Integration and Cooperation in Public Hospitals

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Abstract

Hospital care is a joint production involving a wide range of services; ranging from medical services to support services to hotel services. This paper, focusing on the cooperation between these services, models the internal organization of public hospitals. The analysis is based on the property rights approach to organization (aka the Grossman-Hart-Moore model) and adopts it to the realities of public hospitals. Some institutional features from the Swedish hospital sector are presented to support the analysis, but the results are general. It is found that support services should be integrated into the medical specialities and that hotel services should be outsourced by the hospital. Moreover, it is found that cooperating medical specialities should be integrated, giving support to the use of multi-skilled teams suggested by the advocates of lean health care.

Keywords:
Public Hospitals, Property Rights Approach, Joint Production, Integration, Bargaining, Lean Health Care
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1. Introduction

Hospital care in private and public settings is the joint production of care by several specialities. Joint production requires cooperation, in turn entailing cooperating parties to make relational investments, e.g. learn about the other parties' needs and modify human capital and assets to suit these needs. Consequently, hospital organization that supports good cooperation is a prerequisite, but not a guarantee, for efficient and high quality hospital care.

The economic literature on hospital modelling is sparse;[1] Newhouse (1970) models the objective function of not-for-profit hospitals and Harris (1977) makes a positivistic analysis of the internal organization of US hospitals. Apart from Harris' paper the economic literature on hospitals is typically treating the internal organization as given, although, the literature on integration and strategic interaction between hospitals and physicians practices (e.g. Gal-Or, 1999; Cuellar and Gertler, 2006) and on physician partnerships (Lee, 1990) touches upon this issue in the US-context. However, the internal organization of public hospitals in a public health care system is unexplored by economists. An improved understanding of public hospitals is important because public hospitals are at the very heart of public health care systems and represent the bulk of health care expenditures (cf. McKee and Healy, 2002).

This paper focuses on the need for cooperation in the joint production of hospital care when answering the question of how public hospitals should be organized. This analysis is performed by adopting the property rights approach to organization (Grossman and Hart, 1986; Hart and Moore, 1990; Hart, 1995). Using this approach, which is new to the hospital literature, a comparative study is performed yielding insights into the (dis)integration of hospital services. The results correspond to common empirical observations e.g. that support services that perform no treatment should be integrated into treating medical services, and that hotel services should not be integrated into hospitals.[2] It is, however, also found that two medical services, that

[1] The economic literature on hospitals, to date, typically focuses on either ownership (public, not-for-profit or for-profit see overview in Sloan (2000)), economies of scale (optimal scale of hospitals, see overview in Posnett (2002)), or the payer-provider relationship (either in terms of reimbursement e.g. Ellis and McGuire, 1986 and Ma, 1994 or in terms of provider choice e.g. Barros and Martinez-Giralt, 2008).

[2] Support services are in this paper services that either give diagnostic information

contribute to treatment, should be integrated; a situation that is typically not observed in public hospital where two specialities tend to be different entities even when they cooperate for certain treatments. Suggesting that the organization based on a division into specialities should be revised. This result is connected to the ideas of *lean health care* proposing that hospital care should be organized in teams involving different specialities (*multi-skilled teams*) such that treatments may be completed in one go (see e.g. Kollberg et al, 2007).

1.1. The Property Rights Approach to Organization

The property rights approach to organization (PRA) is an incomplete contracting model.[3] PRA focuses on the importance of asset ownership for the *relationship-specific investments* made in a transaction, investments that are more valuable inside than outside the transaction.[4] That is, the investments, whether in human or in physical capital, ensure that the transaction becomes more efficient and more beneficial for the involved parties.

In PRA, investments follow asset ownership. Asset ownership creates greater incentives for investments because it gives *residual control rights* over the use of the asset - giving the asset owner some control over the transaction. Hence ownership makes the asset owner less vulnerable to hold-ups (withdrawal from trade by the other party).

The simplest version of the model is a two-period model with two parties, one producing the final product and the other an input to this production (Grossman and Hart, 1986; Hart, 1995). These two parties intend to transact with each other; but if they fail to reach an agreement at that time, then each party has a *disagreement option*. Typically this option is to sell and buy the input on a spot-market. This paper treats the disagreement option as an inside option i.e. it is an option that is always available to the parties until they reach an agreement and its existence does not foreclose a future agree-

(radiology, laboratory services) or are used in connection with treatment e.g. anesthetics. Medical services are e.g. surgery, cardiology, and orthopedics. Hotel services are e.g. cleaning, laundry, and cooking.

[3] Also known as the Grossman-Hart-Moore model.

[4] Relationship-specific investments are investments by some party A in the relationship with another party B, and vice versa, that increase the mutual dependence between the parties - ensuring a more rewarding cooperation between A and B; i.e. increasing the value of the relationship.

