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by

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Objective
We investigate sources of imperfect information in the medical service provision, due to vertical integration, by the Japanese hospital industry under the current reimbursement system with the national health care program.
Data Sources/Study Setting
We use three different survey data for this analysis. The first, the Iryo Shisetsu Jittai Chosa:ISJC ("Statistic Survey of Medical Facility in English"), is the 1993 medical facility survey of 9,896 hospitals. The second, the Byoin Houkoku Chosa:BHC ("Survey of Hospital Report in English"), is the 1993 hospital employee survey of 9,844 hospitals. The third, the Local Government Enterprise Almanac:LGEA, Vol.39, Hospital Association of Local Government Financing is the 1993 cost and financing survey of 987 hospitals.
Data Collection/Extraction Methods
In this study, we merge 2 hospital survey data (ISJC and BHC) so as to obtain the data relevant for this study. We then examine three types of hospitals: managed geriatric, general geriatric, and general hospitals. We then selected the in-patients and outpatients in those hospitals. Regarding hospital cost and inefficiency, the establishment of hospitals is categorized as municipal hospitals administered by the national and local governments. We include general hospitals without and those with psychiatric, tuberculosis and/or infectious disease facilities, but we exclude specialized hospitals dealing with psychiatric illness, tuberculosis, infectious disease, cancer and rehabilitation.
Study Design
We use a logit model for the regression analysis concerning the choice of reimbursement between the capitation and the fee-for-service programs. We then use an extended Cobb-Douglas frontier cost function for evaluating information on vertical integration, communication and collaboration, and non-price competition. Finally, we use a tobit model with heteroskedasticity for evaluating information on vertical integration, and on government control and funds, in terms of cost inefficiency .
Principal Findings
The hospitals with more sophisticated medical equipments and larger facilities are more likely to choose the fee-for-service program. The fee-for-service program with the point system induces the hospitals to increase quality and quantity of health and medical services that leads to non-price competition, thus forcing the hospitals to become vertically integrated. An increase in cost inefficiency is attributable to emergency services and the inverse occupancy rate, which pertains to weak physician affiliation with hospitals, and the lack of close communication between hospitals and clinics. An increase in the drug margin ratio and the government subsidies lead to a lager fund balance. This helps in raising capitalization, which eventually leads to imperfect information through the vertical integration of hospitals, by providing a larger range of health and medical services.
Conclusions
Between the choice of fee-for-service and capitation programs with the point system under the Japanese national health care system, well-staffed and well-equipped hospitals will choose the fee-for-service reimbursement program. The fee-for-service program induces hospitals to become quality oriented because of non-price competition that eventually becomes vertically integrated. This monopolistic power stems from vertical integration, which tends to create a shortage of information on hospital services to the public.

Key Words: Imperfect information, Fee-for-service, Communication & collaboration, Reimbursement, Subsidy

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The traditional economic theory begins with the assumption of perfect information. From the view of health economics consumers, namely patients, providers of medical and health care services are fully informed about prices, quantity of services, and medical and health inputs. However, if we try to understand health care markets, this assumption is not a realistic one because of the information gap that exists between patients and providers. This situation is caused by problems of asymmetric information since consumers and providers have different levels of information. Potential problems especially stem from the patients' lack of information, which creates consumer medical illiteracy.

The present Japanese point program, a uniform fee schedule, under the national health care system has helped to ensure equitable accessibility to health and medical services. However, the lack of information on these medical and health care services, that is, limited information to the public, often leads to the covering up for misdiagnoses, mis-treatments, unnecessary services, over-utilization of drugs, and excessive charges by medical and health care service providers. This means the patients do not receive appropriate medical and health care services. It can be said that the problem of asymmetric information is directly related to the quality of medical and health care services.

Asymmetric information, especially from the patient side, shows that patients are relatively knowledgeable about some health care problems. However, it is worth considering that patients do not face a very difficult situation in obtaining general information about health care delivery and about the choice of a physician. In Japan, information on medical and health care services is not usually open to the public. For example, the Medical Accident Investigation

Committee, a private organization composed of physicians and lawyers, sampled 250 medical accident cases from 1996 through to March 1999. Of this number, 195 were malpractice suit cases, and of which, 133 were death cases. None of these cases were referred to other institutions for a second opinion. There is no referral system between patients and physicians. Neither are physicians affiliated with hospitals. This situation makes it more difficult for patients to look for other treatments, physicians and institutions. Under these circumstances, quality of medical and health care services is not easily monitored.

The consequences of poor quality medical and health care services are very severe yet information regarding treatments remains very costly for the consumers. Thus, under the asymmetric information patients often rely on a variety of countervailing arrangements that are intended to reduce risk. Lately, the Ministry of Health and Welfare had decided to allow patients to require reimbursement details of treatments from physicians in 1998. However, the process of opening medical and health care treatment information to the public is still slow. Physicians still monopolize treatment information. There still exists the lack of communication between physicians and patients, as well as the problem of asymmetric information that creates consumer medical illiteracy.

In this paper we focus on the provider side of medical and health care services, especially on hospitals, in order to examine an aspect of the information flow in terms of: (1) non-price competition caused by the current point program of the reimbursement system, (2) lack of collaboration and communication among hospitals through vertical integration, (3) fund balance objective of drug reimbursement, and (4) government subsidies and capitalization influencing vertical integration under the national health care system. Our analysis has at least two contributions in the literature. First, by incorporating aggregate data with micro level data we carefully differentiate factors of the sources of lack of information that cause inefficiency of health care services. Second, we will discuss policy-related information flow in the hospital industry.

BACKGROUND

The insurance system in Japan consists of five insurers under government supervision. Government-managed Health Insurance covers employees at places of work (mainly small and medium sized enterprises) where no Social Health Insurance management is established (30.2% of population). Social Health Insurance covers employees at places of work (mainly large enterprises, or enterprises with 300 or more employees) where it is established (25.6%). Seamen's Insurance covers seamen, and those working on ships/boats (0.3%). Mutual Aid Associations' Insurance covers national public service employees, local public service employees, and private school teachers and employees (9.3%). National Health Insurance covers people who are not covered by employee insurance (farmers, the self-employed, carpenters, doctors, employees of small businesses, etc.) and retirees formerly under the employees' insurance and their dependents (34.6%).[1]

Medical service providers follow a reimbursement schedule using a point system as set by the Japan Ministry of Health and Welfare. The reimbursement price is based on a unified point system that is applicable to all medical service providers, regardless of the type of health insurance cover. The role of the point system is to generate enough revenues to recover the costs incurred. Each item of medical service is assigned a certain number of points, and providers are reimbursed a sum of total points multiplied by 10 yen (approximately 10 cents assuming one dollar equals 100 yen) under the fee-for-service basis.

