Public Hospitals - Incentives and Organization β^*

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1 Introduction

Public hospitals are a central feature of public health care systems. Providing specialized care, they are at the centre of attention of citizens as well as politicians, and they represent the bulk of health care expenditure.

Hospital care, both in private and public settings, is the joint production of care by several different specialities (e.g. Harris, 1977). Obviously joint production requires cooperation and better cooperation renders higher quality of hospital care. Good cooperation entails that the cooperating parties make investments in their relationship e.g. learn about the other parties' needs and modify human capital and assets to suite these needs. Undoubtedly a hospital organization that supports good cooperation is a prerequisite, but not a guarantee, for efficient and qualitative hospital care.

This paper analyzes the organization of public hospitals by applying the property rights approach (PRA) to organizations developed in Grossman & Hart (1986) and Hart & Moore (1990). The actual model in this paper is based on the exposition in Hart (1995). The use of the PRA is conducive, as will be discussed below, to the analysis of public hospitals and new to hospital literature. Using this approach a comparative study is performed yielding insights about privatization and integration of hospital services. This is done in two different scenarios: *privatization*, where an integrated structure serves as the starting point for the analysis and *construction*, where non-integration serves as the starting point. In the latter scenario it is envisioned that the hospital principal wants to construct a new treatment unit within a hospital or a new hospital, while the principal, in the first scenario, considers reorganizing an already integrated structure.

There are, in most hospitals, three broad types of departments/services *medical, support* and *hotel* services. The focus of the paper is on bilateral relationships between

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departments within public hospitals, e.g. between a surgery department and a radiology department. Hence the focus is on *between-department-cooperation* while *within-department-cooperation* is abstracted from.

The paper is organized as follows: section 2 discusses the conduciveness of PRA to analyzing public hospital organization. Section 3 analyzes two different bilateral relationships within public hospitals. Section 4 concludes.

2 The Property Rights Approach and Hospital Organization

PRA - Assumptions and the Basic Mechanism The simplest version of the PRA-model is a two-period model with two parties, one producing the final product and the other an input to this production (Grossman & Hart, 1986, Hart, 1995). These two parties plan to trade with each other, however if they fail to reach an agreement at that time, then each party have a *disagreement option*. Typically this option is to sell respectively buy the input on a spot-market. In this paper the disagreement option is, explicitly, modeled as a threat point (or if you like *status quo* option or inside option) i.e. it is an option that is always available to the parties until they reach an agreement (start trading) and its existence does not foreclose a future agreement.[1]

There is no uncertainty about costs and benefits, and no asymmetric information in this model. It is also assumed that the parties have unlimited wealth to ensure that any transfer of assets is possible, this is equivalent to assuming that asset transfers are without cost. Moreover, the parties can make correct calculations about expected return of any action. However, there is *ex ante* uncertainty about the quality of the input - its characteristics cannot be contracted on, in contingent manner, in period 0.

Figure 1 describes the timing of the model, notably assets are already allocated, i.e. the organizational structure for the transaction is decided, when the investments are made in period 0. In period 1 the parties trade with each other, the uncertainty about input quality is resolved, and the parties bargain over the division of surplus given the threat points.[2]

In PRA the interaction between asset ownership and relationship-specific investments determines the organizational structure. All investments are beneficial for the investing party irrespective if she trades with the other party or not. However, the benefit is greater if the investing parties trade with each other.[3] Furthermore these investments

[1] 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 changes if the disagreement options are viewed as outside options instead of threat points. Outside options are options that are available only after negotiations have permanently broken down.

[2] The bargaining solution used is symmetric Nash bargaining.

[3] Investments make the use of assets more productive, especially in conjunction with the other party's

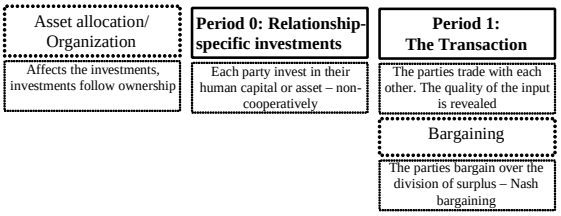

Figure 1: The timing of the PRA-model

are typically assumed to be made in human capital and to be complementary (c.f. Hart, 1995).[4]

Asset ownership gives the asset owner control over contingencies concerning assets not specified in the contract (residual control rights). Residual control rights are important given the uncertainty in the model, stemming from the presence of unforeseen contingencies (since it is an incomplete contracting model) and the *ex ante* uncertainty about input quality. In general asset ownership creates greater incentives for investments because the increased control makes the asset owner less vulnerable to hold-ups.

As noted a *period* 0-*contract*, e.g. establishing the basic conditions for the transaction, cannot not specify the relevant characteristics (the quality) of the input in a verifiable manner.[5] If this was possible the parties could coordinate their investments to maximize the *ex post* surplus, instead the choice of investments is made non-cooperatively.[6]

In the basic setup the incentives for investments crucially depend on asset allocation, but in certain circumstances asset ownership is inconsequential to the choice of investment (as will be seen in the analysis below) for some or all parties involved in the transaction. This enables a comparative analysis of the organizational structure. Two such circumstances would be that the parties' assets are complementary and/or that one or both parties' human capital is essential for the transaction. In the comparative analysis the best organizational structure is the structure that supports the greatest relationship-specific investments, and thus creates the greatest surplus.

Finally, three additional features of PRA deserve mentioning before moving on to specific issues about PRA and hospitals. First, any contract may be renegotiated in the model at any time (until the transaction is carried out) at zero cost. This is due to the uncertainty in the model. Second, the bargaining is assumed to be *ex post* efficient, in line

asset if this party makes similar investments, but also if the investing parties do not trade with each other - albeit to a lesser extent.