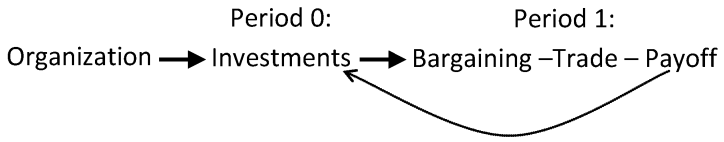

Figure 1: The timing of the model

ment.[5] Figure 1 describes the timing of the model. Notably the organization is determined before investments are made in period 0. When investing the parties foresee their individual payoffs in period 1 for a given organizational structure and choose their investments accordingly (to maximize individual payoff). However, there is *ex ante* uncertainty about the quality of the input. Input quality cannot be contracted on in period 0. In period 1 the parties transact which resolves the uncertainty about input quality, and the parties bargain over the division of surplus given the inside options. This paper uses an asymmetric Nash bargaining model, but other bargaining models may also be used.[6]

In contrast to transaction cost theory (e.g. Klein *et al* 1978, Williamson 1985), PRA suggests that integration does not automatically solve/reduce the hold-up problem. Instead it contends that opportunistic behavior may prevail within firms (cf. Hart 1995), providing an alternative framework for understanding the boundaries of a firm. According to the PRA the optimal organizational structure is the structure that yields the greatest incentives for relationship-specific investments. Hence PRA entails a comparative analysis; any change of organizational structure, from a given starting point, that gives higher investments from one of the parties and equal or higher from the other parties is a Pareto improvement.[7]

[5]Notably, De Meza & Lockwood (1998) and Chiu (1998) show that the predictions of the PRA-model are vulnerable to changes in bargaining assumptions i.e. that the results of the model change if the disagreement options are viewed as outside options instead of inside options. Outside options are options that are available only after negotiations have permanently broken down.

[6]Rehn (2009a) provides a short overview of the PRA literature, where he discusses among other things the different bargaining models used in earlier expositions of the model.

[7]See Rehn (2009b) for a discussion of the conduciveness of (and arguments for) using

1.2. Related literature

Incomplete contracting models and bargaining models are not uncommon in the health economics literature. However it is straightforward to argue that they could be used more frequently because there are inescapable problems in writing complete contracts between actors in the health sector (cf. Bös and De Fraja, 2002) e.g. due to; irreducible uncertainty (McGuire, 2000), two-sided externalities[8] (Che and Hausch, 1999), customized goods and services[9] (Harris, 1977) and information asymmetry (e.g. Arrow, 1963).

Bös and De Fraja (2002) use the incomplete-contracting framework to model the payer-provider relationship in national health system context with private providers. Chalkley and Malcomson (1998) and Glazer and McGuire (1994) are other examples of payer-provider models with non-contractibles.

Health economists have typically used bargaining models either to analyze the payer-provider interaction (e.g. Barros and Martinez-Giralt, 2008, Barros and Martinez-Giralt, 2005, Wu, 2009, Town and Vistnes, 2001, see also Barros and Martinez-Giralt, 2006) or the interaction between hospitals and physicians (e.g. Gal-Or, 1999; Cuellar and Gertler, 2006). Other areas using bargaining models are e.g. priority setting (Clark, 1995) and physician partnerships (Lee, 1990). Studying the efficiency of large physician partnerships, in terms of resource use and monitoring of decentralized decision-making, , Lee (1990) finds that ownership tends to reduce opportunism within the partnerships.

This paper rests on two fundamental findings. First, on the inevitable contractual incompleteness and the need for bargaining solutions in the health care sector. Second, on the fact that hospital care is a joint production requiring cooperation between the services within hospitals (Harris, 1977). Using the property rights approach to analyze the internal organization of public hospitals, fits well with these findings and provides a new way of thinking about hospital organization. The paper is organized as follows; section 2 presents the basic features of public hospitals. Section 3 analyzes hospital treatments involving one medical service and one support service, while section 4 studies the cooperation between two medical departments. The organization of hotel services are discussed in section 5. Section 6 concludes.

PRA to analyze hospital organization.

[8] That is, each actors investments/actions directly affects the other actors.

[9] Meaning that not two patients receive exactly the same treatment.

2. Public Hospitals: Framing the Analysis

The organization and financing of public hospitals varies from one health care system to the other. In this paper public hospitals are thought of as publicly owned and publicly financed entities that are a part of a public health care system. More specifically, the description of public hospitals presented here is based on the Swedish hospital sector.[10]

Typically, Swedish public hospitals are hierarchical organizations containing, from the top down, hospital management and administration, a number of divisions consisting of a number of clinics which in turn consist of a set of departments/services. Within this structure common resources (to be used by the entire hospital) such as expensive equipment are placed within a certain clinic - a system that requires agreement over the terms of use (the terms of the cooperation).

Each treatment is described in a *treatment plan* that technically defines each party's contribution to hospital care. The actual treatment of a certain case, heeding the treatment plan, is decided at a *multidisciplinary conference* where all parties involved meet to decide the procedure of treatment, the use of resources etc. The multidisciplinary conferences gather all cooperating parties for a certain diagnosis. The multidisciplinary conferences are the primary venues for negotiations within the hospital. The major sources of disagreement are division of beds, division of operation time (OP-time) and the amount of other *care services* needed for a certain treatment. Care services are typically the services performed by support services but may also be performed by medical services, e.g. X-ray imaging, anesthetics time, reception services, care days etc.. In a way the nature of hospital care is manifested in the multidisciplinary conferences - cooperating and reaching agreements is the foundation for successful hospital care. The nature of hospital care is also manifested in the ample cooperations and consultations over division and clinic boundaries and in the afore mentioned use of common resources. *"Hospital care has a visible formal structure but the actual process is a flow both within and outside this structure... it's all about knowing the right persons and decision-making at multidisplinary conferences, the process*

[10]The author would like to thank Hospital Economist Karin Fex, Professor Johan Wennerberg (MD,PhD) and Professor Ingemar Ihse (MD, PhD) at Skåne University Hospital for sharing their knowledge about the workings of a public hospital. The usual disclaimer applies.

is flexible..."

