

Research Article

The Financing of Public Hospitals in Senegal: Taking into Account the Anti-selection

Mansoum Ndiaye*

Department of Training, African Center for Graduate Studies in Management, Dakar, Senegal

Abstract

The objective of our study was to analyze the anti-selection that exists between the state and public hospitals in Senegal. The use of a theoretical model to highlight hospital regulation has led to a number of important results. Indeed, the optimal solution consists in introducing a distortion in the cost reduction effort required to achieve an arbitrage between productive efficiency and the extraction of the hospital's rent. The use of a menu of non-linear contracts for hospital funding is consistent with a cost reimbursement policy (such as the overall envelope policy) while a menu of linear contracts is modelled on the fixed-price pricing system (for example, by pathology or activity).

Keywords

Public Hospital, Financing, Information Asymmetry, Anti-selection, Senegal

1. Introduction

Generally, considering the imperfection of the information gives rise to a set of theoretical developments that emphasize active information-seeking behavior. In configurations with information asymmetries, some individuals hold, alone, some information to which others do not have direct access. The essential problem is therefore that from the revelation to other agents, of private information held by informed agents. As in any market, the hospital care market is subject to information asymmetries that corrupt its efficient functioning. For health economists, the situation of a hospital is atypical since the traditional mechanisms of price regulation by supply and demand cannot work in the hospital market. According to the so-called «theory of contracts in information asymmetry», the information asymmetries between the guardianship (the state or a health insurance) and the care producer (the hospital) play a fundamental role in the determination of any resource allocation

and hospital pricing policy [17]. Indeed, in determining these policies, the regulator (or trustee) generally encounters two types of information asymmetries, as shown by [5]. The cost of production of hospitals is not perfectly observable and this therefore induces uncertainties which are of two types: moral hazard and anti-selection. These two health information asymmetries, stemming from the agency relationship, mainly refer to two major economists [1, 2]. It is about moral hazard according to [2] and anti-selection referred to [1]. Moral hazard is when the level of cost can be modified by the actions of the care producer unobservable by the regulator. Anti-selection occurs when the cost is variable without this variability being attributable to a particular action of the care producer [1].

The central problem summarized is: “the hospital is not spontaneously interested in revealing its possible strategy to the trusteeship; for its part, it is not in a position to know the in-

*Corresponding author: mansoum.ndiaye@cesag.edu.sn (Mansoum Ndiaye)

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formation that would be useful to allocate resources between hospitals in an optimal way” [15]. This legitimizes public intervention in order to seek greater efficiency and equity of access to hospital care. The intervention will consist in reducing these informational handicaps that exist between the different actors of the hospital system and that disturb its free functioning, leading to collective inefficiencies. In this respect, the rates of care must be adjusted to take account of these information asymmetries that directly impact costs. Because poorly adjusted hospital pricing policies negatively affect access to hospital care or compromise the quality of care, even leading to unnecessary care at the expense of the community. The difficulty stems from the fact that the guardianship has information problems: it cannot observe or control the efforts made by hospital staff to reduce costs [9]. She is also not well aware of the specific constraints that hospitals may face.

Thus, our problem is to exploit the following questions. How do information asymmetries between the actors of the hospital system manifest themselves? In the face of anti-selection, how can the guardianship ensure an optimal allocation of resources to hospitals and an adapted pricing policy? How to implement public regulatory policies and incentive or competitive market mechanisms that can neutralize information handicaps to ensure efficient production of hospitals?

To answer our research questions, our main objective is to analyze the effects of anti-selection between the state and hospitals for a and find mechanisms to reduce this anti-selection.

The plan of our article is organized as follows. The second section will present the literature review. The third section is devoted to a theoretical model that will analyze the anti-selection between the state and hospitals in Senegal. The fourth section will present the analysis model. The conclusion and implications of regulatory economic policies will complete our article.

2. Review of the Literature: Information Asymmetries in the Hospital Market

In this section on the examination of hospital market information asymmetries, we take the following approach. First, we will describe, in a general way, the existence of information asymmetries between the different actors of the hospital system. Then, we will analyze the inefficiencies of hospital pricing constituted by information asymmetries by studying on the one hand, hospital pricing and moral hazard, and hospital pricing and anti-selection on the other.

2.1. Information Asymmetries Between Actors

The field of hospitals quickly proved to be an area of experimentation for the new microeconomics, especially agency theory [11]. This activity would indeed be marked by uncertainty and information asymmetries. The application of the agency theory in a hospital setting constitutes a mode of operative analysis, to account for the relations between the different actors of this environment which are characterized by

asymmetries of information. The actors of the hospital system are generally composed of three categories: patients (who are also insured), producers (or providers) of care (which groups hospitals and health professionals: doctors, nurses, etc.) and the trusteeship or regulator (which may be the state or health insurance). The existence of information asymmetries between actors in the hospital system (patients, healthcare providers and insurers) disrupts the functioning of the hospital market and can lead to sub-optimal situations. We can consider the following information asymmetries: information asymmetry between patient and provider (physicians), information asymmetry between insurer and insured, and information asymmetry between providers and insurers.

