論 説

Panel Data Analysis on the Efficiency of Public Health Insurance Systems

—— Is Government Intervention Justified in a Market with Asymmetric Information ? ——

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Abstract

As aging continues to push up health care expenditure in Japan, calls have arisen to increase the efficiency of health expenditure by trimming down public health insurance and relying more on the market. Meanwhile, others point out that emerging economies illustrate how the rigorous application of market principles can lead to market failure. To examine whether total expenditure on health can be reined in by cutting public health insurance and relying more on market forces, I conducted a panel analysis of OECD data using two sets of data: 23-country/4-year panel data, and 11-country/15-year panel data. Results show that: (1)total expenditure on health (as % of GDP) is higher when universal health insurance does not exist, and increases as public expenditure on health (as % of total health expenditure) decreases; and (2)over half of total expenditure on health (as % of GDP) can be explained by the existence of universal health insurance, public health expenditure (as % of total health expenditure), percent of population age 15 and over who are daily smokers, number of practicing physicians per 1,000 population, per capita GDP, infant mortality rate, life expectancy, and percent of population age 65 and over. I conclude that since the health insurance market is characterized by asymmetric information, direct government control of the market can increase the efficiency of health expenditure. Moreover, while my conclusion does not consider the issue of equality of distribution, doing so would clearly strengthen the case for government intervention.

1. Introduction

Can health insurance be provided more efficiently under public or private management ? I attempt to answer this question based on a factor analysis of total expenditure on health as a percent of GDP. For context, I begin with a review of the theoretical and empirical

literature.

The health care insurance market is characterized by asymmetric information—in other words, insurers do not fully know the health condition of their customers. A substantial body of theoretical and empirical research addresses market failure and whether the government should intervene to correct this failure. I first review the theoretical research.

Rothschild and Stiglitz (1976) construct a basic model of imperfect information in competitive insurance markets, which they claim applies to many other situations, including a model in which communities offer various menus of public goods and taxes, and individuals refer to the menus when choosing a community.[1] Neudeck and Podczeck (1996) argue that without a rational policy of government intervention, market efficiency cannot be achieved due to the problem of adverse selection—since firms would reject applications for loss-making contracts, there can be no-cross-subsidization between different contracts in a free market environment.[2]

In opposition, Crocker and Snow (1984) argue that if government intervention can improve market efficiency, then efficiency can also be achieved under oligopolistic competition in which private firms can predict competitors' prices.[3]

In the empirical literature, four studies are of interest.

First, Hsiao (1994)[4] shows that medical expenditure has expanded in many countries where the health care system is left to market forces. He notes that it may be very costly or impossible to correct market failure when there is poor understanding of necessary conditions for market efficiency and relevant case studies. As a prime example of unfounded confidence in market forces, he cites the United States, where health care expenditure has grown to 14% of GDP while universal insurance coverage remains elusive.

Hsiao also analyzes market failure of health care systems in emerging economies such as Singapore, Chile and the Philippines.

In 1984, Singapore launched a competitive market-based health insurance system in which people freely choose the health care provider and pay directly for services. Health care expenses can be withdrawn from individual Medisave accounts, which are funded by contributions equal to 6% to 8% of annual income, and which become part of the individual's estate upon death. In 1991, the government introduced the MediShield health insurance plan for treatment of catastrophic illnesses. Enrollment is voluntary, and premiums can be withdrawn from Medisave accounts, but outpatients must pay for all services out of current income or savings. Under this system, patients pay the provider directly for services, and can receive higher quality service by paying more. Singapore's self-financing system has received enthusiastic acclaim from free market advocates. In addition, the Singapore government rigorously applies market principles to make hospitals and clinics operate more efficiently and compete for patients.

However, one decade after the system was introduced, the volume of high-end medical

equipment and services in Singapore doubled. The income of physicians grew at a startling pace, while rising costs caused medical expenditures to expand as a ratio of GDP.

The *1993 White Paper* assessed the system as follows: "Market forces alone will not suffice to hold down medical costs to the minimum. The health care system is an example of market failure. The government has to intervene directly to structure and regulate the health system."

