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Simulation Experiment for Economical Impact by Physicians' Excessive Increase in Japan

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Abstract

We have a difficulty when discussing physician oversupply if we compare the number of physicians per population in the developed countries because of differences in several conditions. We also have a difficulty with demonstrating the oversupply because of a controversy pertaining to adequate number of physicians in terms of an ideal health care delivery. However, I could present by using an analytical approach that the agenda of physicians oversupply can be discussed in its economic impact, when we focus on physician's earning power in future medical institutions' management sustainability under the worse conditions of government's cost containment policy and an oversupply of physicians.

Introduction

Optimal control of medical expenditure is a common policy agenda among industrialized countries including Japan, where ever inexperienced pace of increase in elderly population makes the situation more urgent in spite of government's tight regulation of service price. Several strategies such as capitation are expected to result in containment of medical service utilization and consequent reduction in medical cost through economic incentives towards physicians. On the other hand, optimization of the number of physician supply tries to control cost by modifying an infrastructure of delivery system. In this paper, we will focus on the latter strategy as a policy agenda.

The Ministry of Health and Welfare (MHW) had set up the Committee of Demand and Supply for Medical Doctor in the Future in 1984. The Committee anticipated approximately 10% oversupply of physicians in 2025 even under optimistic conditions, then, recommended that, at minimum, 10% of physician candidates should be cut off until 1995. In fact, 7.7% cut-off of new enrollment capacity of medical schools in all over Japan had been realized by 1995, though it had not reached the recommended level. The Medical Professions Division at the Health Policy Bureau of MHW in 1992 reported that physician oversupply would become a more serious issue than expected before. Then, they called for the Committee for Review of physicians' Demand and Supply in 1993. Their final report in 1994 also warned forthcoming oversupply of physicians. Moreover, the Ministry confirmed the same warning again under the Long-term Care Plan launching from 2000 by the report of the Discussion Group of Demand and Supply for Medical Doctor in 1998.

However, those reports shared several limitations with previous studies on physician supply. Firstly, since it relied on controversial number of physicians in terms of an ideal health care delivery, it failed to demonstrate the oversupply. In addition, since it relied on comparative data of number of physicians per population, it failed to show an optimal level of physician supply corresponding to the characteristics of different financial and delivery systems across countries. That is to say, it lacked a theoretical referent framework to which the level of optimization should be discussed. Finally, the impact of physician oversupply on health economics was not discussed due to a lack of framework and suitable methodology to integrate with this issue, demands in medical services, and the ability of health sectors to maintain their business. In this paper, I propose an alternative approach and a method to overcome these limitations to analyze the impact of physician oversupply in a dynamic context of health service markets.

Analytic Framework

Theory and Method

We started from referring to an economic model of interdependent health service markets by Feldstein[1] to obtain a theoretical framework of analysis. In this model, institutional, manpower, and educational markets are interacting with each other and patients' demand for treatment. Thus, the model provides a relevant scheme to describe the relationship of physician oversupply in a manpower market with two other health sector markets and patients' demand for service utilization. However, due to a regulative nature of Japanese health care system, we had to modify the model as shown in Figure 1.

In Japanese system, physicians are either employees in institutions or owners of institutions. Thus, an institution is a basic unit that makes a decision in terms of an economic behavior in health sector market. Since service prices are regulated by the government payer, and minimum requirement of number of physicians per patient set by the government also determines the level of physician demand for most of institutions, quantity of service provision and wages for physicians are historically under