[4]Investments in physical capital are discussed briefly by Hart (1995) and are in this paper addressed in section 3.2.

[5]E.g. it is difficult to *ex ante* describe all relevant characteristics of a specific X-ray image, e.g. in terms of precision, workload and interpretability - these might vary considerably from patient to patient.

[6]However, the investments are observable to both parties, but not verfiable to outsiders (not enforceable). The same holds for the cost and value of the investments (c.f. Hart 1995).

with the renegotiation argument above, thus the focus is on *ex ante* inefficiencies in the investment decisions (e.g. Hart & Moore, 1990, Hart, 1995). Finally, the model focuses on issues concerning organization and abstracts from demand (consumer side) issues that might affect the benefit of a certain organization. This is of course a short-coming of the model, but an inconsequential short-coming in the case of public hospitals.

PRA and Hospitals There are two fundamental circumstances that decide the optimal organization of hospital care, both in public and private settings: hospital care being a joint production and complete contracting being impossible. The property rights approach to organizations captures both these aspects of hospital care. First, PRA is an incomplete contracting model where the quality of inputs cannot be contracted on and any contract may be renegotiated i.e. the parties cannot commit themselves to a contract - reflecting an irreducible uncertainty in the transaction. Second, and most profoundly, the emphasis on relationship-specific investments in PRA captures the essence of joint production: the coordination and mutual dependence between the different parties contributing to hospital care.

Joint production requires coordination of efforts. The individual efforts are generally not verifiable implying that the quality each party's input to the production of hospital care cannot be contracted on. One way to coordinate the efforts of the parties is to make them mutually dependent of each other. Relationship-specific investments have the potential to ensure a mutual dependence between different parts of the hospital and thus ensure coordination of efforts. This even if the investments are made non-cooperatively, i.e. even if they are chosen to maximize individual benefit. The relationship-specific investment are in this setting modifications of human capital and/or assets to meet the special demands of a specific transaction.

A radiology department, for example, has to supply the surgical department with specific diagnostic information and, to be able to do this, they have to make investments in human capital - learn the special requirements of the surgeon - or in the asset - buy equipment that produces the type of images that the surgery requires. The surgeon, on the other hand, must invest in the interpretation of the diagnostic information (sometimes the interpretation of the actual images).

These investments ensure that the joint production of hospital care runs smoothly and are therefore of great importance.

How does this relate to hospital organization? The link between relationship-specific investments and organization goes through the adaptation to changing circumstances, realtionship-specific investments make the parties, since contracts are incomplete, vulnerable to changing circumstances (unforeseen contingencies).

If the radiology equipment needs to be modified, e.g. through the purchase of new appliances, to fit a special surgical procedure in a way that is not specified in the contract

(between them and the surgical department), then the radiology department will have the ability to do so if they own the equipment. The surgical department, however, is dependent on the radiology department's willingness to make this alteration. Since the surgical department has made relationship-specific investments in the relation with this specific radiology department they, now, may be held up for some of the cost for the modification. The threat of being held-up by the radiology department reduces the surgical department's incentives to make investment in this specific relation.

Thus the ability to change and the cost of changing follow ownership, and it is apparent that ownership also affects the relationship-specific investments. It is likely that the surgical department would have greater incentives to invest if they owned the radiology equipment, they would then have control over the adaptation needed in the new circumstances. Now, since relationship-specific investments are, or at least seem to be, beneficial for the joint production of hospital care the hospital should be organized in a way that promotes these investments. This fits well with the conclusion of PRA that the organizational structure that supports the greatest relationship-specific investments is the optimal way the organize a certain transaction.

Moreover PRA provides a framework for capturing salient features of hospital care such as: the medical departments' human capital, in most cases, being essential for the treatment outcome and that the different departments' assets are likely to be complementary in the treatment. An example of the latter could be the radiology equipment used for mammography and cytologist's equipment used to examine the cells, these two assets are complementary in the diagnosis and treatment of breast cancer.

PRA and Public Hospitals This paper contends that PRA is especially suitable for analyzing public hospitals. Public hospitals, like many other public agencies, are characterized by politically set goals, public funding and ownership, and lack of competition.[7] The public funding of hospital care is in many cases based on a fixed budget principle. When it comes to the internal funding of the departments' services the pattern is similar, i.e. the funding is given in terms of a budget. This total cost may be based on historical as well as predicted treatment costs given the internal prices for the different service needed for a treatment. In this system there is room for disagreements and negotiations over the actual cost, i.e. resources used, for a treatment and over the quality of a service given the price. PRA, in a sense, capture these negotiations since it entails bargaining over the reimbursement for a service - this bargaining may be interpreted both in terms of negotiations over price for a given quality and quality for a given price.[8]

Lack of competition between hospitals is a significant feature of public health care

[7] See Dixit (2002) for a general discussion of characteristics of public agencies.

[8] The fact that contracts may be renegotiated without cost, in the model, captures another public feature namely that public agencies often have the political power breach and renew agreements at any time.

systems. Thus demand does not discipline hospital behavior and affect hospital organization as it potentially does in a private health care system. PRA's focus on organizational issues and the lack of demand side fits well with analyzing public hospitals.

As noted threat points are important for the results in the PRA. There are two prolific ways to think threat points in a public hospitals setting: 1) as an internal spot-market for hospital services or 2) as an external spot-market for hospital services.[9] Where 1) implies that each department involved in a transaction may trade with other departments outside the transaction, but within realms of the hospital, until an agreement is reached. For example:

A medical department (M) needs diagnostic information from a radiology department (imagine that there are two radiology departments in the hospital: radiology I and II). They plan to acquire this information from radiology I and both departments makes investments in this relationship to ensure that their cooperation runs smoothly. When negotiating over the reimbursement for this diagnostic information the medical department's threat point is to acquire diagnostic information (without the specific features that I's investment entails) from radiology II - in fact they acquire information from radiology II until an agreement is reached with radiology I. Radiology I, on the other hand, may prioritize its transactions with other medical departments, not benefiting from the investments made in the relationship with M, over the transaction with M until an agreement is reached. This threat point may be interpreted as radiology I is putting M's request at the bottom of the "to-do list".