2.1.1. The Asymmetry of Information Between Patient and Care Producer

In health care, providers (health facilities and physicians) have discretion in the choice of treatment provided to patients. It is therefore not easy for the financier or regulator to assess the exact content of each treatment, nor its relevance to needs and/or its quality [18].

Indeed, in a hospital, the patient is generally unaware of what he suffers and which is the most appropriate care for his disease, this remains an information hidden from the doctor that is moral hazard. In this case, the patient (mandator) delegates to the physician (mandator) the choice and intensity of care. He is also unable to fully assess the outcome of the treatment of the relative effectiveness of the prescribed treatment compared with other treatment.

Therefore, the physician can influence the consumption of care through induced demand effects [4]. The inducing effect of demand for care is by physicians and consists in encouraging patients to seek more care in hospitals during their therapeutic stay. This attitude of doctors, resulting from the informational advantage they hold on the patient's illness, is part of their objective to increase their income from their salaries with the revenues of the care fees. This phenomenon is more frequent in the case of pay-per-act or rates per act. This may result in a multiplication of consultation acts by doctors wishing to reach a certain level of income, or by the lengthening of the length of stay in hospitals.

Therefore, the remuneration of professionals for the act and the price of the act set, encourages the multiplication of these acts. The freedom of a patient to access all segments of the care system without first visiting a general practitioner (primary care provider) can lead to medical overconsumption. The self-prescription of technical acts by doctors with diagnostic equipment can also lead to overconsumption. The theory of supply-side demand induction is in line with empirical findings on waste in the health sector. For example, [12] note that health insurance controls in France thus reveal, in a number of cases, the repeated existence of unnecessary or redundant acts, Some of which could be explained by voluntary action by care producers responding to their income objective.

Although the supply-driven demand hypothesis is not empiric-

ically substantiated [12], it becomes a priori easy for hospitals to stimulate the demand for care and/or to play on the quality of care variable in order to capture a large number of patients and offer a larger volume of care for the same pathology.

In Senegal and in several African countries, this theory of demand induction due to the moral hazard of doctors is explained by the fact that hospitals are generally underfunded and operate largely on the revenues of the hospital. This policy of inducing the demand for care in hospitals is not compatible with the standard of living of these populations, which are largely made up of poor people. This may result in a decrease in the use of hospitals by these populations who prefer to take refuge in traditional medicine with traditional practitioners.

2.1.2. The Information Asymmetry Between Guardianship and Patient

According to the agency's theory, the guardianship (the insurer) does not generally have all the information about the patient's (the insured) state of health or his possible risks of becoming ill (this remains a hidden information of the insured), nor about his behaviour in relation to the risk of illness (this is a hidden action of the insured).

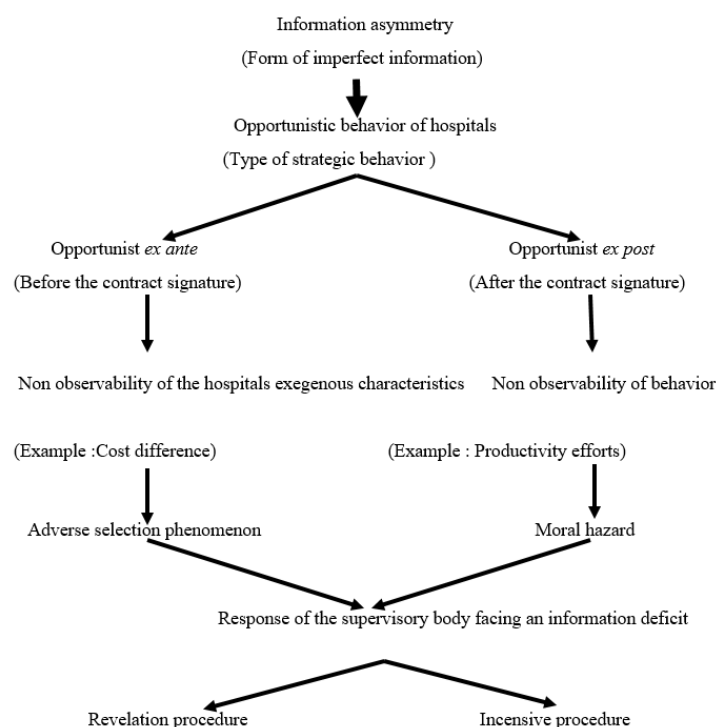
In the first case, we are talking about risk selection if patients with the highest risk of becoming ill seek the most comprehensive health coverage. In the second case, we have ex-ante moral hazard if, following the implementation of health coverage against the risk of disease, its probability of occurrence of a disease increases under the effect of voluntary behaviour of exposure to this disease or reduction of

self-protection and prevention practices on the part of the insured. We still talk about ex-post moral hazard to describe the fact that knowing that they are covered by health insurance, in the face of a given health problem, the insured and/or his doctor will adopt a behavior of recourse to more expensive hospital care (frequency of consultations, number of examinations, length of prescriptions...) only in the absence of this health insurance cover [4].