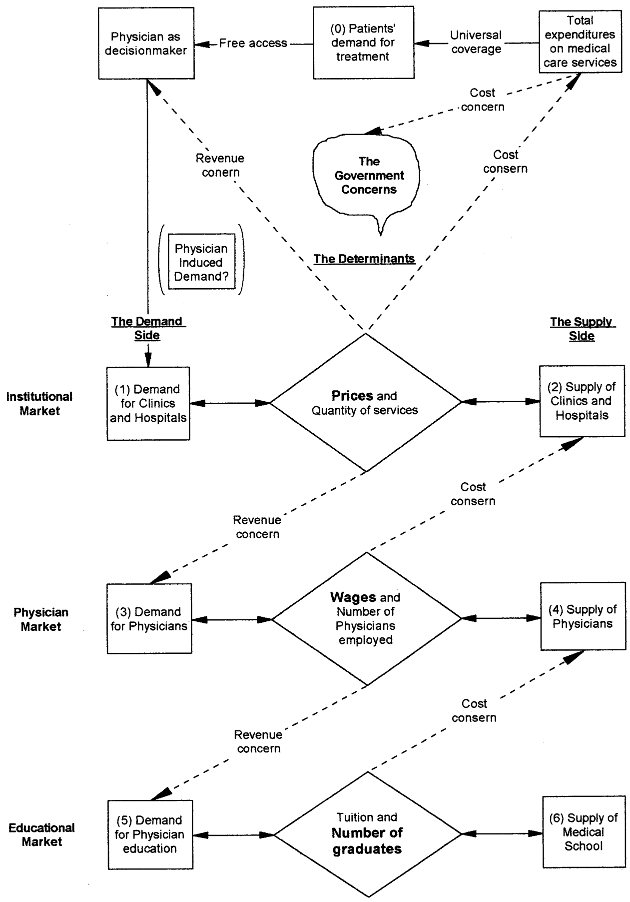


Fig. 1. An overview of the health care sector in Japan besed on Feldstein model

institutional control. In this reason, we cannot deny physician induced demand in Japan yet[2)].

Each institution has to decide market entry/exit by taking consideration of revenue and cost balance, which, in turn, is determined by a decision regarding quantity of service provision and labor cost for physicians and other health providers. Thus, an economic analysis of Japanese health sector market can be reduced to an issue of business sustainability in the institutional level.

Based on this framework, we recognized that our model should be composed of three functions; service demand, physician and institutional supply, and balance for institutional sustainability as shown in Figure 2.

Service demand is mainly a function of the demographic structure of Japanese population. Physician supply, on the other hand, is determined by government policies regarding medical graduates and physicians to be employed. These two components

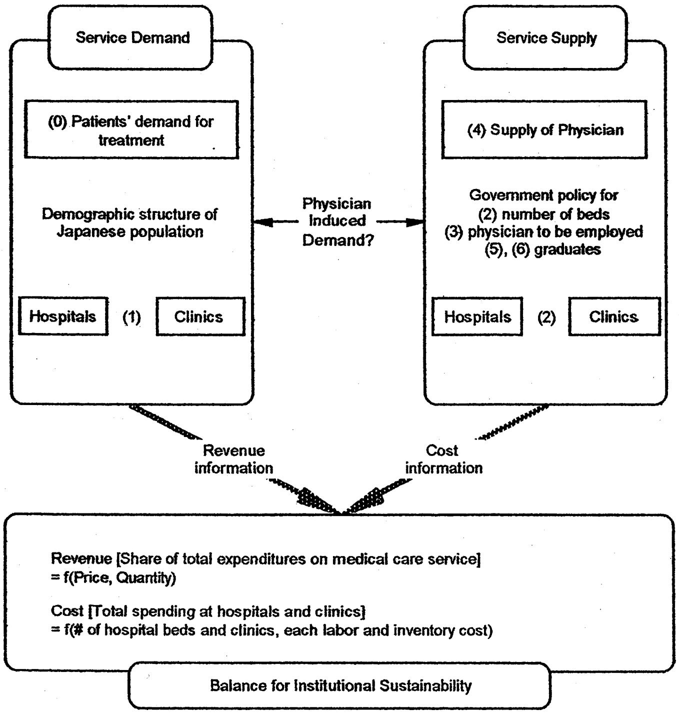


Fig. 2. Three function for institutional sustainability

determine institutional revenue and cost balance. To describe these interactions, all variables are described in a monetary term (YEN) as a common unit of analysis.

Finally, it was a challenge to include all these functions into a single analytic platform. To overcome this, we decided to use System Dynamics (SD) method for several reasons. First, SD is a well developed analytic tool that has been applied since 1950's to an analysis of complex social systems. Second, through a process of SD analysis, we can obtain a clear view of causal relationship among variables, which helps us identify key influential elements. Third, SD can provide a trend forecast of targeted variables by simulating an obtained model. Finally, we can assess political feasibility and relevance of alternative policies by sensitivity analysis in SD.

Development of Causal Model

1. Service Demand

The amount of medical service demand was extrapolated based on available age-specific data on service utilization[3)] and forecast data of population structure[4)]. Utilization was estimated respectively according to types of institutions (hospital vs. clinic) and types of service (inpatient vs. outpatient service), because reimbursement rate differs across those categories. In addition, since utilization pattern varies across age, mainly due to distinctive senior health plan for over 65 years old, population structure was also categorized into three levels; under 15 years old, from 15 to 64 years old, and over 65 years old. Then, obtained number of service utilization was transformed into monetary values by multiplying average charge for each type of service and institution.

2. Service supply and related cost

2-a) Physician supply

The number of enrollment into medical education has been regulated by the government. The enrollment capacity of medical schools almost equals to the number of graduates. Although the medical licenser controls those medical graduates, the boarding exam does not seem a major barrier to restrict new entry physicians since more than 97% of examinees on average passed the exam. Thus, number of physician entry is defined by the following form.

