SHIGA UNIVERSITY

CRR WORKING PAPER SERIES　A

Working Paper No. A-12

Behavioral Difference in Physicians in the Japanese Health Care System

Ryuta Ray Kato and Makoto Kakinaka

February　2009

Center for Risk Research
Faculty of Economics
SHIGA UNIVERSITY

1-1-1 BANBA, HIKONE,
SHIGA 522-8522, JAPAN

Behavioral Difference in Physicians in the Japanese Health Care System*

Ryuta Ray Kato†
Makoto Kakinaka‡

February 6, 2009

Abstract

This paper presents a theoretical framework to describe the behavior of physicians under the Japanese fee-for-service scheme by explicitly incorporating the behavioral difference between self-employed and hospital-employed physicians into the model. The results show that the overprovision or the underprovision of treatmens and procedures by self-employed physicians depends on the current fee-for-service scheme with the regulated price (point) system. This study also presents that a substantial decline in the number of hospital-employed physicians results in an increase in overwork or unpaid work of hospital-employed physicians as well as in a decrease in the health level of patients at hospital. This result could also be interpreted as a possible consequence of the reform of the Japanese trainee programme of physicians in 2004. This paper furthermore shows that as long as the number of patients treated by both types of physicians is identical, hospital-employed physicians attain lower utility with heavier workloads but give better medical services with the higher health level of patients than self-employed physicians do.

Key Words: self-employed physicians, hospital-employed physicians, Japanese health care system, fee-for-service, supply side cost sharing

JEL Classification: I10, I18

*We thank Donghun Kim, and all participants in Health Economics Workshop regularly held at Saku General Hospital, Nagano. We also thank participants in the workshop at the Institute of Statistical Research, Tokyo in April 2008 for their helpful comments and suggestions. The research fund by Promotion and Mutual Aid Corporation for Private Schools is acknowledged. Remaining errors are ours.

†Graduate School of International Relations, International University of Japan, 777 Kokusai-cho, Minami-Uonuma, Niigata 949-7277, Japan, and Department of Economics, University of Essex, Wivenhoe Park, Colchester, Essex, UK (email: kato@iuj.ac.jp).

‡Graduate School of International Relations, International University of Japan, 777 Kokusai-cho, Minami-Uonuma, Niigata 949-7277, Japan (email: kakinaka@iuj.ac.jp).

1 Introduction

This paper tries to present a theoretical framework to describe the optimal behavior of physicians under the Japanese fee-for-service scheme by explicitly considering the difference in the employment structure of physicians; self-employed and hospital-employed.

The supply side of the Japanese health care system can be characterized by the fee-for-service scheme with the regulated price (point) system as well as the difference in the employment structure of physicians; self-employed physicians and hospital-employed physicians. Wright (2007) has recently analyzed hospitals based on their ownership structure to explore the difference between private and public hospitals. In order to explore the supply side of the Japanese health care system, this paper focuses on the employment structure rather than the ownership structure, since it seems that the self-employed and the hospital-employed have been playing their own and thus different role on the supply side of medical services in Japan, and also that little difference can be found between private and public hospitals in terms of their behavior towards their patients in Japan.[1] Thus, the categorization based on the ownership structure would mislead us. Under the current fee-for service scheme, the most distinctive difference between the self-employed and the hospital-employed can be found in their income: Income of hospital-employed physicians is usually paid by salary thus fixed, while income of self-employed physicians depends on their choice of working hours, treatments, and procedures they provide to their patients. This implies that their behavior would be different from each other, and the behavioral difference between the self-employed and the hospital-employed should be considered in order to analyze the supply side of the Japanese health care system[2].

[1] The interaction or the contract between the hospital-employed physician and the hospital is commonly discussed in the literature. However, the main concern of this paper is with the description of the optimal behavior of the Japanese physicians, and the interaction is not considered. This is because we believe that the difference in the employment structure plays an important role under the current Japanese fee-for service, and also that the interaction or the contract between the hospital-employed physician and the hospital is negligible for the main purpose of this paper.

[2] It seems that self-employed physicians in Japan function as gatekeepers or home doctors as the GPs in the UK do. However, the main difference between Japan and the UK can be found in the fact that any patients in Japan do not need referrals by their home doctors or self-employed physicians who they usually visit due

This paper only considers the supply side of the Japanese health care system, and thus any issues related to the demand side such as a possibility of physician-induced demand and the interaction associated with asymmetric information between physicians and patients are not discussed. The main concern of this paper is to highlight the behavioral difference between the self-employed and the hospital-employed physicians under the current Japanese health care system, and in particular the effect of the publicly fixed prices by the government, or the point supply system of the public health care scheme is considered.

There are two issues this paper focuses on. The first issue is concerned with the behavior of physicians related to their profits under the current fee-for-service scheme with the publicly fixed price system; unnecessary treatments and procedures, and overprescription. The fee-for-service potentially gives physicians a financial incentive to provide unnecessary treatments and procedures to their patients, and also to overprescribe patients. A possibility of the over-provision of medical services under the fee-for-service scheme was already pointed out by Ellis and McGuire (1986) as X-inefficiency, and it is re-examined in the context of the optimal behavior of self-employed physicians in this paper. Notice that a high ratio of the cost of medical drugs to the total amount of medical expenditure is observed in the Japanese health care system. A possible reason to explain about this fact has been given in conjunction with the observation of the presence of a positive gap between the legitimately fixed price and the actual purchasing price of drugs supplied by pharmaceutical industries. This positive gap is so called 'yakka saeki', and the effect of the gap on the behavior of the self-employed is also investigated.

The other issue is concerned with the behavior of hospital-employed physicians. It has recently been argued that the reform of the trainee programme of physicians in 2004 resulted in a drastic decrease in the number of hospital-employed physicians particularly in the rural area, and also that it thus eventuated in an increase in workloads of each hospital-employed

to free accessibility of all kinds of medical services at any medical institutions such as general hospitals. Thus, it is a choice of patients in terms of physicians who patients want to obtain medical treatments and procedures from. Since the supply side is only considered in this paper, the role of self-employed physicians as gatekeepers or home doctors is not discussed.

physician. In order to discuss this issue, the concept of 'unpaid work' is applied in this paper (see, e.g., Bell and Hart (1999) and Pennenberg (2005)). In this paper unpaid work implies that working hours of hospital-employed physicians are not fully paid or compensated. Given the fact that hospital-employed physicians get paid by salary, the effect of an increase in workloads of each hospital-employed physician in association with a decrease in the total number of hospital-employed physicians in the same workplace is explored.

To streamline our analysis, it is assumed that both of the self-employed and the hospital-employed supply medical services by using two different inputs; labor and the non-labor input. In general several different types of treatments and procedure, and drugs are usually available to physicians, and their choice of these items is captured by the non-labor input.[3]

The results are summarized as follows. First of all, the over-provision or the under-provision of the non-labor input by self-employed physicians depends on the current fee-for-service scheme with the regulated price (point) system. If the current regulated point system generates positive (negative) marginal income by providing treatments and procedures or by prescribing drugs, then the over-provision (the under-provision) of the non-labor input always occurs. Since Kurasawa (1987) only discusses a case of a linear positive marginal income, this paper generalizes Kurasawa (1987). This paper also finds that the current Japanese point system could achieve the ideal situation from the patients' point of view although the current system is based on the fee-for-service. This result is different from Ellis and McGuire (1986), and this result can be interpreted as a rationale of regulation when the market is not fully competitive. This result implies that the current supply side of the Japanese health care system could result in a better situation compared to the prospective payment system with the DRG as long as the fully regulated points (prices) are correctly allocated to medical events. On the other hand, hospital-employed physicians always provide the optimal level of the non-labor input to their patients, and thus unnecessary treatments and procedures, or

[3]Choice of the non-labor inputs such as complicated treatments and procedures is obviously related to labor, and thus separation of labor and the non-labor input seems difficult. However, it is simply assumed in this paper that a separate decision is made simultanously, and this simplification makes our analysis clear.

overprescription never occurs among hospital-employed physicians even when unpaid work is observed among hospital-employed physicians. Secondly, if the over-provision of the non-labor input by self-employed physicians is observed, then the underprovision of labor by self-employed physicians also occurs. In other words, self-employed physicians compensate an induced decrease in their income by working less with an increase in their income generated by unnecessary treatments and procedures and/or overprescription. Thirdly, an increase in positive marginal income generated by the provision of treatments and procedures or by prescription of drugs reduces labor supply of self-employed physicians per patient, and the increase in the positive marginal income induces a further increase in the over-provision of the non-labor input by self-employed physicians, thus resulting in the more deterioration of health of self-employed physicians' patients. The existence of 'yakka saeki' can be interpreted as one of examples of this positive marginal income. However, the increase in positive marginal income stimulates labor supply of hospital-employed physicians per patient when hospitals use an increase in their profit generated by the increase in positive marginal income, in order to reduce unpaid work. Since hospital-employed physicians always provide the optimal level of the non-labor input to their patients, the increase in positive marginal income results in the improvement of health of hospital-employed physicians' patients. Fourthly, there is a critical value of the number of patients per physician in terms of a possibility of unpaid work of hospital-employed physicians. If the number of patients per physician becomes too large over the critical value, then unpaid work starts to exist. Since it is shown that the elimination of unpaid work always results in an increase in labor supply of hospital-employed physicians, this paper suggests that any government policies which reduce unpaid work would result in the improvement of health of patients if unpaid work exists among hospitals. As examined in this paper, if the presence of unpaid work is associated with a decrease in the number of physicians per patient (or an increase in the number of patients per physician) among hospitals, a government policy to increase the number of hospital-employed physicians could result in the improvement of health. Fifthly, an increase in the number of patients per self-employed physician induces a further increase in the over-provision of the non-labor input per patient as well as a decrease in labor supply per patient by self-employed physicians, and thus the increase in the number of patients results in deterioration of health of self-employed physicians' patients. However, the effect of an increase in the number of patients per on labor supply of hospital-employed physicians and thus on health of their patients is ambiguous. Finally, as long as the number of patients treated by both types of physicians is identical, hospital-employed physicians attain lower utility with heavier workloads but give better medical services with the higher health level of patients than self-employed physicians do. This implies that there is an incentive among physicians to become self-employed although they can provide better medical services as being hospital-employed under the same scheme. However, this paper does not take into account the difference in medical services provided by the self-employed and the hospital-employed, and in fact the self-employed and the hospital-employed have been playing a different role in an actual Japan. Thus, this result should be interpreted as pointing out a problem associated with similar treatment of two different groups of physicians under the current supply side of the Japanese health care system, and it rather suggests that the reform of the current supply side to distinguish the self-employed and the hospital-employed is needed in order to provide different medical services by the different groups of physicians.

The remaining of this paper is organized as follows. Section 2, and 3 briefly review the Japanese health care system, and the theoretical literature. In Section 4, theoretical models of the behavior of self-employed and hospital-employed physicians are presented separately with some discussions of the roles of 'yakka saeki' and unpaid work. Then, several important results are derived, and their related implications are also discussed. In the final section, some concluding remarks are provided.