In total, we can conclude that the imperfect observability by insurers, both of the characteristics and of the behaviour of insured persons, can lead to ineffective balances (with possibly "skimming off risks" on the part of insurance companies) or even the lack of equilibrium in the hospital market.

2.1.3. The Information Asymmetry Between the Guardianship and the Care Producer

In this case, we will assume that the guardianship is the state or health insurance and that the care producer is a hospital or doctor. In the hospital market, there is information asymmetry between the trusteeship (or regulator) and hospitals when they are not in a situation of equivalent information, in quantity and/or quality, which is a source of viscosity, mistrust, and therefore inefficiency in the hospital market. Indeed, the economic literature reveals that these information asymmetries lead to a lack of awareness by the regulator of hospital productivity efforts (moral hazard) and differences in production costs between hospitals (anti-selection). In general, according to the theory of contracts, the asymmetry of information between the guardianship and hospitals can be schematized as follows.



Source: Author

Figure 1. The information asymmetry between the supervisory authority and the hospitals.

The analysis of this pattern is part of a more detailed description of information asymmetries (moral hazard and anti-selection) that are rife in the hospital market between the regulator and hospitals and remain a source of inefficiency in defining any hospital pricing policy. Indeed, the anti-selection interferes with the decision-making of the pricing and financing of guardianship and moral hazard prevents it from knowing how hospitals actually fulfill their part of the contract to ensure good productivity.

In this, the physician's competence, the care production function (including factor productivity) and the cost function of the hospital are unobservable characteristics for guardianship (hidden information from the hospital, i.e., anti-selection). Similarly, the effort of the doctor to seek the best diagnosis, the desire to reduce costs through a more efficient care organization are largely unobservable behaviors for the guardianship (hidden action of the hospital that is moral hazard) [4].

The strategic intervention of the regulator becomes indispensable and consists of incentive mechanisms that rely on disclosure and stimulation procedures to correct the informational defences that corrupt hospital pricing.

In summary, after tracing all the information asymmetries that exist between the different actors of the hospital system, we will focus only on the information asymmetry that exists between the guardianship and hospitals, to be able to study the effects of these information asymmetries on hospital financing. There are essentially two asymmetries of information that compel the supervision to monitor the characteristics of hospitals and observe their productivity behaviors, in the face of the determination of the system of hospital care pricing.

2.2. The Financing of Public Hospital and Anti-selection

In this part, we will successively examine the definition of anti-selection and the sources of heterogeneity of costs between hospitals, and then measure the consequences of this phenomenon on hospital pricing.

2.2.1. Definition of Anti-selection and Sources of Cost Heterogeneity

In contrast to moral hazard, in the case of anti-selection, uncertainty concerns production conditions over which the hospital has no control. The cost of production of a care facility may be influenced, for example, by the socio-cultural context in which it operates (whether it is the level of qualification of its staff or the precariousness or general condition of patients), by technological change or innovation in practice (often expensive at the beginning, when it is implemented experimentally, and sometimes more economical later) [10]. In this, in anti-selection, the cause of uncertainty is exogenous, that is to say, it does not belong to the hospital. Therefore, anti-selection is a situation where the level of the hospital's

cost of production is variable without this variability being attributable to any particular action by the hospital. Indeed, the level of the hospital's production cost is conditioned by exogenous determinants that are difficult to observe for the regulator.

Anti-selection refers to a perverse effect generated by an information asymmetry between the guardianship and the hospital. The trustee (the principal), who ignores the capacities of the hospital (the agent) that he must finance, gives him funding while it does not offer sufficient characteristics. It is therefore an ex-ante risk since the principal must face the strategic behavior of the agent before making his decision. The only solution is to induce the agent to reveal its main characteristics.

The perverse effect of anti-selection linking trusteeship and hospitals leads to an imperfect knowledge of the structure of production costs of hospitals, which is a source of heterogeneity of costs between hospitals. For a broader understanding of anti-selection, it is essential to understand the factors that are sources of heterogeneity in production costs between hospitals in order to provide appropriate and fair responses in hospital pricing and funding.

