

## **B**ehavioral Difference between Self-Employed and Hospital-Employed Physicians in Japan

**Ryuta Ray Kato**  
International University of Japan

and

**Makoto Kakinaka**  
International University of Japan

**July 2008**

Graduate School of International Relations  
International University of Japan

---

<http://gsir.iuj.ac.jp/>

**Behavioral Difference between Self-Employed and  
Hospital-Employed Physicians in Japan<sup>\*</sup>**

**Ryuta Ray Kato**

Associate Professor

Graduate School of International Relations, International University of Japan

**Makoto Kakinaka**

Assistant Professor

Graduate School of International Relations, International University of Japan

**Abstract**

This paper presents a theoretical framework to describe the physicians' behavior under the fee-for-service scheme in Japan by explicitly incorporating the behavioral difference between self-employed and hospital-employed physicians into the model. One crucial assumption is found in the difference in the employment structure related to their income. The results show that self-employed physicians always provide unnecessary non-labor medical treatments, while hospital-employed physicians always give their patients the ideal level of the non-labor medical input. This study also presents that a substantial decline in the number of hospital-employed physicians results in an increase in physicians' overwork or unpaid work as well as in a decrease in the health level of the patients. This result could also be interpreted as a possible consequence of the reform of the Japanese trainee programme of physicians in 2004. We furthermore find 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 and hospital-employed physicians, Japanese medical care, fee-for-service, yakka-saeki, supply side cost sharing, Japanese trainee program of physicians

---

GSIR working papers are preliminary research documents, published by the Graduate School of International Relations. To facilitate prompt distribution, they have not been formally reviewed and edited. They are circulated in order to stimulate discussion and critical comment and may be revised. The views and interpretations expressed in these papers are those of the author(s). It is expected that most working papers will be published in some other form.

<sup>\*</sup> We thank Donghun Kim and all participants in the Health Economics Workshop regularly held at Saku General Hospital, Nagano, and in the workshop at the Institute of Statistical Research, Tokyo (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.

# 1 Introduction

Recent reform of the healthcare system, such as the reform of the trainee programme of physicians commenced in 2004, has been changing the environment surrounding hospitals, physicians, and patients. One important issue is that the behavioral difference between self-employed and hospital-employed physicians gives rise to various impacts on the supply side system of medical services and hence the public health conditions. This paper attempts to examine existing as well as emerging issues in the current Japanese healthcare system through developing a theoretical framework to describe the optimal behavior of physicians with explicit consideration of the difference in their employment structure.

Wright (2007) categorizes hospitals based on their ownership structure to investigate the relationship between private and public hospitals. However, the categorization of the supply side based on the employment structure rather than the ownership structure seems to be also appealing in Japan, since the supply side of the Japanese healthcare system can be well characterized by physicians' employment structure under the fee-for-service scheme. Indeed, the Japanese physicians are often categorized into self-employed and hospital-employed physicians, and the two groups have been playing a different role in the supply of medical services. To some extent, self-employed and hospital-employed physicians in this study could respectively correspond to physicians employed by private hospitals and those by public hospitals in the Wright's sense.<sup>1</sup>

The most distinctive difference in the employment structure is that hospital-employed physicians usually get paid by salary that basically follows the fixed wage schedule decided by the hospital, while self-employed physicians get the income through the profit that is

---

<sup>1</sup>The purpose of this paper is to describe the behavior of the two types of physicians but not of hospitals. In fact, self-employed physicians form one group in Japan, and their behavior seems to be different from that of the other group of physicians, namely hospital-employed physicians. Moreover, it is often observed in Japan that the behavior of the physicians employed by private hospitals is quite similar to that of the physicians employed by public hospitals, and there are many private hospitals which behave like public hospitals in the sense of Wright (2007). Thus, the categorization on the ownership structure would mislead us in terms of the description of the supply side of the Japanese healthcare system. The physicians employed by private and public hospitals are treated as members of the same group of physicians in this paper.

closely dependent on their efforts, their performances, and the management environment. It would be relatively easy for self-employed physicians to control their working hours and financial earnings than hospital-employed physicians. This paper develops a model focusing on this aspect, although there are other important differences in the function between the two types of physicians.<sup>2</sup> Furthermore, our model is based purely on the optimal behavior of physicians under the fee-for-service scheme, so that other various issues, such as strategic interaction associated with asymmetric information between physicians and patients, are not considered. In this paper, patients are assumed to act passively with physicians' strong bilateral power, as in the context of physician-induced demand first studied by Evans (1974).

One crucial issue in this study is that the fee-for-service system would generate undesirable situations, where physicians might not necessarily choose the best drugs and treatments, in concurrence with asymmetric information about medical services, since the system encourages physicians to control medical demand and supply for their own interests with freedom in their choice of medical services. It has been acknowledged that the ratio of the cost of medical drugs to the total amount of medical expenditure in Japan is substantially high among developed countries, and also that the high ratio is associated with the presence of a positive difference between the legitimately fixed price and actual purchasing price of drugs supplied by pharmaceutical industries under the fee-for-service system. This positive gap is so called 'yakka saeki,' which would be more influential to the behavior of self-employed physicians. The effect of the presence of 'yakka saeki' on the behavior of particularly self-employed physicians under the fee-for-service system will be investigated in this paper.

Another issue discussed in this paper is related to the debate that the working condition of

---

<sup>2</sup>Although self-employed physicians in Japan can provide various medical services, the function of many of them seem to be to provide primary care or to be gatekeepers like general physicians (GPs) in the UK. However, the difference between the Japanese and the UK systems is that any patient can obtain medical services by physicians in hospitals without any referral by self-employed physicians, so that free access to any types of medical services at any stage is guaranteed to patients in Japan. Furthermore, since patients can get all medical services at the same price from both types of physicians, there is no difference in terms of financial burdens for the patients. Thus, the patients can choose physicians by taking into account several elements, such as the type of medical services they expect to obtain, seriousness of their disease, the physical distance to physicians, the waiting time, and simply the reputation of physicians or hospitals.

hospital-employed physicians in the workplace particularly of local hospitals has drastically become worse due to the significant shortage of physicians since the reform of the trainee programme of physicians in 2004. To explain such overwork of hospital-employed physicians, we apply the concept of ‘unpaid work’ in the sense that physicians work hours are not fully paid or compensated when they optimally make a decision of their behavior (see, e.g., Bell and Hart (1999) and Pennerberg (2005)). Given the fact that hospital-employed physicians get paid by salary which follows the income schedule decided by the hospital, this study discusses how the decrease in the number of hospital-employed physicians, associated with the policy reform, increases their work loads and generates their unpaid work.

For the purpose to explain our issues on the behavior of the two types of physicians with a simplest formation, our model assumes that physicians supply medical services by providing two inputs: labor and non-labor medical input. The latter medical input may include drugs that generates ‘yakka saeki’ or the margin. The crucial difference between self-employed and hospital-employed physicians in the model is on the budget constraint they face: the self-employed physician’s income is determined by the profit that depends on labor and the non-labor medical input she provides to her patients, while the hospital-employed physician’s income is determined by the predetermined income schedule offered by her employer or the hospital with some possibility of unpaid work.

The results related to self-employed physicians’ behavior from our analysis are summarized as follows. First of all, unnecessary non-labor medical inputs, medical drugs, treatments and procedures, are always given by self-employed physicians, as long as the supply side cost sharing is based on the fee-for-serve scheme. Secondly, self-employed physicians always work less in the sense that their work hours are less than those in the case where they would provide the optimal amount of the non-labor medical input to the patients. Self-employed physicians compensate an induced decrease in their income by working less with an increase in their income generated by the overuse of the non-labor medical input. Thirdly, a rise in the margin of the non-labor medical input (‘yakka saeki’) and a rise in the number of the

patients per physician increase the non-labor medical input per patient and decrease labor supply per patient, which results in the deterioration of the patient's health level. In contrast, a rise in the weight on the benevolence decreases the non-labor medical input per patient and increases labor supply per patient, which results in the improvement of the patient's health level.