2 The Japanese Health Care System

The demand side of the Japanese health care system can be characterized by the compulsory public health insurance and free access to all medical services. Free access implies that persons can obtain all consultations, medical treatments, and procedures at any medical institutions without referrals, and thus persons (patients) can decide where/when they visit to obtain medical services at any time. The public health insurance is compulsory, and it consists of several insurers[4]. All persons are forced to contribute to a body (insurer) of the public health insurance, depending on their employment. There are several bodies (insurers) for employees, and local governments provide the public health insurance for persons who are not insured by the bodies (insurers) for employees. All dependents and the retired persons are also insured. Almost all of medical services are covered by the public health insurance, and the cost of medical services, including medical drugs provided through medical institutions, is financed by the contributions of the public health insurance, public funds (taxes), and co-payments. The co-payment rate depends on age, but not on different insurers[5]. All insured persons can obtain almost all of medical services by paying a co-payment at any medical institutions at the time when they receive the services.

The supply side of the Japanese health care system can be characterized by the fee-for-service scheme[6] with the regulated prices (points) of the medical fee system as well as the difference in the employment structure of physicians. The Japanese medical fee system called 'Shinryo-hoshu Seido' employes a point method. Points are allocated to all treatments, procedures, and drugs covered by the public health insurance, and the points are fully controlled by the government. Since almost all of medical services are covered by the public health insurance, this implies that almost all of prices of medical services are regulated by the

[4]See Ihori, Kato, Kawade, and Bessho (2009), and Tokita (2002) for the detailed explanation about the Japanese health care system.

[5]The current co-payment rates are 20-30%.

[6]There have been several hospitals which moved to the prospective reimbursement scheme with the DPC (Diagnosis Procedure Combination), which is the Japan's specific DRG. However, many medical services are still reimbursed based on the fee-for-service scheme in Japan.

government, and prices, including labor income of physicians, are officially determined. The cost of all medical services covered by the public health insurance is reimbursed to physicians and hospitals based on the points[7]. Although the cost is fully reimbursed by the regulated price system, drugs and some services such as medical inspections are traded in the private market, and thus market prices for these items also exist apart from the regulated prices. This implies that there are financial incentives among hospitals and physicians to motive to use more profitable items if the whole sale prices are lower than the regulated prices.

In terms of physicians, they are categorized by being self-employed or hospital-employed. Note that the Japanese medical fee system does not treat them differently, and any physicians can be self-employed or hospital-employed as long as they are qualified as physicians. The most distinctive difference between the self-employed and the hospital-employed can be found in their income: Income of hospital-employed physicians is usually paid by salary thus fixed, while income of self-employed physicians depends on their choice of working hours, treatments, and procedures they provide to their patients. Although any insured persons can visit any medical institutions, they tend to visit self-employed physicians to obtain primary care, and it seems that self-employed physicians have been playing a role as gatekeepers. Thus, Japanese self-employed physicians could possibly be interpreted as if they have been functioning like GPs in the UK or home doctors in the US, and the study of the behavioral difference between the self-employed and the hospital-employed is important to understand the Japanese health care system.

3 Related Literature

As pointed out by Ellis and McGuire (1993), the theoretical literature was expanded through the development of the research on demand-side cost sharing in the 1970s and on supply-side

[7]A point counts for 10 Japanese yen. Thus, for instance, if a physician provides a medical treatment which earns 1,000 points to a patient, then the physician can claim 10,000 Japanese yen minus the amount of a co-payment paid by the patient to the patient's insurer.

cost sharing in the 1980s. In the discussion of demand-side cost sharing, the role of health insurance was focused, and the optimal behavior of patients was mainly studied. In 1980s research concerns in the theoretical literature shifted to the role of the supply-side, and the optimal behavior of providers of medical services was discussed in association with several supply-side reimbursement systems, such as the cost-based payment (fee-for-service) and the prospective payment systems.[8]

The seminal paper by Ellis and McGuire (1986), in their discussion of supply-side cost sharing, develops a theoretical framework for the behavior of physicians under two different reimbursement systems: the cost-based payment (fee-for-service) system and the prospective payment system. They show that the prospective payment system results in the under-provision of medical services, and also that a mixed reimbursement system of the cost-based and the prospective payment systems could achieve the first best. The following studies also discuss the mixed reimbursement system. Pope (1989) examines the role of the mixed system with the consideration of nonprice competition among hospitals. Ellis and McGuire (1990) consider both demand-side cost sharing and supply-side reimbursement systems and develop an analytical model with bargaining powers of patients and providers to capture the optimal combination of insurance and reimbursement systems.

Selden (1990) examines a capitation payment method and presents that the optimal medical plan is the combination of full insurance with a provider payment system that is a mixture of capitation and partial reimbursement of provider costs. Ma (1994) discusses the first best solution for the regulator in terms of reimbursement payment methods by considering the combination of cost reimbursement and prospective payment in a model of hospitals which are concerned about the quality and the cost of medical services. Moreover, Glazer and McGuire (1994) examine a mixture of prospective and reimbursement methods when there are two payers and one hospital in a stage game model, and Ma and McGuire

[8] Feldstein (1970) numerically points out that physicians have discretionary power to vary both the price and the quantity of medical services. In the studies on supply-side reimbursement systems, it has conventionally been assumed that physicians or providers are concerned with their or hospital's profits as well as patients' health.

(1997) propose a stage game-theoretic model in which there are a patient, a physician, and an insurer to discuss the optimal system under asymmetric information. Among these papers in the theoretical literature, an attention has been rarely paid to the cost-based payment system. Given that Ellis and McGuire (1986) have already showed that a mixed system could achieve the first best, and the US payment system moved from the cost-based reimbursement system to the prospective system in 1986, the inferiority of the cost-based reimbursement system has been commonly recognized.

Regarding theoretical studies on the Japanese health care system, Kurasawa (1987) develops an analytical framework, based on Nishimura (1987), in order to investigate the behavior of hospitals under the fee-for-service payment system. He shows that overprescription always occurs if there is a positive gap between the legitimately fixed price and the actual purchasing price. Tokita (1995) also discusses theoretical models to explain the specific issues in association with the Japanese health care system. Recently, Tokita (2002, 2004) summarizes the characteristics of the Japanese health care system and its policy reform. Chino (2006) also evaluates the Japanese health care system in terms of economic efficiency. Moreover, there have been many empirical studies on the Japanese health care system. For instance, Tokita (2004) discusses current issues mainly by using the micro data of medical receipts in hospitals, and Ohkusa and Sugawara (2005) apply the cost-effective analysis to the evaluation of health care and public health policies (see Ii and Bessho (2006) for empirical studies on the Japanese health care system).

To the best of our knowledge, no theoretical studies exist on the behavioral difference between self-employed and hospital-employed physicians in the Japanese health care system. The categorization of physicians based on the employment structure has not been employed yet. As pointed out by Sano and Kishida (2004) and Ii and Bessho (2006), the difference in the employment structure plays an important role on the supply side of medical services in Japan, and the development of theoretical models for the study on the supply side behavior under the current fee-for-service scheme is quite important to understand the Japanese health care system.

4 The Model

Suppose that there are two types of physicians, self-employed and hospital-employed physicians. Suppose also that all physicians have already made their decision in terms of their employment, so that they are either self-employed or hospital-employed. It is assumed that physicians have no opportunity to change their employment so that the possibility of changing their employment is not investigated in this paper.

Suppose that physicians have their own preference not only over income and leisure, but also over the health level of their patients,[9], and the utility function of both types of physicians is given by the following additive form:

$$U(y, L, H : \gamma) = u(y, L) + \gamma H, \tag{1}$$

where y, L, and H denote income, labor, and the payoff associated with the health level of their patients, respectively. $u(y, L)$ comes from the conventional income-labor relationship. For simplicity, this sub-utility term is assumed to be the quasi-linear form of $u(y, L) = y - c(L)$, where $c(L)$ is increasing and strictly convex. The second sub-utility term, γH, is concerned with physicians' benevolence over health of their own patients. The parameter γ represents the degree or weight of physicians' benevolence. A higher value of γ corresponds to a more benevolent physician in a sense that the physician attaches more importance of his/her own patients to his/her own utility.

To streamline our analysis, it is assumed that physicians can fully control the health level of each of their own patients by providing two inputs, working hours l and all other

[9] In order to highlight the behavioral difference between self-employed and hospital-employed physicians, preference of physicians is assumed to be expressed by (1), rather than being assumed to be over profits and health of patients. We believe that several distinctive features of the current Japanese health care system as well as the behavioral difference can be captured more clearly by (1). Regarding the conventional utility function of physicians, see Ellis and McGuire (1986) for instance.

possible inputs m. Note that l denotes labor supply per patient. All physicians are assumed to treat their patients equally, and thus $L = nl$, where n denotes the total number of their own patients. In general several different types of treatments and procedure, and drugs are usually available to physicians, and m includes all possible medical inputs per patient such as treatments, procedures, and drugs. Although it is generally difficult to define the amount of these medical inputs with a single indicator, it is simply assumed that all medical inputs for each patient can be measured and divided into the two types of medical inputs, l and m. Given the above arguments, the health level of a patient is given by:

$$h \equiv g(m)k(l), \tag{2}$$

where $k(l)$ is increasing and strictly concave with $lk''(l)/k'(l) < -1$, and $g(m)$ is strictly concave and unimodal with $g'(m) > 0$ for $m_t \in [0, m^{FB})$, $g'(m) = 0$ for $m = m^{FB}$, and $g'(m) < 0$ for $m > m^{FB}$. The assumption on $k(l)$ requires that health of each patient is improved by a rise in l, but its marginal increment is diminishing, and also that the sensitivity of the improvement of health in response to a change in l is not so small.

Similar to Ellis and McGuire (1986), Kurasawa (1987), and Nishimura (1987), the restriction on $g(m)$ implies that the health level is increasing in m if $m < m^{FB}$, and it is decreasing in m if $m > m^{FB}$. The value of m^{FB} is the ideal level of the non-labor medical input for patients (see Figure 1).[10] Notice that the assumption that $g'(m) < 0$ for $m > m^{FB}$ captures a possible situation in which physicians provide unnecessary treatments and procedures, or overprescribe to their own patients, since the provision of m over m^{FB} deteriorates health of their patients. Then, the over-provision of the non-labor medical input is defined as a situation where its amount is larger than the ideal level for patients, i.e., $m^{FB} < m$.

Suppose that the physicians' sub-payoff associated with their benevolence depends on

[10]Kurasawa (1987) and Nishimura (1987) introduce the same assumption on the relationship between the health level and medical inputs in the context of the Japanese medical care system. Ellis and McGuire (1986) also use the similar assumption on the relationship between benefits patients receive and the quantity of hospital services.

the health level of each of their own patients, $h = g(m)h(l)$, and the number of their own patients, n. Specifically, the physicians' sub-payoff is given by:

$$H \equiv hr(n) = g(m)k(l)r(n),$$

where $r(n)$ is assumed to be increasing and strictly concave. The assumption on $r(n)$ implies that a rise in n contributes to an increase in utility but its marginal increment is diminishing. n is assumed to be given exogenously, and the effect of the behavioral difference on n is not considered in this paper.