We mean by source of heterogeneity, any factor characterizing a hospital and likely to create consequences on the cost of hospital production [6]. The economic literature on factors that are sources of variations and differences in hospital costs is abundant. Among these factors that explain differences in hospital costs, we can consider: the size of the hospital, the economic situation of the hospital area, the volume of care production, the quality of care, the characteristics of the patients the category of the hospital (defined by its level occupied in the health pyramid), innovation of the technology used, innovation in matters of practices, the factors of production used by healthcare providers in a therapeutic operation, but also other factors specific to the hospital (such as teaching research activities, public or private status).

The sources of heterogeneity are of two kinds: they can be observable or unobservable. Observable heterogeneity results in "systematic uncertainty" on costs [6]. Unobservable (anti-selection) heterogeneity corresponds to "idiosyncratic uncertainty". The latter cannot be compared as it is hospital-specific (for example, organizational history of the hospital). It should be noted that the observable heterogeneity of costs may be related to differences in efficiency between hospitals.

However, the literature on hospital economics identifies many factors that can generate cost differences between hospitals with equal levels of efficiency [18]. Since these factors are often intimately linked to the hospital itself and a set of exogenous constraints rather than its membership in the public or private sector *stricto sensu*, there are different types of hospitals with as many associated cost profiles. The size of the hospital, its implantation area, the diversity of its range of activity, the difference in the characteristics of the patients

being treated. The quality of care provided, and production factors are recognized as contributing factors to differences in costs between hospitals.

It is accepted that some of the observed cost differences between health care institutions may be justified since all these factors are not necessarily controllable by hospitals, particularly in the public sector [13, 14].

With regard to exogenous factors, we can see that public hospitals operate in a constrained environment: they are not able to choose their location or control their “recruitment” of patients. In addition, they have little leeway to manage their size or strategic directions in terms of types of activities to be prioritized. All this influences their costs, regardless of the short-term efficiency of the hospital [7].

The analysis of the different sources of heterogeneity in production costs, especially those that are unobservable (anti-selection), reveals the permanent difficulties of the guardianship to control the structure of production costs of hospitals. This phenomenon of anti-selection therefore has important implications for the financing system of hospitals.

2.2.2. The Consequences of Anti-selection on the Financing of Public Hospitals

A relevant hospital financing system must take into account the heterogeneity between health facilities [8]. As in any resource allocation policy, anti-selection skews hospital pricing and leads to economic and financial inefficiencies. Indeed, when the guardianship faces an anti-selection problem, it cannot observe hospital characteristics such as production costs and finances hospitals on the basis of an announced and undisclosed cost. Therefore, the financing system of public hospitals defined by this guardianship, in the presence of anti-selection, has little connection with the production technologies of hospitals. The resulting disconnection between care fees and costs allows some hospitals to receive a pension.

Analysis of the economic literature shows that with anti-selection, tariffs must be adjusted to take into account factors, which are not always controllable by the guardianship and hospitals. In the presence of anti-selection, poorly adjusted pricing policies can negatively affect access to hospital care or compromise quality of service, even leading to unnecessary care at the expense of the community [18].

Indeed, in the presence of hospital heterogeneity, the disadvantages of a purely prospective pricing system are known: selection of patients, decrease in quality of care. To avoid these, many authors have advocated the use of a mixed pricing system that would combine flat-rate and observed cost reimbursement [8]. These two authors adopted an econometric analysis to define a pricing system that would take into account the heterogeneity of hospitals. To this end, they consider two possible forms of hospital pricing. The first pricing formula takes into account all unobserved heterogeneity between hospitals, provided it is constant over time. The second ignores any unobserved heterogeneity between hospitals. It is

the first form of pricing that seems preferable: it has the great advantage of providing extra funding to hospitals delivering high-quality care. One disadvantage of this system is that it leads to higher funding for hospitals which are permanently more expensive because of mismanagement. Finally, they conclude that the guardianship must choose between a payment that ignores all the unobserved heterogeneity among hospitals and a payment that finances all the unobserved heterogeneity.

Moreover, these authors maintain that the implementation of a mixed procedure of prospective and retrospective payment is desirable, but that it must take into account the specific effects of the hospital so as not to compensate for inefficiency.

Based on the age of patients, anti-screening can distort the hospital pricing system by leading to patient selection. Indeed, if the guardianship sets a rate too low (allowing for example the remuneration of the management of a given pathology for a young patient but not for an elderly person), providers facing the highest costs (those corresponding to the taking care of the elderly person), apparently the least performing, will not be able to cover their production costs even though this cost is lower than the consent to pay. Therefore, a risk of anti-selection can cause a selection of the most «profitable» patients. In this case, the solution is to set a tariff equal to the maximum possible level of cost. This leads to abandoning a pension to hospitals facing the lowest costs, apparently the most efficient.

Ultimately, in the presence of anti-selection, the use of a reimbursement by pathology causes undue rents for some hospitals and losses for others. The resulting consequences may be a reduction in the quality of care provided by hospitals and/or the bankruptcy of some hospitals.