Concerning the results related to hospital-employed physicians, first of all, the non-labor medical input is always provided at the ideal level for the patient, irrespective of whether or not physicians' work is fully paid. Secondly, once the number of patients per physician is large enough, the hospital-employed physicians involve overwork or unpaid work so that their work is not fully compensated. Thirdly, a rise in the margin of the non-labor medical input ('yakka saeki') increases labor supply per patient and hence the patients' health level through reducing the degree of unpaid work, which is in contrast to the result for the self-employed physicians. A rise in the weight on the benevolence increases labor supply per patient and the patient's health level, which is consistent with the result for the self-employed physicians. Moreover, a rise in the number of the patients per physician has an ambiguous effect on labor supply per patient as well as the patients' health level.

Fourthly, if the hospitals change the wage schedule from possible unpaid scheme toward full paid scheme, the hospital-employed physician always increases her labor supply per patient, which results in the improvement of the patients' health level. Thus, public support to local hospitals in Japan, as often emphasized in recent arguments, could help improve medical services. Finally, as long as each type of physicians treat the identical number of patients, the self-employed physician attains a higher utility than the hospital-employed physician, but the hospital-employed physician works more and gives a better medical service with the higher health level of the patients than the self-employed physician.

The remaining of this paper is organized as follows. Section 2 briefly reviews the theoretical literature. In Section 3, we present theoretical models of the behavior of self-employed and hospital-employed physicians separately with some discussion of the roles of 'yakka

saeki' and unpaid work. We then derive several important results and discuss their related implications. In the final section, we provide some concluding remarks.

## 2 Related Literature

As pointed out by Ellis and McGuire (1993), the theoretical literature was expanded through the development of the research on the demand-side cost sharing in the 1970s and on the supply-side cost sharing in the 1980s. In the discussion of the 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.<sup>3</sup>

The seminal paper by Ellis and McGuire (1986), in their discussion of the 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. Some studies have been done on the basis of 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 system and develop the 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

---

<sup>3</sup>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.

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 a 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 were two payers and one hospital in a stage game model, and Ma and McGuire (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 the attention in the theoretical literature has been rarely paid only 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 analytical researches on the Japanese healthcare system, Kurasawa (1987) develops a theoretical framework, based on Nishimura (1987), in order to investigate the behavior of hospitals under the fee-for-service payment system. He shows that over-prescription of drugs always occurs if there is a positive gap between the legitimately fixed price and actual purchasing price. Tokita (1995) also discusses theoretical models to explain the specific issues in association with the Japanese healthcare system. Recently, Tokita (2002, 2004) summarizes the characteristics of the Japanese healthcare system and its policy reform. Chino (2006) also evaluates the Japanese healthcare system in terms of economic efficiency. Moreover, there have been many empirical studies on the Japanese healthcare 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 in the evaluation of healthcare and public health policies (see Ii and Bessho (2006) for the survey of empirical studies on the Japanese healthcare 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 healthcare system. The categorization of physicians based on the employment structure has not been employed. As pointed out in 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. In particular, 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 healthcare system. This paper also attempts to present a theoretical framework in order to discuss hospital-employed physicians' unpaid work or overwork, which might have been caused by the reform of the Japanese trainee scheme for physicians in 2004.

### 3 The Model

We consider a simple model of physicians' behavior in a society, where there are two types of physicians, self-employed and hospital-employed physicians. Each physician has already made her decision in terms of the employment, so that she is either self-employed or hospital-employed. We assume that the physicians have no opportunity to change their employment, so that the possibility of changing the employment is not investigated in this paper.

We suppose that the physicians have their own preference not only over income and leisure, but also over the health level of their patients.<sup>4</sup> Specifically, the utility of the physician is assumed to be given by the following additive form:

$$U(y, L, H : \gamma) = u(y, L) + \gamma H, \quad (1)$$

where  $y$ ,  $L$ , and  $H$  denote the income, labor, and the payoff associated with the health level

---

<sup>4</sup>In order to specifically describe the behavioral difference between self-employed and hospital-employed physicians, the preference of the physicians is assumed to be expressed by this setting rather than that over the profits and the health of the patients. We believe that several distinctive features of the current Japanese medical care system as well as the behavioral difference can be captured more clearly in our setting. Regarding the conventional utility function of the physician, see Ellis and McGuire (1986) for instance.

of the patients, respectively. The first sub-utility  $u(y, L)$  comes from a conventional utility. For simplicity, we assume that this sub-utility has the quasi-linear form of  $u(y, L) = y - c(L)$ , where  $c(L)$  is increasing and strictly convex. The second sub-utility  $\gamma H$  originates from the physician's benevolence over the health level of her own patients. The parameter  $\gamma$  represents the degree or weight of the physician's benevolence. A higher value of  $\gamma$  corresponds to a more benevolent physician in a sense that she attaches more importance of her patients to her own utility.

To streamline our analysis, we assume that the physicians can fully control the health level of each of their own patients by supplying two inputs, work hours  $l$  and other inputs  $m$ , which can be interpreted as the supply of labor and the non-labor medical inputs per patient, respectively. Although it is generally difficult to define the amount of these medical inputs with a single indicator, we simply assume that all medical inputs for each patient can be measured and divided into the two types of medical inputs,  $l$  and  $m$ . The non-labor medical inputs may include drugs. Given the above arguments, the health level for the patient is given by:

$$h \equiv g(m)k(l), \quad (2)$$

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 the individual health level is improved by a rise in  $l$ , but its marginal increment is diminishing, and also that the sensitivity of the health level in response to a change in  $l$  is not so small. We assume that all physician equally treat their patients so that total labor supply for each physician facing  $n$  patients is described by  $L = nl$ .

Similar to the patient's benefit function in Ellis and McGuire (1986), the restriction on  $g(m)$  implies that the individual 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 the patient (see Figure 1).<sup>5</sup> Notice that the assumption that  $g'(m) < 0$  for  $m > m^{FB}$  captures a possible situation in which physicians provide unnecessary medical drags, i.e., the health of their patient is deteriorated if physicians provide too many non-labor medical inputs to their patient. Then, the over-use of the non-labor medical input is defined as a situation where its amount is larger than the ideal level for the patient, i.e.,  $m^{FB} < m$ .

We assume that the physician's sub-payoff associated with the benevolence depends on the individual health level of her patient,  $h = g(m)h(l)$ , and the number of her patients,  $n$ . Specifically, the physician's sub-payoff is given by:

$$H \equiv hr(n) = g(m)k(l)r(n), \quad (3)$$

where  $r(n)$  is increasing and strictly concave so that a rise in  $n$  is associated with a higher level of the sub-payoff for the physician. This study assumes that  $n$  is exogenously given, so that the physicians cannot control the number of their patients, since our objective is to explain the behavioral difference between the two types of physicians in the short-run analysis rather than the long-run analysis that would take into account the labor mobility.

A distinctive feature of the Japanese medical care system is that the price of each medical service is decided by the government through the point system.<sup>6</sup> The payment associated with most medical services is reimbursed under the fee-for-service scheme.<sup>7</sup> For simplicity, we assume that the source of the monetary payoff from a patient,  $R$ , can be simply divided into two parts: the monetary payoff from supplying the non-labor medical input  $m$  and that

---

<sup>5</sup>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.

<sup>6</sup>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.

<sup>7</sup>There are several papers 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 discussion about a possibility of the overuse of medical 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.

from supplying labor  $l$ . Specifically, the monetary payoff per patient that can be obtained by a self-employed physician or a hospital with hospital-employed physicians is given by:

$$R \equiv \Delta m + p(l, m).$$

The first part  $\Delta m$  represents the net receipt from supplying  $m$  to a patient. The parameter  $\Delta \geq 0$  denotes the difference between the marginal revenue and the marginal cost per patient. If we restrict ourselves into the case where medical drug is only the non-labor medical input, the parameter  $\Delta$  can be interpreted as the difference between the actual purchasing price and the legitimately fixed price, which is often called ‘yakka saeki’ in Japan. Indeed, it is often argued in Japan that the legitimate prices are higher than the actual purchasing costs. Our specification explicitly incorporates ‘yakka saeki’ into the model.

One crucial assumption is that the second part  $p(l, m)$ , which is the monetary payoff from supplying labor  $l$ , depends on not only labor itself but also the non-labor medical input  $m$ . This specification would be appropriate since the revenue attached to physician’s labor under the point system is closely dependent on which medical treatment is implemented. Specifically, we assume that the revenue from providing  $l$  associated with  $m$ ,  $p(l, m)$ , is increasing and strictly concave in  $l$  and  $m$ . The revenue is increased with a rise in the labor supply  $l$ , but its marginal increase is diminishing. Moreover, the revenue is also increased when the physician provides more non-labor medical input  $m$ . We furthermore assume that  $p_{lm} < 0$  so that the marginal revenue of the labor supply is decreasing in the non-labor medical input.

