–4 hold.

Assumption 5: Let $F(c) = \frac{\partial u_M}{\partial c}(c, q^*(c))$ then $F(0) \geq 0, F'(c) < 0$ for all $c \geq 0$.

To understand this assumption, note that a Nash equilibrium is a point on the professional's response curve $(c, q^*(c))$ where the manager's cost pressure $\left|\frac{\partial u_M}{\partial c}(c, q^*(c))\right|$ is zero. Indeed, from the manager's view, the Nash game can be interpreted as an optimisation problem, where she seeks to minimise her *cost pressure* along the professional's performance response curve. The leader-follower model, in contrast, assumes that the manager maximises her *utility* along this curve. Assumption 5 (together with Assumptions 1–4) guarantees that there is a unique point of zero pressure, i.e. a Nash equilibrium, on the professional's response curve.

For the quadratic utility functions (1) and (2), Assumptions 1,2 and 3 are satisfied if $\alpha_1, \alpha_2, \beta_1, \beta_2 > 0$. Assumption 4 requires that $\frac{\beta_1}{\beta_2} < 2\frac{\alpha_1}{\alpha_2}$. With these conditions, Assumption 5 holds if $\frac{\beta_0}{\beta_1} < \frac{\alpha_0}{2\alpha_1}$, which holds, for example, if $\alpha_0 > 0,\ \beta_0 < 0$.

Proposition. *If Assumptions 1–5 hold then there exists a unique leader-follower solution* (c_S, q_S) *and a unique Nash solution* (c_N, q_N) *of the game between the manager and the professional. Moreover,* $c_S > c_N$ *and* $q_S > q_N$*, i.e., the resource endowment per medic as well as the medical performance, are larger in the leader-follower model.*

The proof can be found in Appendix 1.

Empirical study

The general result of the last section is obtained within a clean model environment. The purpose of this section is to triangulate the predictions of the model with an empirical study.

Data

As a database, we used the annual standardised quality reports of German hospitals in 2004. These reports are publicly available and include information about treated cases, technical equipment and staff. The reports also include qualitative information about leadership structure, which we used, together with other publically available information, to classify hospitals as either Nash-led or leader-follower-led. To achieve this we used a set of rules (described in Appendix 3). The total database contains 416 hospitals and the classification rules allowed us to classify the leadership structure for 258 hospitals, which form the basic sample for our empirical analysis. The sample amounts to 12% of all German hospitals in 2004.

Dependent variables

We use the variable “inpatients per full-time equivalent employee (FTEE)” as proxy for medical performance and “beds per FTEE” as proxy of resource endowment per medic. While the first variable is frequently used in empirical health work as a performance proxy (Mark et al, 2004; Evans and Kim, 2006), the proximity of the second variable, beds per FTEE, to resource endowment per medic is less common. However, it is an appropriate variable in our context. Indeed, the variable “beds” has been used as a proxy for the “ability to invest” (Ruef and Scott, 1998). The setting of the German health care regulation provides an additional argument, because part of the available cash flow for investment depends directly on the number of certified beds.

Independent variables

The main variable, *level,* is binary and differentiates the hospitals in two TMT groups with *level=0* corresponding to hospitals with a medic on the same level as the manager (Nash hospital) and *level=1* for the group with a single manager as the leader of the TMT (leader-follower hospital). The assignment is described in Appendix 3.

Control variables were size (number of beds), limited company, public hospital, specialised hospital (usually one specialised medical department), special hospital (psychiatric/psychosomatic centre or medical school included), private patients per inpatient, outpatients per inpatient, and inpatients per bed.

Two models were estimated. In the first “medical professionals“ were defined as physicians, while the second model included data for all medical and nursing personnel. We did this to check (a) whether the TMT structure has impact beyond the group of physicians and (b) whether there are substitution effects, i.e., physicians increase performance at the cost of other medical personnel.

Hypothesis

The mathematical model of the foregoing section predicts that the *level* variable (0=Nash, 1=leader-follower) has a positive impact on resource endowment per medic, i.e., "beds per FTEE", and a positive impact on medical performance, i.e. "inpatients per bed".

Results

The summary statistics (Table 2) provide first indications in favour of our hypothesis. Hospitals with a Nash-type TMT provide 0.4 beds fewer per physician than leader-follower hospitals. At the same time, the leader-follower hospitals treat on average 28 more cases per physician than the Nash hospitals. The full personnel model shows the same directional differences.