Eq. (1) $R(t) = f\ (e(t),\ p(t))$

where, $R(t)$: # of physician entry, $e(t)$: enrollment capacity for medical schools

$p(t)$: passing rate of the national examination for medical doctor licensure

Then, we needed to separate physicians working at hospital settings and those working at clinic settings because different institutional types imply different cost structures, which must be integrated into our model of economic impact of physician oversupply. Physicians were categorized into three types; physicians working in clinics (MDC), those in hospitals (MDH), and those working in non-clinical services (NMD). A physician can transit across these categories over time. However, we omit transit flows from MDC to MDH or NMD to simplify our model because they were rare cases. We also neglect the flows from NMD to MDH or MDC with same reasons. Transit rates across categories were estimated from the statistics[5] by MHW in 1990 and 1992.

Physician cohort was divided into 6 sub-cohorts according to age. Number of physicians in each sub-cohort was estimated by taking consideration of transit across categories and age, and mortality rates. Mortality rate of each age sub-cohort was derived from the census statistics in 1990. Then, we can represent physicians number at year (t) by age and by category types as a following difference equation.

Eq. (2) $D_{hj}(t+dt) = D_{hj}(t) + dt\ (m_{hh,j-1} - m_{hh,j} - m_{hc,j} - m_{hn,j} - d_j)$

where $D_{hj}(t)$: number of MDH in cohort(j)

$m_{hh,j}$: portion of MDH in cohort(j), transferring to MDH in the next cohort(j+1)

$m_{hc,j}$: portion of MDH in cohort(j), transferring to MDC in the next cohort(j+1)

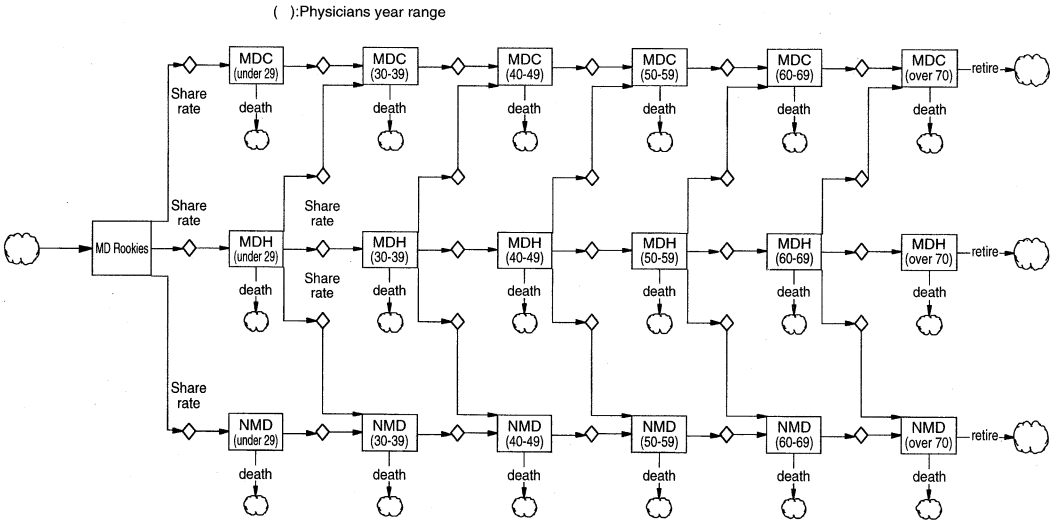


Fig. 3. Physician Supply Model

$m_{hn,j}$: portion of MDH in cohort(j), transferring to NMD in the next cohort(j+1)

d_j : mortality of MDH in cohort(j)

Then, each physician sub-cohorts and transit flows in physician supply is depicted in Figure 3. Here, though estimated number of physicians were assumed to fully be employed by medical institutions, it seems reasonable during simulation, which we will discuss later in this paper. Increased number of physicians was supposed to reflect on cost of institutions. In addition, we assume that the increment of physician also contribute to institutional revenue indirectly through induced demand as discussing later.

2-b) Institutional cost.

We used different units of measuring cost between hospital and clinic settings; in clinics, cost per facility was estimated, whereas cost per bed was estimated as proxy in hospital settings[6)7)].

Labor costs often occupy a dominant share in hospital costs. Therefore, we analyzed the costs by dividing them into three parts, physician cost, non-physician cost and non-labor costs. Those costs were estimated by following formats;

- Physician cost: W_{MD} = f(physician # increase, physician wage growth rate)
- Non-physician labor cost: W_{NP} = f(non-physician' wage growth rate)
- Non-labor costs: E = f(price index growth rate)

3) Cost/revenue balance

3-a) Effects of Induced Demand on revenue

We cannot distinguish whether the induced demand is caused by physician autonomy, or by improved patient's accessibility to medical services. However, we can empirically find a strong correlation between physician density and health care expense and utilization rates across regions in Japan.