The funding of Swedish public hospitals typically consist of two parts: a fixed part and a production/revenue related part. Each hospital is given a *care objective* expressed in DRG-points and the funding is based on this objective. The funding is distributed to each division in relation to their part of the care objective and then distributed further down to clinics and departments. In essence each department receives a fixed budget space (or equivalently a lump-sum transfer) but can also generate revenue through production because an increased production may expand the budget space. The main cost principle is that all costs for a treatment are gathered at the treating departments, implying that support services receive their revenue from the treating departments by supplying care services. The care services are priced according to a price list that is either national or determined by the local municipalities. The costs for hotel services are likewise spread across departments but as a part of their budget space. The procurement of hotel services is decided centrally by the hospital management and their payment is centrally administered.

Asset allocation, at least for certain types of assets, is important within public hospitals. One important asset is operating rooms (OP-rooms) which are fully equipped rooms in the sense that they include all services needed for performing an operation. A department owning an operating room are in a better position than other departments as they decide when and how to use this asset, while other departments must ask for OP-times (e.g. at the multidisplinary conferences). The allocation of common resources to a certain department also gives this department some control over the use of this asset and are hence important.

The following sections use the PRA to analyze how asset ownership (organization) affect the cooperation (relationship-specific investments) within public hospitals and to suggest an optimal way to organize this cooperation.

3. Organizing Hospital Care: Basic Treatments

It may be unjust to label any part of hospital care as "basic", but treatments involving only one treating department and one (or more) support service are in some sense the basic treatments within a hospital. These treatments are less complex both in terms of decision-making and in terms of actual treatment than treatments involving two or more treating departments. For example, a simple leg fracture involving an orthopedic depart-

ment and a radiologist is less complex than an open leg fracture involving an orthopedic department, radiology, anesthetics and a surgeon.

In terms of transaction costs, basic treatments are more easily performed in a system with operating rooms. A medical department owning an operating room may perform basic treatments, more or less, at their convenience - in the operating room all support service they need are gathered and at their disposal unless they allow (or are forced to allow) other medical departments to use their OP-room.[11] In this section it is assumed that the medical department owns an OP-room that is fully equipped except for one support service (e.g. radiology). This is assumed to evaluate how the OP-room system affects the relationship-specific investments and ultimately whether the support service should be integrated into the OP-room. Many support services, e.g. radiology and anesthetics, perform treatment as well as pure support services. To simplify the analysis it is here assumed that the support service only performs pure support services.

As described above the support service gets revenue from the amount of care services it supplies to the medical department, and revenue for the support service is a cost for the medical department. It is therefore assumed that medical department and the support service bargain over the amount of care services used for a certain treatment, the former with an incentive to keep them to a minimum and the latter with an incentive to maximize the number of care services used. If they are unable to reach an agreement the treatment is delayed or the medical department performs the treatment without the support service's input, using the assets that it owns. Parties only can access the assets that they own under disagreement and thus asset ownership becomes important. Asset ownership gives control over the use of the asset (residual control right).[12]

3.1. The Model

Call the medical department M and the support service S. Initially they own one asset each, M's asset is an OP-room containing everything necessary to perform a certain treatment but S's asset (e.g. radiology equipment) and expertise. This paper assumes that the two parties need to cooperate to perform the treatment or that the treatment will be better if they cooperate.

[11] Necessary in a system where some but not all medical departments own OP-rooms.

[12] As will be seen below, asset ownership affects the disagreement payoffs and thereby the incentives for investments in period 0.

Let B_i, $i = M, S$, denote the netbenefit from cooperation for each party. M's netbenefit depends on the treatment outcome, T, the budget space (funding) given by the hospital management, f_M,[13] the amount of care services (cost), v, and the investment cost which is equal to the level of investment, μ.[14] μ is M's investment in human capital, an investment which is more valuable when M and S cooperate than under disagreement - hence μ is M's relationship-specific investment.[15] The treatment outcome $T(\mu)$ depends on this investment and on the presence of S's human capital i.e. that the two parties cooperate - the treatment outcome when they do not cooperate is returned to below. $T(\mu)$ is strictly concave and increasing in μ by assumption. M's net-benefit is:

$$B_M = f_M + T(\mu) - v - \mu \tag{1}$$

S's netbenefit depends on the amount of care services (revenue), v, the production cost C, the budget space f_S and the investment cost σ (equal to the level of investment). Hence σ denotes S's relationship-specific investment and is an investment in S's human capital.[16] The production cost depends on σ, $C(\sigma)$, and the presence of M's human capital. Assume that $C(\sigma)$ is strictly convex and decreasing in σ.[17] S's net benefit is:

$$B_S = f_S - C(\sigma) + v - \sigma \tag{2}$$

When the two parties are not cooperating, i.e. when they have not reached an agreement, their disagreement benefits (inside options) are b_i, $i = M, S$. Disagreement comes at a cost for M as the treatment outcome, denoted t, is lower than under cooperation. Disagreement is also costly for S as the production cost, c, increases. Let $A_i = \{a_M, a_S\}, \{a_M\}, \{a_S\}$ or $\{\varnothing\}$

[13] For simplicity assume that f_M include all eventual revenue from other transactions.