Hsiao also looks at Chile, where health care reform began in 1979 by applying market principles to enhance the efficiency of health care insurance. By 1992, health insurance had become a two-tiered system consisting of public and private insurance plans.

Affluent groups can enroll in private insurance by paying a premium equal to 7% of annual income, with the government subsidizing another 2%. They receive better health care than other income groups. Other income groups can enroll in public insurance and pay a premium equal to 7% of annual income. In 1992, according to a World Bank report, health care expenditure per beneficiary amounted to USD 160 for private insurance plans and USD 44 for the public insurance plan.

Moreover, enrollment in private insurance requires a rigorous health examination. This effectively screens out the less affluent people. In Hsiao's view, Chile's experience shows that private insurance plans are biased toward selecting affluent and healthy persons.

In the Philippines, the market is split between public and private insurance plans. To encourage competition, the government began promoting HMOs (health maintenance organizations) in the 1980s, and their number grew to over two dozen by 1991. Hsiao cites a study finding that HMOs charge higher premiums than either public or private insurance plans.

According to the same study, HMOs were found to focus on high-income, employment-based groups, and to exclude the elderly. Only 55% of HMO revenues went toward providing health benefits, while 15% went to sales commissions, 20% to administrative costs, and 10% to profit. HMO executives monitor the industry to prevent other HMOs from offering lower premiums or better benefits, which are regarded as unfair practices.

The experiences of emerging economies offer several lessons. Economic incentives can significantly affect the behavior of companies and individuals. For example, insurers seek to maximize profit by selecting good risks, and physicians seek to increase revenue by practicing price discrimination. Moreover, the market neither improves overall market efficiency, nor contains overall cost.

The reason that marketization fails to improve overall efficiency in the health care market is that a fundamental assumption of economic theory fails to hold—all stakeholders do not have equal market power. Insurers have more market power than consumers, and physicians have more medical expertise than patients. Moreover, consumers who need medical attention often lack the time, information and composure to shop around.

As a result, administrative and sales costs comprise 45% of premium income for HMOs in the Philippines, and over 30% even for regulated products in Chile. By comparison, the cost ratio of public insurance plans is below 10%.

The economic explanation of this situation is that an asymmetry of information exists in the health care market. Hsiao concludes that because insurers and physicians have an information advantage, market forces enable them to reap larger profits at the expense of consumers.

The second empirical study is Newhouse (1992), who finds that rising health care costs in the U.S. are not adequately explained by the conventional factors of (1)aging, (2)proliferation of health insurance, (3)growth of national income, (4)growth in the supply of physicians, and (5)productivity growth in health care compared to other industries.[5] He then proposes that the residual factor—progress of medical technology—is the main cause of rising health care costs in the U.S.

Newhouse assesses the contributions of the five conventional factors as follows. As for aging, the elderly ratio of the population (aged 65 and over) grew from 8% in 1950 to 12 % in 1987. Compared to this 50% increase, health care expenditure grew by 425%. As for growth of health insurance, while expenditure on health care rose 290% from 1950 to 1980, demand for health care grew only 50% in the same period when price elasticity is considered. As for income, while real national income rose 180% from 1940 to 1990, income growth accounts for only 35% to 70% of the 780% growth in real health care expenditure in this period when income elasticity is considered. As for physician-induced demand, growth per decade in the supply of physicians from 1930 to 1990 is uncorrelated with changes in growth of health care expenditure. As for productivity, differences in productivity growth with other industries are largely qualitative in nature, and the contribution is thought to be small.

Newhouse concludes that since the aggregated contribution of the five factors is not large, the residual—progress of medical technology—is the largest factor causing health care expenditures to grow.

A third study by Barros (1998) finds that aging plays only a minor role in growth of per capita health care expenditure in OECD countries.[6] A fourth study by Herwartz and Theilen (2003) finds that growth of health care expenditure in OECD countries is largely uncorrelated with GDP or growth of the population aged 65 and over when irrelevant correlations are ignored.[7]

2. Hypotheses

Amid the marketization trend, a growing view in Japan holds that private health insur-

ance is preferable to public health insurance to accommodate patients who need high-priced, technologically advanced services.