	Physicians		Medicinal and nursing personnel	
	Beds per FTEE	Inpatients per FTEE	Beds per FTEE	Inpatients per FTEE
Leader-follower (N=180)	5,87 (0.12)	182.68 (4.06)	0.98 (0.017)	31.10 (0.70)
Nash (N=78)	5.47 (0.23)	154.42 (6.60)	0.88 (0.025)	25.94 (1.17)

Table 2: Means (standard errors) for dependent variables with respect of organizational structure

Additional support for the hypothesis is provided by the percentage of better-qualified nurses (i.e. at least three years' education), an additional indicator for higher resource endowment per FTEE, which is 88% in the case of leader-follower hospitals, against 83.1% in the Nash hospitals.

The results of a statistical analysis using these control variables within a multivariate regression model is summarised in Table 3.

	Physicians			Medicinal and nursing personnel		
	Beds per FTEE	Inpat. per FTEE	Pillai-trace p-value	Beds per FTEE	Inpat. per FTEE	Pillai-trace p-value
Constant	9.599*** (0.349)	112.99*** (11.272)	< 0.001	1.257*** (0.053)	9.979*** (1.648)	< 0.001
Level	0.390** (0.183)	16.012*** (5.914)	0.026	0.082*** (0.028)	2.634*** (0.865)	0.009
Limited	0.087 (0.185)	-0.641 (5.994)	0.563	0.042 (0.028)	0.747 (0.877)	0.226
Public	0.390** (0.164)	15.239*** (5.309)	0.018	0.044* (0.025)	1.071 (0.776)	0.198
Beds	-0.003*** (< 0.001)	-0.092*** (0.012)	< 0.001	<0.001*** (< 0.001)	-0.012*** (0.002)	< 0.001
Outpatients	-0.270*** (0.082)	-8.135*** (2.656)	0.005	-0.041*** (0.013)	-1.324*** (0.388)	0.003
Private	-0.278 (0.357)	-7.426 (11.526)	0.739	0.263*** (0.054)	3.738** (1.686)	< 0.001
Inpatients	-0.94*** (0.009)	2.837*** (0.287)	< 0.001	-0.009*** (0.001)	0.694*** (0.042)	< 0.001
Specialized (yes=1,no=0)	-0.391 (0.252)	-20.004** (8.159)	0.031	-0.042 (0.038)	-1.311 (1.193)	0.527
Special (yes=1, no=0)	0.118 (0.368)	-19.893* (11.883)	0.001	-0.070 (0.056)	-2.603 (1.738)	0.326
Model p-value	< 0.001	< 0.001		< 0.001	< 0.001	
N	258			258		
Adjusted R^2	0.489	0.512		0.337	0.660	
* p < 0.10; ** p < 0.05; *** p < 0.01						
Standard errors in parentheses						

Table 3: Results of MANCOVA analysis

Both models show a significant impact of the level variable (0=Nash, 1=leader-follower) on each dependent variable and also simultaneously on both variables (Pillai-trace p=0.026 and 0.009). The Box M-test for homogeneous covariance matrices across the TMT level groups is at an acceptable level (Box M: p=0.083 for the physicians models and p=0.766 for the full medical personnel model). The eta-square for the level variable is small (physician model: 0.029; medical and nursing personnel model: 0.037), but reasonable in view of the many parameters influencing the performance.

We have triangulated these findings with models with different control structures, as well as two-stage least squares models, and found the hypothesised impact of the level variable to be robust. We can therefore conclude that the statistical analysis supports the predictions of the mathematical model.

The empirical study has some limitations. First, the hospitals in the sample are somewhat larger than average, with an average capacity of 329 beds against a nationwide average of 245, so the results do not necessarily translate to smaller hospitals. Second, we have assumed that TMT structure impacts medical performance and resources per medic. It is possible that there are reverse implications of medical performance and resources on the TMT structure as well. For example, a large investment budget could incentivise medics to become more involved in strategic decision making to support their own departments when the budget is allocated. Such causal relationships could not be investigated with our cross-sectional data. Indeed, we believe our results are more relevant for tactical decision making because, by focusing on performance per medic and resource endowment per medic, we are essentially assuming fixed personnel capacity.