In another analytical framework, it is essential to take into account the consequences of certain hospital heterogeneity between the public and private sectors. Because of the differences in pricing between public and private healthcare institutions, we cannot directly compare hospital cost differences. In this, the convergence of public/private hospital rates in the context of activity-based pricing by identifying sources of variations in hospital costs [18]. This analysis can be understood since anti-selection creates inequalities in terms of prices and quality of care between the public and private sectors. In Senegal, for example, this seems to be even more essential in terms of the prices and quality of care offered, as public hospitals are particularly competitive with a strong presence of the private for-profit sector.

We can recall that hospital pricing is a victim of inefficiencies and inefficiencies due to the presence of moral hazard and anti-selection. More generally, moral hazard and anti-selection are simultaneous in the hospital pricing process. Indeed, the guardianship observes the cost but does not know if a high cost is a sign of poor exogenous production conditions or on the contrary of lax behavior of hospitals. In practice, the regulator still has instruments to reduce these

asymmetries of information and observation allowing it to refine its information on costs.

We can look at the hospital system in Senegal to study the anti-selection that exists between the state and hospitals.

2.3. Hospital Pricing and Anti-selection in Senegal

In Senegal, anti-selection is manifested by the heterogeneity of production costs in public hospitals that are not observable by the state and are characteristics that do not depend on the action of hospitals. The heterogeneity of these costs is explained by several exogenous factors such as the category or size of the hospital defined in the health pyramid, the economic situation of the area, its socio-cultural context and the standard of living of the population where the hospital is located, the volume of hospital care output (often equated to the number of patients treated), the quality of patient care provided, the vulnerability of patients in an area, the age of patients, the presence of certain diseases in certain areas (such as malaria in the valley), level of qualification and staff numbers at the hospital, technological evolution or innovation in practices, specialization of hospitals for treating a disease, etc.

In terms of the hospital category, for example, a level 2 hospital located in the Dakar region does not have the same cost-of-production structure as a level 2 hospital located in a rural area such as Louga. The hospitals in Dakar have a large volume of production of care due to the high population density of this region, which may explain the high level of production costs of these hospitals. However, these hospitals in Dakar, which meet a high demand for patient care, at the same time increase their financial revenues from the pricing of hospital services.

Regarding the quality of care, it can be noted that the reference hospitals (all concentrated in Dakar), offer quality care to patients at high rates. This is the case of the Principal hospital in Dakar, which remains the reference hospital with special pricing and attracts, in general, the wealthy population thus constituting a source of impoverishment for poor patients obliged to be treated in this structure, where we see a selection of patients.

The specialization of a hospital for the treatment of a disease causes a difference in cost of production compared to other hospitals, due to the high attractiveness of this hospital for patients suffering from this particular disease. In Senegal, we can consider for this purpose the Mental Health Center «Dalal Xeel» of Thiès which welcomes and treats only the mentally ill.

In short, with anti-selection, all these factors that are not always controllable, plunge the state into an uncertain universe where it cannot effectively know the structure of hospital costs to allocate an optimal budget to the hospital allowing it to define a good system of hospital pricing. In Senegal, the cost of production of hospitals includes the var-

ious hospital expenses which are mainly constituted by operating expenses, investment, maintenance and largely by expenses for hospital staff.

The hospital in its objective of increasing its budget, always seeks to maximize its production cost that it presents to the state to obtain a large budgetary envelope. Therefore, the optimal strategy of the state is to put in place mechanisms to force the hospital to reveal information on its production costs and budgetary needs, based on incentive contracts.

After this review of the economic literature, we will present a theoretical model to better analyze the information asymmetry that exists in the hospital sector.

If we consider the age of patients, we find in Senegal a hospital responsible for collecting and treating only children: it is the Albert Royal Hospital in Dakar. The cost of production of this hospital is therefore lower than that of hospitals treating both elderly and children.

3. The Model

We will draw inspiration from the model of [18] to consider a hospital system in which the guardianship (which may be the state or health insurance) must regulate a public hospital in order to neutralize the anti-selection. Three main actors are considered in this system: the hospital, the state which makes a contract with the hospital and patients.

In this, the state which must regulate the activity of a hospital treating patients for a given pathology with a view to setting up a good financing system. The activity of this hospital can be variously represented by the number of patients treated. Indeed, the main obstacle of the state to this regulation is the existence of information asymmetries linked to the cost of production of the hospital. It is necessary to consider more generally that the two types of information asymmetries are simultaneous: the State observes the cost of production of the hospital but does not know if a high cost is a sign of poor exogenous production conditions (anti-selection) or, on the contrary, lax hospital behaviour (moral hazard).