At present, Japan's public health insurance plan bans the combined use (known as *kongo shinryo*) of uninsured medical treatments. As a rule, whenever a medical treatment contains uninsured components, even the insured components are denied coverage and must be paid for by the patient. Opponents of the ban argue that lifting it would:

- decrease the medical cost for patients who need uninsured treatments; and
- improve the quality of service and facilitate a faster recovery, ultimately reducing the burden on public health insurance.

On the other hand, proponents of the ban argue that:

- only patients who can afford high-priced services would receive more health care services regardless of effectiveness; and
- unnecessary and ineffective treatments would increase, causing national health care costs to expand.

Based on recommendations of the Committee on Marketization and Privatization, the Koizumi Cabinet altered the 2006 revision of the Health Insurance Law so as to facilitate partial privatization of the public health insurance system.

Moreover, in November 2007, the Tokyo District Court ruled as follows: "No basis is found for the denial of public health insurance benefits under the *kongo shinryo* rule when insured and uninsured treatments are combined. The State is erroneous in its legal interpretation and application of *kongo shinryo*." The Ministry of Health, Labor and Welfare has appealed the ruling, prolonging the controversy.

Regrettably, no empirical studies in Japan have tried to determine if reducing and privatizing the public health insurance system would cause national health care expenditures to grow or contract. Even abroad, empirical studies on this issue are limited to the studies we introduced earlier.

Based on our literature review, I propose to test the following two hypotheses.

Hypothesis 1

Reducing the public sector's role and enlarging the private sector's role in health insurance will not improve the efficiency of national health care expenditure.

Hypothesis 2

Growth of national health care expenditure cannot be explained by aging, growth of health insurance, income growth, increase in number of practicing physicians, or low productivity growth of health care services.

The theoretical model of hypothesis 1 needs to be partially revised before testing. The model proposed by Rothschild and Stiglitz (1976) makes the following argument: Since in-

dividuals know their own health condition while private insurers do not, private insurers cannot set the premium based on risk. Thus the same premium reflecting the average risk is set for everyone. This premium is too high for healthy persons, but favorable to less healthy persons. Thus high-risk individuals tend to buy insurance, causing the premium to rise further. As a result, only high-risk individuals stay insured, while relatively low-risk individuals do not enroll in private insurance. Given this asymmetry of information in the health insurance market, market forces cannot achieve sufficient efficiency, making government intervention necessary.

Despite the theoretical model's innovative expression of asymmetric information, it does not accurately reflect the reality that private insurers use physical examinations and other means to adjust the premium according to each individual's risk. As a result, in the U. S., where health insurance is mainly entrusted to the private sector, a high premium is set for high-risk individuals (who are often low-income), and they cannot enroll in private health insurance plans. Managed care plans such as HMOs only cover healthy high-income individuals.

Nonetheless, the theoretical model of Rothschild and Stiglitz (1976) remains valid today in its conclusion that government intervention is warranted in markets where asymmetric information exists. On this basis, I tested Hypothesis 1 using data from 23 countries over a four-year period, and 11 countries over a 15-year period.

Hypothesis 2 is an extension of Newhouse (1992), who shows that growth of health care expenditure in the U. S. is not explained by aging, spread of insurance, growth of income, supplier-induced demand, or differential productivity growth. Our aim is to construct a model that explains changes in total expenditure on health (as % of GDP) at the global level, which would help improve the efficiency of health care expenditure in each country. Thus we use panel data for 23 nations, and add three new independent variables: percent of population age 15 and over who are daily smokers, which is often associated with health care expenditure; infant mortality rate, which is a proxy for what Newhouse calls rate of technological progress; and average life expectancy, which is thought to be related to national health care expenditure. Standardized annual data for all variables is obtained from *OECD Health Data*.

3. Method of Analysis

Below I first construct the theoretical models underlying each hypothesis, and then construct a quantitative model for testing the hypotheses.