Implications and Conclusions

There is ample theoretical and empirical evidence to support the commonsense view that medical professionals should be involved in the TMT of a hospital. Important strategic decisions need direct input from the core clinical function. Goldstein and Ward (2004), for example, demonstrates that hospitals where medics are more strongly involved in decision making tend to have a higher utilisation. But *how* should medics be involved? Our economic model and empirical analysis compare two basic TMT structures: (i) the medical professional and manager on the same hierarchical level and (ii) the manager as leader and final decision maker, informed by the medical professional, as follower, about the reaction of the clinical personnel to the leader's decisions. While the manager would naturally be better off in the second model, the physician might suffer. Interestingly, both a stylised economic model and an initial empirical study provide evidence that this might not be the case and that the physician may well be better off in a subordinate position.

From an economics point of view, the dominance of the leader-follower model devolves from the fact that resource endowment per medic and medical performance are strategic complementarities. If the manager increases resource endowment, the medic is motivated to produce better medical performance, which in turn incentivises the manager to increase the resource endowment. In the equal footing model, the manager is preoccupied with her own variable and does not take this implicit motivational effect into account; the leader-follower model exploits this effect fully. The reason for the improved results is the interaction between the manager's key variable "resources per medic", given the professional's performance, and the professional's key variable "medical performance", given the resources, in the utility functions of the manager and the medic. On the one hand, the manager, while focused on the financial situation, is nevertheless interested in increased medical performance, and trades off medical performance and resource endowment. On the other, the medic, focused on quality-adjusted medical performance, is interested in increased resources, which will allow him to increase the quality and medical performance or reduce his effort without reducing quality of care.

Our results shed some light on the discussion about the nature of the relationship between TMT diversity and performance in the general management literature. First, our results support the view that decision rules and decision culture can be an important driver of performance. Li and Hambrick (2005), for example, discuss the effect of factional groups within work teams. They demonstrate the positive impact of emotional conflict and task conflict on behavioural disintegration, with subsequent negative effect on performance. Within this model, our results argue that the structure of the TMT can have a moderating effect on conflicts and subsequent performance. Another example is a similar moderating influence between diversity and network density and the associated effect on performance (Reagans and Zuckerman, 2001).

Second, our analysis shows that performance along several dimensions, in our case financial and medical performance, can be considered simultaneously. Several studies have investigated the impact of organisational or team variables on professional outcome (e.g. Huckman 2003, Tucker, Nembhard and Edmondson 2007) but relatively little is known about simultaneous effects on several performance variables, e.g. on professional and financial performance. Both improved professional and financial performance can have a beneficial impact on quality of service (Huckman and Pisano 2006). It would be desirable that future research to take account of such simultaneous effects.

Within health care, our results contribute to the topical question as to who should lead a hospital. Schultz (2004) analysed whether a healthcare organisation should be managed by a medically or managerially educated director. He found, by way of a laboratory-type experiment, that medically educated senior managers focused more on quality of care information. In this context, our model stresses that educational background is less important than the managerial or medical role (see Table 1). In the leader-follower set-up, an improved performance is achieved through the fact that the manager understands the medic's role, motivation and utility. Our results indicate that a manager should have a single leadership role. However, medical training can be very beneficial for the leader, and indeed for the applicability of our modelling framework, because it allows effective interpretation of the medical role and helps achieve information symmetry, which our model assumes. This refines views recently expressed by Porter and Olmsted Teisberg (2007), who argue that physician leadership is essential to improve health care value for patients. We argue that if physicians take on a leadership role in a TMT they should assume a managerial role, rather than serving in the role of a practising medic.

Finally, our results can add value in the area of hospital governance, see e.g. Alexander et al. (2003). Specifically, our analysis complements the work of Eldenburg et al (2003), who showed that there is a relationship between ownership and firms' objectives. To some extent owners determine the board structure attempt to achieve different objectives with different board structures. For example, the proportion of medical personnel on the board of for-profit health organisations was found to be 35–45%, while the proportion was about 5% for non-profit organisations. Our results suggest that composition may be less relevant for performance than the way in which medical professionals are involved in the decision-making process.

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Appendix 1: Proof of Proposition.

We repeat the assumptions and proposition.

Assumption 1: The utility functions u_M and u_P are twice differentiable and satisfy $\frac{\partial^2 u_M}{\partial c^2} < 0$, $\frac{\partial^2 u_P}{\partial q^2} < 0$ and the response functions $c^*(q), q^*(c)$ are well-defined, i.e., both optimisation problems have unique optimal solutions.