By referring to the National Health Insurance data in 1990[8], we could empirically find a strong correlation between the number of physicians per 100,000 people and the age-adjusted healthcare expenditure index (HEI : ratio of regional healthcare expenditure to the national average) in 47 prefectures over Japan. As Figure 4 shows, the association between the physician density and age-adjusted regional healthcare expenditure in 1990 is described by ordinary least-square regression as follows;

$Y=0.0028X+0.534$ (R-square=0.67)

where Y : healthcare expenditure index, X : physician density

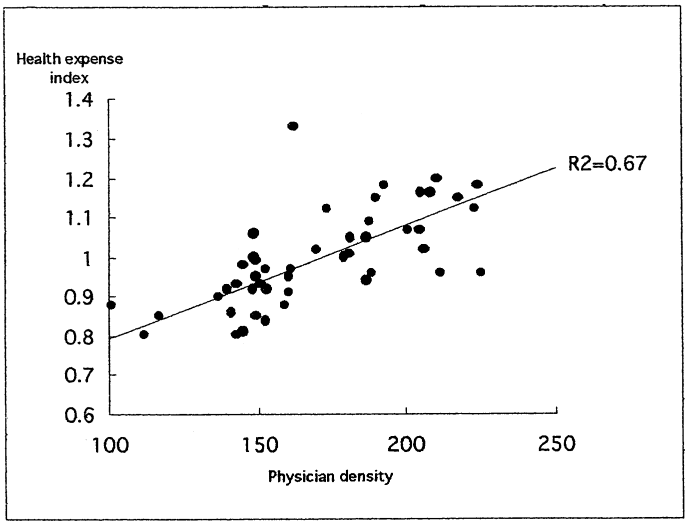


Fig. 4. Correlation/Physician denisity and Health expense index

It implies that a swelled physician density would increase revenues of medical institutes when they can keep hiring physicians. I investigated that any overflows from the governments minimum requirement of physician numbers per patient in clinic/ hospital were scarcely ever happened in our computer simulation period. Then, calculating the HEI growth to the base year 1990 as the model components of service demand and physician supply show the future physician density, the model reflects it as an positive economic impact in the financial balances between revenues and costs at hospital/clinic.

3-b) Hypotheses of business sustainability for private medical institutions

Finally, information regarding service demand and physician supply was integrated into cost/revenue balance at institutional level. As mentioned, the institutional cost is a function of the number of physician to be hired, and the institutional revenue is a function of demographically determined service utilization with the inflation due to increased physician density. Then, we need a third function that determines institutional behavior of market exit/entry, or a function of "business sustainability".

In Japanese healthcare delivery system, medical facilities are driven either by public sector (such as central or local government) or by private sector (owner hospital/clinic). The ratio of these two types are public : private=33 : 67 in hospital beds, and public : private=6 : 94 in clinic offices. Public-driven facilities have been financially protected by the local or central government, and are tax-exempt. On the other hand, privately driven facilities are responsible for financial risk, mostly without tax exemption. Thus, these two types of medical facilities will behave quite differently in the face of cost/revenue balance : public-driven ones are less sensitive to their financial status, whereas privately driven ones would downsize/close or expand/open their business according to the cost/revenue balance varying over time.

Although individual behavior of medical facilities cannot be traced, we have instead developed a macro-level model to approximate institutional behaviors as a whole based on our previous survey results of privately driven medical facilities (Figure 5). In the case of privately driven hospitals, we assume that the number of hospital beds will change in a ramp-curve relationship with the balance of service revenue and running cost. On the other hand, in the case of private clinics, we assume clinic owners will