1. *Construction of Theoretical Models*

(a) Theoretical model 1

In theoretical model 1, total expenditure on health (as % of GDP) is higher when universal health coverage does not exist, and rises as public expenditure on health (as % of total health expenditure) decreases. That is, unless a rational government policy exists, asymmetric information in the health insurance market prevents the market from achieving efficiency through competition. Private health insurers use medical examinations and other means to rationally set premiums that reflect individual risk. As a result, individuals in poor health (and often low income) cannot buy private health insurance. On the other hand, individuals in good health (and often high income) can afford private health insurance as well as advanced medical services. In addition, private insurers incur additional costs such as medical examinations. Thus the national health care expenditure tends to grow.

(b) Theoretical model 2

In theoretical model 2, total expenditure on health (as % of GDP) can largely be explained by the existence of universal health coverage, public expenditure on health (as % of total expenditure on health), percent of population age 15 and over who are daily smokers, practicing physicians per 1,000 population, per capita GDP, infant mortality rate, average life expectancy, and percent of population age 65 and over. I attempt to increase the explanatory power of the Newhouse (1992) model by: (1)expressing the dependent variable as total expenditure on health as a percent of GDP; (2)adding two independent variables related to public health insurance; and (3)using the infant mortality rate as a proxy for rate of progress in medical technology.

2. *Quantitative Model*

To test the two theoretical models, we constructed a quantitative model as follows. The test of theoretical model 1 is based on the signs of the $X_1 \cdot D_4$ coefficients. The test of model 2 is based on the coefficient of determination.

Dependent variable Y is total expenditure on health (as % of GDP). Independent variable X_1 is public expenditure on health (as % of total expenditure on health); X_2 is percent of population age 15 and over who are daily smokers; X_3 is number of practicing physicians per 1,000 population; X_4 is per capita GDP (in US dollars); X_5 is infant mortality rate (per 1,000 live births); X_6 is average life expectancy; and X_7 is percent of population age 65 and over. Dummy variable D_1 denotes an advanced economy, D_2 denotes an intermediate economy, D_3 is a time dummy variable, and D_4 denotes the existence of a public health insurance system.

The number of countries is denoted by n, and number of years by T. In the basic model with panel data for 23 countries over a period of four years, $n = 23$ and $T = 4$, and dummy

variable D_2 (intermediate economy) is excluded. In the model with panel data for 11 countries over a 15-year period, $n=11$ and $T=15$, and independent variables for per capita GDP and average life expectancy are excluded.

The basic model is shown below.

$$Y_{it}=\beta_0+\beta_1X_{1it}+\beta_2X_{2it}+\cdots\cdots+\beta_7X_{7it}+\delta_1D_1+\delta_2D_2+\mu D_3+\gamma D_4+u_{it}$$
$$(i=1,\ \cdots\cdots,\ n)\quad(t=1,\ \cdots\cdots,\ T)$$

The standard assumptions are as follows.

$E(u_{it})=0$
$E(u_{it},\ u_{it-1})=0$
$E(u_{it}^2)=\sigma^2$
$X_j(j=1,\ \cdots\cdots,\ 7)$: non-stochastic
$E(X_j,\ u_{it})=0$

4. The Data

Unless otherwise noted, all data is derived from *OECD Health Data 2006*.[8] While I would have preferred to include all 30 OECD member countries in the study, data limitations restricted the number of countries and time period for constructing balanced panel data sets.

To include as many countries as possible, I first compiled a panel data set for 23 countries over a reduced time period of four years. The 23 countries are Australia, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Luxembourg, Mexico, Netherlands, New Zealand, Spain, Sweden, Switzerland, United Kingdom, and United States. The four-year period is from 1999 to 2002.

Table 1 shows a sample of the 23-country / 4-year data. Countries are listed in order of total expenditure on health (as % of GDP) as of 2001. Also shown are data on public expenditure on health (as % of total health expenditure), per capita GDP in USD, and ratio of population age 65 and over.