[14] Concerning investments, note that investments in human capital e.g. education is decided on clinic level, while major investments are decided centrally but often on departments' or clinics' initiative and the hospital management prioritizes over the investments.

[15] Typically this is an investment that allows M to make efficient use of S's input , e.g. it could be an investment in knowledge and interpretation of diagnostic information (X-ray images) if S is a radiology department.

[16] This investment enables S to produce an input that is suitable for M's treatment, e.g. by learning about the treatment and its requirements on diagnostic information.

[17] The assumptions for $T(\mu)$ and $C(\sigma)$ are used throughout this paper for all benefit and cost function under cooperation.

be the set of assets that the parties own under disagreement, where a_M is M's asset and a_S is S's asset. Hence the treatment outcome under disagreement is $t(\mu, A_M) < T(\mu)$ and the production cost is $c(\sigma, A_S) > C(\sigma)$. Notably the funding from the hospital management is the same as under cooperation, yielding the following disagreement benefits for M and S respectively:

$$b_M = f_M + t(\mu, A_M) - \mu \tag{3}$$

$$b_S = f_S - c(\sigma, A_S) - \sigma \tag{4}$$

Assume that $t(\mu, A_M)$ is concave (increasing) in μ, and that $c(\sigma, A_S)$ is convex (decreasing) in σ.[18] From the assumptions it follows that cooperation is beneficial. Furthermore assume that this holds for all ownership configurations (cf. Hart 1995). Hence the parties will cooperate in equilibrium.[19]

Following Hart (1995) it is assumed that the first derivatives with respect to investments, in essence the incentives for investments, are ranked in the following way (hereinafter called *marginal conditions*.[20]):

$$\frac{\partial T(\mu)}{\partial \mu} > \frac{\partial t(\mu, a_M, a_S)}{\partial \mu} \geq \frac{\partial t(\mu, a_M)}{\partial \mu} \geq \frac{\partial t(\mu, \varnothing)}{\partial \mu} \tag{5}$$

$$-\frac{\partial C(\sigma)}{\partial \sigma} > -\frac{\partial c(\sigma, a_M, a_S)}{\partial \sigma} \geq -\frac{\partial c(\sigma, a_S)}{\partial \sigma} \geq -\frac{\partial c(\sigma, \varnothing)}{\partial \sigma} \tag{6}$$

The strict inequalities in (5) and (6) mean that party i's investment is at least partly specific to j's human capital ($i, j = M, S,\ i \neq j$). The weak inequalities mean the marginal value of the assets given the investment is undetermined when not cooperating. In other words the investment may or may not be specific to the assets (cf. Hart, 1995). The marginal conditions show that ownership (organization) matters because it affects the marginal

[18] These assumptions are used throughout this paper for all benefit and cost function under disagreement.

[19] Obviously, departments in a public hospital have little alternative than to cooperate in the end, but it is reasonable that cooperation also is rewarding given the joint production characteristic of hospital care.

[20] Not to be confused with the usual interpretation of marginal conditions.

benefit of disagreement. The marginal benefit of an investment is greater, or at least as great, if the investing party owns more assets. The intuition is that a party will invest more if it has more control over the transaction. This is generally the case when the investing party owns more of the assets

Definitions[21]

Definition 1: *Essential Human Capital.* Party i's human capital (expertise) is essential for the treatment outcome if i is capable of performing the decisive part of the treatment without cooperating with party j, $i \neq j$. Here $i, j = M, S$.

If M's human capital is essential then:

$$-\frac{\partial c\left(\sigma, a_M, a_S\right)}{\partial \sigma} \equiv -\frac{\partial c\left(\sigma, a_S\right)}{\partial \sigma} \equiv -\frac{\partial c\left(\sigma, \varnothing\right)}{\partial \sigma} \tag{7}$$

If S's human capital is essential then:

$$\frac{\partial t\left(\mu, a_M, a_S\right)}{\partial \mu} \equiv \frac{\partial t\left(\mu, a_M\right)}{\partial \mu} \equiv \frac{\partial t\left(\mu, \varnothing\right)}{\partial \mu} \tag{8}$$

Assume that the decisive part of the treatment is the treatment required for the patient to be expected to reach full recovery. Given the contention that hospital care is a joint production it is reasonable to assume that this expectation is higher or that the path towards full recovery is smoother, e.g. in terms of time to recovery, if the two parties cooperate. That is, even if patients recover in both instances they are better off if the parties cooperate, as reflected in the assumption $T\left(\mu\right) > t\left(\mu, A_M\right)$.