Assumption 2: $\frac{\partial u_M}{\partial q}(c, q^*(c)) > 0,$ for all $c \geq 0$.

Assumption 3: $q^{*\prime} > 0$

Assumption 4: Let $f(c) = u_M(c, q^*(c))$. Then $f''(c) < 0$ and f decreases for large c.

Assumption 5: Let $F(c) = \frac{\partial u_M}{\partial c}(c, q^*(c))$ then $F(0) \geq 0, F'(c) < 0$ for all $c \geq 0$.

Proposition. *If Assumptions 1-5 hold then there exists a unique leader-follower solution* (c_S, q_S) *and a unique Nash solution* (c_N, q_N) *of the game between the manager and the professional. Moreover,* $c_S > c_N$ *and* $q_S > q_N$, *i.e., the resource endowment per medic as well as the medical performance are larger in the leader-follower model.*

Proof. By Assumption 1 the response functions $q^*(c)$ is implicitly defined by the optimality conditions

(4) $$\frac{\partial u_P}{\partial q}(c, q) = 0;$$

it's derivative is given by

(5) $$q^{*\prime} = -\frac{\frac{\partial^2 u_P}{\partial c q}}{\frac{\partial^2 u_P}{\partial q^2}}.$$

The leader-follower solution is the maximum of $f(c) = u_M(c, q*(c))$. In view of Assumption 4 we can replace the maximization by the optimality condition

(6) $$\frac{\partial u_M}{\partial c} + \frac{\partial u_M}{\partial q} q^{*\prime} = 0 .$$

We can use the professional's response function $q*(c)$ to link the Nash and leader-follower solutions by way of a homotopy parameter t in the optimal response condition for the manager:

(7) $$\Phi(c,t) = \frac{\partial u_M}{\partial c}(c, q*(c)) + t\,\frac{\partial u_M}{\partial q}(c, q*(c)) q^{*\prime}(c) = 0 .$$

For $t = 0$, we recover the Nash equilibrium, in view of Assumption 1. For $t = 1$ the equation defines the leader-follower equilibrium. Notice that in the Nash case the manager is only concerned with his cost pressure while in the leader-follower case, he will weigh cost and quality pressure equally. The homotopy parameter combines these two scenarios.

We first show that there exist solutions $c \ge 0$ for every $t \in [0,1]$. Since $\frac{\partial u_M}{\partial q} \ge 0$ (Assumption 2) and $q^{*\prime} \ge 0$ (Assumption 3) we have

(8) $\Phi(c,t) \le \Phi(c,t') \;\; \forall 0 \le t \le t' \le 1$.

Since $\Phi(0,0) = \frac{\partial u_M}{\partial c}(0, q*(0)) \ge 0$ (Assumption 5) and there exists $\overline{c} \ge 0$ s.t. $\Phi(\overline{c},1) \le 0$ (Assumption 4), existence of solutions $c \ge 0$ of (7) follows from continuity because $0 \le \Phi(0,0) \le \Phi(0,t)$ and $\Phi(\overline{c},t) \le \Phi(\overline{c},1) \le 0$, in view of (8).

Next we will show that $\Phi(.,t)$ is in fact strictly monotone in c, which will guarantee unique solutions. To this end we show that

(9) $$\frac{\partial \Phi}{\partial c} = \frac{\partial^2 u_M}{\partial c^2} + \frac{\partial^2 u_M}{\partial cq} q^{*\prime} + t\left[\left(\frac{\partial^2 u_M}{\partial cq} + \frac{\partial^2 u_M}{\partial q^2} q^{*\prime}\right) q^{*\prime} + \frac{\partial u_M}{\partial q} q^{*\prime\prime}\right] < 0$$

If, on the one hand, $\left[\left(\frac{\partial^2 u_M}{\partial cq}+\frac{\partial^2 u_M}{\partial q^2}q^{*}{'}\right)q^{*}{'}+\frac{\partial u_M}{\partial q}q^{*}{''}\right]\geq 0$ we can set $t=1$ and the result follows from Assumption 4 since the left-hand term of (6) equates to $f''(c)$. If, on the other hand, the latter term is negative, then we can set $t=0$ and the inequality follows from Assumption 5 because the left-hand side coincides with $F'(c)$.