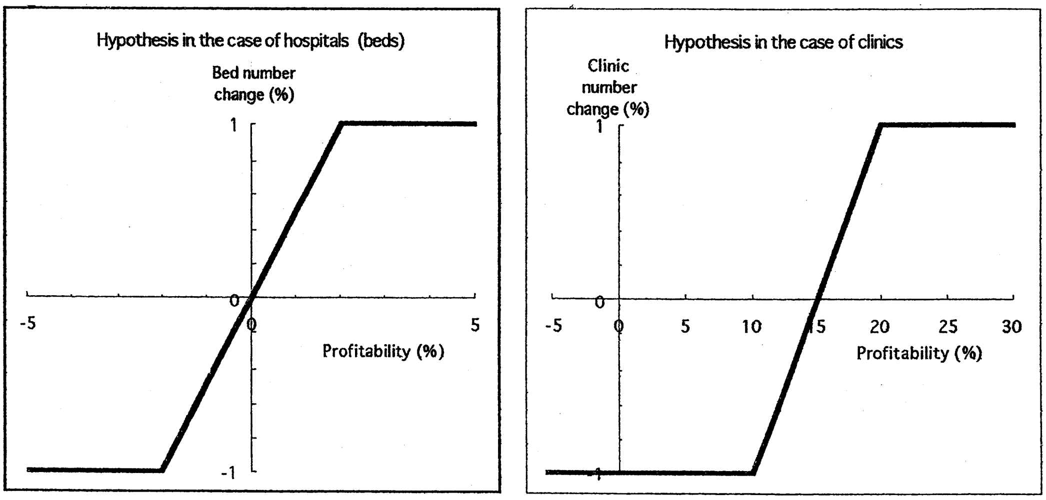


Fig. 5. Hypotheses of business sustainability for private medical institutions

make a decision to close/open their business at the critical point of 15% excess of margin ratio of revenue and cost. Fifteen percent of average revenue of clinics as of 1990 was approximately identical with average salaries of senior attending physicians in hospitals. If the profitability would become less, clinic owner physicians would reconsider to keep their business. On the other hand, there must be financial incentives for salaried physicians to open their own clinics, if the profitability would become more than the critical value.

The model traces balance between those revenues and expenses with time series and shows sustainability of finance of hospitals and clinics under the hypothesis of their management behavior mentioning here.

System Dynamics Method

We applied the System Dynamics (SD) method to describe the intertwined behaviors of three components in the model. The analysis by SD typically follows five processes as below.

(1) Hypothesize a causal diagram by mapping all the elements of interest. (figure 6)

(2) Translate the causal diagram into a flow diagram that assists computer programming.

(3) Then, translate the flow diagram into SD language (e.g. DYNAMO).

(4) Do a pilot run of model simulation to check the consistency of the model.

(5) Finally, perform sensitivity analyses for several alternative hypothesis/policies.

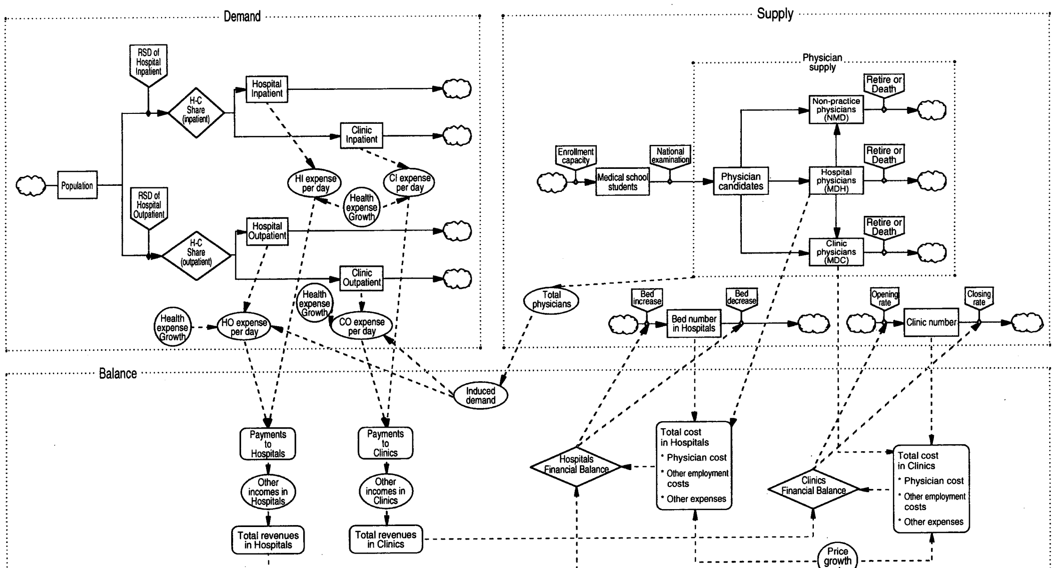


Fig. 6. Health Care Demand and Supply and Balancing

Recent availability of a special PC-based software "ithink"[9] makes it easier for us to use the method in this study. By using the software, we could complete not only a SD flow diagram as shown in figure 7 but also a simulation programming.