In practice, to focus our analysis, we will assume that the information asymmetry in which the State is located is related to the parameter of productivity of the hospital and the effort to reduce costs. This is what a large section of the economic literature has been interested in case the company has a better knowledge of its production costs than the guardianship [3]. We will make a number of assumptions about the hospital, patients and the state to better support our analysis.

3.1. The Hypotheses of the Analysis

We assume that patients are not insured in the hospital so their demand for care is elastic relative to rates of care. The patient care demand function is therefore governed by an inverse demand function with P being the cost of care and x being the hospital's production volume of care which is the number of patients treated. The hospital provides a public

service that is sold to patients at P rate. The hospital's monetary income, i.e., hospital revenues, are therefore equal to $R(x)$.

$$R(x) = P(x) \cdot x \quad (1)$$

We believe that in its negotiation with the hospital, the State renounces these hospital revenues generated by the pricing of care. These revenues are used to cover the hospital's budget deficit. The surplus of patients is therefore written:

$$S(x) = \int_0^x P(s)ds - P \cdot x \quad (2)$$

For the hospital, suppose that the unit cost of a pathology is endogenous and equal to $\theta - e$ where θ is a productivity parameter which is a private information of the hospital and which can be assimilated to the technology of the hospital and (e) the level of the effort to reduce costs, which are unobservable by the State. It should be noted that this effort to reduce the cost, generates and causes a disuse at the hospital whose monetary evaluation is: $\varphi(e)$, the function $\varphi(\cdot)$ being assumed increasing and convex, ie $\varphi'(\cdot) > 0$ and $\varphi''(\cdot) > 0$. The total cost of production in the hospital which is observable, ex-post by the State is therefore written:

$$C(\theta, e, x) = (\theta - e)x \quad (3)$$

We assume that this observable cost can be reimbursed by the state. However, the same cost can be achieved by different combinations of θ and e depending on the number of patients treated. Thus, if the hospital has a low parameter θ , it can announce that it is high to achieve a cost C with lower effort.

The hospital is therefore regulated by the State, which pays it additional transfers representing the budget (B) to cover its observed production cost. The state therefore determines a monetary compensation structure to encourage the hospital to ensure good production while improving the quality of care provided to patients. So, we assume that the financing of transfers by the State is done by making compulsory levies which generate distortions in society (since the transfers are generally not lump-sum). These distortions jointly define the opportunity cost of public funds [17]. That is, $\lambda > 0$, the opportunity cost of public funds. It is reasonable to assume that any transfer or budget (B) entails a social cost λB , so transfers made by the state to the hospital must be multiplied by $(1+\lambda)$. In this case, the net surplus of patients is written:

$$V(x) = S(x) - (1 + \lambda)B$$

and that of the hospital is: $U(x, e) = B + R(x) - C(\theta, e, x) - \varphi(e)$.

The state enters into a contract with the hospital by maximizing social welfare (the surplus of patients and that of the whole hospital) under a constraint of individual rationality of the hospital ensuring that the latter participates. This con-

straint implies that if the hospital participates, it then obtains at least a utility greater than the alternative utility U (that is the perceived utility when it does not participate), this alternative utility being normalized to zero. The constraint of individual rationality is therefore written $U \geq \bar{U}$, that is to say $U \geq 0$. The social surplus is thus written:

$$\begin{aligned} W &= V + U = S(x) + R(x) - (1 + \lambda)B + B - C(\theta, e, x) - \varphi(e) \\ &= S(x) + R(x) - C(\theta, e, x) - \varphi(e) - \lambda B \end{aligned}$$

Thus, the program of de maximisation is:

$$\begin{cases} \text{Max}_{x,e} W = S(x) + R(x) - C(\theta, e, x) - \varphi(e) - \lambda B \\ S.C \quad U \geq 0 \end{cases}$$

3.2. Optimal Regulation in Perfect Information

Consider the first allocation that the State could achieve if it could observe the parameter of activity of the hospital and the level of activity of cost reduction defined by: $e = \theta - \frac{C}{x}$. Notating by: $c = \frac{C}{x}$ the average cost, we have: $e = \theta - c$. Then this first-rank allowance is defined as the State:

- 1) leaves a nil pension in the hospital, that is to say: $B^* + R(x^*) = C(\theta, e^*, x^*) + \varphi(e^*)$. In this case, the constraint of the hospital is saturated: it will treat a number of patients so that the sum of its monetary income can cover its production and effort costs;
- 2) Orders the hospital a level of reduction effort (e^*) given by: $\varphi'(e^*) = x^*$. The hospital achieves an optimal level of effort recommended by the State so that its effort-related marginal disutility equals optimum production;
- 3) and imposes on the hospital a pricing system defined by: $T = P(x^*) = (\theta - e) - S'(x^*)$.