A distinctive feature of the Japanese public health care system on the supply side is that the prices of treatments, procedures, and drugs are all determined by the government through the point system.[11] Points are allocated to all medical treatments and procedures as well as drugs under the current public health care scheme[12]. A point is counted as 10 Japanese yen, and the total points are interpreted as the total revenue physicians or hospitals can obtain, since physicians or hospitals are reimbursed based on the total points which they earn by providing treatments and procedures as well as prescribing to patients. Since physicians do not get paid for their labor supply separately under the current point system, a payoff in association with their labor supply is interpreted as being included in the points. Since different treatments and procedures obviously involve different labor supply, the total revenue by providing m also depends on l. On the other hand, the total cost to provide m would not depend on the amount of labor supply, and it is simply assumed that the total amount of a monetary payoff per patient, R, is the difference between the total revenue and the total cost such that:

[11] In this system, not only all drugs but also all medical treatments and procedures have their own prices that are publicly fixed and are indexed by the point system. One point corresponds to 10 Japanese yen. For instance, if a physician gives her patient a medical treatment which has 5,000 points, then the physician can be reimbursed 50,000 Japanese yen through the public health care system.

[12] There exists some treatments and procedures which are not covered by the public health care scheme. However, except for very expensive treatments and procedures, almost all treatments and procedures are covered by the public health care scheme, and this paper ignores the treatments and procedures which are not covered by the public health care scheme.

$$R = p(l, m) - s(m), \tag{3}$$

where $p(l, m)$ and $s(m)$ denote the total revenue and the total cost, respectively. $p(l, m)$, is assumed to be increasing and strictly concave in l and m, and $s(m)$ is assumed to be increasing and convex in m. $p(l, m)$ is determined by the government, and the current point system of the supply side is characterized by $p(l, m)$. (3) expresses possible payment schemes: the fee-for-service scheme corresponds to $p_m \left(\equiv \frac{\partial p(l,m)}{\partial m}\right) > 0$, and the prospective payment scheme is expressed by $p_m = 0$. Note that (3) includes Kurasawa (1987) as a special case. Kurasawa (1987) discusses the effect of the presence of the positive margin generated by the provision of m under the assumption that the margin is the linear function of m, and his case is expressed such that:

$$R = p(l, m) - s(m) = p(m) - s(m) = \Delta m,$$

where $\Delta \geq 0$ denotes the difference between the marginal revenue and the marginal cost per patient[13]. If m is interpreted as the amount of only prescription of drugs, then Δ can also be interpreted as the difference between the actual purchasing price and the legitimately fixed price, which is often called 'yakka saeki'. Furthermore, $p_{lm} < 0$ is assumed in order to capture the Japanese point system. Under the current point scheme, the smaller amount of points is allocated to the same treatments and procedures when the amount of m increases beyond a critical value, in order to reduce national medical expenditure. Since the same treatments and procedures need the same amount of labor supply, $p_{lm} < 0$ is assumed. This assumption captures an aspect of the current supply side system[14].

[13] There are several studies which incorporate a margin to the physician in the fee-for-service (reimbursement) system. However, their concerns are rather with how to use the margin as a policy instrument, and the possibility of unnessary treatments and procedures is not their key issue. For instance, see Ma (1994) and Ma and McGuire (1997). Chalkley and Malcomson (1998) also discuss the financial surplus which the hospital can obtain.

[14] All possible medical inputs are assumed to be measured by a single indicator, m, and thus choice of different kinds of treatments, procedures, and drugs cannot be discussed in this paper. However, (3) implies that physcians would choose m which generates the largest monetary payoff among all possible treatments,

It should be mentioned that the behavior of patients is not incorporated into the model and thus this paper uses a partial equilibrium framework. This implies that issues related to the demand-side cost sharing such as health insurance cannot be discussed in this study.[15] However, as pointed out by Ellis and McGuire (1993), supply-side cost sharing would be superior to demand-side cost sharing in terms of risk sharing as well as cost controlling. Thus, this paper simply assume that patients are fully insured and they accept any medical treatments and procedures provided by their physician. Indeed, almost all medical events, except for particular treatments and procedures, are covered by the public health insurance in Japan, and it seems that patients often behave as if they lack the concept of the cost of medical services.

5 Physicians' Behavior

This section attempts to show how behaviors of self-employed and hospital-employed physicians are different. A crucial distinction between the two types is found in the employment structure or the different payment scheme. Self-employed physicians can determine their income by themselves by choosing the amount of labor supply as well as the non-labor input, while hospital-employed physicians follow predetermined income by hospitals and thus their income cannot be determined by themselves.

5.1 Self-Employed Physicians

This subsection examines the optimal behavior of self-employed physicians. Since they are self-employed, their (net) income is simply equal to the monetary payoff, which depends on

procedures, and drugs, since $p(l, m)$ is determined by the government under the current fee-for-service scheme with the point system.. The distortionary effect of the fixed price of the current fee-for-service scheme on choice of medical inputs by physcians is discussed in Kakinaka and Kato (2008b).

[15] Ellis and McGuire (1990) takes into account both demand-side cost sharing and supply-side cost sharing in order to discuss optimal health services in a mixed reimbursement system within a bargaining framework.

their decision on supply of labor and the non-labor medical input:

$$y = Rn = [p(l, m) - s(m)]n. \tag{4}$$

The objective of self-employed physicians is assumed to choose m and l such that (1) is maximized subject to the budget constraint (4). The first-order conditions are:

$$\gamma g'(m)k(l)r(n) = -n[p_m(l, m) - s_m(m)]; \tag{5a}$$

$$\gamma g(m)k'(l)r(n) = n[c'(nl) - p_l(l, m)]. \tag{5b}$$

The left hand side (LHS) corresponds to marginal utility related to benevolence. $p_m(l, m) - s_m(m)$ in (5a) is the marginal income per patient associated with an increase in m. Since an increase in m induces an increase in utility through both an increase in income and an increase in health of patients, self-employed physicians increase m up to the level where a marginal increase in income is offset by a marginal decrease in benevolent utility generated by deterioration of health of their patients, and the optimal level of m is determined in order to (5a). $c'(nl) - p_l(l, m)$ in (5b) is the marginal (net) cost associated with an increase in l. An increase in l induces an increase in marginal utility by $np_l(l, m) + \gamma g(m)k'(l)r(n)$, and the optimal l is determined at the level where marginal utility is equated with the marginal cost, $nc'(nl)$.

Let $m^* \equiv m^*(n, \gamma)$ and $l^* \equiv l^*(n, \gamma)$ denote the self-employed physicians' optimal level of the non-labor input and labor supply per patient, respectively, and let $h^*(n, \gamma) \equiv g(m^*)k(l^*)$ denote the resulting health level of patients. Then (5a) implies $g'(m^*) \lesseqgtr 0$ depending on $p_m(l^*, m^*) - s_m(m^*) \gtreqless 0$, and thus $m^{FB} \lesseqgtr m^*$ depends on the marginal revenue of m. Then the first result regarding the behavior of self-employed physicians in terms of the non-labor input m is presented as follows:

Proposition 1 *The optimal amount of the non-labor input by self-employed physicians such as treatments, procedures, and prescription depends on marginal income of it. If marginal in-*

come is positive (negative), then the over-provision (under-provision) of the non-labor input always occurs ($m^{FB} < m^*(m^{FB} > m^*)$). If the government sets $p(l,m)$ for its marginal revenue being equal to the marginal cost under the current system, then self-employed physicians provide the optimal level from the patients' point of view.

Note that $p(l,m)$ is the amount of allocated points to medical events, and it is regulated by the government in the current point system. Since $s(m)$, the cost of the provision of m, is determined by technology, or purely medical reasons, the marginal income $(p_m(l,m) - s_m(m))$ is solely determined by the government. Since the fee-for-service scheme is expressed by $p_m > 0$, the current Japanese supply side system, which is characterized by the fee-for-service with the regulated point system, determines the possibility of the over-provision as well as the under-provision of treatments, procedures, and drugs. In practice there are usually several different treatments, procedures, and drugs available, and the current point system gives self-employed physicians an incentive to choose the most profitable ones even though they know which ones should be chosen based on purely medical reasons.

The above proposition implies that unnecessary medical treatments and procedures or overprescription by self-employed physicians always occur, as long as the marginal income is positive. Kurasawa (1987) corresponds to the special case in which $p_m(l,m) - s_m(m) = \Delta > 0$, and the over-provision always occurs in his case.

Note also that the prospective payment system, or supply side cost sharing based on the DRG, is expressed by $p_m = 0$, and (5a) implies that the prospective system always induces the under-provision of m, as proved by Ellis and McGuire (1986). Ellis and McGuire (1986) also point out that the fee-for-service scheme induces the overprovision, and they prove that the mixed scheme achieves the first best. On the other hand, (5a) implies that $m^* = m^{FB}$ can be achieved as long as $p_m(l,m) = s_m(m)$. Thus, the current Japanese point system could achieve the best situation from the patients' point of view, although it is based only on the fee-for-service scheme. The over-provision under the fee-for-service scheme could be explained by market failure due to asymmetric information, and $p_m(l,m) > s_m(m)$ would happen if $p(l,m)$ were determined freely in the private market. This could be a rationale for the regulation on $p(l,m)$ by the government, and it is possible to result in $m^* = m^{FB}$ in the regulated point system of the current Japanese fee-for-service scheme, as long as $p(l,m)$ is set by the government correctly in order to make its marginal revenue equal to the marginal cost.

In practice, there are usually alternatives of treatments, procedures, and drugs, and self-employed physicians would not give such treatments, procedures and drugs that do not generate positive marginal income. Thus, from now on the only case of positive marginal income through the provision of m is discussed.

To discuss the optimal choice of labor supply l^*, let $\bar{l}(m)$ denote the optimal choice of l when only l can be chosen such that:

$$\bar{l}(m) = \arg\max_{l} u(n[p(l,m) - s(m)], nl) + \gamma g(m)k(l)r(n).$$

Then proposition 1, (5b), and the condition of $m^* > m^{FB}$ give the following result.

Proposition 2 *When marginal income associated with treatments, procedures, and prescription is positive, self-employed physicians always work less compared to the case when positive marginal income does not exit, i.e.,* $l^* < \bar{l}(m^{FB})$.

Proposition 1 and Proposition 2 imply that physicians compensate an induced decrease in their income by working less with an increase in their income generated by unnecessary treatments and procedures and/or overprescription if positive marginal income exits. Note that both a smaller amount of labor supply and over-provision of treatments and procedures (and/or overprescription) reduce the health level of patients. Thus, if the regulated point system results in the positive marginal income ($p_m(l,m) - s_m(m) > 0$), then the current scheme deteriorates health of patients.