The second interpretation of threat points imply that there is an demand for special hospital services outside the actual hospital - typically from other hospitals.

The medical department (M) and radiology I may both sell their services to (nearby) hospitals, that do not have M's specialist abilities or a radiology department, until they reach an agreement.

Either of these interpretations of threat points seem valid in most public settings. The specifics of the threat points, in terms of payoffs *etc.,* irrespective of interpretation are presented in the next section.

The choice of PRA is also justified by its ability to address relevant issues such as privatization and restrictions on ownership. In the political debate a major issue concerning public hospitals is whether certain activities could, and should, be privatized or, put in other words, disintegrated. The PRA may be used evaluate the benefits from disintegration by using integration as the starting point for the analysis. A related issue is politically assigned restrictions on ownership. A common characteristic of public ownership, from a historical point of view, is that public asset are seldom for sale. Obviously, some public assets are never or seldom sold to private interests, e.g. military defense

[9] Spot-market in the sense that there is an near immediate delivery of the services, but not in the sense that they are paid for in cash.

facilities, and, in some instances, hospital facilities. This characteristic is easily captured in PRA by assuming some restrictions on ownership. This kind of assumption will be used in the analysis below.

Finally, the PRA assumes that the parties have unlimited wealth which is an unjust assumption in many settings. In the case of public hospitals it seems less restrictive and in some sense even reasonable. In particular hospital departments typically have a soft budget constraint, publicly founded hospital departments may run a deficit years on end without going bankrupt. Moreover, the implication of the assumption is that asset always can be transferred so that they are put in their best use (c.f. Hart, 1995) and it is reasonable to believe that public hospital principals have the authority and the means to transfer assets if needed.

Limitations of the PRA There are some obvious limitations of applying PRA to public hospitals, this subsection is devoted to a discussion of these limitations. There are two types of limitations: one type that arise because assumptions or mechanisms in PRA are unsuitable for the analysis of public hospitals, and a second type that stems from public hospital characteristics not being readily captured by the PRA.

There are two limitations of the first type:

- There is an assumption of no asymmetric information between trading parties in the PRA, this assumption is a odds with the contention that there is asymmetric information in hospitals between, at least, hospital managers and treating departments.[10] It might be argued that information asymmetric is smaller between departments that interact with each other at a daily basis than between the management and the departments. In spite of the latter it is an obvious simplification of the informational structure between departments to assume no asymmetric information.

- In PRA the incentives for investments are provided by asset ownership. This does not give a full-fledged picture of the incentives within hospitals. Incentives for investments in human capital are to a great extent provided by career opportunities, salary, peer reviews and so on. However, to make investments it is important for the investing party to know that this investment pays off, asset ownership might be a way to ensure this since this gives control over the use of the asset. Hence the residual control right that stems from asset ownership plays a part in providing the incentives for investments, but it is an simplification to assume that it is the sole source of investment incentives.

Furthermore there are three limitations of the second type:

[10] See most of the hospital reimbursement literature e.g. Ma, 1994

- Hospital care is typically characterized by team-work not only between departments but also within departments, hence the workers' incentives within the departments are important for the outcome. The PRA generally focuses on management incentives i.e. treats the department as black box implicitly assuming incentive alignment between the department management and the department staff.[11] This is an obvious drawback from using PRA to analyze public hospital, but also an simplification that high-lights the focus on between-department cooperation.

- The PRA-model presented here, and elsewhere, describes a quite simple structure while the actual structure of public hospitals obviously is complex. This kind of simplification is however commonplace when dealing a theoretical model.

- Investment decisions are generally centralized in public hospitals. The public hospital principal decides on investments and prioritizes between investments, the initiatives for investments are, however, likely to stem from the individual departments. The departments appeal for resources, from the principal, for investments and are responsible for their implementation (in particular investments in human capital). These appeals are made non-cooperatively (i.e. in the private interest of the departments) and it is unlikely that principal can force cooperative investment upon the departments (at least given the decentralized implementation of investment). In the PRA-model the investment decisions are decentralized and non-cooperative, not capturing the centralized decision-making but it may well capture the potential internal conflicts arising from appeals for investments and that investments, typically, are implemented by departments (without stretching too much one might consider the implementation as an investment - once again think about investments in human capital). However, the fact that PRA does not capture centralized investment decision is an obvious limitation.

In spite of these limitations it is in this paper suggested that applying PRA to the organization of public hospitals might be rewarding. In particular since it nicely captures the joint production of hospital care. Moreover this approach is novel to literature and might serve as a stepping stone towards a full-fledged model of public hospitals. In next section PRA is applied most basic transaction within a public hospital namely a *bilateral transaction* where two departments cooperate to produce hospital care.

3 Bilateral Transactions in Public Hospitals

As discussed in previous sections hospital care is the joint production between medical services, support services and hotel services. In its most basic form the joint production

[11] Hart & Moore (2008) states that the PRA-model is unsuitable for analyzing the internal organization of firms, i.e. workers' incentives, authority and so on.

involves two parties, i.e. it is a *bilateral transaction*, e.g. a medical department and a support service or a medical department and a hotel service. There are many examples of bilateral transactions of this kind within public hospitals e.g. the treatment of a simple leg or arm fracture (orthopedic department and radiology department) or a treatment requiring a special diet (medical department and hospital kitchen) and so on. The plenitude of potential bilateral transactions within a hospital makes the organization of these transaction both important for hospital performance and interesting to analyze.