The hospital will always treat a number of patients such that the price of care is equal to the difference between the unit cost of a disease and the increase in the surplus of patients caused by the treatment of an additional patient.

As we are in the presence of a fixed-price contract where the state observes the cost of the hospital and reimburses it in the form of a budget. The optimal solution for the State is to define a contract allowing the budget to be allocated according to cost such as:

$$B(C) = \varphi'(e^*) - (C - C^*), \text{ with } C^* = (\theta - e^*)x^*$$

In this contract, the hospital is always obliged to choose an optimal effort (e^*) to have a consistent budget that can cover its production cost. It is now important to consider the regulation of the hospital in a more realistic situation characterized by the information asymmetry between the state and the hospital.

3.3. Optimal Regulation in the Presence of Information Asymmetry

In a situation of information asymmetry where the State can neither observe the parameter (θ), nor the effort to reduce costs (e) of the hospital. On the other hand, we can consider that it observes the cost of production C a posteriori, that it knows the functional form of $\varphi(\cdot)$ and has beliefs about θ . Indeed, the State does not know the exact value of the parameter θ but it nevertheless knows that this parameter is derived by a law of density $f(\theta)$ and of distribution function F defined on a support $[\underline{\theta}, \bar{\theta}]$ and the support being common knowledge. Based on this assumption, we can define a number of elements related to the uncertainty of the productivity parameter (θ) such as the expectation, risk and chance rate of this parameter.

- 1) The expected value of θ is: $E(\theta) = \frac{\underline{\theta} + \bar{\theta}}{2}$
- 2) The variance of θ is equal: $\vartheta(\theta) = \frac{(\bar{\theta} - \underline{\theta})^2}{12}$
- 3) The random rate of the parameter (θ) is defined by:

$$h(\theta) = \frac{f(\theta)}{1 - F(\theta)}$$

In this context of information asymmetry, the hospital always seeks to make an effort under optimal cost reduction and to announce a value ($\hat{\theta}$) higher than the real value of (θ), thus overestimating its cost with a view to increasing the budget envelope received from the State. It will be assumed that in this situation of asymmetry of information, the State renounces the hospital revenues generated by the pricing of care.

Note by $v(\theta)$ the utility obtained by the hospital at the optimum if it announces the true value (θ) of its parameter, without lying to the State. The utility $v(\theta)$ can be conceived as the informational rent of the hospital. We will assume that this rent is a growing function of the parameter, it means that we have: $\frac{dv}{d\theta} > 0$.

Let us now define the individual rationality constraint (IRC) which ensures that the hospital finds an interest in participating in its relationship with the state. We will assume that this constraint is taken independently of the parameter; this amounts to assuming that private information is relevant only in its relationship with the state. As a result, the hospital obtains a utility greater than or equal to its reservation utility, that is, what it could best obtain outside of its relationship with the state. We can normalize the booking utility to zero. This allows us to write the individual rationality constraint of the hospital:

$$v(\theta) \geq 0, \forall \theta$$

Taking into account the growth of function v , the constraint of individual rationality is therefore reduced to: $v(\underline{\theta}) \geq 0$ which must also be saturated since the financing of the budget is costly for the State.

If the hospital announces a high value of (θ), it gains a benefit from its private information. Thus, the hospital can claim to announce a value ($\hat{\theta}$) that is greater than (θ). For this reason, we can add an incentive constraint to mitigate any false announcement from the hospital. This constraint ensures that if the hospital announces a true value of its parameter, it obtains at least as much utility as any false announcement. It can therefore be written:

$$B(\theta) - C(\theta) - \varphi(\theta - c(\theta)) \geq B(\hat{\theta}) - c(\hat{\theta}) - \varphi(\theta - c(\hat{\theta})) \quad \forall \theta, \forall \hat{\theta}$$

This revealing mechanism states that for any budget obtained by the hospital by announcing ($\hat{\theta}$), it must bear the cost reduction effort ($\theta - c(\hat{\theta})$) to reach the cost of production $C(\hat{\theta})$. Hence, we obtain:

$$v'(\theta) = -\varphi'(\theta - c(\theta))$$

It should be noted that a first consequence of this equation is that the annuity v becomes a decreasing function of θ . This means that if the hospital claims to advertise a high value of θ in order to increase its budget then it obtains a low annuity. In this case, the hospital has no incentive to overestimate its productivity parameter. Since this yield of information must be positive or nil, in order to fulfil the constraint of individual rationality, the State will therefore fix: $v(\bar{\theta}) = 0$. As always, the hospital receives a nil annuity if it announces a different value of θ . Thus, by integrating, the hospital's informational pension can be written:

$$v(\theta) = \int_{\theta}^{\bar{\theta}} \varphi'(u - c(u)) du = \int_{\theta}^{\bar{\theta}} \varphi'(e(u)) du$$