The point system is classified into thirteen service categories: medication, injections, examination, hospital service, general treatment, radiology, mental treatment, anesthesia, basic consultation, home care, image diagnosis, operation and physiotherapy. The Ministry of Health and Welfare imposes stringent price controls for the skilled type of services, like injections, general treatment, consultation and operation. On the other hand, under the fee-for-service basis, it allows for more generous reimbursement prices for material types of services, like medication and examination (Yamada, Yamada, Fahs, Kim and Noguch,1998).

Within these groups there are further classifications. For example, an initial consultation is accorded 195 points; nursing in hospitals is accorded 318 points; injection ranges from 15 to 150 points, depending on the skill required. As an exception, the medication points are awarded 1 point per 15 yen and this is the material purchasing price plus the prescription, which is 74 points per unit. These changes in points are dependent on whether the patients are children, adults, or the elderly, the degree of skill required, the quantity of material needed and the patient's length of treatment. The government reimbursement price consists of these complicated pricing classifications on a fee-for-service basis.

The following is a brief description of the Japanese hospital system. The total number of hospitals is about 10,100. Private hospitals constitute 72% of these, with a total bed share of about 54 percent.[2] These private hospitals are prohibited from operating for profit, and chief executives must be physicians. Their capital investments are not restricted except for the recently regulated bed expansions (Ikegami, 1992). According to the Local Government Enterprise Law, public hospitals are recommended to run on break even. However, they are allowed to run at a loss in view of the social welfare policy. The local government compensates them for such losses from the general and social accounts (Chino, 1995). The number of general hospitals is about 9,000, the rest being psychiatric, tuberculosis treatment, infectious diseases treatment, leprosy treatment and other long-term care hospitals. Hospitals with less than 100 beds number about 4,500 while those with more than 100 are about 5,600.

Clinics number a total of 82,000. Private clinics share is about 84 percent with a 96 percent of total bed share. The remaining number are public clinics. A clinic is defined as having a less than 20-bed capacity and is legally prohibited to hold a patient for more than 48 hours, except under special circumstances.[3] Unlike the United States, Japanese physicians in the clinics do not have access to hospital facilities because they are not affiliated with the hospital system. The physicians in the clinics must refer all patients needing care, whom they cannot legally and physically provide for within their own premises. Thus, both clinics and hospitals compete for patients. Recently, patients have increasingly been turning to large public hospitals because of the remarkable gap in human resources, such as physicians, pharmacists, nurses, and other medical staffs, and in facilities, such as capital assets and medical equipments per bed, between hospitals and clinics.

In the United States, a prospective reimbursement system based on diagnosis-related groups (DRGs) was instituted in 1984 by the Health Care Financing Administration (HCFA) for Medicare inpatient hospital services. Unlike the U.S. Medicare system, the Japanese system is a partially prospective payment system for hospital services. The general health insurance program for those under the age of 65 with the fee-for-service and the Elderly Health Insurance Program (EHIP) for the age of 65 and over has two types: the FFS, a retrospective cost-based method of reimbursement with the point system, and the CAP, a prospective reimbursement with the same point system.[4]

The Ministry of Health and Welfare introduced a new reimbursement system that was incorporated to the existing fee-for-service system in 1990. The new system is a partial capitation system for elderly care in hospital. Hospitals can employ the capitation program if they fulfill the government requirements on personnel and facilities for long-term care and if they also get an approval for a prefectural government. After being accredited, the hospitals have the option of choosing either the capitation system or fee-for-service system as reimbursement for the elderly care given. The former covers four types of hospital services for elderly health care: medicine, injection, examination, and nursing. The latter, a retrospective cost-based reimbursement under the current government-regulated point system, covers all other services.

Hospital services under the capitation program are classified into four categories: medication, injection, examinations, and inpatient care including nursing care. These services come under the name of managed medical hospitalization treatment. As the capitation program is in its early trial stage, all hospital services are not subject to the program. The Japanese government has not fully implemented capitation, and hospital services other than the four above-mentioned service categories are still provided with points under the fee-for-service program.

Revision of fees and medical fee schedule decisions are important factors in alleviating or accelerating problems that are related to medical and health care expenditures. The Ministry of Health and Welfare determines the rates and the Central Social Insurance Medical Council determines allocation methods in the decision making for the fee schedule. The Central Social

Insurance Council is composed of representatives from the medical community (physicians, dentists and pharmacists), and the insurance community as well as the insured and those representing public interest. The calculation method used is the sliding cost method but no specific calculation method is disclosed. For example, the simplified sliding cost method consists of the expense items: physician's technical fee (physician's fee), which is adjusted to the rate of GDP increase, personnel expenses of other staff, which are adjusted to the workers' wage index, expenses of materials, which are adjusted to the consumer price index, and, medicine expenses which are adjusted to the revised rate of drug prices. The physician's technical fee (physician's fee), which can be divided into fees for medicines and other supplies, is equal to the technology index multiplied by both actual working hours and wage per unit hour. Regional price differences are introduced as regional extra fee. Technical differences/extra fees are legally established for special medical technology and treatments, amenities, etc. (Nishimura, 1997).

Government protection exist in the form of subsidies, the drug reimbursement pricing policy, and other regulations. Under the National Health Insurance System, physicians are able to use only the medicines approved by the Ministry of Health and Welfare, and are included in the list covered by health insurance. Together, these create a non-competitive environment in the hospital industry. With the assistance of these protective barriers, non-profit hospitals or public hospitals, often become involved in either over-capitalization and/or under-utilization of medical resources (Eakin, 1991). The cost inefficiency attitude is further exacerbated by less stringent profit constraints for public hospitals. For example, in recent years, nearly 90 percent of the sampled public hospitals were in the red as compared to the 45 percent or less of private hospitals (Yamada, Yamada, Ogura and Suzuki,1999).[5] The non-competitive environment seems responsible for the cost inefficiency of public hospitals.