The Japan’s point system that regulates the prices of medical services is extremely complicated and is also changing over time due to various political and administrative reasons. Given the fact, our specification of the monetary payoff  $R$  seems to be too simple and somewhat ad-hoc. However, we believe that our model setup with the division of the source of the revenue into the above two parts would be enough to capture the essence of the point

system, such as the characteristics of ‘yakka saeki’ and the points attached to physicians’ labor work.

It should be noted that the optimal behavior of patients is not incorporated into the model and thus this paper uses a partial equilibrium framework. This implies that issues related to demand-side cost sharing such as the optimal health insurance cannot be discussed in this study.<sup>8</sup> 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, it is simply assumed that patients are fully insured and they accept any medical treatments provided by their physician. Indeed, in Japan, almost all medical events, except for particular treatments and procedures, are covered by the public health insurance, so that the patients are likely to lack the concept of the cost of medical services.

## 4 Physicians’ Behavior

This section attempts to show how the behaviors of self-employed and hospital-employed physicians are different through characterizing the optimal behaviors of the two types of physicians. A crucial distinction between the two types originates from the employment structure or the payment scheme. The self-employed physicians face the wage schedule that depends on their own net monetary payoff from supplying labor and the non-labor medical input, while the hospital-employed physicians face the different wage scheme that is decided by the hospital. In a later part, the wage scheme that hospital-employed physicians face will be explained carefully.

### 4.1 Self-Employed Physicians

Since there is not an actual regulation such as the regulated maximum number of registered self-employed physicians in each place, a person can become a self-employed physician in

---

<sup>8</sup>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.

Japan, as long as she is a qualified physician. This subsection examines the optimal behavior of the self-employed physicians. Since they are self-employed, their (net) income is simply equal to the monetary payoff, which depends on their decision of the supply of labor and the non-labor medical input:

$$y = Rn = [p(l, m) + \Delta m]n. \quad (4)$$

The problem for the self-employed physician is to choose  $m$  and  $l$  such that the utility (1) is maximized subject to the budget constraint (4). The first-order conditions are:

$$\gamma g'(m)k(l)r(n) = -n[p_m(l, m) + \Delta]; \quad (5)$$

$$\gamma g(m)k'(l)r(n) = n[c'(nl) - p_l(l, m)]. \quad (6)$$

These conditions require that for each of the two medical inputs, the marginal change of the conventional part of the utility is equal to that related to the benevolence part.

Let  $m^* \equiv m^*(\Delta, n, \gamma)$  and  $l^* \equiv l^*(\Delta, n, \gamma)$  denote the self-employed physician's optimal choice of the non-labor medical input and labor supply per patient, respectively, and let  $h^*(\Delta, n, \gamma) \equiv g(m^*)k(l^*)$  denote the resulting health level of the patient. Since the condition (5) with  $p_m > 0$  implies  $g'(m^*) < 0$  and hence  $m^{FB} < m^*$ , we deduce the following result related to the optimal choice of the non-labor medical input,  $m^*$ :

**Proposition 1** *The self-employed physicians always involve the over-use of the non-labor medical input, i.e.,  $m^{FB} < m^*$ .*

This result implies that unnecessary medical treatments and procedures given by the self-employed physicians always occur, as long as the cost sharing in the supply side is based on the fee-for-service scheme. Kurasawa (1987) presents that such unnecessary prescriptions comes from the difference between the actual purchasing price and the legitimately fixed price which is often called 'yakka saeki.' However, our model has two driving forces to this

result: the first is 'yakka saeki,'  $\Delta > 0$ , and the second is a positive marginal increment of the monetary payoff from the non-labor medical input,  $p_m(l, m) > 0$ . Thus, the over-use of the non-labor medical input occurs even without 'yakka saeki.'

To discuss the optimal choice of labor supply  $l^*$  more carefully, we consider the case where the physician optimally chooses only labor supply under the constraint that the ideal level of the non-labor medical input  $m^{FB}$  as given for some reasons. The comparison of  $l^*$  and the constrained optimal choice of labor supply would indicate a simple assessment of labor supply. Let  $\bar{l}(m)$  denote the constrained optimal choice of the labor-related medical input with  $m$  as given, such that  $\bar{l}(m) = \arg \max_l u(n[p(l, m) + \Delta m], nl) + \gamma g(m)k(l)r(n)$ . Noticing that  $m^{FB} < m^*$  from Proposition 1, we derive the following result from the condition (6):

**Proposition 2** *The self-employed physicians always work less compared to the case when they would work in association with the ideal level of the non-labor medical input for the patient, i.e.,  $l^* < \bar{l}(m^{FB})$ .*

When we compare the labor supply derived from the self-employed physician's optimal decision with the corresponding labor supply derived from her constrained optimal decision under the condition that  $m^{FB}$  must be given for some reasons, it can be said that the self-employed physician always works less than work hours in association with  $m^{FB}$ . This implies that the self-employed physician has two negative effects on the patient's health level: the first is the over-use of the non-labor medical input, as in Proposition 1; and the second is less labor supply, as in Proposition 2.

We now consider the role of the difference between the legitimate and actual purchasing prices (the margin or 'yakka saeki'), the physician's weight on the benevolence, and the number of the patients per physician. To do that, we examine how a change in  $\Delta$ ,  $\gamma$ , and  $n$  affects the behavior of the self-employed physicians. Differentiating the first-order conditions (5) and (6) with respect to  $\Delta$ ,  $\gamma$ , and  $n$  yields  $m_\Delta^* > 0 > l_\Delta^*$ ,  $m_\gamma^* < 0 < l_\gamma^*$ , and  $m_n^* > 0 > l_n^*$  (see the Appendix for the proof), which also implies that  $h_\Delta^* < 0$ ,  $h_\gamma^* > 0$ , and  $h_n^* < 0$ . Then, we summarize the above results as follows:

**Proposition 3** *For the self-employed physician, a rise in the margin of the non-labor medical input and a rise in the number of the patients per physician increase the non-labor medical input per patient and decrease labor supply per patient, which results in the deterioration of the patient's health level. In contrast, a rise in the weight on the benevolence decreases the non-labor medical input per patient and increases labor supply per patient, which results in the improvement of the patient's health level.*

The brief intuitions behind the results are as follows. We first consider the case where  $\Delta$  increases due to some reasons, like a rise in the legitimate price. This causes the marginal benefit of the non-labor medical input in the conventional part of the utility function to rise, so that the physician increases the non-labor medical input. The increase in the non-labor medical input reduces the patient's health level, since it is already in the region of the over-use. This decline in the health level decreases the marginal benefit of labor in the benevolence part of the utility, so that the physician has an incentive to decrease labor supply per patient.

We next consider the case where  $\gamma$  increases, so that the physician pays more attention to their patients' health level. This causes the physician to intensify an incentive to decrease the non-labor medical input and increase labor supply per patient in order to improve the patients' health level. We finally explain the economic intuition for the case where  $n$  increases. The increase in  $n$  reduces labor supply per patient, mainly due to the fact that the increase in  $n$  raises the marginal cost of labor in the conventional part of the utility. However, the impact of a change in  $n$  on labor supply in total is ambiguous. In addition, the increase in  $n$  increases the non-labor medical input per patient since it increases the marginal benefit of the non-labor medical input per patient in the conventional part of the utility.

The health level of each patient is determined through the optimal decision of her self-employed physician. The decline in the margin of the non-labor medical input and the number of patients per physician as well as the rise in physician's weight on the benevolence cause the self-employed physician to decrease the non-labor medical input per patient and



to increase labor supply to each patient. As a result, such physician's behaviors improve the patient's health level.

## 4.2 Hospital-Employed Physicians

Hospitals consist of many physicians. Although hospital-employed physicians take into account mutual interactions with other physicians within the same workplace, this study does not consider such a possibility in order to stress on our objective to explain the behavioral difference between hospital-employed and self-employed physicians in the simplest formation.<sup>9</sup> This subsection first examines the optimal behavior of the hospital-employed physicians whose income schedule is exogenously given by the hospital. Then, we endogenize and determine the income schedule such that the hospital is benevolent in the sense of the zero-profit constraint. We assume that all hospital-employed physicians are homogeneous so that they share the identical weight on the benevolence,  $\gamma$ .