To complete the proof, let $(q^{*}\circ c)(t)=q^{*}(c(t))$. We will show that $c'(t)$ and $(q^{*}\circ c)'$ are positive for every $t\in(0,1)$, which implies that both, resource endowment per medic c and medical performance q are larger in the leader-follower case $(t=1)$ than in the Nash case $(t=0)$.

Differentiating the professional's optimal response condition $\frac{\partial u_P}{\partial q}(c(t),q^{*}(c(t)))=0$ w.r.t. t we obtain $\frac{\partial^2 u_P}{\partial cq}c'+\frac{\partial^2 u_P}{\partial q^2}(q^{*}\circ c)'=0$. Hence for c' and $(q^{*}\circ c)'$ to have the same sign, their multipliers must have opposite signs. In view of (5), this follows from Assumption 1 and 3.

It therefore remains to be shown that $c'>0$. To this end, we first differentiate the homotopy equation (7) w.r.t. t to obtain

$$\frac{\partial^2 u_M}{\partial c^2}c'+\frac{\partial^2 u_M}{\partial cq}q^{*}{'}c'+t\left[\left(\frac{\partial^2 u_M}{\partial cq}c'+\frac{\partial^2 u_M}{\partial q^2}q^{*}{'}c'\right)q^{*}{'}+\frac{\partial u_M}{\partial q}q^{*}{''}c'\right]=-\frac{\partial u_M}{\partial q}q^{*}{'}$$

The term on the right-hand side is negative, due to Assumptions 2 and 3. Factoring out c' on the left-hand side, we can therefore deduce that $c'>0$ provided

(10) $$\frac{\partial^2 u_M}{\partial c^2}+\frac{\partial^2 u_M}{\partial cq}q^{*}{'}+t\left[\left(\frac{\partial^2 u_M}{\partial cq}+\frac{\partial^2 u_M}{\partial q^2}q^{*}{'}\right)q^{*}{'}+\frac{\partial u_M}{\partial q}q^{*}{''}\right]<0$$

This is precisely what we had shown in (9). Q.E.D.

Appendix 2: Sufficient conditions for Assumption 4

We define the manager's cost pressure and quality pressure by $\left|\frac{\partial u_M}{\partial c}\right|$ and $\left|\frac{\partial u_M}{\partial q}\right|$, respectively. Below we will assume at places that the cost and quality isobars define locally at points on the professional's response curve implicit functions $q_{c,}q_q$ satisfying the equations $\frac{\partial u_M}{\partial c}(c, q_c(c)) = const$ and $\frac{\partial u_M}{\partial q}(c, q_q(c)) = const$. Note that the derivates of these functions are given by

$$q_c' = -\frac{\frac{\partial^2 u_M}{\partial c^2}}{\frac{\partial^2 u_M}{\partial cq}}, \qquad q_q' = -\frac{\frac{\partial^2 u_M}{\partial cq}}{\frac{\partial^2 u_M}{\partial q^2}}.$$

Recall that the Nash equilibrium can be interpreted as the point where the manager's cost pressure $\left|\frac{\partial u_M}{\partial c}\right|$ is minimised along the professional's response curve. In contrast, in the leader-follower equilibrium the manager maximises her utility along the professional's response curve.

We will need the following assumptions to derive a condition that implies the concavity assumption in Assumption 4.

Assumption 6 $q^{*}'' \leq 0$,

Assumption 7 $\frac{\partial^2 u_M}{\partial q^2} < 0$,

Assumption 8 $\frac{\partial^2 u_M}{\partial cq} \geq 0$,

Assumption 9 $\frac{q_c' - q^{*}'}{q^{*}'} > \frac{q_q' - q^{*}'}{q_q'}$.

Assumptions 6 and 7 are straightforward in their economic interpretation. For the interpretation of Assumption 8 recall that $\frac{\partial u_M}{\partial q} > 0$ by Assumption 2. Assumption 8 is therefore equivalent to the statement that the manager's quality pressure $\left|\frac{\partial u_M}{\partial q}\right|$ increases with increasing resource endowment. Before we come back to the interpretation of Assumption 9, we state and prove the main result of this section.

Proposition. *If Assumptions 1-3, Assumption 5, and Assumptions 6-9 hold then* $f''(c) < 0$ *on* $(0,\infty)$*, where* $f(c) = u_M(c, q^*(c))$.