In the analysis below one may think of the bilateral transactions either as the simplest incarnation of a hospital or as a treatment unit within a larger hospital, both interpretations are valid. Below are two, somewhat different, bilateral transactions are considered. First, a transaction with one medical department and one support service, where both parties make investments in human capital, is analyzed. Second, a transaction involving a medical department and a hotel services is considered. In both case the medical department produces the final good and also functions as the public principal. In the latter transaction one party invests in its physical asset while the other party invests in its human capital. In both cases a comparative analysis is performed *vis-a-vis* two different starting points: integration (to analyze the privatization of hospital services) and non-integration (to analyze the construction of treatment units).

3.1 Medical Department plus Support Service

Consider a setting with one support service (S) (e.g. radiology department) and one medical department (M) (e.g. surgery department). S supplies an input to M's production of the final good - hospital care. The support service uses one asset, p_S, to produce the input and the medical department uses one asset, p_M, and the input to finalize the hospital care.

Both departments make relationship-specific investments S's investment enables them to produce an input suitable for M's production of hospital care. Moreover, M's investment allows them to make efficient use of the input. These investments are, by construction, investments in human capital; M's investment is μ_S and S's investment is σ_M. The assumption that these investments are made in the respective parties' human capital is important and implies that these investments cannot be transferred from one party to the other. That is S cannot make M's investment and vice versa - irrespective of ownership structure. Assume that these investments reflect both the level and the cost of the investment (c.f. Hart, 1995).

3.1.1 The Model

If both parties decide to enter this particular transaction (*trade*), where S supplies the input and M uses the input to produce hospital care, i.e. reach an agreement over the

terms of trade, then their payoffs are the following:

$$U_M = T(\mu_S) - v \quad (1)$$

$$U_S = v - C(\sigma_M) \quad (2)$$

where $T(\mu_S)$ is the treatment outcome and v is the reimbursement paid to the support department for the input. Assume that the treatment outcome can be interpreted in monetary units. $T(\mu_S)$ is the treatment outcome when S's human capital is available to M i.e. when the parties trade with each other. $C(\sigma_M)$ is the support department's production cost for the input. The treatment outcome is improved when M invests more (i.e. μ_S increases) and S's production cost falls with greater σ_M. That is, the more the parties invest in their relationship the greater is the surplus from trade (i.e. treatment outcome minus cost). This reflects the benefits of increased coordination in the joint production of hospital care. Notably, both assets are accessible for both parties, irrespective of ownership structure, if they reach an agreement. However, the party owning the asset has the final say over its usage (i.e. residual control right).

Up until the time when they reach an agreement both parties may trade with other departments within or outside the hospital (see section 2) - these transactions (hereafter labeled *spot-trade*) are their threat points. In the threat point M acquires (buys) a generic input and S supplies (sells) a generic input, this generic input is supposed to priced according to an agreed upon price-list for hospital services - let this price be denoted $\bar{v}$**.** Here generic means that the input is not adjusted to fit the transaction between M and S. The production cost for a generic input is $c(\sigma_M; P_S)$ and P_S are the asset owned by S before an agreement is reached, at this time the parties may only access the assets that they own. Notably, S makes a relationship-specific investment, in period 0, also in this case. Given this investment S has to incur a cost to make the input generic, i.e. although the investment always is beneficial it creates an extra cost in spot-trade. It is assumed that $c(\sigma_M; P_S) > C(\sigma_M)$ since it is costly to make the input generic. In spot-trade M still produces the final good using a generic input and in the absences of S's human capital. The treatment outcome in this cases is $t(\mu_S; P_M)$, where P_M are the assets owned by M. Given the need for coordination in the joint production of health care it is assumed that $t(\mu_S; P_M) < T(\mu_S)$.

Notably asset ownership affects the treatment outcome and the cost in spot-trade. Asset ownership matters in the threat point because the parties do not have access to the other party's asset unless they own them. Here P_M may equal $\{p_M\}$ or $\{p_M, p_S\}$ while P_S may equal $\varnothing$ or $\{p_S\}$. That is, it is assumed that S may never own M's assets, because public assets are infrequently for sale, reflecting inertia or a political preference for public ownership. This assumption is called *restricted ownership.* The payoffs under

spot-trade are given by u_M and u_S.

$$u_M = t(\mu_S; P_M) - \bar{v} \tag{3}$$
$$u_S = \bar{v} - c(\sigma_M; P_S) \tag{4}$$

As already been hinted it is assumed that $T(\mu_S)$ is strictly concave in μ_S and that $C(\sigma_M)$ is strictly convex in σ_M. Moreover, assume that $t(\mu_S; P_M)$ is concave in μ_S and that $c(\sigma_M; P_S)$ is convex in σ_M.[12]

Relationship-specific investments are beneficial in any industry and maybe especially so for the hospital industry, given the joint production and the complementaries between different services in hospital care. This is reflected by the assumption that the surplus from trade is greater than the surplus from spot-trade:

$$T(\mu_S) - C(\sigma_M) > t(\mu_S; P_M) - c(\sigma_M; P_S) \tag{5}$$
$$\text{for } \forall\ P_M, P_S \text{ where } P_M \cap P_S = \varnothing, P_M \cup P_S = \{p_M, p_S\}$$