Now, the effects of the change in positive marginal income ($p_m(l,m) - s_m(m) > 0$), benevolence(γ), and the number of patients (n) on the optimal behavior are considered. For simplicity, the only case of $p_m(l,m) - s_m(m) = \Delta > 0$ is explored, and this case corresponds to Kurasawa (1987). If m includes only drugs, Δ is interpreted as so-called 'yakka saeki'. Differentiating the first-order conditions (5a) and (5b) with respect to Δ, γ, and n yields $m^*_\Delta > 0 > l^*_\Delta$, $m^*_\gamma < 0 < l^*_\gamma$, and $m^*_n > 0 > l^*_n$ (see Appendix), which also implies that $h^*_\Delta < 0$, $h^*_\gamma > 0$, and $h^*_n < 0$. Then, the results are summarized as follows:

Proposition 3 *For self-employed physicians, both of a rise in positive marginal income of the non-labor input and a rise in the number of patients per physician increase the non-labor input per patient, and they also decrease labor supply per patient. In contrast, a rise in the degree of benevolence decreases the non-labor medical input per patient and increases labor supply per patient,*

The first part of Proposition 3 implies that either a rise in positive marginal income generated by treatments and procedures, or a rise in the number of patients per self-employed physician results in the deterioration of health of patients. The other part of Proposition 3 implies that a rise in benevolence results in the improvement of health of patients, since self-employed physicians provide m beyond m^{FB} when positive marginal income exits. The size of Δ is fully controlled by the government through the current point system. The number of patients per self-employed physician is also affected by the total number of physicians, which is also controlled by the government in several ways[16]. Thus, a change or reform of allocated points to medical events which results in an increase in positive marginal income, or any policies which induce an increase in the number of patients per self-employed physician would eventuate in the deterioration of health of patients.

5.2 Hospital-Employed Physicians

It has recently been argued that working environments for Japanese hospital-employed physicians become more severe particularly in the rural area, and that the severe conditions caused

[16] For instance, the total number of students of medical school is fully controlled by the government.

their overwork. Since hospital-employed physicians in Japan usually get paid by salary and thus their money income is fixed, it has also been argued that the overwork resulted in an increase in unpaid work of hospital-employed physicians.

This paper tries to explore this issue. However, in stead of examining a possibility of unpaid work of hospital-employed physicians, this paper presents a theoretical model by which the effect of unpaid work on the behavior of hospital-employed physicians can be investigated[17]. This paper does not try to explain the reason why unpaid work exists. Bell and Hart (1999) empirically show the importance of unpaid work in the UK. Pennenberg (2005) estimates key determinants for unpaid work in West Germany, and he concludes that workers still work with their expectation for future benefits although they are not fully paid. Oruga (2007) uses the data of the Japanese service industry and empirically finds that approximately 29 hours out of the total amount of overtime work are not paid every month. Sano and Kishida (2004) also study non-financial incentives of the Japanese physicians empirically. An excellent study on the Japanese empirical literature by Ii and Bessho (2006) point out that there would be possible reasons why hospital-employed physicians still work even when they do not fully get paid; better research environments, more challenging medical opportunities, and simply better working experience for their future career. Along the empirical literature, this paper presents a theoretical model by which the optimal behavior of hospital-employed physicians who accept unpaid work can possibly be discussed. Then, the effect of unpaid work is discussed in association with the number of patients per hospital-employed physician, since the current debate on the severe workloads of hospital-employed physicians in the rural area is often related to a drastic decrease in the number of hospital-employed physicians (thus a drastic increase in the number of patients per hospital-employed physician in the rural area).

Hospitals consist of many physicians. Although hospital-employed physicians usually take into account mutual interactions with others within the same workplace, this study

[17]This paper, in stead of discussing what overwork implies, tries to present a theoretical model for the current debate, by investigating the effect of unpaid work within a framework of the optimal behavior.

does not consider such interactions[18]. The optimal behavior of hospital-employed physicians is discussed in the following two sections. The first section considers the optimal behavior when salary of hospital-employed physicians is pre-determined and it is exogenously given to them. The second section expands the model by taking into account profits of hospitals in terms of the decision of salary. In the second section, salary of hospital-employed physicians is adjusted based on the amount of profits of hospitals, and salary is endogenously determined in order to satisfy the current Japanese regulation for hospitals as medical institutions.

In the following sections, all hospital-employed physicians are simply assumed to be homogeneous so that they share the identical weight on benevolence, γ.

5.2.1 Optimal Choice of Hospital-Employed Physicians

Hospital-employed physicians usually get paid monthly in Japan, and their salary is pre-determined based on their contract with the hospital where they are employed. Although their pre-determined salary usually depends on several items such as age and working experience, it is simply assumed that their wage income depends only on labor supply, L, in this paper. In order to include a possibility of unpaid work, this paper assumes wage income of hospital-employed physicians such that:

$$w(L,\delta) = \begin{cases} \bar{w}L & \text{if } L \leq \bar{L} \\ \bar{w}L - \delta a(L) & \text{if } L > \bar{L}, \end{cases} \tag{6}$$

where $\bar{w} > 0$ is the constant wage rate when labor supply is less than a fixed amount $\bar{L} > 0$.[19] The parameter values of $\bar{w}$ and $\bar{L}$ are assumed to be pre-determined in the contract with the hospital, and they are exogenously given in the model. $a'(L) > 0$ and $a''(L) > 0$ for $L \geq \bar{L}$, and $a'(\bar{L}) = 0$ are assumed. This specification of their income requires that the wage rate

[18] Kakinaka and Kato (2008) discuss a possibility of the existence of multiple equilibria by examining the behavior of hospital-employed physicians, where mutual interactions associated with intrinsic motivation of physicians is introduced..

[19] As long as overtime work is paid, it is assumed to be included in $\overline{w}L$.

per unit of labor supply (working hour) is constant up to $\bar{L}$, but it is decreasing in L once L is larger than $\bar{L}$, as illustrated in Figure 2. The ranges of $L \leq \bar{L}$, and of $L > \bar{L}$ correspond to fully paid, and unpaid work, respectively, since labor supply over $\bar{L}$ is not fully paid, and the existence of unpaid work is assumed to be expressed by the decreasing wage rate. The value of $\delta \geq 0$ represents the degree of unpaid work, and $\delta a(L)$ in (6) can be interpreted as the monetary value of the marginal increment of labor supply that is not compensated or unpaid (the difference between dotted line and the thick concave curve in Figure 2). A larger degree of unpaid work, δ, is associated with a larger value of labor supply that is not compensated or unpaid.

A possibility of the existence of unpaid work depends on benevolence of hospital-employed physicians. Hospital-employed physicians are assumed to maximize their utility given by (1) subject to their income constraint, $y = w(L, \delta)$, and the first-order conditions are:

$$g'(m) = 0; \tag{7a}$$

$$\gamma g(m)k'(l)r(n) = n[c'(nl) - w_L(nl, \delta)], \tag{7b}$$

where $w_L(nl, \delta) = \frac{\partial w}{\partial L}$. Notice that marginal income, $p_m(l, m) - s_m(m)$, does not appear in the above first order conditions, and thus the pre-determined points regulated by the government, $p(l, m)$, do not affect the optimal behavior of hospital-employed physicians as long as their wage income is fixed by salary. Notice also that the possibility of unpaid work depends on $w_L(nl, \delta)$ and the marginal rate of substitution between income and labor. If the indifference curve is tangent to (6) at which $w_L(nl, \delta) = \overline{w} - \delta a'$, then unpaid work is optimally chosen. The curvature of the indifference curve depends on the left hand side of (7b) and c'.

Let $\hat{m} \equiv \hat{m}(n, \gamma, \delta)$ and $\hat{l} \equiv \hat{l}(n, \gamma, \delta)$ denote the optimal choice of the non-labor medical input and labor supply per patient, respectively. Since the condition (7a) implies $\hat{m} = m^{FB}$, the first result in terms of the optimal behavior of hospital-employed physicians is given as follows.

Proposition 4 *From the patients' point of view, hospital-employed physicians always provide the ideal level of the non-labor medical input such as treatments, procedures, and drugs. i.e.,* $\hat{m} = m^{FB}$.

Note that the above proposition holds as long as wage income of hospital-employed physicians is fixed. Obviously if hospitals where they are employed change their salary depending on the amount of marginal income generated by the provision of treatments and procedures or by prescription, then the presence of positive marginal income would also affect the optimal behavior of hospital-employed physicians through the change in their wage income. This issue is discussed in the next subsection.

The impact of a change in γ, n, and δ on the optimal level of labor supply per patient, $\hat{l}$, as well as the total labor supply, $\hat{L} = n\hat{l}$, are now examined. Differentiating the first-order condition (7b) with respect to γ, n and δ yields $\hat{l}_\gamma > 0$, $\hat{l}_n < 0$, $\hat{l}_\delta < 0$, $\hat{L}_\gamma > 0$, $\hat{L}_n > 0$, and $\hat{L}_\delta < 0$, which imply the following results (see the Appendix for the proof):

Proposition 5 *Suppose that* $w(L, \delta)$ *is exogenously given to hospital-employed physicians. Then, a rise in the degree of benevolence increases labor supply per patient, and it results in the improvement of health of patients. Moreover, a rise in the number of patients per physician decreases labor supply per patient,* l, *and hence it deteriorates health of patients. However the rise in the number of patients increases the total labor supply,* L. *Furthermore, if hospital-employed physicians optimally supply labor beyond the fully paid level, then a rise in the degree of unpaid work decreases labor supply per patient, and the rise eventuates in the deterioration of health of patients.*

As γ increases, hospital-employed physicians become more benevolent, so that they increase labor supply in order to improve health of patients. On the other hand, a rise in n reduces labor supply per patient, since marginal disutility of an increase in l is larger than marginal utility of the increase in l, which is caused by the rise in n. However, a rise in n

increases the total labor supply. Furthermore, a rise in δ reduces the marginal benefit of labor so that hospital-employed physicians have an incentive to decrease labor supply, which results in the deterioration of health of patients.

One important concern is with unpaid work; whether or not hospital-employed physicians choose to provide $\hat{L} = n\hat{l}$ beyond $\bar{L}$. To discuss it, the trajectory of $\bar{L} = \hat{L}(\gamma, n, \delta)$ on the (n, γ)-space is considered. By the derived property of $\hat{L}_\gamma > 0$ and $\hat{L}_n > 0$ in Proposition 5, the trajectory can be drawn as a down-sloping curve in Figure 3. Hospital-employed physicians optimally supply labor beyond the fully paid level if a pair of n and γ is in the region above the curve, but they do not supply labor beyond the fully paid level if the pair is in the region below the curve. This implies that there exists the critical number of patients per physician, $\hat{n}(\gamma)$, for the degree of benevolence γ such that hospital-employed physicians optimally supply labor beyond the fully paid level if $n > \hat{n}(\gamma)$, and they never accept unpaid work if $n < \hat{n}(\gamma)$. Furthermore, it can be shown that $\hat{n}(\gamma)$ is decreasing in γ. That is, hospital-employed physicians optimally accept unpaid work or overwork if they have a relatively large number of patients and/or have a relatively high degree of benevolence to patients.