### 4.2.1 Optimal Choice of Hospital-Employed Physicians

The hospital-employed physicians usually get paid monthly in Japan, and their salary is determined following the income schedule that has already decided by the hospital. Although the income schedule is generally complicated due to the fact that the wage depends on various factors, such as work hours, overtime work, age, and past experiences, it might be reasonable to assume for simplicity that the wage rate of the hospital-employed physicians depends only on work hours or labor supply,  $L$ , in this paper. Specifically, the income schedule is assumed to be given by:

$$w(L, \delta) = \begin{cases} \bar{w}L & \text{if } L \leq \bar{L} \\ \bar{w}L - \delta a(L) & \text{if } L > \bar{L}, \end{cases} \quad (7)$$

---

<sup>9</sup>Kakinaka and Kato (2008) discuss a possibility of the existence of multiple equilibria through examining the behaviors of the hospital-employed physicians with the introduction of mutual interaction associated with intrinsic motivation of physicians.

where  $\bar{w} > 0$  is the constant wage rate when labor is less than some fixed amount  $\bar{L} > 0$ . The parameters  $\bar{w}$  and  $\bar{L}$  are exogenously given in the model, so that they have been predetermined due to some institutional reasons. We assume  $a'(L) > 0$  and  $a''(L) < 0$  for  $L \geq \bar{L}$ , and  $a'(\bar{L}) = 0$ . This specification of the income schedule requires that the wage rate per unit of labor supply (work hour) is constant up to some value  $\bar{L}$ , but it is decreasing in  $L$  once  $L$  is larger than  $\bar{L}$ , as illustrated in Figure 2. The decreasing wage rate means that the physicians are not fully paid for their labor supply that exceeds  $\bar{L}$ . The value of  $\delta \geq 0$  represents the degree of unpaid work, as explained in a later part.

It has recently been pointed out in Japan that each of hospital-employed physicians, particularly in local areas, can be characterized by ‘overwork.’ This is because the physicians try to fulfill the total work loads of hospital per day, due to a rapid decrease in the total number of hospital-employed physicians within the same workplace. The decrease in the total number of hospital-employed physicians within the same hospital obviously implies an increase in working hours of *each* hospital-employed physician per day. If they are forced to work more than they want to, then why don’t they quit their job? What does ‘overwork’ actually mean in economics? If each hospital-employed physician optimally chooses her own working hours, as usually assumed in economics, then ‘overwork’ should not occur in a sense of the optimality.

Given the fact that they usually get paid by the income schedule decided by the hospital, this study considers their overwork as ‘unpaid work,’ i.e., the work hours that are not fully compensated or unpaid. The value of  $\delta a(L)$  in the income schedule (7) could be considered 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,  $\delta$ , is associated with a larger value of labor supply that is not compensated or unpaid.

Some work has examined the situation where people work although not fully paid. Bell and Hart (1999) empirically establish the importance of unpaid work in the UK. The study of

Pennenberg (2005) on the estimation of key determinants for unpaid work in West Germany concludes that workers still work with their expectation for future benefits although they are not fully paid. For the case study on the Japanese employment practices throughout the whole industries, Oruga (2007) finds that approximately 29 hours of overtime allowances get unpaid each month for those working at least one hour of unpaid overtime. Sano and Kishida (2004) empirically study non-financial incentives of the Japanese physicians.

Ii and Bessho (2006) survey empirical literature on the Japanese health related issues and 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 work experience for their future career. Although we admit that various reasons exist to justify the presence of unpaid work, this study simply considers that the benevolence part in the utility function (1) plays a crucial role in the physician's involvement of unpaid work or overwork. The hospital-employed physicians optimally, rather than forcibly, make a decision of their labor supply and whether or not to provide unpaid work, taking the income schedule (7) as given.<sup>10</sup> It is formally said that they provide unpaid work if their optimal labor supply is larger than the critical value  $\bar{L}$ , i.e.,  $L > \bar{L}$ .

Given the income schedule  $w(L, \delta)$ , the problem for the hospital-employed physician is to choose  $m$  and  $l$  such that the utility (1) is maximized subject to the budget constraint  $y = w(L, \delta)$ . The first-order conditions are:

$$g'(m) = 0; \tag{8}$$

$$\gamma g(m) k'(l) r(n) = n [c'(nl) - w_L(nl, \delta)]. \tag{9}$$

These conditions require that for each of the two medical inputs, the marginal change of

---

<sup>10</sup>The observation of overwork or unpaid work could be interpreted as the situation in which hospital-employed physicians optimally supply their overwork. Thus, if their (subjective) expected benefits decrease or the cost of unpaid work increases, then it is more likely for hospital-employed physicians to quit their job, and they would choose to be self-employed. However, the present study does not consider the labor mobility in order to focus on the behavioral difference between the hospital-employed and self-employed physicians.

the conventional part of the utility is equal to that related to the benevolence. Notice that the optimal decision of the hospital-employed physicians is independent on the margin of the non-labor medical inputs,  $\Delta$ . Let  $\hat{m} \equiv \hat{m}(n, \gamma, \delta)$  and  $\hat{l} \equiv \hat{l}(n, \gamma, \delta)$  denote the hospital-employed physician's optimal choice of the non-labor medical input and labor supply for a patient, respectively. Since the condition (8) implies  $\hat{m} = m^{FB}$ , we deduce the following result related to the optimal choice of the non-labor medical input:

**Proposition 4** *The hospital-employed physicians always provide the ideal level of the non-labor medical input for the patient, i.e.,  $\hat{m} = m^{FB}$ .*

In contrast to self-employed physician's over-use of the non-labor medical input, the hospital-employed physician's optimal level of the non-labor medical input,  $\hat{m}$ , must be consistent with its ideal level for the patient,  $m^{FB}$ .

We now examine the impact of a change in  $\gamma$ ,  $n$ , and  $\delta$  on the behavior of each hospital-employed physician related to labor supply per patient,  $\hat{l}$ , and the total labor supply,  $\hat{L} = n\hat{l}$ . Differentiating the first-order condition (9) with respect to  $\gamma$ ,  $n$  and  $\delta$  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** *The income schedule  $w(L, \delta)$  is exogenously given. For the hospital-employed physician, a rise in the weight on the benevolence increases labor supply per patient and in total and hence the patient's health level. Moreover, a rise in the number of the patients per physician decreases labor supply per patient and hence the health level of her patients, but it increases labor supply in total. Furthermore, if the physician involves unpaid work, then a rise in the degree of unpaid work decreases labor supply per patient and in total and hence the patient's health level.*

The economic intuitions behind the results are as follows. As  $\gamma$  increases, the physician pays more attention to their patients' health level, so that she intensifies an incentive to increase labor supply in order to improve the patients' health level. On the other hand, a rise in  $n$

reduces labor supply per patient, since it significantly induces the rise in the marginal cost of labor in the conventional part of the utility. However, a rise in  $n$  increases the total labor supply per physician. Furthermore, a rise in  $\delta$  reduces the marginal benefit of labor so that the physician has an incentive to decrease labor supply, which results in the deterioration of the health level.

One important issue in the case of the hospital-employed physicians is on whether or not the physician involves unpaid work, i.e., whether the physician's total labor supply  $\hat{L} = n\hat{l}$  is larger than  $\bar{L}$ . To discuss it, we consider the trajectory of  $\bar{L} = \hat{L}(\gamma, n, \delta)$  on the  $(n, \gamma)$ -space. 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. The hospital-employed physician involves unpaid work if the pair of  $n$  and  $\gamma$  is in the region above the curve, but her labor is fully paid if the pair is in the region below the curve. This implies that given the income schedule  $w(L, \delta)$ , for each hospital-employed physician with the weight on the benevolence,  $\gamma$ , there exists a critical number of the patient per physician,  $\hat{n}(\gamma)$ , such that the hospital-employed physician involves unpaid work if  $n > \hat{n}(\gamma)$ , and she never involves unpaid work if  $n < \hat{n}(\gamma)$ . Furthermore, it is directly observed that  $\hat{n}(\gamma)$  is decreasing in  $\gamma$ . That is, the hospital-employed physician involves unpaid work or overwork if she faces a relatively large number of patients and/or has a relatively high weight on the benevolence to the patients.