Proof. We have to show that

$$f''(c) = \frac{\partial^2 u_M}{\partial c^2} + \frac{\partial^2 u_M}{\partial cq} q^{*\prime} + \left(\frac{\partial^2 u_M}{\partial cq} + \frac{\partial^2 u_M}{\partial q^2} q^{*\prime} \right) q^{*\prime} + \frac{\partial u_M}{\partial q} q^{*\prime\prime} < 0 .$$

This inequality can be further simplified by eliminating the term $\frac{\partial u_M}{\partial q} q^{*\prime\prime}$, which is non-positive by Assumption 2 and 6. Hence the above inequality holds if

$$\frac{\partial^2 u_M}{\partial c^2} + \frac{\partial^2 u_M}{\partial cq} q^{*\prime} + \left(\frac{\partial^2 u_M}{\partial cq} + \frac{\partial^2 u_M}{\partial q^2} q^{*\prime} \right) q^{*\prime} < 0 .$$

If $\frac{\partial^2 u_M}{\partial cq} = 0$ then the inequality follows immediately from Assumptions 1 and 7. So we may assume that $\frac{\partial^2 u_M}{\partial cq} > 0$. In view of Assumption 7, both isobars q_c and q_q are locally well defined. Dividing the above inequality by $\frac{\partial^2 u_M}{\partial cq}$ and reformulating it in terms of the isobar functions q_c and q_q we obtain the equivalent inequality

$$-q_c' + 2q^{*\prime} - \frac{q^{*\prime 2}}{q_q'} < 0 .$$

The latter is true if $q^{*\prime} - \frac{q^{*\prime 2}}{q_q'} < q_c' - q^{*\prime}$, which is equivalent to $\frac{q_c' - q^{*\prime}}{q^{*\prime}} > \frac{q_q' - q^{*\prime}}{q_q'}$.

Q.E.D.

Notice that Assumption 7 is not satisfied for the quadratic utility functions (1) and (2)

$$u_P(c,q) = q(\alpha_0 - \alpha_1 q + \alpha_2 c), \quad \alpha_1, \alpha_2 \geq 0$$
$$u_M(c,q) = -c(\beta_0 - \beta_1 q + \beta_2 c), \quad \beta_1, \beta_2 \geq 0$$

that we had given as examples in the text. In this case the implicit function q_q is not defined because $\frac{\partial u_M}{\partial q}$ does not depend on q. The isobar is parallel to the q-axis and an infinitesimal increase in c would have to be compensated by an infinite increase in q. We can therefore define $q_q' = \infty$ in this case. Note if q_q' tend to ∞ in the expression $\frac{q_c' - q^*'}{q^*'} > \frac{q_q' - q^*'}{q_q'}$ then this condition turns into the stronger assumption

Assumption 9' $\frac{q_c' - q^*'}{q^*'} > 1$,

which is equivalent to $\frac{\beta_1}{\beta_2} < 2\frac{\alpha_1}{\alpha_2}$ in the case of the above quadratic utilities. The stronger Assumption 9' allows us to replace Assumption 7 by the weaker condition

Assumption 7' $\frac{\partial^2 u_M}{\partial q^2} \leq 0$.

It is not difficult to see that the proposition remains valid if Assumptions 7 and 9 are replaced by Assumptions 7' and 9'.

A further interesting special case arises when the function u_M is jointly concave in (c,q) with a negative definite Hessian. Under Assumptions 1-3, Assumption 5, and Assumptions 6-8, the negative definiteness is equivalent to $q_c' > q_q'$ and that this implies $\frac{q_c' - q^*'}{q^*'} > \frac{q_q' - q^*'}{q_q'}$.

Economic interpretation of Assumptions 9

To interpret Assumptions 9 it is useful to distinguish whether the manager, in a Nash environment, feels under pressure to increase or decrease costs, i.e., whether $\frac{\partial u_M}{\partial c} > 0$ or $\frac{\partial u_M}{\partial c} < 0$. The former happens if the costs provided are perceived too low for the delivered medical performance q^*. Despite low costs the medic delivers relatively high performance, drawing on his intrinsic professional motivation. In the second case, the manager perceives the delivered quality q^* to be too low for the given resource endowment.