METHOD OF EMPIRICAL STUDY

Regression Models

In this paper, we are concerned with hospital behavior in the short run. We assume that a hospital is concerned with information given to the public. Also, we assume that information to the public affects consumer welfare, i.e., patients. "Information" includes the following: (1) physicians, nurses, and other medical personnel per bed, (2) facilities and equipment per bed, (3) reimbursement, or the reimbursement details of treatments, (4) drug margin ratio, (5) subsidies from the governments, both national and local, and, (6) other hospital-related characteristics. The hospital adjusts its medical and health care services to improve its quality and positive fund balance. The above-mentioned information (1), (2) and (3) pertains to quality of hospital services while information (4) and (5) pertains to the fund balance, which depends on the number of patients treated and input costs.

A hospital faces a choice between the capitation program and the fee-for-service program. The capitation reimbursement is made based on a lump sum health care per person per day. This gives the hospital an incentive not to provide health care beyond the maximum reimbursement per person per day. On the other hand, a cost-based fee-for-service has a positive influence on providing beyond some optimal level. In this framework, we also assume that physicians have no direct role in changing the reimbursement rate under the Japanese government point system. However, in our model, physicians can make the decision in choosing either the capitation program or the fee-for-service program as the reimbursement plan. Physicians in Japan are normally salary-based employees, although they allow for the hospital's interest on the surplus of the fund balance and the patient's interest in services, which augment consumer welfare. The current fee-for-service system with non-price competition induces the hospital to become vertically integrated. This, in turn, creates a monopolistic power. Thus, imperfect information can be attributed to the monopolistic power of the hospital.

The following is **a regression equation for the choice of reimbursement** between the capitation program and the fee-for-service program. The factors used to evaluate hospital vertical integration includes the following: (1) number of outpatients and inpatients, (2) human resources, (3) equipments and facilities, (4) other services, and (5) relative competition.

Physicians control and coordinate the delivery of medical and health care services, given a level of resources and the market environment. Also, hospital behavior tends to reveal their economic objective through physicians' decisions. We are interested especially in how the fee-for-service program with the current point system, that is, the reimbursement rates under the National Health Insurance System is related to a hospital vertical integration. The specification using our logit model is as follows (the subscript i is omitted for brevity):

Capitation or Fee-for-Service by hospital "i" = α_0 + α_1Patients + α_2Human Resources +

α_3Equipments and Facilities + α_4Other Services + α_5Relative Competition +

$\Sigma_j \alpha_j$other factors + u [1].

The variables in this logit model are defined in Table 1. u is a random term with zero mean and a constant variance. The focus of the analysis is on how these factors influence the hospital decision regarding the reimbursement program. We then group the variables. Quantity of patients (outpatients and inpatients) affects the choice of the program because the quantitative variation of patients make the steady balance fund stream difficult (Yamada, Yamada, Ogura and Suzuki, (1999). Under the point program of the current fee-for-service system, the Ministry of Health and Welfare sets a fixed fee for each item of medical service. In other words, the price of medical and health care service is predetermined for the hospital. Thus, non-price competition induces the hospital to increase quality of services to consumers by providing vertically integrated services. In this way, the hospital tries to optimize costs of production by increasing human resources, i.e. medical personnel, equipment, and facilities. The cost-based fee-for-service reimbursement has an advantage over the capitation reimbursement since the hospitals have more freedom for sophisticated medical equipment. Consequently, the hospitals are able to meet their economic objectives such as the quality of services, and a non-negative fund balance.

For **the hospital cost regression** equation, we used an extended Cobb-Douglas frontier cost function. In this regression we examine the factors that reveal information on vertical integration, communication, collaboration, and non-price competition (The subscript i is omitted for brevity.).

Costs of hospital "i" = $\beta_0 + \beta_1$Information of Vertical Integration + β_2Communication and Collaboration + β_3Non-Price Competition + $\Sigma_k \beta_k$other factors + v [2].

The variables in this hospital cost function are defined in Table 3. v is a composite error term, defined as: $v = v_1 + e$. v_1 is the identically, independently and normally distributed (i.i.d) random term with zero mean and a constant variance. e is the inefficiency component, which is assumed to be truncated at zero and is identically, independently and normally distributed with a positive mean and a constant variance (Greene, 1993; Lovell, 1993; Battese and Coelli, 1995).

The rationale for including the variables in the model may be found in similar studies in the existing literature. Thus, only the variables of interest are discussed. A decision of hospital services may be generated by the factors and the production processes influenced by the hospital decision-making staff. Therefore, intensity in some underlying production function is embodied in services expected to be correlated with each other. The production endogeneity requires an instrumental variable approach (Breyer, 1987). The output endogeneity also requires an instrumental variable approach. To estimate the quantity of inpatients, the following variables are included: hospital types, both specialized and emergency beds as a percent of total beds, severity, drug utilization, and the numbers of doctors, nurses, pharmacists, laboratory technicians, radiation technicians and X-ray technicians.

Based on the assumption of linear homogeneity in input prices, the total cost and input prices are divided by the price of materials. Utilization of various types of medical personnel depends on skill-mixed inputs of human resources. Therefore, we predict the labor input prices by using the instrument variables of the average experiences of doctors, nurses, associate nurses, clerk and administrative workers, other employees and their average ages. The price of capital is defined in both real depreciation and interest payments per bed.

Concerning hospital inpatient outputs, the inpatient days or length of hospital stay is influenced by the decision-making staff. Further, hospital output decisions may be generated through factors and the cost of production. Therefore, vertical integration in some underlying production function is embodied in outputs expected to be correlated with cost inefficiency. We use a dummy variable to differentiate a general hospital from a hospital with psychiatric, tuberculosis and infectious disease facilities. We also use another dummy variable, a teaching hospital, to capture capital integration information.

To evaluate communication and collaboration, we use proxy variables such as an emergency hospital that requires communication and collaboration to operate efficiently. The variable, inverse occupation rate, reflects the uncertainty of the facility to be filled. That is, the larger the inverse occupancy rate is, the lower the probability for hospitals to accept emergency patients, the less communication and collaboration there is in the hospital operation. An urban dummy reflects characteristics of the geographic and hospital environment. A hospital location in a more competitive urban area reveals non-price competition under the point system. Non-price competition is attributable to quality services that induces the hospital to equip with better facilities using capital. The hospital then becomes more vertically integrated with a monopolistic power, and with less information given to the public. We also include variables that reflect non-price competition, e.g., government standards for bed, nurse and meal.