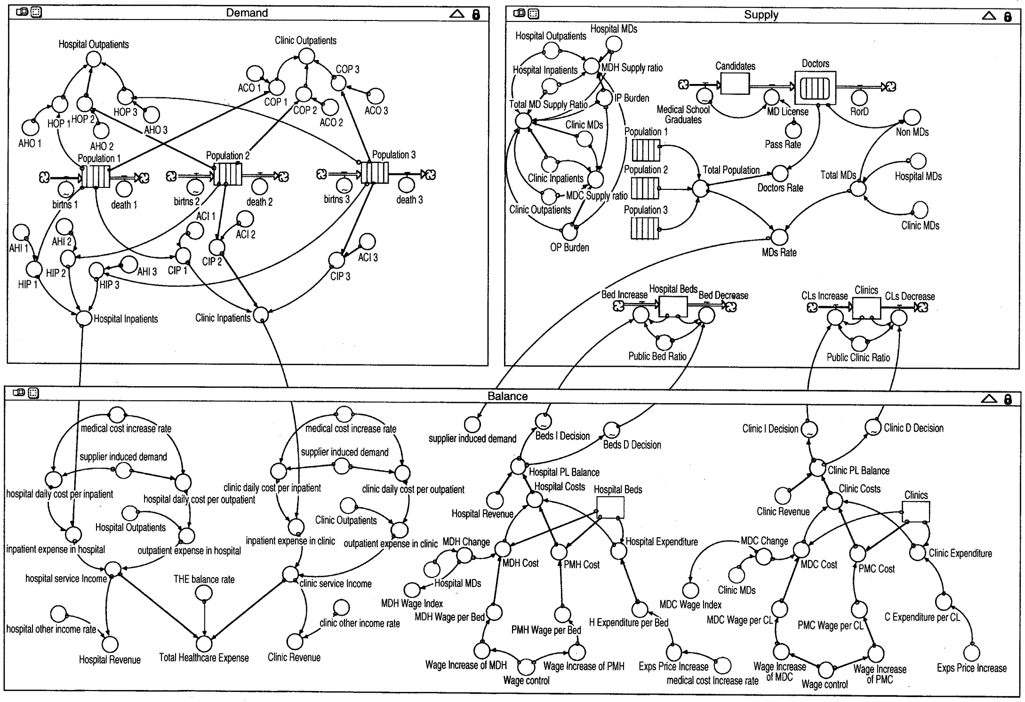


Fig. 7. SD Flow Diagram based on health care demand/supply/balanching

Results

1. Forecast Trend in Service Demand

According to MHW, National Health Expenditure(NHE) would grow up with high pace after this. It means that the revenues of hospital/clinic would be expected to grow up. This simulation experiment is carried on along with the high health expenditure growth as MHW expects. Then, it skyrocketed from 21 trillion yen in 1990 to 145 trillion yen in 2025.

2. Trends of physician supply

Physician supply would saturate with around 310,000 as depicted in Figure 8 if the government stops their efforts to decrease enrollment capacity of medical schools by the level in 1994. The simulation result shows that it would take more than 50 years until hitting the peak of physician number in Japan. Keeping the trend of physicians mobility among categories and sub-cohorts as observed in 1990 and 1992, clinic physicians would become double.