One of the most important and distinctive purposes of the public healthcare system of Japan would be to provide minimum medical services to the public. However, it has been argued that the reform of the Japanese trainee programme of physicians commenced in 2004 eventuated a drastic decrease in the number of hospital-employed physicians in local areas. Our results in this study present that the increase in the number of patients per physician, associated with a decrease in the number of hospital-employed physicians, could enforce the physicians to do heavy unpaid workload, which may result in various serious problems, such as a higher risk to have medical accidents in the hospital.

We next provide some brief discussion about how the hospital-employed physicians' be-

havior changes once they are fully paid with the wage rate  $\bar{w}$  for any amount of labor supply, i.e.,  $y = \bar{w}L$  for any  $L$ , or simply  $\delta = 0$ . In Figure 4, the budget constraint  $y = w(L, \delta)$  with the possibility of unpaid work in the previous discussion is represented by the thick up-sloping concave curve, while the budget constraint  $y = \bar{w}L$  with fully paid schedule is represented by the dotted up-sloping straight line. The indifference curves corresponding to some utility level are captured by the convex curves, AA, BB, and CC.<sup>11</sup> Since our assumed utility is of the quasi-linear form, it is directly observed that the change toward full-paid schedule induces the hospital-employed physician to change their optimal bundle from point E to point F. Then, we summarize the above discussion as follows:

**Proposition 6** *Suppose that a hospital-employed physician initially involves unpaid work. If the hospital changes the income schedule such that the physician's labor is fully paid (i.e.,  $\delta = 0$ ), then she increases labor supply, and hence the health level of her patients is improved.*

#### 4.2.2 Endogenous Income Schedule within the Hospital

The previous discussion has assumed that the income schedule  $w(L, \delta)$  is exogenously given to the hospital-employed physicians in the hospital. In this subsection, we attempt to endogenize the income schedule by assuming that the hospital is a benevolent institution such that the degree of unpaid adjusts with its zero profit. This zero-profit condition requires that the sum of the labor cost for the physicians and the acquiring cost of the non-labor medical inputs must be covered by total revenues.

For simplicity, our model assumes that the income schedule can be characterized by the degree of unpaid work,  $\delta$ . This specification implies that the hospital manager chooses  $\delta$  in the income schedule to meet the zero-profit condition.<sup>12</sup> Thus, noticing that the hospital-

---

<sup>11</sup>The condition that the indifference curves in Figure 4 is 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  $L$ .

<sup>12</sup>It is generally difficult to characterize the income schedule by using one measurement. Indeed, the hospital manager has several ways to change the income schedule for their employees. In our model, in addition to  $\delta$ , the wage rate  $\bar{w}$  and the critical work hours  $\bar{L}$  might be also considered as other choices to adjust the income schedule. However, we believe that assuming that  $\bar{w}$  and  $\bar{L}$  are exogenously determined

employed physicians always choose the ideal level of the non-labor medical input,  $m^{FB}$ , as shown in Proposition 4, the equilibrium degree of unpaid work,  $\tilde{\delta} \equiv \tilde{\delta}(\Delta, \gamma, n)$ , must satisfy:

$$w(\tilde{L}, \tilde{\delta}) = [p(\tilde{l}, m^{FB}) + \Delta m^{FB}]n, \quad (10)$$

where  $\tilde{l}(\Delta, \gamma, n) \equiv \hat{l}(\gamma, n, \tilde{\delta}(\Delta, \gamma, n))$  and  $\tilde{L}(\Delta, \gamma, n) \equiv \hat{L}(\gamma, n, \tilde{\delta}(\Delta, \gamma, n))$  the equilibrium level of the hospital-employed physician's labor supply per patient and in total, respectively.  $\hat{l}(\gamma, n, \delta)$  and  $\hat{L}(\gamma, n, \delta)$  are the hospital-employed physician's optimal level of labor supply per patient and in total, respectively, which we have already derived in the previous subsection. Let  $\tilde{h}(\Delta, \gamma, n) \equiv g(m^{FB})k(\tilde{l}(\Delta, \gamma, n))$  denote the corresponding health level of the patient.

Figure 5 illustrates the equilibrium outcome with the hospital's zero-profit condition, where the hospital-employed physician's labor supply is  $\tilde{L}(> \bar{L})$  with unpaid work. Curves AA and BB respectively represent the budget constraint for the physician and the hospital, i.e., the physician's income schedule offered by the hospital and the zero-profit condition for the hospital, while curve CC represents the indifference curve of the physician that attains the maximum utility under the constraints. In this equilibrium outcome, the marginal income of labor for the hospital is assumed to be smaller than that for the physician, i.e.,  $w_L(\tilde{L}, \delta) = \bar{w} - \tilde{\delta}a'(\tilde{L}) > p_l(\tilde{l}, m^{FB})$ . In the rest of the paper, we assume that this condition holds.

We now attempt to evaluate how the hospital-employed physicians' behavior is affected by a change in the margin of the non-labor medical input,  $\Delta$ , and the weight on the benevolence,  $\gamma$ . First, concerning the impact of a change in the margin, we differentiate the zero-profit condition (10) with respect to  $\Delta$  and obtain  $\tilde{\delta}_\Delta < 0$ ,  $\tilde{l}_\Delta = \hat{l}_\delta \tilde{\delta}_\Delta > 0$ ,  $\tilde{L}_\Delta = \hat{L}_\delta \tilde{\delta}_\Delta > 0$ , and  $\tilde{h}_\Delta = g(m^{FB})k'(\tilde{l})\hat{l}_\Delta > 0$  (see the Appendix for the proof). The rise in the margin of the non-labor medical input allows the hospital to offer the income schedule with less unpaid work to each physician. This in turn causes the physician to intensify an incentive

---

due to some institutional reasons would be beneficial to achieve our purpose in explaining how the income schedule is determined. One possible justification may be that adjusting  $\delta$  is more common than changing  $\bar{w}$  and  $\bar{L}$  for the hospital manager in the short-run, i.e.,  $\delta$  relatively flexible compared to  $\bar{w}$  and  $\bar{L}$ .

to work more, and hence the patients' health level is improved. Second, the impact of a change in the weight on the benevolence on the physician's behavior can be characterized by differentiating the zero-profit condition (10) with respect to  $\gamma$ , which 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 the Appendix for the proof). The rise in the physician's benevolence is associated with the increase in labor supply and in the hospital's monetary payoff, which allows the hospital to offer the income schedule with less unpaid work. As a result, the patients' health level is improved. We summarize the above results as follows:

**Proposition 7** *Suppose that the hospital-employed physician involves unpaid work. Then, a rise in the margin of the non-labor medical input decreases the degree of unpaid work in the income schedule and increases labor supply per patient and in total and hence the patient's health level. Moreover, a rise in the weight on the benevolence increases the degree of unpaid work in the income schedule, labor supply per patient and in total, and hence the patient's health level.*

Recall in Proposition 3 that for the self-employed physician, a rise in  $\Delta$  decreases labor supply per patient and the patient's health level, while a rise in  $\gamma$  increases labor supply per patient and the patient's health level. The hospital-employed physician's behavior of labor supply in response to a change in the margin is in contrast to the self-employed physician, but her behavior of labor supply in response to a change in the benevolence is consistent with the self-employed physician.

Concerning the impact of a change in the number of patients per physician,  $n$ , we differentiate the zero-profit condition (10) with respect to  $n$  yields:

$$\tilde{\delta}_n = \frac{[w_L(\tilde{L}, \tilde{\delta}) - p_l(\tilde{l}, m^{FB})]\hat{L}_n(\gamma, n, \tilde{\delta}) - [p(\tilde{l}, m^{FB}) + \Delta m^{FB}]}{\Gamma}, \quad (11)$$

where  $\Gamma \equiv (p_l - w_L)\hat{L}_\delta - w_\delta > 0$ . The first sub-effect in the right-hand side,  $(w_L - p_l)\hat{L}_n > 0$ , captures the marginal increment of the physician's monetary payoff from the increase in



labor supply associated with the increase in  $n$ , while the second sub-effect,  $p + \Delta m^{FB} > 0$ , represents the marginal increment of the hospital's revenue from the increase in  $n$ . Equation (11) simply states that the sign of  $\tilde{\delta}_n$  is highly dependent on which sub-effect dominates the other. The rise in  $n$  increases the degree of unpaid work if the first sub-effect dominates the second, and it decreases the degree of unpaid work if the second sub-effect dominates the first, i.e.,  $\tilde{\delta}_n \geq 0$  if  $(w_L - p_l)\hat{L}_n \geq p + \Delta m^{FB}$ .