Moreover it is assumed (as in Hart (1995)) that the marginal benefit from an increased investment is greater, or at least as great, the more assets the party making the investment has access to. The ranking of the first derivatives with respect to investments, hereafter called the *marginal conditions*, are the following:

$$\begin{aligned} \frac{\partial T(\mu_S)}{\partial \mu_S} &> \frac{\partial t(\mu_S; p_M, p_S)}{\partial \mu_S} \geq \frac{\partial t(\mu_S; p_M)}{\partial \mu_S} \geq \frac{\partial t(\mu_S; \varnothing)}{\partial \mu_S} \\ \frac{\partial C(\sigma_M)}{\partial \sigma_M} &< \frac{\partial c(\sigma_M; p_M, p_S)}{\partial \sigma_M} \leq \frac{\partial c(\sigma_M; p_S)}{\partial \sigma_M} \leq \frac{\partial c(\sigma_M; \varnothing)}{\partial \sigma_M} \end{aligned} \tag{6}$$

The strict inequalities in (6) imply that M's investment is at least partly specific to S's human capital and that S's investment is at least partly specific to M's human capital. For example, if the medical department is a specialist on neuro surgery and the radiology department invests in increased knowledge about brain tomography then the latter's investment is at least specific to the medical department's human capital. The weak inequalities mean that the investments may or may not be specific to the assets p_M and p_S respectively. In the example, the knowledge in brain tomography might be specific to the radiology equipment, p_S, but not to the surgical equipment, p_M or in terms of (6): $\frac{\partial c(\sigma_M; p_M, p_S)}{\partial \sigma_M} = \frac{\partial c(\sigma_M; p_S)}{\partial \sigma_M} < \frac{\partial c(\sigma_M; \varnothing)}{\partial \sigma_M}$.

In equilibrium the parties will trade with each other. As already stated, trade creates a surplus compared to spot-trade, the division of this surplus is decided by negotiation and

[12] That is, $T'(\mu_S) > 0, T''(\mu_S) < 0$, $C'(\sigma_M) < 0, C''(\sigma_M) > 0$ and $t'(\mu_S) \geq 0, t''(\mu_S) \leq 0$, $c'(\sigma_M) \leq 0, c''(\sigma_M) \geq 0$.

following Hart (1995) symmetric Nash bargaining is applied. This negotiation decides the reimbursement from M to S for the input that S supplies, in this case the reimbursement is:[13]

$$v = \bar{v} - \frac{T(\mu_S) - t(\mu_S; P_M) + C(\sigma_M) - c(\sigma_M; P_S)}{2} \tag{7}$$

That is, the parties each get half the surplus from trade relative the threat points. The individual *ex post* benefits from trade are equal to the payoff from trade, after inserting the reimbursement v, minus the investment cost i.e.:

$$\begin{aligned} T(\mu_S) - \bar{v} - \frac{T(\mu_S) - t(\mu_S; P_M) + C(\sigma_M) - c(\sigma_M; P_S)}{2} - \mu_S = \\ = \frac{T(\mu_S) + t(\mu_S; P_M) - C(\sigma_M) + c(\sigma_M; P_S)}{2} - \bar{v} - \mu_S \end{aligned} \tag{8}$$

$$\begin{aligned} \bar{v} - \frac{T(\mu_S) - t(\mu_S; P_M) + C(\sigma_M) - c(\sigma_M; P_S)}{2} - C(\sigma_M) - \sigma_M = \\ = \frac{T(\mu_S) - t(\mu_S; P_M) - C(\sigma_M) - c(\sigma_M; P_S)}{2} + \bar{v} - \sigma_M \end{aligned} \tag{9}$$

In the *second-best world* of incomplete contracting M and S choose investments non-cooperatively at date 0 to maximize (8)and (9) respectively. Hart (1995) shows that the non-cooperative choice of investments leads to under-investments, for any ownership structure, compared to the *first-best*. In the first-best the investments are chosen cooperatively in period 0 to maximize total surplus from trade. The second-best first order conditions are:

$$\frac{1}{2}\frac{\partial T(\mu_S)}{\partial \mu_S} + \frac{1}{2}\frac{\partial t(\mu_S; P_M)}{\partial \mu_S} - 1 = 0 \tag{10}$$

$$-\frac{1}{2}\frac{\partial C(\sigma_M)}{\partial \sigma_M} - \frac{1}{2}\frac{\partial c(\sigma_M; P_S)}{\partial \sigma_M} - 1 = 0 \tag{11}$$

In this model ownership, organization, matters because it affects marginal benefit of spot-trade. The marginal benefit of an investment is greater or at least as great, depending on the nature of the assets and investments, if the investing party owns more assets, see (6). The intuition is that the investing party will invest more if the reduction in benefit in spot-trade, compared to trade is low, and this is generally the case when it owns more assets.

3.1.2 Organizational Choice

The aim of the analysis is to decide the optimal organization for the bilateral transaction under certain circumstances. These circumstances are typically characteristics of assets and human capital, but the characteristics of investments may also be a factor. Definition

[13] Calculated by maximizing the Nash Bargaining product:
$NBP = [(T(\cdot) - v) - (t(\cdot) - \bar{v})] \times [(v - C(\cdot)) - (\bar{v} - c(\cdot))]$

1 and 2 define the effects of two important characteristics for the production of hospital care.[14]

Definition 1 *Asset p_M and p_S are strictly complementary if either $t'(\mu_S; p_M) \equiv t'(\mu_S; \varnothing)$ or $c'(\sigma_M; p_S) \equiv c'(\sigma_M; \varnothing)$*

Definition 2 *M's human capital (S's human capital) is essential if $c'(\sigma_M; p_M, p_S) \equiv c'(\sigma_M; \varnothing)$ ($t'(\mu_S; p_M, p_S) \equiv t'(\mu_S; \varnothing)$)*

Strict complementarity implies that incentive for investment, for one of the parties, in the threat point (i.e. where ownership matters) is unaffected by ownership unless the party owns both assets. That is, owning only one of the assets does not increase the marginal return of investments. Essential human capital, on the other hand, implies that the investment incentive for the non-essential party is equalized over ownership structures.