According to Table 1, total expenditure on health (as % of GDP) is twice as high in the U.S. as in Japan. Notably, when countries are listed in order of total expenditure on health (as % of GDP), other variables such as public expenditure on health (as % of total health expenditure), per capita GDP, and elderly share of population appear to be randomly ordered. This seems consistent with the finding by Newhouse (1992) that factors thought to increase health care expenditure in the U.S. actually do not. Of course, this hunch could change after conducting the panel data analysis of numerous variables in the cross-section-

Table 1 Ranking by Total Expenditure on Health as % of GDP (2001)

	Total expenditure on health (as % of GDP)	Public expenditure on health (as % of total expenditure on health)	Per capita GDP (USD 1,000)	Population age 65 and over (%)
United States	14.0	44.8	35.3	12.4
Switzerland	10.9	57.9	34.6	15.4
Germany	10.6	78.4	22.9	16.9
Greece	10.4	55.5	10.7	17.0
Canada	9.4	69.9	22.7	12.6
France	9.3	75.9	22.5	16.2
Iceland	9.3	82.7	27.0	11.6
Australia	8.9	67.8	19.6	12.5
Belgium	8.7	76.4	22.5	16.9
Sweden	8.7	84.9	24.9	17.2
Denmark	8.6	82.7	30.0	14.8
Netherlands	8.3	62.8	24.9	13.6
Italy	8.0	75.8	19.4	18.6
New Zealand	7.8	76.4	13.5	11.9
Japan	7.8	81.7	32.7	17.8
United Kingdom	7.5	83.0	24.4	15.9
Hungary	7.3	69.0	5.1	15.2
Spain	7.2	71.2	14.9	17.0
Czech Republic	7.0	89.9	6.0	13.9
Finland	6.9	75.9	23.5	15.1
Ireland	6.8	75.6	27.2	11.2
Luxembourg	6.4	87.9	45.6	13.8
Mexico	6.0	44.9	6.2	5.1

Note: Shows ranking for 23-country / 4-year panel data set.
Source: *OECD Health Data 2006*.

al and time series data.

Next, to extend the time dimension as far as possible, I compiled a balanced panel data set containing 11 countries over a 15-year period. The eleven countries are Australia, Canada, Denmark, France, Greece, Iceland, Japan, Luxembourg, Netherlands, Sweden, and United Kingdom. The 15-year period is from 1988 to 2002.

5. Results

First, I performed a pooled regression of the basic model excluding dummy variables, and estimated the fixed effects and random effects models. I performed the Hausman test on the 23-country / 4-year panel data. The null hypothesis, that individual effects are uncorrelated with other independent variables in the model, has a P-value of 0.023 and is rejected, meaning that the fixed effects model is preferable to the random effects model.

Table 2 23-country / 4-year data set (1999-2002)
Dependent variable: Total expenditure on health as % of GDP

Independent variable	Coefficient	Standard deviation	P-value
Public expenditure on health (as % of total expenditure on health)	−0.1218	0.01088	<0.0001
Tobacco consumption (% of population age 15 and over who are daily smokers)	−0.1078	0.02109	<0.0001
Practicing physicians, density per 1,000 population	0.04093	0.1842	0.8247
Per capita GDP (USD)	0.00001571	0.00001194	0.1921
Infant mortality rate, deaths per 1,000 live births	−0.3692	0.0523	<0.0001
Average life expectancy	−0.1689	0.0627	0.0085
Percent of population age 65 and over	0.0268	0.0543	0.6233
Country dummy variable (advanced economy)	1.3302	0.2769	<0.0001
Time dummy variable	−0.3786	0.1751	0.0336
Public health insurance dummy variable	0.9595	0.2950	0.0017
Constant	34.8275	5.6180	<0.0001

Mean value of dependent variable [standard deviation]: 8.4402 [1.7584]
Coefficient of determination: 0.8072

Next, I performed the Hausman test on the 11-country / 15-year data. The null hypothesis, that individual effects are uncorrelated with other independent variables of the model, is rejected with a P-value of 0.000, again meaning that the fixed effects model is preferable to the random effects model. Since the fixed effects model is adopted for both panel data sets, I set the dummy variables specified in the basic model to improve the model's explanatory power.

Table 2 shows the panel regression results for the basic model with the 23-country / 4-year data on total expenditure on health (as % of GDP). The estimated auto-correlation of the disturbances is small, and thus not a problem.

As shown in Table 4, country dummy variable D_1 is set at 1 for the top nine advanced economies (out of 23) based on per capita GDP, infant mortality rate, and physicians per 1,000 population. All other countries are set at 0. The time dummy variable is set at 1 for the first two-year period, and 0 for the second 2-year period.