Definition 2: *Strictly Complementary Assets.* Physical assets are strictly complementary if the treatment cannot be performed without access to all assets. If both party i and party j, $i \neq j$ perform treatment then complementarity affects both parties' incentives for investment when not cooperating. If only one party perform treatment it affects this party's incentive, but not the other party's incentives. Again consider $i, j = M, S$ and suppose that S is a pure support service then strictly complementary assets imply:

$$\frac{\partial t\left(\mu, a_M, a_S\right)}{\partial \mu} > \frac{\partial t\left(\mu, a_M\right)}{\partial \mu} \equiv \frac{\partial t\left(\mu, \varnothing\right)}{\partial \mu} \tag{9}$$

[21] Definitions 1 and 2 are in essence the same as in Hart (1995), but are in this paper clearer in their implications and adapted to the hospital setting.

Definition 3: *Bargaining Power*. If one of the parties, say M, has the ability to affect the other party's, S, position outside the transaction (features not captured in the model), e.g. its reputation (peer reviews) or access to common resources, then M has greater bargaining power than S.

Bargaining power is treated as exogenous for two reasons. First, it simplifies matters. Second, if treated as endogenous, e.g. as the value of the disagreement options (cf. Barros and Martinez-Giralt, 2005), it is superfluous since the value of the disagreement options crucially depend on asset ownership - bargaining power would always move in the same direction as asset ownership. Bargaining power may be viewed as market power (e.g. Cuellar and Gertler, 2006) on the internal hospital market[22]. It could be the case that there is only one support service supplying, or only one medical service demanding, a certain service. Bargaining power may also be interpreted as preferential treatment by the hospital management.

Bargaining and Post-Bargaining Benefits

At the multidisciplinary conference the treatment process is decided, including amount of care services, v. The multidisplinary conference is modelled as an asymmetric Nash Bargaining, where $\delta \in [0,1]$ is M's bargaining power and hence $(1-\delta)$ is S's bargaining power. The resulting v is[23]:

$$v = (1-\delta)\left[T(\mu) - t(\mu, A_M)\right] + \delta\left[C(\sigma) - c(\sigma, A_S)\right]$$

Let the post-bargaining benefits (after inserting v to B_i) from cooperation be denoted U_i, $i = M, S$.

$$\begin{aligned} U_M &= f_M + \delta\left[T(\mu) - (C(\sigma) - c(\sigma, A_S))\right] + \\ &\quad + (1-\delta)\left[t(\mu, A_M)\right] - \mu \end{aligned} \tag{10}$$

$$\begin{aligned} U_S &= f_S - (1-\delta)\left[C(\sigma) - T(\mu) + t(\mu, A_M)\right] + \\ &\quad -\delta c(\sigma, A_S) - \sigma \end{aligned} \tag{11}$$

[22] This perspective holds as long as market power does not depend on asset ownership, otherwise it would again be superfluous.

[23] After maximizing the Nash Bargaining product:
$\left([f_M + T(\mu) - v - \mu] - [f_M + t(\mu, A_M) - \mu]\right)^{\delta}$
$\times \left([f_S - C(\sigma) + v - \sigma] - [f_S - c(\sigma, A_S) - \sigma]\right)^{1-\delta}$

The Maximization Problems

Following the basic PRA model, M and S cannot contract on choosing the first-best investments, the investments that maximizes the total net benefit from trade. Instead M and S choose (second-best) investments at date 0 to maximize (10) and (11) respectively. Hart (1995) shows that this choice of investments leads to under-investments compared to the first-best, for any ownership structure. Notably, Hart's proof also applies for the assumptions made here. The first order conditions corresponding to the choices are:

$$FOC_M = (1-\delta)\frac{\partial t(\mu, A_M)}{\partial \mu} + \delta\frac{\partial T(\mu)}{\partial \mu} - 1 = 0 \tag{12}$$

$$FOC_S = -(1-\delta)\frac{\partial C(\sigma)}{\partial \sigma} - \delta\frac{\partial c(\sigma, A_S)}{\partial \sigma} - 1 = 0 \tag{13}$$

3.2. Organizational choice

There are three organizational structures to choose from: M-integration (M owns all assets), S-integration (S owns all assets) and non-integration (M and S owns their own assets). As mentioned, the optimal organizational structure is the one that gives the greatest relationship-specific investments. The first order conditions under the respective organizational structures give the incentives for investments and are straightforward to construct by replacing A_M and A_S in (12) and (13) respectively with the assets owned in each case e.g. $(1-\delta)\frac{\partial t(\mu, a_M, a_S)}{\partial \mu} + \delta\frac{\partial T(\mu)}{\partial \mu} - 1 = 0$ and $-(1-\delta)\frac{\partial C(\sigma)}{\partial \sigma} - \delta\frac{\partial c(\sigma, \varnothing)}{\partial \sigma} - 1 = 0$ for M-integration. Using non-integration as the base-line, i.e. the alternative organizational structures are compared with non-integration, it is found that:

- M-integration is the optimal choice (entailing a Pareto improvement) if M's human capital is essential for the treatment (definition 1), and if M's human capital is essential and asset are strictly complementary (definition 2).

- S-integration is the optimal choice if assets are strictly complementary and M's human capital is not essential for the treatment.

- Bargaining power act as a substitute for asset ownership in its extremes, i.e. if M has all the bargaining power ($\delta = 1$) then M is indifferent over ownership structures and S-integration is the optimal organization (maximizing S's investment).