The next concern with unpaid work is to investigate the optimal behavior of hospital-employed physicians if they are always fully paid. Then their income is given by $y = \bar{w}L$ for any L, or simply $\delta = 0$. In Figure 4, the budget constraint $y = w(L, \delta)$ with unpaid work is represented by the thick up-sloping concave curve, while the budget constraint $y = \bar{w}L$ with fully paid work is represented by the dotted up-sloping straight line. Indifference curves corresponding to several utility levels are captured by the convex curves, AA, BB, and CC.[20] Since the utility function is of the quasi-linear form, it can be shown that a shift from unpaid work to fully paid work income schedule induces hospital-employed physicians to change their optimal bundle from point E to point F. Then, the result is summarized as follows:

[20]The condition that the indifference curves in Figure 4 are inverse unimodal and strictly convex is that $V(L) \equiv c'(L) - \gamma g(m^{FB})k'(L/n)r(n)/n$ is strictly increasing in L with $V(L) < 0$ for a relatively small L and $V(L) > 0$ for a relatively large L.

Proposition 6 *Suppose that hospital-employed physicians initially accept unpaid work. If the hospital decides to pay them fully for their work (i.e., $\delta = 0$), then they increase labor supply, and hence health of patients is improved.*

5.2.2 Endogenized Income of Hospital-Employed Physicians

It has been assumed so far that income of hospital-employed physicians $w(L, \delta)$ is exogenously given. However, their income should be related to profits of hospitals where they are employed, and the degree of unpaid work δ should also be affected by profits of hospitals. In principle hospitals in Japan are regulated such that they cannot behave as profit seeking institutions. Thus, this section expands the model by endogenizing $w(L, \delta)$ such that the degree of unpaid work δ is determined endogenously in order to satisfy the zero profit condition. The zero-profit condition requires that the sum of the cost of labor and the cost of the non-labor medical inputs must be covered by the total revenue.

For simplicity, it is assumed that income of hospital-employed physicians, $w(L, \delta)$, can be characterized by the degree of unpaid work, δ. This specification implies that the hospital chooses δ to satisfy the zero-profit condition.[21] Recall that hospital-employed physicians always choose the ideal level of the non-labor medical input, m^{FB}, as proved in Proposition 4. Then the degree of unpaid work, $\tilde{\delta} \equiv \tilde{\delta}(\gamma, n)$, with the zero profit condition must satisfy:

$$w(\tilde{L}, \tilde{\delta}) = [p(\tilde{l}, m^{FB}) - s\left(m^{FB}\right)]n, \tag{8}$$

where $\tilde{l}(\gamma, n) \equiv \hat{l}(\gamma, n, \tilde{\delta}(\gamma, n))$, and $\tilde{L}(\gamma, n) \equiv \hat{L}(\gamma, n, \tilde{\delta}(\gamma, n))$ denote the equilibrium levels of labor supply, both of which have already been derived in the previous subsection. Let $\tilde{h}(\gamma, n) \equiv g(m^{FB})k(\tilde{l}(\gamma, n))$ denote the corresponding health level of a patient.

Figure 5 illustrates the equilibrium outcome with the zero-profit condition, where labor

[21] $\bar{w}$ and $\bar{L}$ could be modified to satisfy the zero profit condition rather than δ. However $\bar{w}$ and $\bar{L}$ are usually determined based on the contract between hospitals and hospital-employed physicians, and they seem to be more difficult to be changed than δ. Thus, this paper assumes that hospitals use δ rather than $\bar{w}$ and $\bar{L}$ in order to satisfy the zero profit condition.

supply by hospital-employed physicians is $\tilde{L}(> \bar{L})$ with unpaid work. Curves AA, and BB represent the budget constraint for hospital-employed physicians, and that for hospitals, respectively; AA is income of hospital-employed physicians, and BB is the zero-profit condition for hospitals. Curve CC represents the indifference curve of hospital-employed physicians that attains the maximum utility level with the constraint. Figure 5 is drawn based on the assumption that marginal income of labor for hospitals is assumed to be smaller than that for hospital-employed physicians, i.e., $w_L(\tilde{L}, \delta) = \bar{w} - \tilde{\delta}a'(\tilde{L}) > p_l(\tilde{l}, m^{FB})$, and this paper assumes that this condition holds.

Now, the effect of changes in positive marginal income $(p_m(l, m) - s_m(m) > 0)$ and benevolence(γ) on the optimal behavior is considered. For simplicity, the only case of $p_m(l, m) - s_m(m) = \Delta > 0$ is explored. Differentiating the zero-profit condition (8) with respect to Δ yields $\tilde{\delta}_\Delta < 0$, $\tilde{l}_\Delta = \hat{l}_\delta \tilde{\delta}_\Delta > 0$, $\tilde{L}_\Delta = \hat{L}_\delta \tilde{\delta}_\Delta > 0$, and $\tilde{h}_\Delta = g(m^{FB})k'(\tilde{l})\hat{l}_\Delta > 0$ (see Appendix). A rise in Δ, positive marginal income of treatments and procedures, allows hospitals to offer income with the smaller amount of unpaid work to each hospital-employed physician. Thus, the rise also gives hospital-employed physicians an incentive to work more, and hence it eventuates in the improvement of health of patients. In terms of the impact of a change in the degree of benevolence, differentiating the zero-profit condition (8) with respect to γ yields $\tilde{\delta}_\gamma > 0$, $\tilde{l}_\gamma > 0$, $\tilde{L}_\gamma > 0$, and $\tilde{h}_\gamma = g(m^{FB})k'(\tilde{l})\hat{l}_\gamma > 0$ (see also Appendix). A rise in benevolence induces an increase in labor supply as well as an increase in the monetary payoff for hospitals, thus resulting in hospitals offering income with the smaller amount of unpaid work to hospital-employed physicians. Hence, health of patients is also improved. These results are summarized as follows:

Proposition 7 *Suppose that hospital-employed physicians optimally supply labor beyond the fully paid level, and thus they accept unpaid work. Suppose also that their income is endogenously determined with the zero profit condition of hospitals. Then, a rise in positive marginal income of treatments and procedures Δ decreases the degree of unpaid work, and it increases labor supply per patient, l, as well as the total amount of labor supply, L. The rise* *thus improves health of patients. Moreover, a rise in the degree of benevolence increases the degree of unpaid work* (δ)*, labor supply per patient* (l)*, and the total amount of labor supply* (L)*. Hence, the rise in benevolence also improves health of patients.*

Recall Proposition 3 such that self-employed physicians decrease their labor supply per patient if Δ increases, and an increase in Δ deteriorates health of self-employed physicians' patients. Thus, the effect of a rise in positive marginal income generated by treatments and procedures is opposite between the self-employed and the hospital-employed, while the effect of an increase in benevolence is the same between the self-employed and the hospital-employed.

In terms of the effect of a change in the number of patients per physician, n, differentiating the zero-profit condition (8) with respect to n yields:

$$\tilde{\delta}_n = \frac{[w_L(\tilde{L}, \tilde{\delta}) - p_l(\tilde{l}, m^{FB})]\hat{L}_n(\gamma, n, \tilde{\delta}) - [p(\tilde{l}, m^{FB}) + \Delta m^{FB}]}{\Gamma}, \tag{9}$$

where $\Gamma \equiv (p_l - w_L)\hat{L}_\delta - w_\delta > 0$. The first term in the numerator of the right-hand side, $(w_L - p_l)\hat{L}_n > 0$, captures the marginal increment of the monetary payoff of hospital-employed physicians generated by an increase in their labor supply associated with an increase in n, while the second term, $p + \Delta m^{FB} > 0$, represents the marginal increment of the revenue of hospitals caused by the increase in n. Equation (9) simply states that the sign of $\tilde{\delta}_n$ depends on which term dominates the other. The rise in n increases (decreases) the degree of unpaid work if the first (the second) term dominates the other term, i.e., $\tilde{\delta}_n \gtreqless 0$ if $(w_L - p_l)\hat{L}_n \gtreqless p + \Delta m^{FB}$.

Notice that $\tilde{L}_n = \hat{L}_n + \hat{L}_\delta \tilde{\delta}_n$ and $\tilde{l}_n = \hat{l}_n + \hat{l}_\delta \tilde{\delta}_n$ with $\hat{L}_n > 0$, $\hat{L}_\delta < 0$, $\hat{l}_n < 0$, and $\hat{l}_\delta < 0$. These two equations imply that the effect of a change in n on labor supply can be divided into two effects; the direct effect $\left(\hat{L}_n \text{ and } \hat{l}_n\right)$, and the indirect effect through a change in δ associated with the change in n $\left(\hat{L}_\delta \tilde{\delta}_n \text{ and } \hat{l}_\delta \tilde{\delta}_n\right)$. The direct effect requires that a rise in n increases the total amount of labor supply ($\hat{L}_n > 0$), and also that it decreases labor supply per patient ($\hat{l}_n < 0$). The indirect effect depends on the values of $(w_L - p_l)\hat{L}_n$ and $p + \Delta m^{FB}$. Note that when income of hospital-employed physicians is exogenously given there is the only direct effect, and the direct effect of a change in n is summarized in Proposition 5. The indirect effect is added due to endoginized income with the zero profit condition.

In the case of $(w_L - p_l)\hat{L}_n > p + \Delta m^{FB}$, a rise in n increases the degree of unpaid work ($\tilde{\delta}_n > 0$), and it gives hospital-employed physicians an incentive not to work. Then the indirect effect of the rise in n reduces labor supply per patient ($\hat{l}_\delta \tilde{\delta}_n < 0$) as well as the total amount ($\hat{L}_\delta \tilde{\delta}_n < 0$). Thus, the overall effect of the rise in n results in a decrease in labor supply per patient ($\tilde{l}_n < 0$), but the effect on the total amount of labor supply ($\tilde{L}_n \gtrless 0$) is ambiguous. On the other hand, if $(w_L - p_l)\hat{L}_n < p + \Delta m^{FB}$, then the rise in n decreases the degree of unpaid work ($\tilde{\delta}_n < 0$), and it gives hospital-employed physicians an incentive to work. Then the indirect effect of the rise in n increases labor supply per patient ($\hat{l}_\delta \tilde{\delta}_n > 0$) as well as the total amount of labor supply ($\hat{L}_\delta \tilde{\delta}_n > 0$). Thus, the overall effect of the rise in n results in an increase in the total amount of labor supply ($\tilde{L}_n > 0$), but the effect on labor supply per patient ($\tilde{l}_n \gtrless 0$) is ambiguous. The impact of a change in n on labor supply is summarized as follows:

Proposition 8 *Suppose that hospital-employed physicians optimally supply labor beyond the fully paid level, and thus they accept unpaid work. Suppose also that their income is endogenously determined with the zero profit condition of hospitals. If $(w_L - p_l)\hat{L}_n > p + \Delta m^{FB}$, then a rise in the number of patients per hospital-employed physician increases the degree of unpaid work, and it decreases labor supply per patient, l, thus resulting in the deterioration of health of patients. In contrast, if $(w_L - p_l)\hat{L}_n < p + \Delta m^{FB}$, then the rise in the number of patients per hospital-employed physician decreases the degree of unpaid work, and it increases the total amount of labor supply, L.*

Recall Proposition 5 which states that when income of hospital-employed physicians is exogenously given an increase in the number of patients always reduces labor supply per patient (l) and increases the total number of labor supply (L). Prop 8 implies that endogeneity of income does not change the result but it weakens the result of Proposition 5 in terms of the effect of a change in n.