In addition, the dummy variable for existence of public health insurance is set at 1 if less than 99% of the population is eligible for public health insurance, and 0 otherwise.[9] In other words, the dummy variable is 0 only when universal coverage exists.

Table 3 shows the panel data regression results for total expenditure on health (ratio to GDP) for the 11-country / 15-year data, in conformance with the basic model. The estimated auto-correlation of the disturbances is small and not a problem. Compared to Table 2, which emphasizes international comparisons, Table 3 emphasizes a time series comparison.

As Table 4 shows, country dummy D_1 is set at 1 for the top five advanced economies (out of 11) based on per capita GDP, infant mortality rate, and physicians per 1,000 population, and set at 0 for the rest. Country dummy D_2 is set at 1 for the next three interme-

Table 3 11-country / 15-year panel data set (1988-2002)
Dependent variable: Total expenditure on health care (as % of GDP)

Independent variable	Coefficient	Standard deviation	P-value
Public expenditure on health (as % of total expenditure on health care)	−0.0198	0.0078	0.0121
Tobacco consumption (% of population age 15 and over who are daily smokers)	0.0081	0.0132	0.5414
Practicing physicians, density per 1,000 population	1.6067	0.1400	<0.0001
Infant mortality rate, deaths per 1,000 live births	−0.1152	0.0504	0.0237
Percent of population age 65 and over	0.0135	0.0252	0.5923
Country dummy variable 1 (advanced economy)	−0.8981	0.2389	0.0002
Country dummy variable 2 (intermediate economy)	−2.3978	0.2566	<0.0001
Time dummy variable	0.1000	0.1357	0.4625
Public health insurance dummy variable	0.9667	0.2067	<0.0001
Constant	6.4486	1.0409	<0.0001

Mean value of dependent variable [standard deviation]: 7.9867 [1.2080]
Coefficient of determination: 0.7768

Table 4 Ranking by country (*1)

	Per capita GDP in USD	(ranking)	Infant mortality rate per 1,000 live births	(ranking)	Practicing physicians per 1,000 population	(ranking)	Average ranking	23-country	11-country	9-country
Australia	19,638	16	5.3	15	2.5	14	15.0	0	0	0
Belgium	22,471	15	4.5	8	3.9	3	8.7	1		
Canada	22,711	13	5.2	14	2.1	20	15.7	0	0	0
Czech Republic	5,953	22	4.0	6	3.4	6	11.3	0		
Denmark	29,956	5	4.9	11	2.8	13	9.7	1	2	2
Finland	23,487	11	3.2	3	2.3	17	10.3	0		1
France	22,534	14	4.5	8	3.3	7	9.7	1	2	2
Germany	22,932	12	4.3	7	3.3	7	8.7	1		
Greece	10,744	20	5.1	13	4.4	1	11.3	0	1	
Hungary	5,136	23	8.1	22	3.2	10	18.3	0		
Iceland	27,002	7	2.7	1	3.5	4	4.0	1	2	2
Ireland	27,181	6	5.7	19	2.4	16	13.7	0		1
Italy	19,440	17	4.7	10	4.3	2	9.7	1		
Japan	32,699	4	3.1	2	2.0	21	9.0	1	2	
Luxembourg	45,648	1	5.8	20	2.5	14	11.7	0	1	
Mexico	6,217	21	22.4	23	1.5	23	22.3	0		
Netherlands	24,913	8	5.4	16	3.3	7	10.3	0	1	
New Zealand	13,521	19	5.6	18	2.2	19	18.7	0		
Spain	14,906	18	3.4	4	3.1	12	11.3	0		
Sweden	24,902	9	3.7	5	3.2	10	8.0	1	2	
Switzerland	34,593	3	5.0	12	3.5	4	6.3	1		2
United Kingdom	24,437	10	5.5	17	2.0	21	16.0	0	0	
United States	35,341	2	6.8	21	2.3	17	13.3	0		1

(*1) Ranking by country is based on 2001 data from *OECD Health Data 2006*. Average ranking is calculated from three rankings—per capita GDP, infant mortality rate, and number of physicians.

diate economies, and 0 for the rest. The time dummy variable is 1 for the first 8-year period, and 0 for the next 7-year period.