Let us first assume we are at a point $(c, q^*(c))$ where the Nash manager feels pressure to reduce cost, i.e., $\frac{\partial u_M}{\partial c} < 0$. Then q_c' is the maximal reduction in performance the manager in a Nash situation would tolerate for a unit reduction in resource for otherwise the combined effect of the manager's reduction of cost and the medic's reduction in performance would lead to an increase of the manager's cost pressure. The medic could therefore argue that the "non-professional" reaction to a unit resource reduction is a reduction of performance by q_c' units. However, his actual reduction $q^{*\prime}$ is lower, for otherwise Assumption 5, which guarantees a unique Nash equilibrium, would break down because the Nash manager wouldn't find it sensible to lower the resource endowment along the performance response curve. In fact, direct differentiation shows that the condition $F'(c) < 0$ in Assumption 5 is equivalent to the condition that either $\frac{\partial^2 u_M}{\partial cq} = 0$ or $q_c' > q^{*\prime}$.

Following these interpretations, we can express the medic's performance reduction in response to a unit cost decrease as $q^{*\prime} = q_c' - (q_c' - q^{*\prime})$, where the q_c' is the natural reduction of a non-professional and $(q_c' - q^{*\prime})$ is the deduction due to medical professionalism. What is the economic value of the professional discount? The value to the medic is $c_P'(q_c' - q^{*\prime})$, where c_P' is the medic's marginal cost of performance, defined via $\frac{\partial u_P}{\partial q}(c_P(q), q) = 0$, i.e., c_P is the inverse function of q^*. The medic's economic value of his professional discount is precisely the left-hand side of Assumption 9, $\frac{q_c'-q^{*}'}{q^{*}'} = c_P'(q_c'-q^{*}')$.

We will interpret the right-hand side as the value-argument for professionalism that the medic will be able to make to the manager. To this end, the medic will ask the manager to take on the role of a medic for argument's sake. This will, of course, be easier with hospital managers who have a medical background. Slipping into the medic's role means that the manager is now not interested in reducing cost pressure but instead in reducing medical performance pressure. The manager, in the role of the medic, would not reduce performance by more than q_q' following a unit resource reduction, for otherwise medical performance pressure would increase. As before we can write $q^{*}' = q_q' - (q_q' - q^{*}')$, i.e. the manager's actual reduction of performance is the performance reduction the manager, in the role of the medic, would accept minus a deduction for professional attitude. The manager's valuation for this professional attitude, still in the role of the professional, is $c_M'(q_c'-q^{*}')$, where c_M' is the manager's marginal cost of performance at constant medical performance pressure, defined by $\frac{\partial u_M}{\partial q}(c_M(q), q) = const$. Note that c_M is the inverse function of q_q and therefore the right-hand side of Assumption 9 is equivalent to $c_M'(q_c'-q^{*}')$.

In summary, Assumption 9 requires that the medic's economic valuation of his professionalism exceeds the value argument he can make to the manager, by appealing to her to slip into his role.

Recall that we had assumed that we are at a point where the Nash manager feels pressure to reduce cost, i.e., $\frac{\partial u_M}{\partial c} < 0$. For the case where the pressure is to increase cost $\frac{\partial u_M}{\partial c} > 0$, the arguments go through in a similar way, with increasing costs instead of reducing costs.

Appendix 3: Classification of hospital TMT structure

In this Appendix we describe how hospitals in our data set were classified as either Nash-led or leader-follower-led. We have to make a judgement whether the medical director is on an equal footing with or subordinate to the commercial director.

In Germany medical representation (medical director) in hospital TMTs is mandatory. The commercial director, even if medically qualified, cannot substitute a medical director.

Two main data sources were used to judge whether a hospital is Nash- or leader-follower-led: (a) information in the certified quality reports (chapter 5 on hospital leadership and further information) and (b) hospital website, including org-charts and other information about the leadership structure.

We discarded all hospital managers who are in the TMT of five or more hospitals because they are representatives of the group to which all these hospitals belong.

For limited companies we classified a hospital as leader-follower-led if it has a single managing director; the hospital was classified as Nash-led if it has at least two managers of which at least one is a medic.

The assignment rule for hospitals that are not limited companies is led by the prevalent TMT structure with three core members, the commercial director, the medical director and the nursing director. The default assumption was that medical and commercial director are on equal footing. The classification was changed to leader-follower if the commercial director was called managing director or hospital director.

The rule-based classification was triangulated with the textual information. At times this information was incompatible with the rule-based classification, e.g. a commercial director was referred to as hospital director but the report also referred to joint or consensus-based decision making. If the classification was inconsistent with the additional textual information, the hospital was regarded unclassified.

Using the rules and the textual triangulation, we were able to classify 258 out of 414 hospitals.