In order to highlight the difference in the behavior between self-employed physicians and hospital-employed physicians, the optimal decisions are compared when the number of patients is identical for each type of physicians. Figure 6 illustrates this situation. Curve AA represents income of hospital-employed physicians, and curve BB represents the budget constraint for self-employed physicians who are enforced to provide $m = m^{FB}$. Curves CC, and C'C' represent the indifference curves that attain the maximum utility levels of hospital-employed physicians, and self-employed physicians with the constraint $m = m^{FB}$, respectively. Point E corresponds to the optimal decision of hospital-employed physicians, and point E' corresponds to the optimal decision of self-employed physicians with the constraint $m = m^{FB}$.

Figure 6 shows that labor supply of hospital-employed physicians is larger than that of self-employed physicians. As shown in Proposition 2, the optimal level of labor supply of self-employed physicians without any restriction on m is less than that with the constraint $m = m^{FB}$, and hospital-employed physicians provide more labor supply per patient than self-employed physicians do ($l^* < \tilde{l}$), since $L^* < \tilde{L}$ and n is identical. Moreover, note that hospital-employed physicians provide the ideal level of the non-labor medical input, $\tilde{m} = m^{FB}$, as stated in Proposition 4, and also that self-employed physicians provide unnecessary treatments and procedures and/or overprescribe to their patients beyond m^{FB}, as stated in Proposition 1. Thus, hospital-employed physicians provide better medical services in the sense that labor supply per patient is larger ($l^* < \tilde{l}$) and they provide the non-labor medical input at the ideal level from the patients' point of view ($\hat{m} = m^{FB} < m^*$). Furthermore, Figure 6 shows that self-employed physicians obtain a higher level of utility than hospital-employed physicians do. The results are summarized as follows:

Proposition 9 *Suppose that the number of patients is identical between self-employed and* *hospital-employed physicians. Then, self-employed physicians attains a higher level of utility than hospital-employed physicians do. However, hospital-employed physicians work more and provide better medical services compared to self-employed physicians.*

Finally, the effect of an introduction of a subsidy to hospitals is briefly discussed. Nakayama (2004) points out that about 65% of all public hospitals received subsidies from local governments in fiscal year 2005. Assume now that a hospital receives a lump-sum subsidy S per hospital-employed physician, and (8) is modified as:

$$w(\tilde{L}, \tilde{\delta}) = [p(\tilde{l}, m^{FB}) + \Delta m^{FB}]n + S.$$

Figure 7 illustrates how a subsidy to a hospital affects the behavior of hospital-employed physicians. The equilibrium before the provision of any subsidy ($S = 0$) is represented by point E, where the degree of unpaid work is δ_1, and income, $y = w(L, \delta_1)$, is given by curve BB. BB is tangent to the indifference curve CC at point E. The budget constraint of the hospital, $y = [p(L/n, m^{FB}) + \Delta m^{FB}]n$, also intersects income, $y = w(L, \delta_1)$, at point E.

Suppose now that the hospital receives a subsidy $S > 0$ per physician. The subsidy moves the budget constraint of the hospital up by S (from curve BB to curve B'B'). This shift allows the hospital to obtain a positive profit and hence to reduce the degree of unpaid work from δ_1 to δ_2. At the new equilibrium, which is represented by point E', new income, $y = w(L, \delta_2)$, represented by curve B'B', is tangent to the indifference curve C'C' at point E', and the new budget constraint of the hospital, $y = [p(L/n, m^{FB}) + \Delta m^{FB}]n + S$, intersects new income,$y = w(L, \delta_2)$, at point E'. Thus, the subsidy S results in an increase in labor supply per patient as well as the total amount of labor supply (from $\tilde{L}_1$ to $\tilde{L}_2$), and it improves health of patients.[22]

[22]Note that the discussion here does not consider public and private hospitals separately. As argued by Nakayama (2004), subsidies might induce inefficiency of public hospitals in Japan.

6 Concluding Remarks

This paper has presented a theoretical framework to describe the behavioral difference between self-employed and hospital-employed physicians by explicitly incorporating two distinctive features of the Japanese health care system; the fee-for-service system and the fully regulated point system. The current system fully regulates the official prices of medical events, and the marginal revenue generated by providing treatments and procedures, or by prescribing drugs is fully controlled by the government. Since there is asymmetric information on the quality of medical services, the private market does not achieve Pareto efficiency, and the supply price of medical services would be higher compared to the fully competitive situation. This imperfect competition would justify the regulation over supply prices by the government. As long as the current point system correctly allocates points such that the marginal revenue is equal to the marginal cost, the current fee-for-service with the fully regulated point system would eventuate self-employed physicians to provide treatments and procedures or to prescribe drugs optimally. On the other hand, if unpaid work exits among hospital-employed physicians, the presence of a positive gap between the marginal revenue and the marginal cost would work to reduce unpaid work as long as hospitals use the positive gap to reduce the amount of unpaid work. This paper has related the existence of unpaid work to the total number of patients per hospital-employed physician, and also shown that the reduction of the total number of patients, or an increase in the total number of hospital-employed physicians per patient would reduce unpaid work, thus resulting in the improvement of health of patients.

Several drawbacks should also be mentioned. This paper assumes that each physician does not change the employment structure between being self-employed and hospital-employed. In particular hospital-employed physicians would consider being self-employed if their working environments get more severe in the long run. Another issue is concerned with the choice of different treatments and procedures. In general there are similar treatments and procedures available to physicians. Thus, the current point system should be investigated based on the assumption that physicians can be selective in terms of treatments and procedures, since the current system gives physicians a financial incentive when they choose a treatment and procedure. The incorporation of a possibility of selection would be a way to extend the model in order to explore the current point system.

Appendix

Proof of Proposition 3 The first-order conditions can be rewritten by:

$$n[p_m(l,m)+\Delta]+\gamma g'(m^*)k(l^*)r(n)=0;$$
$$n[p_l(m,l)-c'(nl)]+\gamma g(m^*)k'(l^*)r(n)=0.$$

Differentiating these conditions with respect to Δ yields:

$$\begin{bmatrix} A & B \\ B & C \end{bmatrix}\begin{bmatrix} m^*_\Delta \\ l^*_\Delta \end{bmatrix}=\begin{bmatrix} -n \\ 0 \end{bmatrix},$$

where $A=np_{mm}(l,m)+\gamma g''(m)k(l)r(n)<0$, $B=np_{lm}(l,m)+\gamma g'(m)k'(l)r(n)<0$, and $C=np_{ll}(l,m)-n^2c''(nl)+\gamma g(m)k''(l)r(n)<0$. Noticing that $AC-B^2>0$, the following signs are obtained:

$$m^*_\Delta=\frac{-nC}{AC-B^2}>0>\frac{nB}{AC-B^2}=l^*_\Delta,$$

which are the results. Moreover, differentiating the first-order conditions with respect to γ yields:

$$\begin{bmatrix} A & B \\ B & C \end{bmatrix}\begin{bmatrix} m^*_\gamma \\ l^*_\gamma \end{bmatrix}=\begin{bmatrix} -g'(m)k(l)r(n) \\ -g(m)k'(l)r(n) \end{bmatrix}.$$

Then, the following signs are obtained:

$$m^*_\gamma=\frac{g(m)k'(l)r(n)B-g'(m)k(l)r(n)C}{AC-B^2}<0<\frac{g'(m)k(l)r(n)B-g(m)k'(l)r(n)A}{AC-B^2}=l^*_\gamma.$$

Finally, differentiating the first-order conditions with respect to n yields:

$$\begin{bmatrix} A & B \\ B & C \end{bmatrix} \begin{bmatrix} m_n^* \\ l_n^* \end{bmatrix} = \begin{bmatrix} D \\ E \end{bmatrix},$$

where $D = -[p_m(l,m) + \Delta] - \gamma g'(m)k(l)r'(n)$ and $E = -[p_l(l,m) - c'(nl)] + n^2 c''(nl) - \gamma g(m)k'(l)r'(n)$. Notice that from the first-order conditions, D and E can be rewritten as:

$$D = \gamma g'(m)k(l)\left[\frac{r(n)}{n} - r'(n)\right]; \qquad E = n^2 c''(nl) + \gamma g(m)k'(l)\left[\frac{r(n)}{n} - r'(n)\right].$$

Since $r(n)/n - r'(n) > 0$, $D < 0$ and $E > 0$ can be obtained. Solving for m_n^* and l_n^* yields:

$$m_n^* = \frac{CD - BE}{AC - B^2} > 0 > \frac{AE - BD}{AC - B^2} = l_n^*.$$

□

Proof of Proposition 5 The first-order condition with $\hat{m} = m^{FB}$ can be rewritten by:

$$\gamma g(m^{FB})k'(\hat{l})r(n) = n[c'(n\hat{l}) - w_L(n\hat{l}, \delta)].$$

The impact of a change in γ on $\hat{l}$ and $\hat{L}$ can be shown. Differentiating this with respect to γ yields:

$$\hat{l}_\gamma = \frac{-g(m^{FB})k'(\hat{l})r(n)}{Z},$$

where $Z = \gamma g(m^{FB})k''(\hat{l})r(n) - n^2[c''(n\hat{l}) - w_{LL}(n\hat{l}, \delta)]$. Since $Z < 0$, $\hat{l}_\gamma > 0$ and hence $\hat{L}_\gamma = n\hat{l}_\gamma > 0$ can be obtained. The impact of a change in δ on $\hat{l}$ and $\hat{L}$. can also be shown. Differentiating the first-order condition with respect to δ yields:

$$\hat{l}_\delta = \frac{-nw_{L\delta}}{Z}.$$

Since $Z < 0$ and $-nw_{L\delta} \geq 0$, $\hat{l}_\delta < 0$ and hence $\hat{L}_\delta = n\hat{l}_\delta < 0$ can be obtained. The impact of a change in n on $\hat{l}$ and $\hat{L}$ can now be investigated. Differentiating the first-order condition with respect to n yields:

$$\hat{l}_n = \frac{1}{Z}\left(\gamma g(m^{FB})k'(\hat{l})\left[\frac{r(n)}{n} - r'(n)\right] + n\hat{l}[c''(n\hat{l}) - w_{LL}(n\hat{l}, \delta)]\right).$$

Since $Z < 0$ and $r(n)/n - r'(n) > 0$, $\hat{l}_n < 0$ can be obtained. Moreover, differentiation $\hat{L}$ with respect to n yields:

$$\hat{L}_n = \frac{\gamma g(m^{FB})r(n)[\hat{l}k''(\hat{l}) + k'(\hat{l})] - n\gamma g(m^{FB})k'(\hat{l})r'(n)}{Z}.$$