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 the derived properties of  $\hat{L}_n > 0$ ,  $\hat{L}_\delta < 0$ ,  $\hat{l}_n < 0$ , and  $\hat{l}_\delta < 0$ . These two equations imply that the impact of a change in  $n$  on labor supply can be decomposed into two sub-effects: the first is the direct effect that has been discussed in the previous subsection; and the second is the indirect effect that comes from the change in  $\delta$  associated with a change in  $n$ . The direct effect requires that a rise in  $n$  increases labor supply in total ( $\hat{L}_n > 0$ ) and 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  $p + \Delta m^{FB}$ .

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 in the income schedule ( $\tilde{\delta}_n > 0$ ). This in turn causes the physician to have less incentive to work, and as a result, the indirect effect implies that a rise in  $n$  decreases labor supply per patient and in total ( $\hat{l}_\delta \tilde{\delta}_n < 0$  and  $\hat{L}_\delta \tilde{\delta}_n < 0$ ). Taking into account the direct and indirect effects, we observe that a rise in  $n$  causes the physician to decrease labor supply per patient ( $\tilde{l}_n < 0$ ) and hence the patient's health level, but it has ambiguous effect on labor supply in total ( $\tilde{L}_n \geq 0$ ). On the other hand, in the case of  $(w_L - p_l)\hat{L}_n < p + \Delta m^{FB}$ , a rise in  $n$  decreases the degree of unpaid work in the income schedule ( $\tilde{\delta}_n < 0$ ). This in turn causes the physician to have more incentive to work. Thus, the indirect effect requires that a rise in  $n$  increases labor supply per patient and in total ( $\hat{l}_\delta \tilde{\delta}_n > 0$  and  $\hat{L}_\delta \tilde{\delta}_n > 0$ ). With the consideration of both the direct and indirect effects, a rise in  $n$  causes the physician to increase labor supply in total ( $\tilde{L}_n > 0$ ), but it has ambiguous effect on labor supply per patient ( $\tilde{l}_n \geq 0$ ). Then, we summarize the impact of a change in  $n$  as follows:

**Proposition 8** *Suppose that the hospital-employed physician involves unpaid work. If  $(w_L -$*

$p_l)\hat{L}_n > p + \Delta m^{FB}$ , then a rise in the number of patients per physician increases the degree of unpaid work in the income schedule and decreases labor supply per patient and hence the patient's health level. In contrast, if  $(w_L - p_l)\hat{L}_n < p + \Delta m^{FB}$ , then a rise in the number of patients per physician decreases the degree of unpaid work in the income schedule and increases labor supply in total.

The results are relatively complicated compared to the self-physician's case in Proposition 3 where a rise in  $n$  always decreases labor supply per patient and the patient's health level. The degree of unpaid work in the income schedule with the hospital's zero-profit condition has an important role in determining the hospital-employed physicians.

For the better understanding of the difference between self-employed and hospital-employed physicians, we next examine their optimal decision in the case where each type of physicians face the identical number of patients. Figure 6 illustrates this situation. Curve AA represents the income schedule for the hospital-employed patients, and curve BB represents the budget constraint for the self-employed physicians who are enforced to meet the constraint  $m = m^{FB}$  for some reasons, as in Proposition 2. Curves CC and C'C' respectively represent the indifference curve that attains the maximum utility for the hospital-employed physician and that for the self-employed physician with the constraint  $m = m^{FB}$ . Point E represents the optimal decision of the hospital-employed physician, and point E' represents the optimal decision of the self-employed physician with the constraint  $m = m^{FB}$ .

It is observed from Figure 6 that labor supplied by the hospital-employed physician is larger than that by the self-employed physician with the constraint  $m = m^{FB}$ . Since the optimal level of labor supply for the self-employed without any restriction on  $m$  is less than that for the self-employed physician with the constraint  $m = m^{FB}$ , as shown in Proposition 2, the hospital-employed physician provides more labor supply to a patient than the self-employed physician, i.e.,  $l^* < \tilde{l}$  and  $L^* < \tilde{L}$ . Moreover, note that the hospital-employed physician provides the ideal level of the non-labor medical input,  $\tilde{m} = m^{FB}$ , as shown in Proposition 4, while the self-employed physician involves the over-use through providing the

non-labor medical input more than  $m^{FB}$ , as shown in Proposition 1. Thus, the hospital-employed physicians provide a better medical service with the higher health level of the patients from the perspectives of both the supply of labor and the non-labor medical input. On the other hand, it is also observed from Figure 6 that the self-employed physicians obtain a higher utility than the hospital-employed physicians. The above arguments are summarized as follows:

**Proposition 9** *Suppose that the self-employed and hospital-employed physicians need to treat the identical number of patients. Then, the self-employed physician attains a higher utility than the hospital-employed physician. However, the hospital-employed physician works more and provides a better medical service with the higher health level of the patients than the self-employed physician does.*

Finally, we briefly discuss the role of public subsidy to hospitals, in particular public hospitals, using the model of the hospital-employed physicians. As often mentioned in various studies, such as Nakayama (2004), it has been widely acknowledged in Japan that many public hospitals (around 65% of all public hospitals in fiscal year 2005) receive public subsidies from local governments. Assuming that the hospital receives lump-sum subsidy  $S$  per physician, we can rewrite the condition (10) as:

$$w(\tilde{L}, \tilde{\delta}) = [p(\tilde{l}, m^{FB}) + \Delta m^{FB}]n + S. \quad (12)$$

Figure 7 illustrates how the subsidy to the 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  $\delta_1$ , the graph of the income schedule  $y = w(L, \delta_1)$ , curve BB, is tangent to the indifference curve CC at point E, and the graph of the hospital's budget constraint  $y = [p(L/n, m^{FB}) + \Delta m^{FB}]n$  intersects with the graph of the income schedule  $y = w(L, \delta_1)$ , curve BB, at point E.

We now consider the case where the hospital receives public subsidy  $S > 0$  per physician.

The public subsidy causes the hospital's budget constraint to shift up by  $S$  (shift-up of curve BB to curve B'B'). This allows the hospital to obtain a positive profit and hence to reduce the degree of unpaid work from  $\delta_1$  to  $\delta_2$ . At the new equilibrium, which is represented by point E', the graph of the new income schedule  $y = w(L, \delta_2)$ , curve B'B', is tangent with the indifference curve C'C' at point E', and the graph of the new hospital's budget constraint  $y = [p(L/n, m^{FB}) + \Delta m^{FB}]n + S$  intersects with the graph of the income schedule  $y = w(L, \delta_2)$ , curve B'B', at point E'. As a result, public subsidy  $S$  increases the supply of labor per patient and in total (from  $\tilde{L}_1$  to  $\tilde{L}_2$ ) and improves the patients' health level. The above result has an important implication. Recent arguments of public support to regional hospitals in Japan could help improve medical services from the theoretical perspective in the model, although some studies, such as Nakayama (2004), argue that public subsidy induces the management inefficiency of public hospitals in Japan.

## 5 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 healthcare system: the fee-for-service system and the presence of 'yakka saeki' that is a positive difference between the legitimately fixed price and purchasing price of pharmaceutical materials. We have also illustrated currently severe working conditions in local hospitals after the 2004 reform of the Japanese trainee programme by introducing the concept of unpaid work into the model. The model has shown several important results.

First, self-employed physicians provide the over-use of the medical treatments that are less related to their labor supply, while hospital-employed physicians provide the medical treatments at their ideal level for the patients. Secondly, in terms of labor supply, self-employed physicians have more incentive to avoid much work load at some expense of the

patients' health, while hospital-employed physicians could involve unpaid work with much work load particularly in the case that they face a large number of patients. Thirdly, 'yakka saeki' affects the degree of the over-use of medical treatments for self-employed physicians, and its increase deteriorates the health level of the patients treated by the self-employed physicians. Fourthly, the recent shrink in the number of hospital-employed physicians in local regions, associated with the 2004 reform, could cause the physicians to have more severe work load even with unpaid work and to reduce the quality of medical services. The public support to mitigate unpaid work would help improve the health level of the patients. Finally, as long as the self-employed and hospital-employed physicians treat the identical number of patients, the self-employed physician attains a higher utility than the hospital-employed physician, but the hospital-employed physician works more and gives a better medical service with the higher health level of the patients than the self-employed physician.