In the analysis below two organizational forms are considered: *non-integration* and *integration.* Notably, the incentives for investments are given by the first order conditions in the different organizational structures:

Under non-integration (N) the first-order conditions become:

$$\frac{1}{2}\frac{\partial T\left(\mu_S^N\right)}{\partial \mu_S^N} + \frac{1}{2}\frac{\partial t\left(\mu_S^N; p_M\right)}{\partial \mu_S^N} = 1 \tag{12}$$

$$-\frac{1}{2}\frac{\partial C\left(\sigma_M^N\right)}{\partial \sigma_M^N} - \frac{1}{2}\frac{\partial c\left(\sigma_M^N; p_S\right)}{\partial \sigma_M^N} = 1 \tag{13}$$

Under full integration (F) the first-order conditions become:

$$\frac{1}{2}\frac{\partial T\left(\mu_S^F\right)}{\partial \mu_S^F} + \frac{1}{2}\frac{\partial t\left(\mu_S^F; p_M, p_S\right)}{\partial \mu_S^F} = 1 \tag{14}$$

$$-\frac{1}{2}\frac{\partial C\left(\sigma_M^F\right)}{\partial \sigma_M^F} - \frac{1}{2}\frac{\partial c\left(\sigma_M^F; \varnothing\right)}{\partial \sigma_M^F} = 1 \tag{15}$$

The marginal conditions (6) state that M will invest at least as much under integration as under non-integration, while it is the other way around for S. That is: $\mu_S^F \geq \mu_S^N$ and $\sigma_M^F \leq \sigma_M^N$. To determine which ownership structure that is best for the public hospital one needs to find the structure supports the greatest investments and hence creates the greatest total surplus. Notably, any ownership structure change that increases investments by one party, and does not decrease the other party's investment is beneficial for the transaction. This because of the inherent under-investments in the second-best, i.e. a change in ownership structure with the described effect on investments will imply that the economy comes closer to the first-best. A change of this kind is thus a Pareto improvement relative the starting point for the analysis.

[14] Definition 4 and 5 in Hart (1995) with appropriate adaptations to the current model.

Two Starting Points for the Analysis It is important to establish the starting point for the analysis, especially when there are rigidities in the allocation of asset e.g. a political opinion for public ownership or organizational inertia in public hospitals.[15] The assumption of restricted ownership could reflect a rigidity in the allocation of assets. When thinking about public hospitals it is natural to think of them as large integrated entities, possibly inefficient and in need of disintegration i.e. privatization of certain activities. Thus one natural starting point is full integration. One could also think of a public principal wanting to construct a new *hospital division* or *treatment unit* consisting of support services and medical services. In this case non-integration is the natural starting point. The two starting points yield two different strands of analysis labeled, as above, *privatization and construction*. Next both views are exemplified using definition 1 and 2.

Strict Complementarity In the production of hospital care it is reasonable to assume that the assets are complementary and thus that either $t'(\mu_S; p_M) = t'(\mu_S; \varnothing)$ or $c'(\sigma_M; p_S) = c'(\sigma_M; \varnothing)$. That is, the complementarity of assets either implies that M is indifferent between owning p_M and not owning p_M, or that S is indifferent indifferent between owning p_S and not owning p_S. The reason for this is that p_M is useless without p_S, and *vice versa*, when the assets are strictly complementary. Complementarity implies that some form of integration is optimal (Hart, 1995). Given the assumption about restricted ownership the case when $t'(\mu_S; p_M) = t'(\mu_S; \varnothing)$ becomes irrelevant. Thus if the assets are complementary then the complementarity implies that $c'(\sigma_M; p_S) = c'(\sigma_M; \varnothing)$ i.e. that S is indifferent. The intuition is that S as a support service is dependent on access to the other party's (the party S is supporting) asset to be able to realize a higher marginal benefit of the investment when the assets are complementary. M, on the other hand, that produces the final product might be able to realize a greater marginal benefit, compared to the case when M does not own any assets, by only owning p_M in spot-trade, even if assets are complementary.

Construction Here the starting point for the analysis is non-integration. Obviously strict complementarity, that makes S indifferent in the sense described above, implies that (13) and (15) are the same, which in turn implies that $\sigma_M^F = \sigma_M^N$. That is, S invests as much under integration as under non-integration. M, on the other hand, invests weakly more under integration ($\mu_S^F \geq \mu_S^N$) thus integration entails a weak Pareto improvement over non-integration.

[15] If there are no such rigidities and assets are easily allocated and reallocated the starting point could be less important and *relative productivity of investments* more important for the organizational choice. See Rehn (2007b) for a more detailed discussion of these issues.

Privatization Does disintegration increase the total relationship-specific investments compared to full integration when assets are strictly complementary? The answer is no. As in the construction case strict complementarity implies that S makes the same investment under both non-integration and full integration while M will invest weakly less under non-integration than under full integration. Thus privatization does not constitute a Pareto improvement in this setting.

Essential Human Capital One or both parties human capital may be essential for the production of hospital care, e.g. the doctors and nurses at the medical department. The question is how this affects the choice of organization. Definition 2 formalizes the idea of essential human capital, it says that if one party's human capital is essential then ownership does not matter for the other party in its threat point. That is. if e.g. M's human capital is essential for the production of hospital care, then S's marginal (spot-trade) benefit of investments is independent of ownership i.e. $c'(\sigma_M; p_M, p_S) = c'(\sigma_M; p_S) = c'(\sigma_M; \varnothing)$. In short the absence of M's human capital makes asset ownership irrelevant.