To examine the factors affecting **hospital cost inefficiency** related to the information of vertical integration, and government controls, we use a frontier inefficiency residual e_i by hospital i, such that $E(e_i)$. This is defined as follows (the subscript i is omitted for brevity):

$E(e_i)$ of hospital "i" = $\mu_0 + \mu_1$Information of Vertical Integration + μ_2Government Control and Funds + μ_3Severity + w [3].

The variables in this Tobit model are defined in Table 3. "w" is a stochastic error term affected by factors not measured. Since $E(e_i)$ has a truncated standard normal distribution, we use a truncated Tobit model to avoid biased estimates (Greene, 1993; Dor, 1994; Skinner, 1994). We note that the residuals tend to be heteroskedastic and the regressors are often multi-collinear. We then correct for multicollinearity. Having a condition index number of 26, which is less than 30, we can note that no harmful multicollinearity exists in our estimation (Kennedy, 1998). We employ a Tobit model with heteroskedasticity to correct for heteroskedasticity.

Equation (3) should not include the same variables as those in equation (2) for specification purposes (Vitaliano, 1994) and should rather emphasize information of vertical integration, and the government control and fund. The second-stage regression includes variables that affect efficiency by using variables of input resources. Although Dranove (1998) emphasizes a positive correlation between hospital size and the quality of care, we use the number of beds as proxy for evaluating vertical integration of capital inputs; and, a nonlinear specification of the number of beds (i.e., beds, squared and cubed) is used to evaluate hospital vertical integration in our model. Other variables include the number of doctors, nurses, radiation, X-ray and laboratory technicians, and clerk and administrative workers, per 100 beds. This is done because a higher staffing of medical personnel through vertical integration reflects the quality aspect of medical and health care services provided by the hospital.

Data

In this study, regarding the choice between the capitation program or the fee-for-service program for vertical integration, we use three different survey data. The first, the Iryo Shisetsu Jittai Chosa ("Statistic Survey of Medical Facility in English"), is the 1993 medical facility survey of 9,896 hospitals. The second, the Byoin Houkoku Chosa ("Survey of Hospital Report in English"), is the 1993 hospital employee survey of 9,844 hospitals. The third, the Shakai Iryo Shinryo Koibetsu Chosa ("Survey of Medical Treatments"), is the 1994 medical services survey of 311,292 patients.

We merge the first 2 hospital survey data so as to obtain the data relevant for this study. We then examine three types of hospitals: managed geriatric, general geriatric, and general hospitals. We then selected the in-patients and outpatients in those hospitals, whose age is 65 and over.

Regarding the study on hospital cost and inefficiency, we use "The Local Government Enterprise Almanac, Vol.39, Hospital, Association of Local Government Financing, 1993" as the data source for this analysis. The establishment of hospitals is categorized as municipal hospitals administered by the national and local governments. There were 987 municipal hospitals in 1993, 722 of these returned the survey made by the Japan Hospital Federation. Of this 722 municipal hospitals, we include general hospitals without and those with psychiatric, tuberculosis and/or infectious disease facilities, but we exclude specialized hospitals dealing with psychiatric illness, tuberculosis, infectious disease, cancer and rehabilitation. Our sample size is consequently reduced to 657 municipal hospitals, with a given allowance the missing data necessary to this study.

Each hospital in our sample provides the following information: existing facilities, loss and/or surplus, balance sheet, financial flows, various costs of management, which include medical and non-medical expenses, costs and revenues of services, average salaries, and experiences and ages of various medical and non-medical personnel (see Tables 1 and 3 for the definitions of the variables used in this study). The number of beds in these municipal hospitals ranges from 20 to 1028 beds, with a mean of about 215 beds per hospital.

EMPIRICAL RESULTS

Results of the Choice Between the Fee-For-Service or Capitation

The empirical results for the model, i.e., Equation 1, regarding the choice between the fee-for-service and the capitation programs are presented in Table 2. Given a level of human resources, equipments and facilities, and other factors, a hospital is more likely to choose the cost-based fee-for-service program with an increase in inpatients. A less volatile number of inpatients in the hospital is important for decision makers to maintain a positive fund balance under the fee-for-service program. The positive sign of outpatients indicates that decision makers are less likely to use the fee-for-service program for outpatients by a fixed lump sum on health care per person per day.

The effect of human resources shows a clear distinction between physicians and pharmacists, and the group of nurses (nurses, associate nurses and assistant nurses). An increase in the number of physicians and pharmacists make it more likely for decision makers to select the fee-for-service program. Physicians usually provide skilled type of services, such as administering injection, general treatment, consultation and operation, and are more likely to be suitable for the cost-based fee-for-service program. Moreover, physicians are more likely to lead to a closer integration of physician and hospital services.

The negative sign of pharmacists indicates that they contribute to a positive fund balance by prescribing more drugs under the fee-for-service. The Japanese government allows for generous reimbursement prices for material-type services, i.e. prescription of drugs. The large difference between the government drug reimbursement price and the cost of drugs from pharmaceutical companies gives incentives to hospitals to prescribe more drugs to patients.

For many of the parameter estimates of equipments and facilities, the variables are negative and statistically significant. The result implies that the more sophisticated medical equipments and the larger facilities there are, the more likely the choice of the fee-for-service program. Thus, the results show that there exists a positive relationship between more inpatients, more medical personnel, especially physicians and pharmacists, more equipment and larger facilities. This relationship is likely to be attributable to the cost-based fee-for-service program. The point program itself induces the hospital to increase quality of medical and health care services, namely, non-price competition, thus forcing the hospital to become vertically integrated. The Japanese medical and health care system under the National Health Insurance System tends to cause vertical integration that results in the monopolistic power of the hospital. This situation is likely to create asymmetric information and relatively poorly informed patients, i.e. consumers. Furthermore, the largely integrated hospital needs less communication and collaboration with other clinics and hospitals.