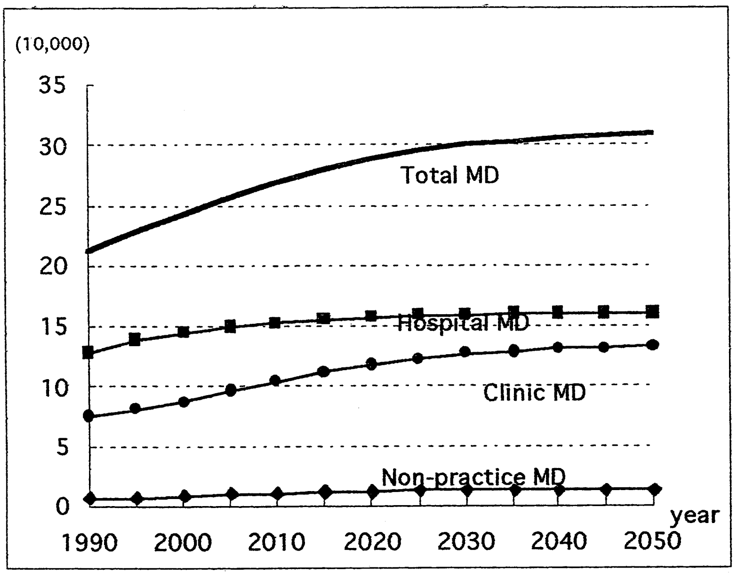


Fig. 8. Forecasting of physician number by institution

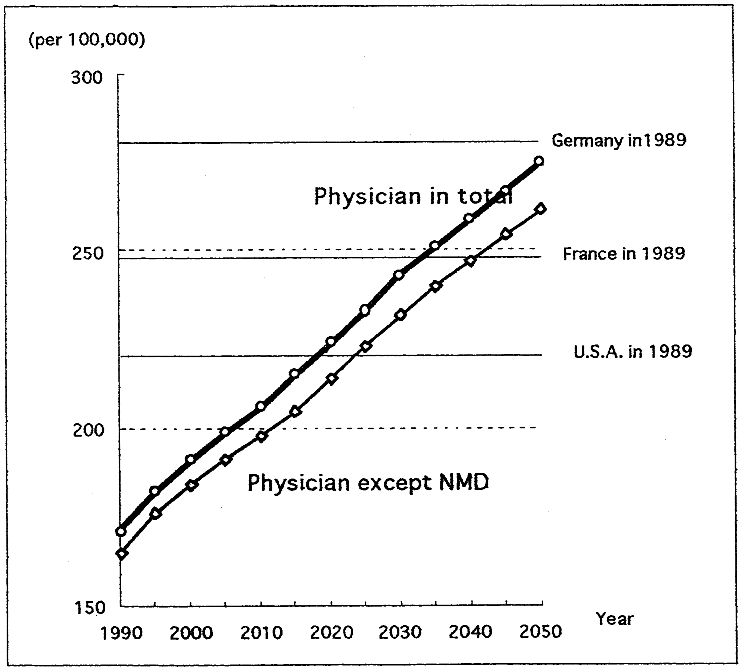


Fig. 9. Physician density trend

On the other hand, physician density would increase almost linearly as shown in Figure 9 because the population in Japan will hit the peak soon and decrease moderately.

3. Predicted Labor Market

The Japanese Medical Care Law provides a guideline for hospital/clinic about standard numbers of physicians per inpatient and outpatient. Roughly calculating physician job markets in the future by using those standards and comparing them with anticipated physician supply in the model, the job filling ratio would keep around 100% even if it would be under the hard conditions which means a physician sees more patients than the optimistic conditions through understanding the Law (Figure 10).

It implies that physicians in Japan would have enough job opportunities insofar as the Medical Care Law is applied to medical institutions strictly. Then, since physician employment at medical institutions has with no restrain, they would increase along with the growing physician supply.

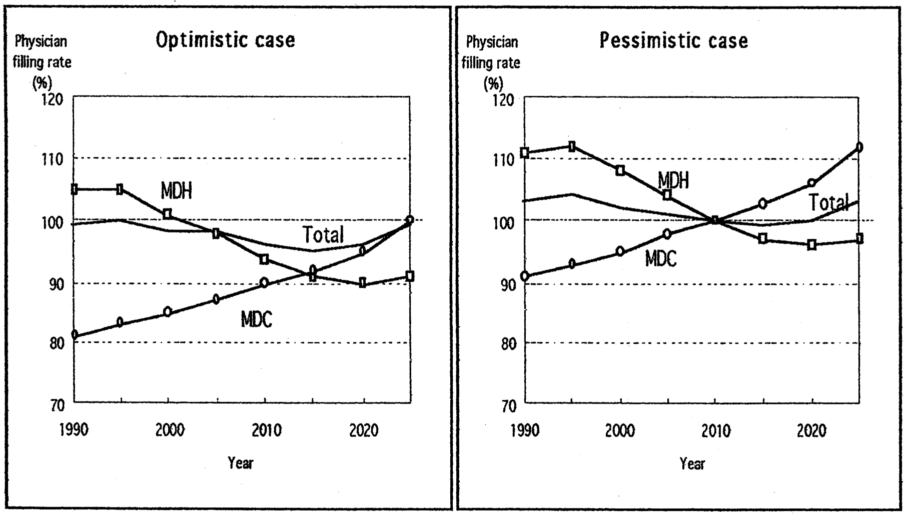
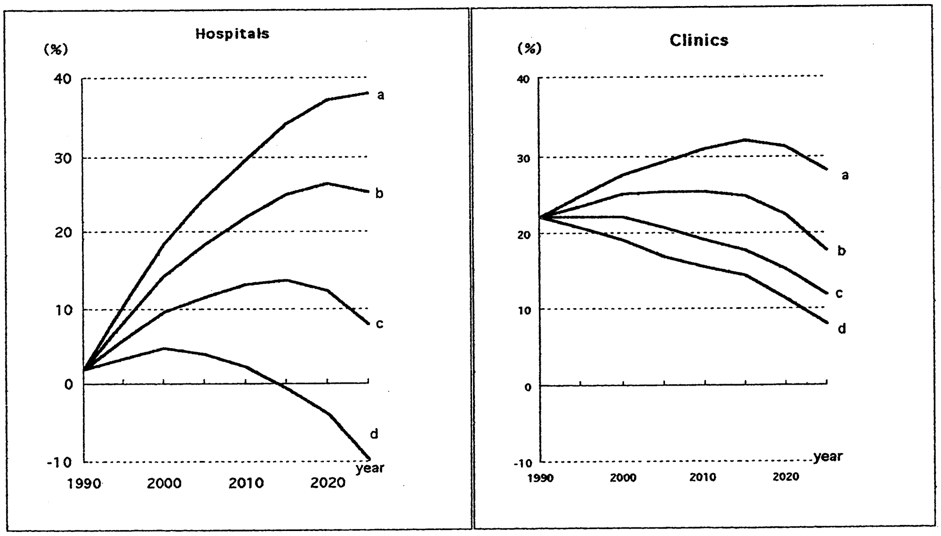