In addition, the dummy variable for public health insurance is set at 1 if less than 99% of the population is eligible for public health insurance, and 0 otherwise.[10] Thus the dummy variable is 0 only when universal coverage exists.

1. *Empirical Results for Theoretical Model 1*

In Table 2, public expenditure on health (as % of total expenditure on health) has an estimated coefficient of −0.122 and P-value of 0.000, indicating that it significantly reduces total expenditure on health (as % of GDP). In Table 3, public expenditure on health (as % of total health expenditure) has an estimated coefficient of −0.0198 and P-value of 0.012, again indicating a negative effect on total expenditure on health.

This result is consistent with Hsiao (1994), and strongly suggests the ironic outcome that when economies seek to make health care more efficient by reducing public health insurance, total expenditure on health expands. Thus for both the 23-country / 4-year panel data and 11-country / 15-year panel data, I confirmed that since health care systems are characterized by asymmetric information, it is preferable for the government to construct and manage the health care system to ensure appropriate control of health care expenditure.

In Table 2, the dummy variable for public health insurance has an estimated coefficient of 0.960 and P-value of 0.002, indicating that total expenditure on health (as % of GDP) is clearly higher in countries without universal coverage. In Table 3, the public health insurance dummy variable has an estimated coefficient of 0.967 and P-value of 0.000, again indicating the same result. These results are consistent with the case studies in Hsiao (1994).

These results confirm that theoretical model 1 is correct—total expenditure on health (as % of GDP) increases when universal health coverage does not exist, and also increases as public expenditure on health (as % of total expenditure on health) decreases.

2. *Empirical Results for Theoretical Model 2*

In Table 2, most of the independent variables have a P-value of 0.050 or less, indicating that the model is statistically very significant in explaining total expenditure on health (as % of GDP). The coefficient of determination is 0.807, indicating that the ten independent variables explain 80.7% of changes in total health expenditure (as % of GDP). The F-test rejects the null hypothesis (that the model has no explanatory power) with a P-value of 0.000.

Most of the independent variables in Table 3 also have a P-value of 0.050 or less, indicating again that the model is statistically very significant in explaining total expenditure on health (as % of GDP). The coefficient of determination of 0.777 indicates that the ten

independent variables explain 77.7% of changes in total health expenditure (as GDP ratio). The F-test rejects the null hypothesis (that the model has no explanatory power) with a P-value of 0.000.

In Newhouse (1992), the five factors under study failed to explain the growth of total expenditure on health in the U. S. However, I modified the approach by using total health expenditure (as % of GDP) as the dependent variable, adding independent variables related to public health insurance, and using infant mortality rate as a proxy for technological change. In this way, I can explain a larger portion of changes in total expenditure on health (as % of GDP).

The results confirm the validity of theoretical model 2 — over half of total health expenditure (as % of GDP) is explained by the following independent variables: existence of universal public health insurance, public expenditure on health (as % of total health expenditure), percent of population age 15 and over who are daily smokers, practicing physicians per 1,000 population, per capita GDP, infant mortality rate, life expectancy, and percent of population age 65 and over.

6. Additional Examination of Theoretical Model 1

My results confirm the following points in both the 23-country / 4-year panel data and 11-country / 15-year panel data.

1. Total health expenditure (% of GDP) increases when universal health coverage does not exist, and also increases as public expenditure on health (as % of total health expenditure) decreases.
2. Over half of total health expenditure (as % of GDP) can be explained by the existence of universal health coverage, public expenditure on health (as % of total health expenditure), percent of population age 15 and over who are daily smokers, practicing physicians per 1,000 population, per capita GDP, infant mortality rate, average life expectancy, and percent of population age 65 and over.

Total expenditure on health care consists of two components: (1)actual cost of medical treatment, and (2)non-medical cost, which includes administrative cost and profit.

As for the actual cost of medical treatment, universal health coverage may prevent the bias in participation due to asymmetric information. Universal public health insurance is the simplest way to eliminate the effect of asymmetric information.