These results are produced by combining the marginal conditions, the definitions and the first order conditions of the respective organizational structures. When M's human capital is essential, for example, then S's investment is the same irrespective of ownership structure since definition 1 implies that S's first order conditions, for each organizational structure, are equal. Hence changing from non-integration to $M-$integration does not change S's investment while it increases M's investment (cf. the marginal conditions) thus this change is a Pareto improvement.

In sum; given that the medical department's human capital is essential for treatment, which seems reasonable, the OP-room system, where a medical department owns all support services assets, is well founded. However, if the medical department has an extreme advantage in the bargaining, e.g. through preferential treatment by the hospital management, then S-integration is the best way to organize the clinical treatment. This gives the support service control over the use of the assets, strengthening its position in the cooperation, and thereby giving it stronger incentives to invest in the cooperation with the medical department.

4. Organizing Hospital Care: Advanced Treatments

Advanced treatments, in contrast to basic treatments, involve two (or more) medical departments and one (or more) support services. *Acute myocardial infarction* (AMI) is an example of an advanced treatment. AMI involves a cardiology department (with main responsibility for the treatment, determining the diagnosis, administering thrombolytic therapy etc.) and a (thoracic) surgery department (consultation, stand-by for and performance of by-pass-surgery). For each treatment there is one department that is considered the treating department or *main department* even if many medical departments are involved in the treatment. All support service costs are, as pointed out above, gathered at the main department, but other medical departments also incur costs for their production and these costs are not transferred to the main department. The hospital management gives a budget space, which is increasing with production, to cover the other medical departments' production costs.

The following analysis is restricted to a treatment involving two medical departments, one owning an OP-room containing all support services needed (as suggested by the analysis in the previous section), and one owning an asset used for its production. In the AMI example the surgery department's asset

could be a heart-lung machine but also other facilities or patient journals. The cost of care services of the main department is abstracted from because its inclusion leaves the results unaltered, i.e. it does not affect the relationship between the two medical departments. Moreover, the main department owns a fully equipped OP-room and is unlikely to need care services from other sources. Concerning the other medical department the interaction between budget space and production is captured by keeping the budget space fixed and assuming that the production cost is lower under cooperation (when production is higher) than under disagreement.

The two medical departments are assumed to bargain over OP-time which is a scarce resource.[24] Initially the main department has all OP-times since it owns the OP-room. However it cannot use all OP-times (but likes to keep them anyway) and is required, by the hospital management, to share its facility with the other medical department. Following that it is impossible to write complete contracts or create binding rules to regulate OP-times, the two parties bargain over the division of OP-time.

4.1. The Model

The basic structure of the analysis is the same as above, and is not repeated in detail, with one exception: the division of OP-time. OP-time is valuable for both parties involved in the treatment and the total OP-time available is 1. The main department's, M, part of the OP-time is $1-x$ where x is the time M gives up to the other medical department, N. As above the two parties make investments in their human capital that is specific to their cooperation, M's investment is denoted μ and N's investment is denoted ξ. Furthermore $K(\xi)$ is N's production cost under cooperation and both parties receive funding, f_i, $i = M, N$, from the hospital management. The resulting net-benefits from cooperation are B_i, $i = M, N$:

$$B_M = f_M + T(\mu) + (1 - x) - \mu \tag{14}$$

$$B_N = f_N - K(\xi) + x - \xi \tag{15}$$

If parties are in disagreement over the division of OP-times their net-benefits from disagreement are b_i, $i = M, N$, where $k(\xi, A_N)$ is N's pro-

[24] All departments want as much OP-time as possible to be able to act freely and to have a reserve capacity, e.g. to be able to respond to a sudden change in demand.

duction cost under disagreement and A_i, $i = M, N$ is the set of assets the respective party owns: $A_i = \{a_M, a_N\}\{a_M\}\{a_N\}$ or $\{\varnothing\}$.:

$$b_M = f_M + t(\mu, A_M) + 1 - \mu \tag{16}$$

$$b_N = f_N - k(\xi, A_N) - \xi \tag{17}$$

Cooperation is beneficial and will result in equilibrium.

The marginal conditions for advanced treatments are:

$$\frac{\partial T(\mu)}{\partial \mu} > \frac{\partial t(\mu, a_M, a_N)}{\partial \mu} \geq \frac{\partial t(\mu, a_M)}{\partial \mu} \geq \frac{\partial t(\mu, \varnothing)}{\partial \mu} \tag{18}$$

$$-\frac{\partial K(\xi)}{\partial \xi} > -\frac{\partial k(\xi, a_M, a_N)}{\partial \xi} \geq -\frac{\partial k(\xi, a_N)}{\partial \xi} \geq -\frac{\partial k(\xi, \varnothing)}{\partial \xi} \tag{19}$$

The interpretation of the marginal conditions is the same as above. Moreover after adjusting the notation the definitions from the previous analysis are applicable also in this setting, with the addition that if assets are strictly complementary then:

$$\frac{\partial t(\mu, a_M, a_N)}{\partial \mu} > \frac{\partial t(\mu, a_M)}{\partial \mu} \equiv \frac{\partial t(\mu, \varnothing)}{\partial \mu} \tag{20}$$

and

$$-\frac{\partial k(\xi, a_M, a_N)}{\partial \xi} > -\frac{\partial k(\xi, a_N)}{\partial \xi} \equiv -\frac{\partial k(\xi, \varnothing)}{\partial \xi} \tag{21}$$

since both parties are performing a part of the treatment.