Results of Hospital Cost Function

Table 4 provides the results of the hospital cost function, used to evaluate aspects of vertical integration, and communication and collaboration. As for the patients, i.e., numbers of inpatient and outpatient visits, the estimated coefficients of the inpatient visits and inpatient cubed are statistically significant. From the negative coefficients of inpatient, we are able to infer that a hospital is relatively large scale with diminishing total costs by a diminishing rate. Regarding the number of outpatient visits, we obtain a positive coefficient for outpatient visits, a negative one for squared outpatient visits and a positive coefficient for cubed outpatient visits. On the other hand, total costs increase at a diminishing rate as the outputs expand, then eventually increase at an increasing rate. These positive values indicate that the average Japanese municipal hospital enjoys the declining average costs on the left side of the U-shaped average cost curve.[6] Thus, the results show that the hospital delivers medical and health care services through a vertically integrated structure. A large-sized hospital, as its structure becomes vertically integrated, benefits in that it is able to reduce transaction costs, or the costs of controlling and coordinating the delivery of medical and health care services. The structure involves the collection of information about patients and about the different supply of components of medical and health care services. The Japanese medical and health care delivery system, under the cost-based fee-for-service with the point program system, deters the promotion of communication and collaboration among clinics and hospitals.

We now turn to the regression estimates for communication and collaboration in Table 4. The provision of emergency services also engenders a hospital to face higher total costs because a hospital with an emergency department needs a large medical staff, more equipment and facilities to cope with emergencies. In Japan, physician hospital affiliation arrangements are weak. Efficient utilization of emergency beds and a hospital through a physician's affiliation could possibly lighten the heavy burden of operation costs. Thus, close communication and collaboration with physicians in other clinics and hospitals are important.

The effect of inverse occupation on the hospital cost function is positive and it reflects the attitude of the hospital in coping with uncertainty. That is, the larger the inverse occupancy rate is, the higher the probability for the hospital to accept emergency patients. In other words, keeping a relatively high occupancy rate by developing physician-hospital affiliation agreements will contribute to cost efficiency.

With regard to hospital location, the hospitals in the urban areas experience much higher total costs than those in the rural areas. The competitive urban environment causes a hospital to be vertically integrated to meet patient demand for quality medical and health care services. This induces non-price competition. Thus, in urban areas, the hospital is vertically integrated with sophisticated equipment. This integration enhancement in turn makes the hospitals monopolistic medical and health care providers with a variety of services. This monopolistic power is able to reduce information available to the public. The cost-based fee-for-service reimbursement program also induces the hospital to provide additional services in order to maintain its costly sophisticated equipment. Thus, the efficient utilization of equipment by expanding affiliation arrangements with physicians of other small clinics is the viable option for the largely integrated hospital.

Results of Hospital Cost Inefficiency

Now we turn to the analysis of hospital inefficiency in equation (3). The results, in Table 5, present semi-log coefficients of the factors affecting the cost inefficiency of hospital, based on a truncated regression of Tobit model. From the estimated results, we have three major inquiries to answer. First, is the size of hospital on an optimal level and does the size cause the vertical integration of hospital? Second, does the quality-seeking behavior of the hospital, under the present health care delivery system, have an optimal mix of medical and health care services? Finally, is there any evidence for the government protection to cause a hospital to have more services and be more cost inefficient?

Concerning our first inquiry on the size of hospital, the estimated coefficients of the number of beds show that as the size of hospital expands, cost inefficiency rises initially at a decreasing rate but eventually rises at an increasing rate. Minimum cost inefficiency is located somewhere in the range of 414 beds and 626 beds.[7] If we take the middle point between these two values, the average size of minimum cost inefficiency is about 520. Since the sample mean of beds per hospital is 214.14, the average municipal hospital seems to be not exhausting the economies of scale yet. Therefore, an increase in the size of hospital not only lowers the average cost but also increases the cost efficiency. The optimal size level is much larger than the current average hospital size. Thus, the development of vertical integration is cost efficient under the current fee-for-service with the point program, although the size of a general hospital, i.e., the number of beds, and medical staff are regulated by the Ministry of Health and Welfare.[8]

As for the second inquiry, we examine seven proxy variables for the quality of hospital services: doctor, nurse, pharmacist, technician I, technician II, and administration, all per 100 beds. Most of these variables except technician II are negative and statistically significant. The current level of human resources are not at an optimal mix. This indicates that Japanese hospitals seem to be under-employing medical staff. The results imply that an increase in the number of medical personnel may lead to levels of quality with efficiency if a hospital operates at an optimal level of resource input mix. The vertically integrated hospital is heavily furnished with medical equipment and other facilities as compared to its employed human resources. This is noted because the Japanese Medical Association currently controls the annual number of doctor certifications among new medical graduates and this directly affects hospital management in terms of the resource input mix.

We now turn to the third inquiry as to the government involvement in health care delivery. Two positive factors that cause hospital inefficiency are the drug margin ratio and the subsidies, as shown in Table 5. Concerning medicine, there are considerable differences in the actual reimbursement among individual patients. Because medication is a material type of service, the government provides generous reimbursement. Even though the medication fee is, in principle, determined under the point system, hospital revenue increases with more medicine or with larger doses prescribed in order to maintain the fund balance. Since the revenue from drug prescriptions to patients is one of the major revenue sources for Japanese hospitals, we examine the drug margin ratio, a proxy for the drug reimbursement price under government control within the National Health Insurance System. A rise in the drug-margin-ratio reimbursement may alter the resource input mix in the hospital because the larger the drug revenues are the more incentives there are for hospitals to prescribe more drugs to patients. The results confirm that the medical drug reimbursement policy, a type of government subsidy to hospitals, is also another way in understanding the supplier-induced demand under the fee-for-service program in Japan.