Now we can rewrite social welfare as follows:

$$\begin{aligned} W &= S - C - \varphi(e) - \lambda B = S - C - \varphi(e) - \lambda(v + C + \varphi(e)) \\ &= S - \lambda v - (1 + \lambda)(C + \varphi(e)) \end{aligned}$$

Thus, the objective of the State is to choose to cover the cost $C(\cdot)$ of the hospital, from the budget provided, in order to maximize:

$$\begin{aligned} \text{Max } EW &= \int_{\underline{\theta}}^{\bar{\theta}} [S - \lambda \int_{\underline{\theta}}^{\bar{\theta}} \varphi'(u - c(u)) du - (1 + \lambda) \\ &\quad \lambda)(C(\theta) + \varphi(\theta - c(\theta)))] f(\theta) d\theta \end{aligned}$$

Under the constraints:

$$v(\theta) \geq 0, \forall \theta \text{ (C.R.I)}$$

$$B(\theta) - C(\theta) - \varphi(\theta - c(\theta)) \geq B(\hat{\theta}) - C(\hat{\theta}) - \varphi(\theta - c(\hat{\theta})) \quad \forall \theta, \forall \hat{\theta} \quad (C.I)$$

3.4. Presentation and Analysis of Results

This problem of maximization can be solved by applying the Fubini theorem or simply after integrations by parts and then making point-by-point maximizations. In doing so, by noting the effort by: $e(\theta) = \theta - c(\theta)$, we obtain the following results:

$$C^*(\theta) = (\theta - e^*(\theta))x^*$$

$$v^*(\theta) = \int_{\theta}^{\bar{\theta}} \varphi'(e^*(u)) du$$

$$\varphi'(\theta - c^*(\theta)) = \varphi'(e^*(\theta)) = x^* - \frac{\lambda}{1+\lambda} \frac{F(\theta)}{f(\theta)} \varphi''(e^*(\theta))$$

$$B^*(\theta) = \varphi(e^*(\theta)) + v^*(\theta)$$

Analysis of the results shows that:

- 1) the effort is sub-optimal, that is to say: $e(\theta) \leq e^*$ because the first-rank optimum effort is defined by $\varphi'(e^*) = x^*$ whereas in a second-rank situation we notice that $\varphi'(e^*(\theta)) < x^*$;
- 2) the cost equation shows that the hospital with a lower productivity parameter will try to define its cost on the socially optimal effort. For the hospital that has a higher parameter, we can create a distortion by requiring the hospital to have less effort and a higher cost (thus representing productive inefficiency): the effort required decreases with the productivity parameter (θ);
- 3) the hospital with the lowest parameter will get the highest pension while the hospital with the highest parameter has no pension.

In this case the hospital will not be interested to announce a high value.

4. Conclusion and Implications of Economic Policies

The objective of our study was to analyze the information asymmetry that exists between the state and public hospitals in Senegal. The effects of information asymmetry between the State and hospitals are well known: this may consist for the State in non-observability for effort to reduce the costs of hospital production (moral hazard) but also to a lack of knowledge of the formation of costs in the hospital and only a statistical knowledge of the charges in the hospital environment (anti-selection).

The use of a theoretical model inspired by that of [16] to highlight hospital regulation has led to a number of important results. Indeed, by symmetry to the mechanism of [3], the

optimal solution consists in introducing a distortion in the cost reduction effort required to achieve an arbitrage between productive efficiency and the extraction of the hospital's rent. These results lead to the definition of an optimal contract that can be implemented by a menu of linear contracts but also non-linear contracts. The use of a menu of non-linear contracts for hospital funding is consistent with a cost reimbursement policy (such as the overall envelope policy) while a menu of linear contracts is modelled on the fixed-price pricing system (for example, by pathology or activity). We can recall that in the presence of information asymmetry between the state and hospitals, several mechanisms to reduce information asymmetry must be adopted to ensure a good system of pricing and financing of hospitals.

As lessons learned, we can conclude that in asymmetric information, regulation faces a dilemma:

- 1) to encourage the hospital to adopt the most efficient techniques of care production and to make the necessary productivity efforts (productive efficiency) while preserving the general interest of the community. Productive efficiency is achieved as follows. If the cost of production is endogenous (i.e., in the presence of a cost reduction effort), care production must be carried out at the minimum cost (such that the marginal disutility of the cost reduction effort equals the marginal cost reduction).
- 2) or, restore the optimal allocation of hospital resources (allocative efficiency) while minimizing the distorting effects of public interventions. Allocative efficiency is when the amount of care produced by the hospital is such that its marginal cost equals the social marginal benefit.

Author Contributions

Mansoum Ndiaye is the sole author. The author read and approved the final manuscript.

Conflicts of Interest

The author (Mansoum Ndiaye) declares no conflicts of interest regarding the publication of this paper.

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