Bargaining, Post-Bargaining Benefits and First Order Conditions

Once again the (asymmetric) Nash Bargaining solution is used to determine the bargaining outcome, x. Abusing notation slightly, the bargaining power for M is $\delta \in [0, 1]$ and hence $(1 - \delta)$ is N's bargaining power. Maximizing the Nash Bargaining product over x and solving for x gives:

$$x = (1 - \delta)[T(\mu) - t(\mu, A_M)] + \delta[K(\xi) - k(\xi, A_N)] \tag{22}$$

Inserting x in the net benefits gives the post-bargaining benefits:

$$\begin{aligned} U_M &= f_M + \delta\left[T(\mu) - K(\xi) + k(\xi, A_N)\right] + \\ &\quad +(1-\delta)\left[t(\mu, A_M)\right] + 1 - \mu \end{aligned} \tag{23}$$

$$\begin{aligned} U_S &= f_N - (1-\delta)\left[\begin{array}{c} K(\xi) - T(\mu) + \\ +t(\mu, A_M) \end{array}\right] + \\ &\quad -\delta k(\xi, A_N) - \xi \end{aligned} \tag{24}$$

M maximizes its post-bargaining benefit by choosing its investment level, yielding the following first order condition:

$$FOC_M = (1-\delta)\frac{\partial t(\mu, A_M)}{\partial \mu} + \delta\frac{\partial T(\mu)}{\partial \mu} = 1 \tag{25}$$

Correspondingly, N maximizes its post-bargaining benefit by choosing its investment level, giving the following first order condition:

$$FOC_S = -(1-\delta)\frac{\partial K(\xi)}{\partial \xi} - \delta\frac{\partial k(\xi, A_N)}{\partial \xi} = 1 \tag{26}$$

4.2. Organizational choice

The organizational choice stands between M-integration, N-integration, and non-integration. The analysis follows the same pattern as in the previous section, and, once again with non-integration as the base-line, it is found that:

- M-integration is optimal if:
  - M's human capital is essential for the treatment
  - M's human capital is essential and assets are strictly complementary
  - Assets are strictly complementary and N has all the bargaining power
- N-integration is optimal if:
  - N's human capital is essential for the treatment

  - N's human capital is essential and assets are strictly complementary
  - Assets are strictly complementary and M has all the bargaining power

- If both M's and N's human capital is essential for the treatment then all ownership structures are equally good (cf. Hart 1995).

Interestingly, integration between the medical departments is the best option in most instances. It is only when both departments' human capital is essential that non-integration is among the optimal choices, together with all other organizational structures. Suggesting that medical departments should be integrated to ensure greater relationship-specific investments, and thereby better cooperation, for a treatment. This conclusion lends some support to lean health care and formation of multi-skilled teams (e.g. Kollberg et al, 2007).

5. Organizing Hotel Services

Now consider a somewhat different setup in which the transaction involves a hotel service and a public principal (assumed to be the hospital management). The public principal, P, owns one asset a_P (e.g. a building or room) and the hotel service, H, owns one asset a_H. H's asset is for example a kitchen (kitchen equipment) where the patients' food is produced - an input to the production of hospital care which P uses e.g. during *pre-* and *post-*operative care. The principal pays H a reimbursement h for the input. In this setup, P makes an investment in its physical asset while H invests in its human capital.

The public principal is interested in the quality of the hotel service (Q) and may affect the quality by making investments in its physical capital (e.g. adapting the building such that it is fitting for a kitchen). This section assumes that P's investment is generic, i.e. there is no strict complementarity between the assets (the non-generic case for a similar setup is discussed in Rehn (2009b)).

5.1. The Model

H makes a relationship-specific investment θ in human capital, e.g. educating the kitchen personnel about suitable food for different diagnosis or

the hospital's special requirements about nutrition values and cooking procedures. The hospital management makes a generic investment π in the physical asset a_P. This investment increases the value of the asset in the transaction, but also in all other uses. Once the investment is made the increase in value is independent of whether H and P cooperate or not (cf. Hart, 1995). If the parties cooperate the quality of the hotel service is $Q(\pi)$ and the cost of producing the hotel service is $L(\theta)$. The benefits from cooperation are the following:

$$U_P = Q(\pi) - h - \pi \tag{27}$$

$$U_H = h - L(\theta) - \theta \tag{28}$$

If the two parties do not cooperate with each other they have to buy and sell the hotel service on a spot-market, e.g. a market for catering. In practice P can make investments that enable the management to produce the hotel service itself. However it is assumed that this is time consuming and costly compared to buying on a spot-market (i.e. the costs of installing kitchen equipment and hiring kitchen personnel are higher than the catering costs) until an agreement is reached.[25] The spot-market price for a non-specific (without relationship-specific investments) hotel service is $\bar{h}$. The benefits from non-cooperation are the following:

$$u_P = q(\pi; A_P) - \bar{h} - \pi \tag{29}$$

$$u_H = \bar{h} - l(\theta; A_H) - \theta \tag{30}$$

Here $q(\pi; A_P)$ is the quality in the absence of H's human capital and $l(\theta; A_H)$ is the production cost in the absence of P's human capital i.e. when they are not cooperating. A_P denotes the assets available to P in the threat point, and $A_P = \varnothing$, $\{a_P\}$ or $\{a_P, a_H\}$. Similarly, A_H is the assets available to the supplier of hotel services if the parties do not trade with each other, and $A_H = \{a_P, a_H\}$, $\{a_H\}$ or $A_H = \varnothing$. The marginal conditions in this case are:

$$\frac{\partial q(\pi; a_P, a_H)}{\partial \pi} = \frac{\partial q(\pi; a_P)}{\partial \pi} \geq \frac{\partial Q(\pi)}{\partial \pi} > \frac{\partial q(\pi; \varnothing)}{\partial \pi} \tag{31}$$

$$-\frac{\partial L(\theta)}{\partial \theta} > -\frac{\partial l(\theta; a_P, a_H)}{\partial \theta} \geq -\frac{\partial l(\theta; a_H)}{\partial \theta} \geq -\frac{\partial l(\theta; \varnothing)}{\partial \theta} \tag{32}$$

[25] This only holds if the time for reaching an agreement is not too long. The exact length of time is beyond the scope of this paper.

To understand the marginal conditions remember that an investment in a physical asset only is valuable to the party owning the asset. This fact leads to somewhat different marginal conditions, compared to the two above, for the investing party (in this case P). First, only ownership of the asset invested in, a_P, matters for investment incentives - explaining the equality in (31). Second, the incentives for investments under cooperation also depend on asset ownership. Incentives are lower (when not owning a_P) or equal (when owning a_p) than when owning a_p and not cooperating. The latter implies that access to the asset, which P always has under cooperation, does not give as strong incentives as owning a_p. Access, however, gives stronger incentives than not owning and not having access to the asset - explaining the strict inequality in (31). In the latter case it is reasonable to assume that the incentives for investment are completely muted, i.e. that $\frac{\partial q(\pi;\varnothing)}{\partial \pi} = 0$. However, the presence of H's human capital has a positive level effect on the quality, since H makes a relationship-specific investment, and it is assumed, in the standard way, that there is a surplus from trade, $Q(\pi) - L(\theta) > q(\pi; A_P) - l(\theta; A_H)$, for all ownership structures.

The payment h is determined through negotiations and once again asymmetric Nash bargaining is applied to the problem. The bargain power for P is $\delta \in [0,1]$ and H's bargaining power is $(1-\delta)$. The payment h is given by:

$$h = \bar{h} + (1-\delta)\left[Q(\pi) - q(\pi; A_P)\right] + \delta\left[L(\theta) - l(\theta; A_H)\right] \tag{33}$$

5.2. Organizational choice

In equilibrium the parties will cooperate and reach an agreement. Foreseeing the equilibrium outcome both parties choose their investments to maximize their individual benefits from cooperation (after inserting h). The first order conditions follow the now familiar pattern. The relevant organizational forms are; P-integration, H-integration and non-integration. In this setup it found that:

- Non-integration cannot be improved on. That is, neither P-integration nor H-integration entail a Pareto improvement over non-integration.

This result stems from the fact that both the public principal and the hotel service will invest less when not owning their respective physical assets. Any move away from non-integration will imply lower investments for at least one of the parties. This result is in line with the empirical observation that

modern public hospitals often outsource hotel services like laundry, cooking and cleaning.

However, extreme allocations of bargaining power could alter this conclusion. If the public principal has all the bargaining power then it would be, for the same reasons as in the previous sections, an improvement to give both assets to the hotel service (H-integration). This scenario is unlikely as long as the hotel service has alternative buyers of their service - giving the hotel service some bargaining power vis-a-vis the public principal.

6. Concluding Remarks

This paper develops a straightforward model of the joint production of hospital care in public hospitals. The model is based on the property rights approach to organization. Adaptation of this approach to public hospitals is new to the hospital literature and is, to the author's knowledge, the first attempt to formalize the analysis of the internal organization of public hospitals. Although the formulation of the model is general it is partly based on information about the Swedish hospital sector, information which enhances its intuitive appeal. However, to provide policy recommendations, more empirical knowledge is needed - e.g. about the importance of a party's human capital for a treatment, the parties' bargaining power and to which extent two assets are complementary.

The results in this paper are general and give an indication to the mechanisms that should govern the choice of internal organization. It is found that support services (not performing any treatment) should be integrated into the medical departments as long as the latter's human capital is essential for the success of the treatment. This finding supports the Swedish practice of integrating fully equipped operating rooms into medical departments. Furthermore, it is shown that hotel services should not be integrated into hospitals. Again this seems to be common practice. Lastly, it is found that two medical departments that cooperate for a certain treatment should be integrated, suggesting that a movement towards explicitly forming multi-skilled teams, as suggested by the advocates of lean health care, is well-founded.

Being a first attempt to model the internal organization of public hospitals, it is obvious that more work needs to be done especially in terms of empirics. Nonetheless, this paper provides a better understanding of public hospitals in terms integration and cooperation and a starting point for future research on the subject.

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