Another form of government involvement in the hospital industry is the subsidy from both national and local governments. A largely vertically integrated public hospital with sophisticated equipment through government subsidy must meet complex and intense treatment requirement. The Local Government Enterprise Law allows the public hospital to run at a loss, which is then compensated for by the government. Hence, municipal hospitals generally make their investments in sophisticated and complex machines and instruments in return for accepting and providing for all types of patients, as well as, meeting the complex and intense treatment requirements. The estimated result suggests that if the subsidy to an average municipal hospital were reduced by one million yen (approximately, $9.9 thousand per year), hospital cost inefficiency could be lowered by approximately 24%.[9]

POLICY IMPLICATIONS AND CONCLUSION

A common source of imperfect information is the lack of a competitive market. A characteristic of the health care sector is the problem of asymmetric information on the consumer side. Under the fee-for-service system with the point program of the Japanese National Health Insurance System, well-staffed and well-equipped hospitals choose the fee-for-service program over the capitation program. However, the fee-for-service program induces hospitals to become quality-oriented because of non-price competition. The hospital's objective is not only quality and a positive fund balance but also by further improving quality of medical and health care service for the consumer welfare. Through this process however the hospital is becoming vertically integrated and the hospital becomes vertically integrated. Insufficient information availability stems from this monopolistic power. The situation then reduces the competitiveness of the medical and health care service market, and deters to make medical and health care information more available to the public in Japan.

The over-capitalization and underemployment of the medical staff in the hospital industry caused by the fee-for-service program causes a great inefficiency of health care delivery. The current average hospital size(215 beds) is far smaller than the optimal level of hospital size (520 beds) because of vertical integration. An estimated cost inefficiency rate of hospital is about 22.48% on average due to vertical integration (see Table 6) under the current health care delivery system. An increase in hospital size through an increase in patients will be more efficient. A heavily equipped hospital and/or a full-utilization of equipment and facilities can be achieved by expanding and improving the current very weak hospital-affiliation agreements with physicians in clinics. Better communication and collaboration with physicians in other clinics and hospitals will lighten the heavy cost burden of medical equipment and facilities created by vertical integration through non-price competition under the current health care system.

Our empirical results show the underemployment of doctors, nurses and other types of medical staff in contrast to the heavily equipped hospital. An increase in the number of doctors and nurses raises cost efficiency. Inefficiency in hospitals may be caused by the control of

Japanese Medical Association on the annual number of doctor certifications granted for new medical graduates, which consequently increases the relative cost of hiring doctors. Thus, more competitive medical labor markets with less regulations are required in order to facilitate allocation and/or employment of medical staff in the Japanese hospital industry. A solution for underemployed medical staffs in a heavily equipped hospital is to develop affiliation agreements with physicians in clinics. The close communication and collaboration through a development of human resources networks would be helpful.

With regard to government protection of hospitals, an increase in the drug reimbursement price raises cost inefficiency of hospitals. This inefficiency can be attributed to the fee-for-service system with the point program. Hospitals and doctors can prescribe more drugs and injections to increase revenues in maintaining their fund balance. A transition of pharmaceutical services from hospitals to pharmacies by differentiating their roles in health care services will reduce a supply-side induced demand for pharmaceutical products, and hence this change would lower the expenditures on medical drugs, which account for 25% of the current total medical and health care expenditures.

Government subsidy motivates hospitals to become more vertically integrated and this facilitate non-price competition by emphasizing quality oriented competition among hospitals. Over-capitalization through a vertical integration results in inefficiency of cost operation in hospitals. Hence, if government subsidy to hospital can be monitored by an external committee, it is a viable option for health care delivery. In conclusion, the current Japanese reimbursement system, namely the fee-for-service system, internally incurs a vertical integration of hospital through quality oriented non-competition. In turn, this situation creates a monopolistic power of hospital medical and health care delivery, which leads consumers to be in medical illiteracy.

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NOTES

1 Health and Welfare Statistics Association. *Kokumin Eisei no Doko 1997* (The Trend of National Public Health 1997), Tokyo: 1997.

2 Social Insurance Agency of Japanese Government. *Outline of Social Insurance in Japan 1995*, Tokyo: 1996.

3 Sorifu Shakai Hoshoseido Shingikai Jimukyoku. *Shakai Hosho Tokei Nenpo 1995* (Social Security Yearbook 1995), Tokyo: 1996.

4 Health and Welfare Statistics Association. *Hoken to Nenkin no Doko 1997* (The Trend of Insurance and Pension 1997), Tokyo: 1997.

5 Yamada and Yamada (1999), and *Management Survey of Hospitals in Japan* (ed. the Japan Hospitals Federation, p.29, 1997) show 89.6% of the sampled 676 municipal hospitals (i.e., N = 676) are in the red in 1996, 86.6% (N = 711) in 1995, and 92.4% (N = 684) in 1994. On the other hand, a much less proportion of for-profit hospitals are in the red: 39.1% (N = 238) in 1996, 44.7% (N = 253) in 1995, and 45.7% (N = 219) in 1994.

6 Economies of scale in quantity are measured by 1-(∂log total costs/∂log patients). Gertler and Waldman (1992) state that the measurement of economies of scale depends on the quality of hospital services. We control the quality factors in the frontier cost function in this study.

7 Here, we set $\partial E(e_i)/\partial Bed = 0$ in equation (3) and Table 5 to solve for B. We obtain two values of Bed: 413.6 and 625.6, based on the estimated coefficients of beds, reported in Table 5.

8 For the number of beds in a general hospital, the Ministry of Health and Welfare evaluates size of an area on the basis of population within the vicinity of a hospital, the age composition of the population, and their risk of sickness.

9 The sample mean of real total costs of municipal hospital per year is 726.14 million yen (see Table 3). 726.14 x 0.0062 = 4.5 million yen, which is about $41 thousand ($1 = 110 yen) per year.

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Table 1: Definition of Variables for Table 2