Construction Starting from non-integration and assuming that M's human capital is essential gives that integration is a Pareto improvement. To see this note that the solutions to (13) and (15) are the same (asset ownership has no effect on S's investment incentive), while $\mu_S^F \geq \mu_S^N$ still holds. Notably, if M's human capital is essential this effect overrides any effect from the relation between assets, that is integration is optimal irrespective of assets being complements or independent when M's human capital is pivotal for the production of hospital care. This begs the question whether M's human capital is essential. Given that M is a medical department and medical care is the primary output from a hospital it is natural that M's human capital is essential. What about S's human capital? It is of course important in the joint production of hospital care but in most cases not essential. However, even if S's human capital is essential as well, i.e. if both parties human capital is essential, this does not alter the conclusion that integration is optimal, in the sense that it is still in the set of optimal organizational forms, because organizational form does not matter in this case - "... neither party's investment will pay off in the absence of agreement with the other" (Hart, 1995:48).

Privatization Clearly, disintegration or privatization does not constitute a Pareto improvement over full integration when M's human capital is essential. That is, S will make the same investment but M will invest weakly less if the asset p_S is reallocated from M to S. If both M and S human capital is essential then privatization is an option. However all other organizational forms are equally good because the incentives for investments are the same in all ownership structures for both parties. Thus if privatization

is opted for in this case it can be made without cost, in terms of the model, but it is not an improvement as such.

3.1.3 Conclusion M & S

The analysis provides a strong case for integration given that assets are strictly complementary in the way described and that the medical department's human capital is essential for the production of hospital care. Both assumptions are likely to hold for many treatments performed in hospitals. Interestingly privatization of the support service is weakly Pareto dominated by keeping the vertical structure in all instances. Furthermore, also when constructing new treatment units integration should be opted.[16]

3.2 Medical Department plus Hotel Service

Now consider a different setup, in this setup the transaction involves a hotel service, H, and a medical department/public principal, M. M owns one asset p_B and H owns one asset p_H. H's asset is for example a kitchen (kitchen equipment) where the patients' food is produced. M uses this input in the production of hospital care, e.g. during *pre-* and *post*-operative care. The medical department pays H a reimbursement h for the input. Furthermore, M makes an investment in its physical asset while H invests in human capital. Thus this section deals with a somewhat different, bilateral transaction needed in the production of hospital care. In this transaction M's physical asset may be thought of as a building or some asset not directly used in the production of hospital care. Thus the public principal might be less restricted in disposing of this asset than other assets used directly in the production of health care. One might actually think of M having two assets p_M and p_B. Hence the assumption of restricted ownership is relaxed for p_B in the analysis below.

3.2.1 The M & H Setup

Here H makes a relationship-specific investment δ in period 0, this investment is an investment in human capital e.g. educating the kitchen personnel about suitable food for different diseases and/or the hospitals special requirements about nutrition values and cooking procedures. The hospital management (the medicine department) makes a generic investment β in the physical asset p_B, e.g. a building where the kitchen may be placed, in period 0. The investment is generic in the sense that it is not specific to H's asset, i.e. any kitchen equipment may be placed in this building. This investment increases the value of the asset in the transaction, but also in all other uses - the increase

[16] This might be interpreted in terms of *lean production* where complementary assets and competencies should be close to each other. This to enable a quick and comprehensive treatment of patients. (see e.g. Kollberg et al (2006) for a discussion of lean thinking and health care)

in value is independent of both H and M's participation in the transaction once the investment is made (c.f. Hart, 1995). The payoffs from trade are the following:

$$U_M = Z(\beta) - h \tag{16}$$

$$U_H = h - L(\delta) \tag{17}$$

Where $Z(\beta)$ is the treatment outcome when H's human capital is available and $L(\delta)$ is the cost of producing hotel services when the investment β (in practice a part of p_B) and M's human capital are available to H. If the two parties do not trade with each other they have to buy and sell the hotel service on a spot-market, here it is suitable to think about an external spot-market e.g. a market for catering. $\bar{h}$ is market price for a generic hotel service. The payoffs in spot-trade are the following:

$$u_M = z(\beta; P_B) - \bar{h} \tag{18}$$

$$u_H = \bar{h} - l(\delta; P_H) \tag{19}$$

$z(\beta; P_B)$ is the treatment outcome in the absence of H's human capital and $l(\delta; P_H)$ is the production cost in the absence of M's human capital. P_B denotes the assets available to M in the threat point, and $P_B = \varnothing$, $P_B = \{p_B\}$ or $P_B = \{p_B, p_H\}$. Similarly, P_H is the assets available to the supplier of hotel services if the parties do not trade with each other, and $P_H = \{p_B, p_H\}$, $P_H = \{p_H\}$ or $P_H = \varnothing$. The marginal conditions are in this case:

$$\frac{\partial Z(\beta)}{\partial \beta} = \frac{\partial z(\beta; p_B, p_H)}{\partial \beta} = \frac{\partial z(\beta; p_B)}{\partial \beta} > \frac{\partial z(\beta; \varnothing)}{\partial \beta} = 0 \tag{20}$$

$$\frac{\partial L(\delta)}{\partial \delta} < \frac{\partial l(\delta; p_B, p_H)}{\partial \delta} \leq \frac{\partial l(\delta; p_H)}{\partial \delta} \leq \frac{\partial l(\delta; \varnothing)}{\partial \delta} \tag{21}$$