Since $Z < 0$ and $\hat{l}k''(\hat{l})/k'(\hat{l}) < -1$, $\hat{L}_n > 0$ can be obtained. $\square$

Proof of Proposition 7 Differentiating equation (8) with respect to Δ and γ yields:

$$\tilde{\delta}_\Delta = \frac{nm^{FB}}{n[(\bar{w} - \tilde{\delta}a'(\tilde{L})) - p_l]\hat{l}_\delta - a(\tilde{L})}; \qquad \tilde{\delta}_\gamma = \frac{-n[(\bar{w} - \tilde{\delta}a'(\tilde{L})) - p_l]\hat{l}_\gamma}{n[(\bar{w} - \tilde{\delta}a'(\tilde{L})) - p_l]\hat{l}_\delta - a(\tilde{L})}.$$

Since $\bar{w} - \tilde{\delta}a'(\tilde{L}) > p_l$, $\hat{l}_\delta < 0$ and $\hat{l}_\gamma > 0$, $\tilde{\delta}_\Delta < 0$ and $\tilde{\delta}_\gamma > 0$ can be obtained. These signs imply that $\tilde{l}_\Delta = \hat{l}_\delta\tilde{\delta}_\Delta > 0$, $\tilde{L}_\Delta = n\tilde{l}_\Delta > 0$, and $\tilde{h}_\Delta = g(m^{FB})k'(\tilde{l})\tilde{l}_\Delta > 0$. Moreover, noticing that $\tilde{l}_\gamma = \hat{l}_\gamma + \hat{l}_\delta\tilde{\delta}_\gamma$, the following sign can be obtained:

$$\tilde{l}_\gamma = -\frac{n(1 - \hat{l}_\delta)[(\bar{w} - \tilde{\delta}a'(\tilde{L})) - p_l] + a(\tilde{L})}{n[(\bar{w} - \tilde{\delta}a'(\tilde{L})) - p_l]\hat{l}_\delta - a(\tilde{L})}\hat{l}_\gamma > 0,$$

which implies that $\tilde{L}_\gamma = n\tilde{l}_\gamma > 0$ and $\tilde{h}_\gamma = g(m^{FB})k'(\tilde{l})\tilde{l}_\gamma > 0$. $\square$

References

Bell, D. N. F., and R. A. Hart (1999): "Unpaid Work," *Economica*, 66, 271–290.

Chalkley, M., and J. M. Malcomson (1998): "Contracting for Health Services when Patient Demand Does not Reflect Quality," *Journal of Health Economics*, 17, 1–19.

Chino, T. (2006): "System and Regulation as the Function of Resource Allocation (in Japanese: Shigen Haibun toshiteno Seido Kisei: Wagakuni Iryo Seido no Keizai Bunseki)," *Kaikei Kensa Kenkyu*, 34, 55–66.

Ellis, R. P., and T. G. McGuire (1986): "Provider Behaviour under Prospective Reimbursement," *Journal of Health Economics*, 5, 129–151.

——— (1990): "Optimal Payment Systems for Health Services," *Journal of Health Economics*, 9, 375–396.

——— (1993): "Supply-Side and Demand-Side Cost Sharing in Health Care," *Journal of Economic Perspectives*, 4, 135–151.

Feldstein, M. S. (1970): "The Rising Price of Physician's Services," *Review of Economics and Statistics*, 52(2), 121–133.

Glazer, J., and T. G. McGuire (1994): "Payer Competition and Cost Shifting in Health Care," *Journal of Economics and Management Strategy*, 3(1), 71–92.

Ihori, T., R. R. Kato, M. Kawade, and S. Bessho (2009): "The Reform of Public Health Insurance and Economic Growth in Japan," *mimeo.*

Ii, M., and S. Bessho (2006): "A Survey: The Empricial Literature on Health Economics of Japan and Health Policies (in Japanese: Iryo no Kisoteki Jissyo Bunseki to Seisaku: Servey)," *Financial Review*, 80(1), 117–156.

Kakinaka, M., and R. R. Kato (2008): "Intrinsic Motivation of Physicians," GSIR Working Papers: Economic Analysis and Policy Series EAP08-1, International University of Japan.

Kurasawa, M. (1987): "A Theory of the Hospital Behavior (in Japanese: Byoin Koudo no Riron)," Economia: Yokohama National University, 93, 1–13.

Ma, C.-T. A. (1994): "Health Care Payment Systems: Cost and Quality Incentives," *Journal of Economics and Management Strategy*, 3, 93–112.

Ma, C.-T. A., and T. G. McGuire (1997): "Optimal Health Insurance and Provider Payment," *American Economic Review*, 87(4), 685–704.

Nakayama, N. (2004): "Technological Efficiency of Public Hospitals (in Japanese: Jichitai Byoin no Gijyutsu Kouritsusei to Hojyokin)," *Iryo to Syakai*, 14(3), 69–79.

Nishimura, S. (1987): "Medical Services and Public Hospitals in Japan (in Japanese: Wagakuni no Iryo Seido to Kouritsu Byoin)," *Kikan: Gendai Keizai*, 22, –.

Ohkusa, Y., and T. Sugawara (2005): "Analysis on Medical and Public Health Policies and its Applications (in Japanese: Iryo Kousyu Eisei Seisaku niokeru Hiyoutaikouka Bunseki to sono Ouyou)," *Financial Review*, 77(3), 164–196.

Oruga, K. (2007): "Working Hours and Japanese Employment Practices," *Japan Labor Review*, 4(4), 139–160.

Pennenberg, M. (2005): "Long-Term Effects of Unpaid Overtime," *Scottish Journal of Political Economy*, 52(2), 177–193.

Pope, G. C. (1989): "Hospital Nonprice Competion and Medicare Reimbursement Policy," *Journal of Health Economics*, 8, 147–172.

Sano, H., and K. Kishida (2004): "Empirical Study on Non-Monetary Incentive of Physicians (Ishi no Hi-Kinsenteki Incentive ni kansuru Kenkyu)," *Kikan Syakai Hosyou Kenkyu*, 40(2), 193–203.

Selden, T. M. (1990): "A Model of Capitation," *Journal of Health Economics*, 9, 397–409.

Tokita, T. (1995): "Issues on the Medical Service Market in Japan (in Japanese: Nihon no Iryo Service Shijyo no Syomondai)," in *Nihon no Iryo Keizai*, ed. by T. Tokita. Toyo Keizai Shinpousya, Tokyo.

——— (2002): "The Prospects for Reform of the Japanese Healthcare System," *Phamacroeconomics*, 9(S3), 55–66.

——— (2004): *Medical Reform in Japan (in Japanese: Nihon no Iryo Kaikaku)*. Toyo Keizai Shinpousya, Tokyo.

Wright, D. J. (2007): "Specialist Payment Schemes and Patient Selection in Private and Public Hospitals," *Journal of Health Economics*, 26, 1014–1026.