This work could be extended in several directions. One possibility is to introduce labor mobility of physicians between self-employed and hospital-employed in order to provide careful discussion of why serious shortage of physicians in local regions has emerged recently. Another possibility is to incorporate the logic of demand-side cost sharing into the present model in order to examine the role of public health insurance in Japan. We believe that the model outlined in this paper would be applied to analytically address such on-going issues of the Japanese healthcare system.

## Appendix

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

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

Differentiating these with respect to  $\Delta$  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  $C = np_{ll}(l, m) - n^2 c''(nl) + \gamma g(m)k''(l)r(n) < 0$ . Noticing that  $AC - B^2 > 0$ , we obtain:

$$m_{\Delta}^* = \frac{-nC}{AC - B^2} > 0 > \frac{nB}{AC - B^2} = l_{\Delta}^*,$$

which are the desired results. Moreover, differentiating the first-order conditions with respect to  $\gamma$  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, we obtain:

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

which are the desired results. 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 by:

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

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

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

which are the desired results.  $\square$

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

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

We first show the impact of a change in  $\gamma$  on  $\hat{l}$  and  $\hat{L}$ . Differentiating this with respect to  $\gamma$  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  $Z < 0$ , we obtain  $\hat{l}_\gamma > 0$  and hence  $\hat{L}_\gamma = n\hat{l}_\gamma > 0$ , which are the desired results. We next show the impact of a change in  $\delta$  on  $\hat{l}$  and  $\hat{L}$ . Differentiating the first-order condition with respect to  $\delta$  yields:

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

Since  $Z < 0$  and  $-nw_{L\delta} \geq 0$ , we obtain  $\hat{l}_\delta < 0$  and hence  $\hat{L}_\delta = n\hat{l}_\delta < 0$ , which are the desired results. We finally show the impact of a change in  $n$  on  $\hat{l}$  and  $\hat{L}$ . 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  $r(n)/n - r'(n) > 0$ , we obtain  $\hat{l}_n < 0$ , which is the desired result. 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  $\hat{l}k''(\hat{l})/k'(\hat{l}) < -1$ , we obtain  $\hat{L}_n > 0$ , which is the desired result.  $\square$

**Proof of Proposition 7** Differentiating equation (10) with respect to  $\Delta$  and  $\gamma$  yields:

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

Since  $\bar{w} - \tilde{\delta}a'(\tilde{L}) > p_l$ ,  $\hat{l}_\delta < 0$  and  $\hat{l}_\gamma > 0$ , we obtain  $\tilde{\delta}_\Delta < 0$  and  $\tilde{\delta}_\gamma > 0$ . These 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  $\tilde{l}_\gamma = \hat{l}_\gamma + \hat{l}_\delta \tilde{\delta}_\gamma$ , we obtain:

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

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),” *Kaiei Kensa Kenkyu*, 34, 55–66.



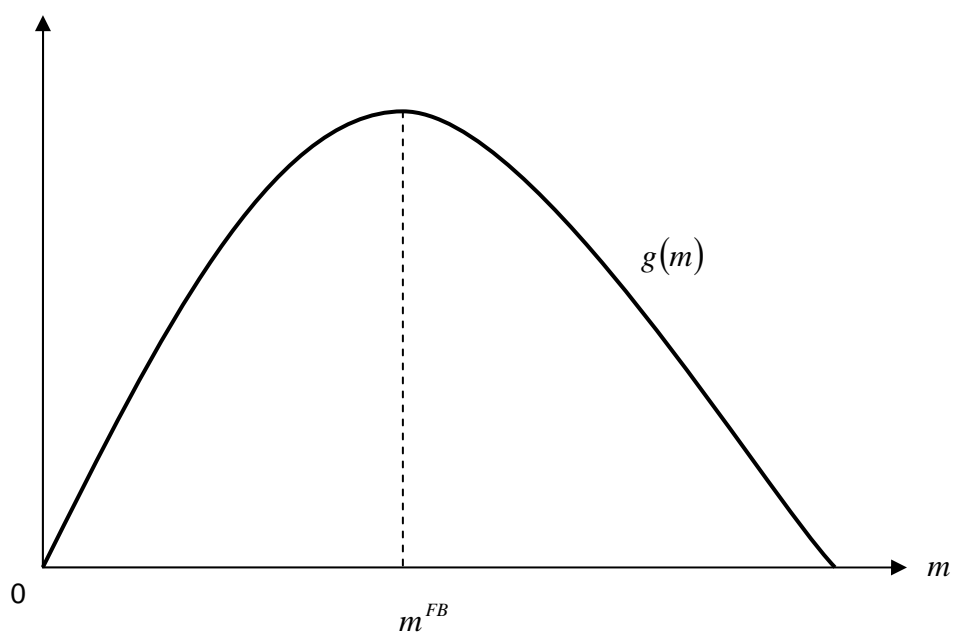
- ELLIS, R. P., AND T. G. MCGUIRE (1986): "Provider Behaviour under Prospective Reimbursement," *Journal of Health Economics*, 5, 129–151.
- (1990): "Optimal Payment Systems for Health Services," *Journal of Health Economics*, 9, 375–396.
- (1993): "Supply-Side and Demand-Side Cost Sharing in Health Care," *Journal of Economic Perspectives*, 4, 135–151.
- EVANS, R. G. (1974): "Supplier-Induced Demand: Some Empirical Evidence and Implications," in *The Economics of Health and Medical Care*, ed. by M. Perlman. Macmillan, London.
- 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.
- II, M., AND S. BESSHO (2006): "A Survey: The Empirical Literature on Health Economics of Japan and Health Policies (in Japanese: Iryo no Kisoteki Jissyo Bunseki to Seisaku: Survey)," *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 Competition 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 Hosyous 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,” *Pharmacoeconomics*, 9(S3), 55–66.

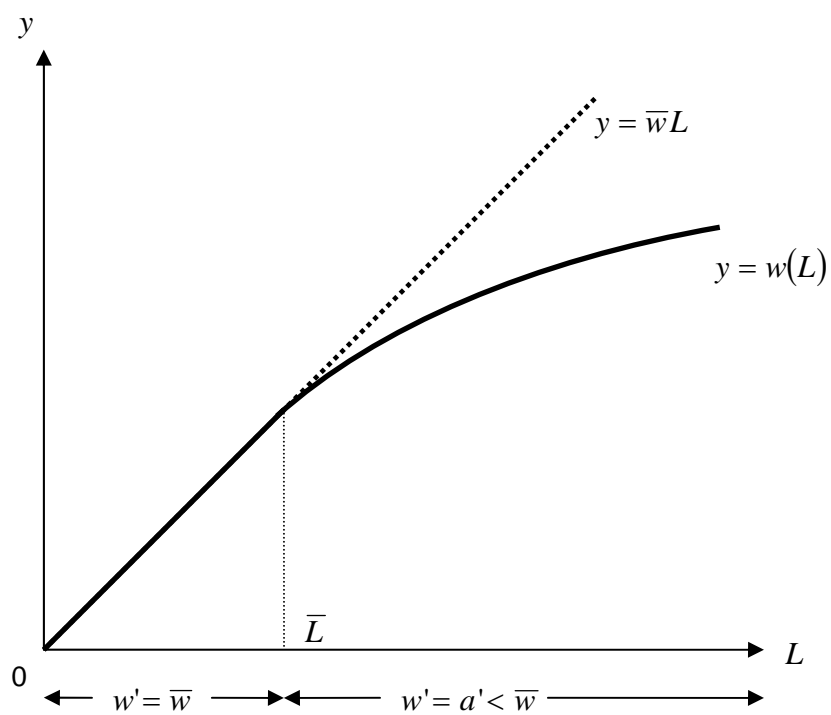
——— (2004): *Medical Reform in Japan (in Japanese: Nihon no Iryo Kaikaku)*. Toyo Keizai Shinpousya, Tokyo.