Variable	Definition
Policy Factors	
Capitation	geriatric hospitals with capitation (i.e., managed geriatric hospitals) =1, otherwise =0. (Mean=0.614, S.D.=0.487)
Patients	
Outpatient	the number of outpatient admissions per month. (Mean=523.86, S.D.=549.70)
Inpatient	the number of inpatient admissions per month. (Mean=148.79, S.D.=127.70)
Human Resources	
Physician	the number of full-time physicians. (Mean=6.873, S.D.=4.805)
Pharmacist	the number of pharmacists. (Mean=2.407, S.D.=1.637)
Nurse	the number of nurses. (Mean=14.121, S.D.=13.832)
Asso-nurse	the number of associate nurses. (Mean=25.870, S.D.=20.218)
Assistant	the number of nursing assistants. (Mean=29.005, S.D.=29.179)
Radio-tech	the number of radiology technicians. (Mean=1.430, S.D.=1.107)
Lab-tech	the number of clinical laboratory technicians. (Mean=2.930, S.D.=1.858)
Nutritionist	he number of nutritionists. (Mean=2.951, S.D.=1.664)
Administration	the number of employees in an administrative department. (Mean=9.692, S.D.=7.131)
Equipments and Facilities	
Fiberscope(K)	the number of fiberscope of (upper) digestive tract. (Mean=3.568, S.D.=4.867)
High-energy(K)	the number of medical high-energy radiograph (or radiographic equipment). (Mean=1.973, S.D.=8.759)
Dialyzator	the number of renographic dialyzator. (Mean=1.687, S.D.=3.543)
Gene-bed	the number of general beds. (Mean=148.225, S.D.=126.278)
Geria-bed	the number of geriatric beds. (Mean=122.187, S.D.=119.598)
Ward	the size of ward in square meters. (Mean=2121.767, S.D.=1279.601)
Clinical	the size of clinical section in square meters. (Mean=666.894, S.D.=631.039)
Administration	the size of administrative section in square meters. (Mean=1086.015, S.D.=1009.303)
Other Services	
Ergotherapy	the number of patients treated in ergotherapy unit per month. (Mean=0.277, S.D.=0.448)
Psychiatric	the number of patients treated in psychiatric ergotherapy unit per month. (Mean=18.482, S.D.=159.887)
Geria-day-care	the number of patients treated in geriatric day-care unit per month. (Mean=19.912, S.D.=138.030)
Prescription	the number of prescriptions issued per week. (Mean=48.696, S.D.=179.893)
Relative Competition	
D1	district dummy =1 (Hokkaido and Touhoku), otherwise =0. (Mean=0.115, S.D.=0.320)
D2	district dummy =1 (North Kantou), otherwise =0. (Mean=0.046, S.D.=0.209)
D3	omitted district (East Kantou where includes Tokyo). (Mean=0.194, S.D.=0.396)
D4	district dummy =1 (Hokuriku), otherwise =0. (Mean=0.059, S.D.=0.235)
D5	district dummy =1 (Tokai), otherwise =0. (Mean=0.079, S.=S.D.=0.270)
D6	district dummy =1 (Kinki), otherwise =0. (Mean=0.121, S.D.=0.326)
D7	district dummy =1 (Chugoku), otherwise =0. (Mean=0.073, S.D.=0.261)
D8	district dummy =1 (Shikoku), otherwise =0. (Mean=0.082, S.D.=0.275)
D9	district dummy =1 (Kyushu and Okinawa), otherwise =0. (Mean=0.231, S.D.=0.422)

(Table 1 continued)

Severity Control Measure	
ICU	the average number of patients per bed in intensive care unit (ICU) per month. (Mean=2.118, S.D.=4.858)
ANESTHESIA	the number of general anesthesia administered per month. (Mean=2.018, S.D.=5.231)
FEMUR	the number of os femoris administered per month. (Mean=1.121, S.D.=0.757)
FIBERSCOPE	the frequency of usage per fiberscope of (upper) digestive tract per week. (Mean=1.372, S.D.=0.805)
DIGITAL-RADIO	the frequency of usage per digital radiography per week. (Mean=3.141, S.D.=31.229)
X-RAY CT	the frequency of usage per generally computed tomograph (X-ray (CT) per week. (Mean=11.832, S.D.=18.474)
MRI	the frequency of usage per nuclear magnetic resonator-tomograph (NMR-CT or MRI) per week. (Mean=2.636, S.D.=8.051)
BONE	the frequency of usage per bone-salt measuring apparatus (or Equipment) per week. (Mean=1.280, S.D.=3.00)
HIGH-ENERGY	the frequency of usage per high-energy medical radiograph (or radiographic equipment) per week. (Mean=1.018, S.D.=0.159)
Other Characteristics	
Private	hospitals run by private individual. (Mean=0.286, S.D.=0.452)
Emergency	emergency hospital for medical care treatment system =1, otherwise=0. (Mean=0.277, S.D.=0.448)

All means are original means.

Table 2: Choice of Fee-For-Service or Capitation
(Dependent Variable: Capitation)
(Logit Estimation)

Independent Variable	Estimated Coefficients	t-statistic
Patients		
Outpatient*	0.2209	1.833c
Inpatient*	-1.243	-3.022a
Human Resources		
Physician*	-0.8743	-1.744c
Pharmacist*	-1.193	-3.765a
Nurse*	1.432	6.052a
Asso-nurse*	1.439	3.389a
Assistant*	1.834	6.647a
Radio-tech*	-0.1144	-0.292
Lab-tech*	-0.4085	-0.983
Nutritionist*	0.0621	0.161
Administration*	0.2235	0.692
Equipments and Facilities		
Fiberscope(K)*	-0.6410	-1.883c
High-energy(K)*	-1.272	-0.982
Dialyzator*	-0.5825	-2.757a
Gene-bed*	0.4171	1.297
Geria-bed*	-0.2715	-1.801c
Ward*	-0.9622	-2.947a
Clinical*	0.0783	0.423
Administration*	-0.3273	-2.042b
Other Services		
Geria-day-care*	0.3959	2.223b
Psychiatric*	0.2779	1.894c
Relative Competition		
D1	0.4248	0.974
D2	1.103	1.793c
D4	1.017	1.810c
D5	0.1434	0.296
D6	0.8956	2.116b
D7	0.7008	1.221
D8	1.715	3.144a
D9	0.6679	1.720c

Number of observation = 546
R-squared = 0.388326
Log likelihood = -249.069

(i) * indicates natural logarithm.
(ii) a, b and c represent statistically significant coefficients at 1% , 5% and 10% significant levels, respectively.
(iii) The model includes Severity Control Measure (ICU, ANESTHESIA,FEMUR, FIBERSCOPE, DIGITAL-RADIO, X-RAY CT, MRI, BONE, HIGH-ENERGY), Other Services (Ergotheraphy and Prescription), and Other Characteristics (Private and Emergency).
Reference: Tetsuji Yamada and Tadashi Yamada (1999).