Figure 1

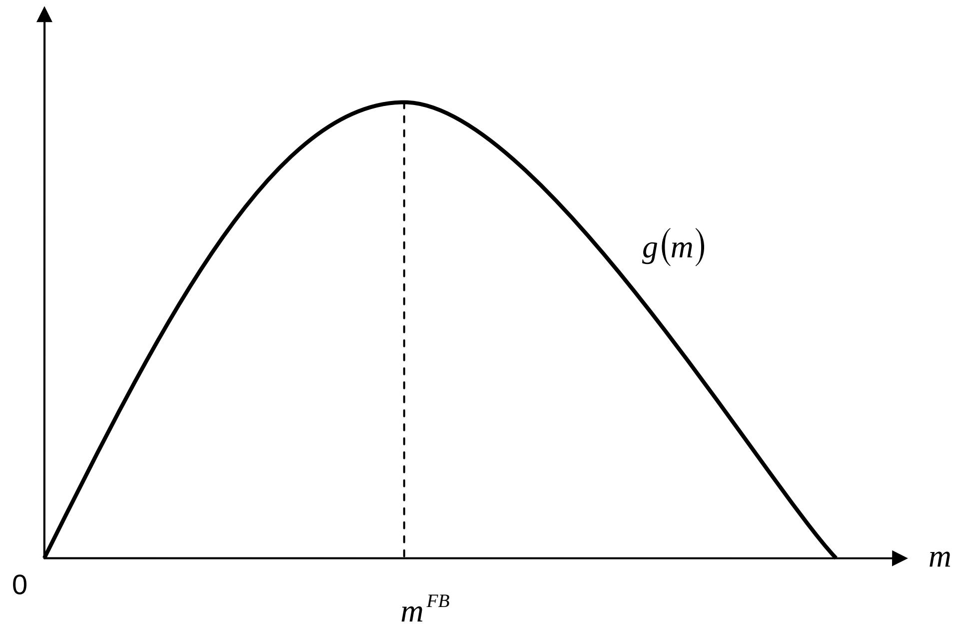


Figure 2

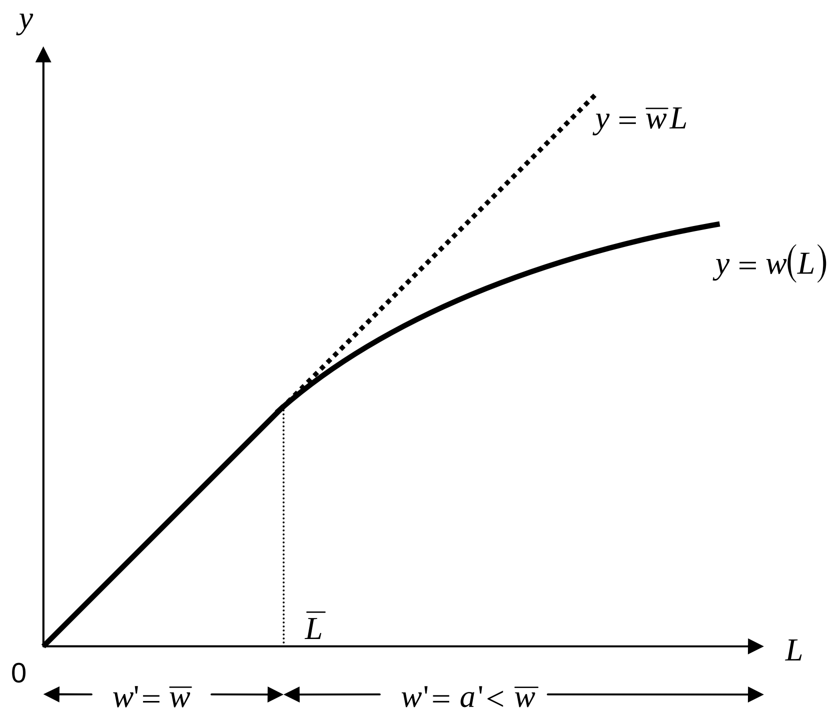


Figure 3

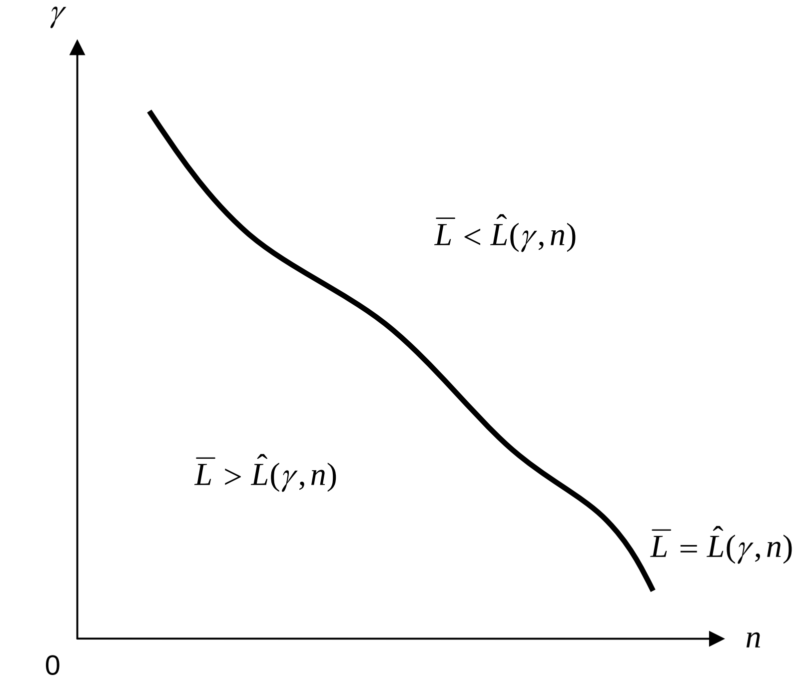


Figure 4

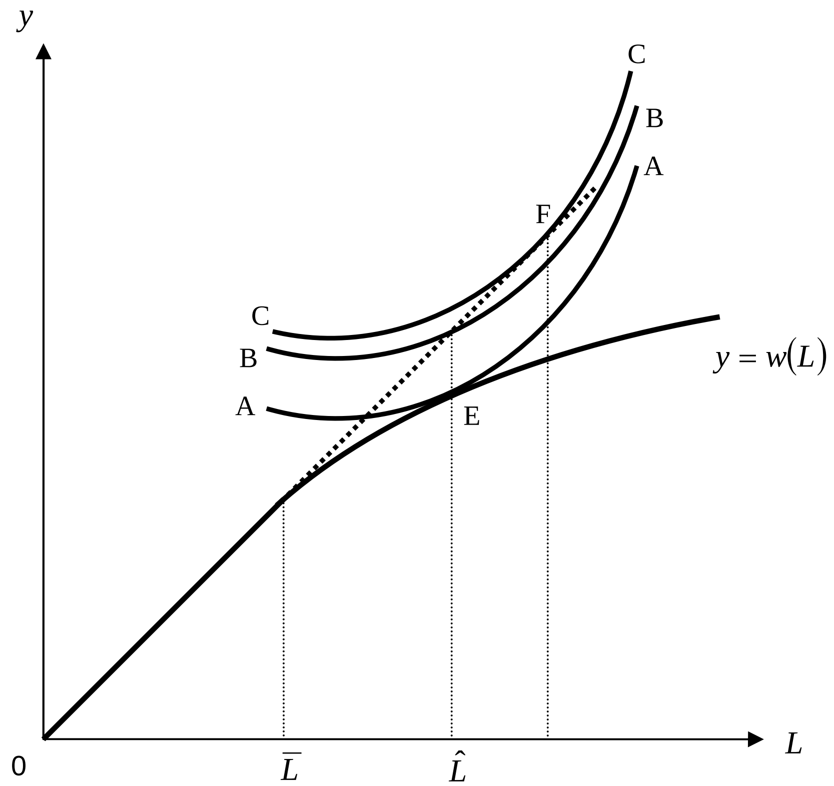


Figure 5

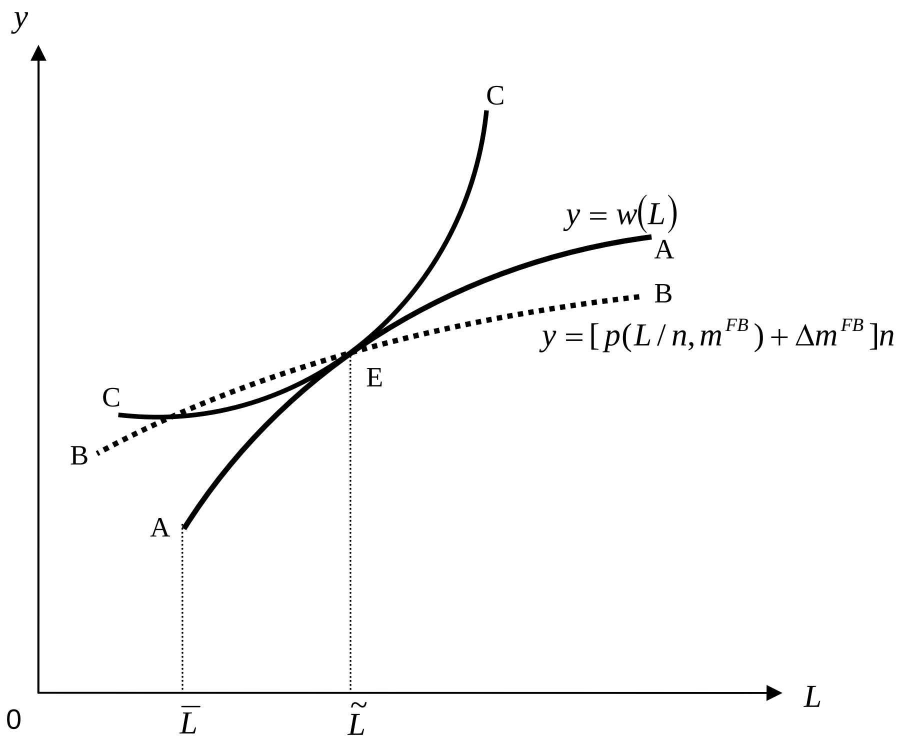


Figure 6

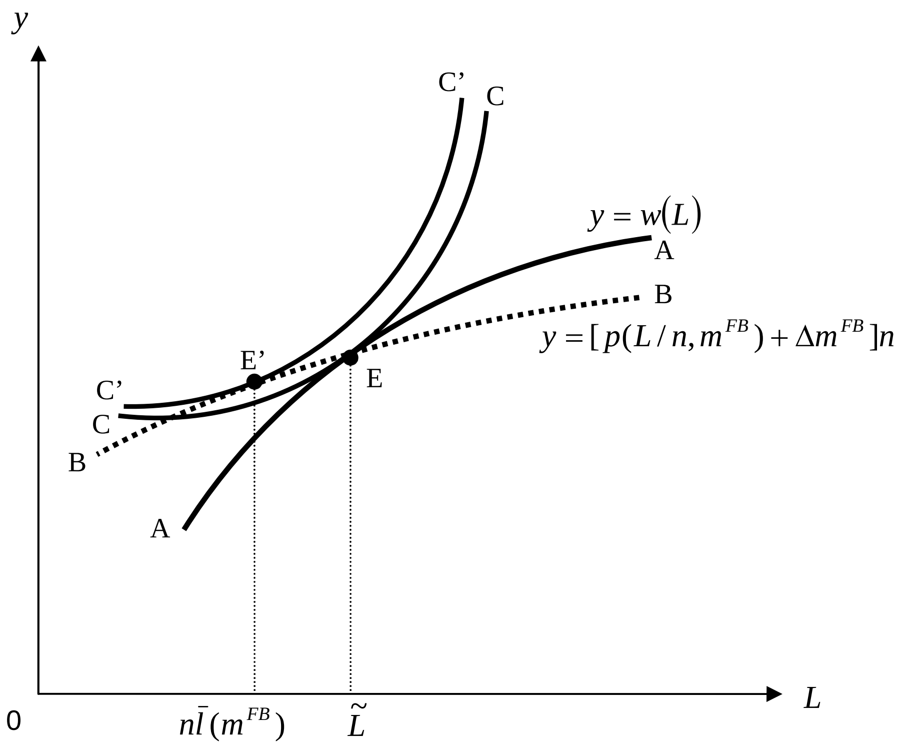
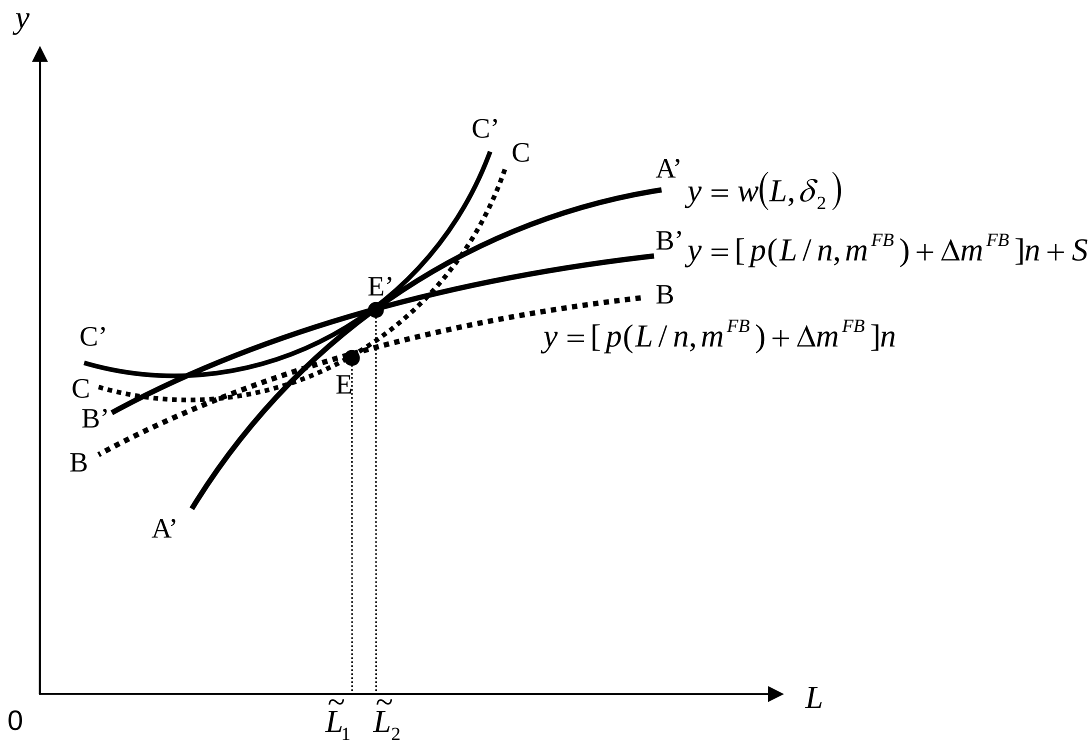


Figure 7


y
C'
C
A'
$y = w(L, \delta_2)$
B'
$y = [p(L/n, m^{FB}) + \Delta m^{FB}]n + S$
E'
B
$y = [p(L/n, m^{FB}) + \Delta m^{FB}]n$
C'
C
E
B'
B
A'
L
0
$\tilde{L}_1$
$\tilde{L}_2$