Fig. 10. Forecasting physician filling in medical institutions

Discussion

We have to review the reality of the simulation forecasting carefully. For instance, NHE growth expected by MHW is much higher than the recent Japanese economic growth. Since the government has contained health care expenditure repeatedly and, especially, did it very much in 1997, the growth slows down temporally. This means that revenue growth of hospital/clinic has been lower than expected. On the other hand, reviewing co-medical staff wages from 1989 to 1994, we find their average annual growth rate was 3.9% as similar as the hypothesis of NHE growth. However, physician wage grew by about 1.2% which was much lower than NHE growth.

Then, we tried a sensitivity analysis on the labor cost growth rate to certify reality of the simulation results. In the model, the financial balances of hospital/clinic would get down explicitly as shown in Figure 12 when the labor cost growth rate increases more than the growth of NHE. It suggests that management of medical institutions necessarily keep to pay their attentions to controlling labor cost in the future. Especially, they have to focus on physicians cost because they have any more space to curtail the employee cost except physicians who get much higher salaries than the others. As a consequence, physician wage growth will be probably contained.



Conditions: **a: Wage growth = National Health Expenditure growth = 4.3 %**
b: Wage growth = 5.3 %, c: =6.3 %, d: = 7.3 %

Fig. 11. Sensitivity analysis for medical institutions' profitability by wage growth rate

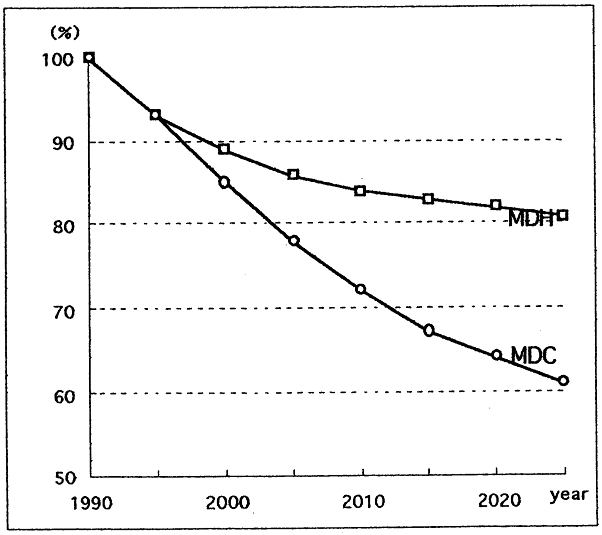


Fig. 12. Feasibility of physician's wage down

Therefore, if medical institutions keep hiring physicians to fill their facilities along with the provision of the Medical Care Law, their management must be ceiling physician cost. If such a budget ceiling would be kept, physicians' average wage decreases in inverse proportion to physicians' growing supply. As shown in Figure 12, we expect 20% down for hospital physician wage and 40% down for clinic physician wage respectively in 2025 based on real value, comparing with the present wage level in 1990. Physician wage level in 1990 was 70% more than the average wage of salaried people. This means that it could be no difference in income level between physicians and ordinary salaried men in the future.

By the way, though the government feels that physician oversupply will happen in Japan, the trend of physician density shows that Japan would take a long time to reach the level of the US, France and Germany in 1989. It implies nonsense to discuss such an oversupply by simply comparing with physician density among industrialized countries because the difference among them derives from not only health care system but also economical sustainability of health care facilities.

The simulation result suggested that, even if the higher growth rate in health care expenditures is realized and the physicians' employment is ensured, it is unavoidable that physician will lose their bargaining power against hospital/clinic management, otherwise, medical institutions lose their business. In this context, I warn that it may cause problems of deteriorating physicians' quality because the simulation experiment forecasts that the average physician's wage would become similar to other salaried workers in about 30 years in the worst case.

We have a difficulty when discussing physician oversupply if we compare the number of physicians per population in the developed countries because of differences in several conditions. We also have a difficulty with demonstrating the oversupply because of a controversy pertaining to adequate number of physicians in terms of an ideal health care delivery. However, by using this analytical approach, we can see that the agenda of physicians oversupply can be discussed in term of its economic impact, when we focus on an physician's earning power in the future medical institutions' management sustainability under the worse conditions of government's cost containment policy and an oversupplied physicians.

Acknowledgment

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