Table 3: Definitions of variables for Tables 4 and 5

Variable	Definition
Cost*	the real total costs per year. (Mean=726.14 million yen, S.D.=572.68)
Inefficiency*	the mean valuse of inefficiency. (Mean=0.2028, S.D.=0.064)
Information of Vertical Integration in Table 4	
Inpatient	the number of inpatients per day. (Mean=180.90, S.D.=97.13)
$Inpatient^2$	the number of inpatients per day-squared. (Mean=42147, S.D.=38525)
$Inpatient^3$*	the number of inpatients per day-cubed. (Mean=11193E+03, S.D.=14647E+03)
Outpatient	the number of outpatients per day. (Mean=458.74, S.D.=365.69)
$Outpatient^2$	the number of outpatients per day-squared. (Mean=34396E+01, S.D.=55198E+01)
$Outpatient^3$	the number of outpatients per day-cubed. (Mean=34518E+04, S.D.=947867E+04)
General	1 if a general hospital is without psychiatric, tuberculosis and/or infectious disease facilities and 0 if a general hospital has these facilities. (Mean=0.992, S.D.=0.087)
Teaching	1 if a hospital has facilities for teaching and training nurses and 0 otherwise. (Mean=0.079, S.D.=0.270)
Communication and Collaboration in Table 4	
Emergency	the number of beds for emergency patients. (Mean=6.465, S.D.=22.09)
Inverse.occup	the inverse of occupancy rate. (Mean=1.267, S.D.=0.341)
Urban	1 if a hospital is located in an urban area and 0 otherwise. (Mean=0.817, S.D.=0.386)
Non-Price Competition in Table 4	
Bed standard	1 if a hospital meets required government standard of quality of bed and 0 otherwise. (Mean=0.992, S.D.=0.087)
Nurse standard	1 if a hospital meets required government standard of quality of nurses and 0 otherwise. (Mean=0.673, S.D.=0.469)
Meal standard	1 if a hospital meets required government standard of quality of meals and 0 otherwise. (Mean=0.982, S.D.=0.134)
Other in Table 4	
Salary*	the real average annual salary per employee. (Mean=4.980 million yen, S.D.=7.296)
Capital*	the real depreciation and interest expenses per bed. (Mean=0.227 million yen, S.D.=0.127)
Information of Vertical Integration in Table 5	
Bed	the number of beds. (Mean=214.14, S.D.=168.00)
Bed^2	the number of beds-squared. (Mean=74035, S.D.=11412E+01)
Bed^3	the number of beds-cubed. (Mean=33842E+03, S.D.=82727E+03)
Doctor	the number of doctors per 100 beds. (Mean=8.722, S.D.=3.351)
Nurse	the number of nurses per 100 beds. (Mean=48.54, S.D.=13.72)
Pharmacist	the number of pharmacists per 100 beds. (Mean=3.557, S.D.=1.351)
Technician I	the number of radiation and X-ray technician per 100 beds. (Mean=2.438, S.D.=1.224)
Technician II	the number of laboratory technicians per 100 beds. (Mean=3.991, S.D.=1.900)
Administration	the number of clerk/administrative workers per 100 beds. (Mean=10.85, S.D.=4.466)
Government Control and Funds in Table 5	
Drug margin	the ratio of the amount of reimbursement from the government for prescribed drugs and injections to the costs incurred by the hospital, (%). (Mean=131.94, S.D.=10.684)
Subsidy	the subsidy by the governments per bed (1 million yen). (Mean=0.361, S.D.=0.589)
Severity in Table 5	
Examination	the number of examinations per 100 patients. (Mean=2048.2, S.D.=1076.5)
Radiology	the number of radiology units per 100 patients. (Mean=139.57, S.D.=148.13)
Operation	the number of operations per day. (Mean=0.784, S.D.=0.640)

(i) All means are original means. N=657.

(ii) * is a natural logarithm in the regression.

Table 4: Estimated Regression Results: Hospital Cost Function
(Parameter Estimate of Stochastic Frontier Cost Function)
(Maximum Likelihood Estimates)

Variable	Coefficient	t-Statistics
Information of Vertical Integration		
Inpatient	0.026E-01	2.082b
$Inpatient^2$	-0.081E-05	-0.328
$Inpatient^3$*	-0.054	-3.113a
Outpatient	0.036E-01	8.197a
$Outpatient^2$	-0.020E-04	-4.035a
$Outpatient^3$	0.041E-08	2.403b
General	-1.702	-8.862a
Teaching	0.174	2.267b
Communication and Collaboration		
Emergency	0.166E-02	2.131b
Inverse.occup	0.852E-01	1.924c
Urban	0.284	5.981a
Non-Price Competition		
Bed standard	0.189	1.104
Nurse standard	0.218	5.044a
Meal standard	0.525	3.497a
Other		
Salary	0.085	2.484b
Capital	0.151	5.339a
Constant	5.955	18.124a
Log likelihood	-305.598	
$\sigma u/\sigma v$	0.719	3.009a
σ	0.436	9.680a
Sample size	657	

(i) a, b and c represent statistically significant coefficients at 1%, 5% and 10% significant levels, respectively.
(ii) To complete the iteration for conversion, a variable ($Inpatient^3$*) is the log of $inpatient^3$. We use the cubed log form of the number of inpatient because the maximum likelihood estimation of the frontier cost function with the cubed non-log form of inpatient does not converge.

Table 5: Estimated Regression Results: Hospital Cost Inefficiency
(Dependent Variable: Estimated "e")
(Maximum Likelihood Estimates)

Variable	Coefficient	t-Statistics
Information of Vertical Integration		
Bed	0.684E-03	7.476a
Bed^2	-0.137E-05	-5.812a
Bed^3	0.879E-09	4.827a
Doctor	-0.053E-01	-5.976a
Nurse	-0.015E-01	-5.870a
Pharmacist	-0.055E-01	-2.852a
Technician I	-0.021E-01	-0.842
Technician II	0.032E-01	1.921c
Administration	-0.011E-01	-1.758c
Government Control and Funds		
Drug margin ratio	0.435E-03	2.262b
Subsidy	0.164	4.781c
Severity		
Examination	0.487E-05	2.212b
Radiology	0.104E-04	0.767
Operation	0.029E-01	0.751
Constant	0.193	6.427a
-2 Log likelihood	1042.232	
σ	0.050	36.248a
Sample size	657	

a, b and c represent statistically significant coefficients at1%, 5% and 10% significant levels, respectively.