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

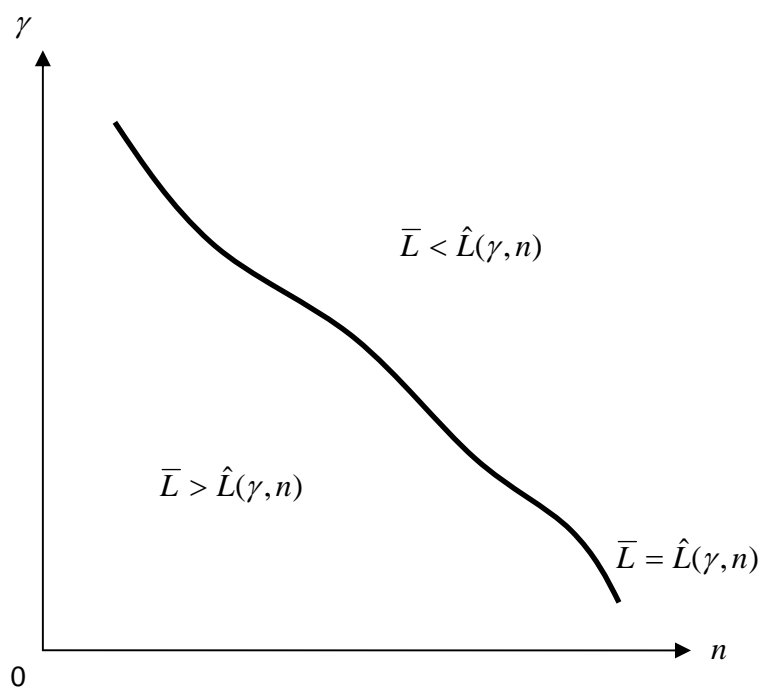
**Figure 1**



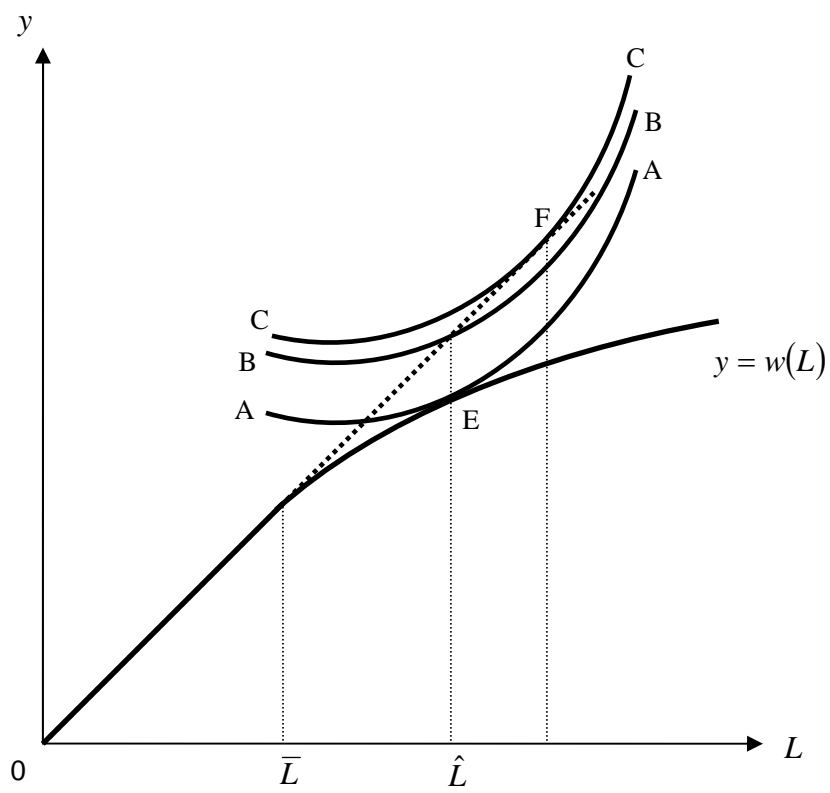
**Figure 2**



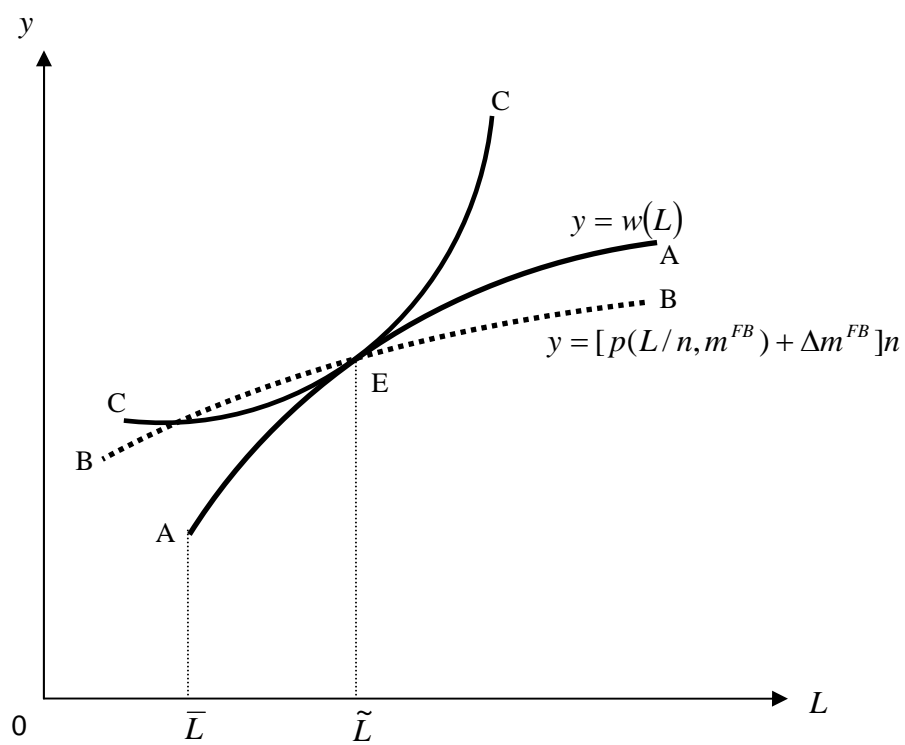
**Figure 3**



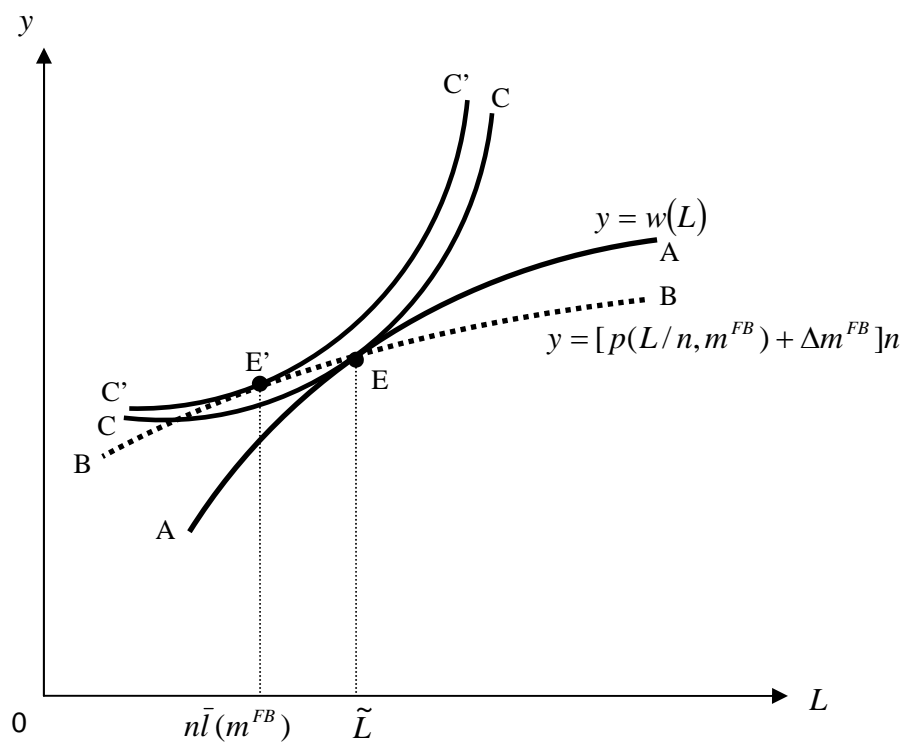
**Figure 4**



**Figure 5**



**Figure 6**



**Figure 7**