The derivative $\frac{\partial z(\beta;\varnothing)}{\partial \beta}$ equals zero because an investment in p_B is of no value to M, in spot-trade, when M does not own p_B . Furthermore, the equalities in (20) are explained by the assumption that β is an generic investment in the physical asset (p_B) - thus the presence of H's human capital and physical asset has no effect on the marginal benefit of this investment. However the presence of H's human capital has a positive effect on the treatment outcome in an absolute sense, there is therefore a surplus from trade i.e.: $Z(\beta) - L(\delta) > z(\beta; P_B) - l(\delta; P_H)$ for all ownership structures. This surplus is divided through negotiations and once again the symmetric Nash bargaining solution is applied to find the reimbursement h, which in this case is:

$$h = \bar{h} + \frac{Z(\beta) - z(\beta; P_B) + L(\delta) - l(\delta; P_H)}{2} \tag{22}$$

Inserting this h in the payoffs from trade and subtracting the investment cost produces the *ex post* benefits from trade. The first order conditions are given by maximizing these benefits with respect to the investments. In this setting three organizational forms are considered M-integration, H-integration and non-integration. Skipping the first order conditions in the general case, the first order conditions under non-integration (N), M-integration (M) and H-integration (H) are:

$$\frac{1}{2}\frac{\partial Z\left(\beta^N\right)}{\partial \beta^N} + \frac{1}{2}\frac{\partial z\left(\beta^N; p_B\right)}{\partial \beta^N} = 1 \tag{23}$$

$$-\frac{1}{2}\frac{\partial L\left(\delta^N\right)}{\partial \delta^N} - \frac{1}{2}\frac{\partial l\left(\delta^N; p_H\right)}{\partial \delta^N} = 1 \tag{24}$$

$$\frac{1}{2}\frac{\partial Z\left(\beta^M\right)}{\partial \beta^M} + \frac{1}{2}\frac{\partial z\left(\beta^M; p_B, p_H\right)}{\partial \beta^M} = 1 \tag{25}$$

$$-\frac{1}{2}\frac{\partial L\left(\delta^M\right)}{\partial \delta^M} - \frac{1}{2}\frac{\partial l\left(\delta^M; \varnothing\right)}{\partial \delta^M} = 1 \tag{26}$$

$$\frac{1}{2}\frac{\partial Z\left(\beta^H\right)}{\partial \beta^H} + \frac{1}{2}\frac{\partial z\left(\beta^H; \varnothing\right)}{\partial \beta^H} = \frac{1}{2}\frac{\partial Z\left(\beta^H\right)}{\partial \beta^H} = 1 \tag{27}$$

$$-\frac{1}{2}\frac{\partial L\left(\delta^H\right)}{\partial \delta^H} - \frac{1}{2}\frac{\partial l\left(\delta^H; p_B, p_H\right)}{\partial \delta^H} = 1 \tag{28}$$

Organizational Choice Since M owns p_B both under non-integration and M-integration and the investment β increases the value of this asset irrespective of the ownership structure they will make the same investments in both cases i.e. $\beta^N = \beta^M$. The same reasoning gives that M will invest less under H-integration. When M owns p_B H does not get a part of the increase in value from the investment, i.e. the asset owner receives the full increase in value (c.f. Hart 1995). H, the other hand, will invest weakly more the more assets H owns hence $\delta^H \geq \delta^N \geq \delta^M$ (see (21)). Under H-integration M will invest strictly less and H will invest weakly more than under both M-integration and non-integration, thus H-integration is not a Pareto improvement irrespective of the starting point. Non-integration, however, implies that H will invest weakly more than under M-integration while M will make the same investment, hence non-integration is an Pareto improvement over M-integration. This reasoning also gives that non-integration cannot be improved on if this is the starting point.

It is obvious that the best organizational choice this transaction is non-integration with each party owning its own asset. This is in line with casual observation of modern public hospitals suggesting that hotel services like laundry, cleaning and cooking often are outsourced i.e. not integrated in the hospital organization.

3.2.2 Conclusion M & H

The optimal way to organization the transaction between a medical department/public principal and a hotel service depends on the characteristics of investments. In this section it is assumed that the hotel service makes an investment in its human capital and that the medical department invests in its physical asset. In this scenario non-integration is optimal. This holds as long as the M's investment is generic. Rehn (2007a) shows that if M's investment is specific to the hotel service's asset then the transaction may optimally be organized as either M-integration, H-integration, or joint ownership of p_H depending on the starting point and the complementarity of investments and assets.

4 Concluding Remarks

By studying a straightforward model of the joint production of hospital care this paper produces a number of results. Most interestingly it is found, when studying the transaction involving a medical department (public principal) and a support service, that integration should be opted for both when constructing new treatment units as well as when considering privatization of the support service. Both results are foremost driven by the realization that the medical department's human capital is essential for production of hospital care. This is intuitively appealing, and somewhat trivial, since without the cooperation with medical departments most support services would experience difficulties in giving patients suitable treatment. Furthermore, this proposes that public ownership of all assets in the transaction is the best option as long as the public principal's human capital is essential.[17]

Hospitals also consist of hotel services that contribute to the joint production e.g. by producing food and doing the laundry. The analysis of the transaction between the medical department and the hotel service reveal that non-integration should be opted for as long as the principals investment is generic.

The focus in this paper is on bilateral transactions and the applicability of the PRA-model to public hospitals some extensions to the model, e.g. to trilateral transactions, can be found in Rehn (2007a). The results presented here depend on the assumptions about characteristics of investments, human capital and assets. These assumptions need to be scrutinized and compared to the actual characteristics of investments, human capital and assets in public hospitals to enable a conclusion applicable to a specific hospital. This research lies in the future. This paper, however, provides a basic framework for thinking about public hospital organization from a new perspective, that seems useful, this by applying the property rights approach to organizations to the problem.

[17] Obviously, if the public principal were not also a medical department, as assumed here, it would be more questionable that its human capital is essential for hospital care and this would change the conclusion made here.

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