With regard to administrative cost, Hsiao (1994) finds that transaction costs and profit comprise 45% of premium revenues at HMOs in the Philippines, and over 30% in Chile's regulated insurance market. By comparison, the non-medical cost ratio is less than 10% in most public health insurance systems.

Comparable cost data is not available for Japan. However, for reference, I made a rough comparison of public and private sector cost ratios using selected data. The public sector is represented by the government-run national health insurance system. The private sector is represented by Aflac Japan, a typical private health insurer.

In fiscal 2004, the national health insurance system posted non-medical costs of 195.0 billion yen, equivalent to 1.8% of premium income of 10.8627 trillion yen.[11] By comparison, according to fiscal 2006 financial statements, Aflac Japan, whose products are heavily concentrated in health insurance, reported administrative costs and profit (operating expense of 256.3 billion yen + basic profit of 133.6 billion yen) equivalent to 30% of ordinary revenue.

Thus while the government is known to be inefficient, private health insurance can actually cost even more due to costs associated with adverse selection and its elimination, sales commissions, and advertising.

7. Conclusions

My quantitative analysis of both the 23-country / 4-year panel data and 11-country / 15-year panel data confirmed the validity of the two theoretical models:

1. Theoretical model 1: Total expenditure on health (as % of GDP) increases when universal health insurance does not exist, and also increases as public expenditure on health (as % of total expenditure on health) decreases.
2. Theoretical model 2: Over half of the total expenditure on health (as % of GDP) can be explained by the following independent variables—existence of universal health insurance, public expenditure on health (as % of total expenditure on health), percent of population age 15 and over who are daily smokers, practicing physicians per 1,000 population, per capita GDP, infant mortality rate, average life expectancy, and percent of population age 65 and over.

As far as health insurance is concerned, results show that expansion of public health insurance helps to contain health expenditure growth. Since health insurance is characterized by asymmetric information, direct government control of the market in practice leads to greater efficiency of health expenditure. This result is consistent with the theoretical model constructed by Rothschild and Stiglitz (1976). Moreover, our conclusion does not even consider the policy issue of equality of distribution, which would make the argument for government intervention even more compelling.

In analyzing international panel data, each country's data obviously needs to be compiled in a consistent manner. In this regard, I note only that the consistency of our data relies entirely on the source data as found in *OECD Health Data*.

8. Additional Comment

My results suggest that to appropriately control the expenditure of health care systems, which are characterized by asymmetric information, it is important to establish a universal health insurance system, and to achieve a relatively high share of public expenditure in total health expenditure. The question arises as to why a high level of government intervention can reduce total health expenditure (as % of GDP). In the U.S., where the private insurance comprises over 50% of all health insurance, pharmaceutical prices are higher than in Japan, where the government sets prices. In fact, Japan's large pharmaceutical companies are said to rely on the U.S. market for over half of their profits.

Below I analyze factors in the annual change in real health care price level over the past five years (deflated with the GDP deflator).

I analyzed the international panel data using real health care price level as the dependent variable, and the following independent variables: public expenditure on health (as % of total health expenditure), percent of population age 15 and over who are daily smokers, practicing physicians per 1,000 population, infant mortality rate per 1,000 live births, percent of population age 65 and over, per capita GDP (in USD), country dummy variable, time dummy variable.

In my model, dependent variable Z is annual change in real health care price level (deflated with the GDP deflator) over the past five years, X_1 is public expenditure on health (as % of total health expenditure), X_2 is percent of population age 15 and over who are daily smokers, X_3 is number of practicing physicians per 1,000 population, X_4 is infant mortality rate per 1,000 live births, X_5 is percent of population age 65 and over, X_6 is per capita GDP (in USD), D_1 is country dummy variable 1 (advanced economy), D_2 is country dummy variable 2 (intermediate economy), and D_3 is a time dummy variable.

In addition, n is number of countries, and T is number of years. Since the data consists of nine countries over a period of nine years, $n=9$ and $T=9$.

The health care price model is thus:

$$Z_{it} = \beta_0 + \beta_1 X_{1it} + \beta_2 X_{2it} + \quad + \beta_6 X_{6it} + \delta_1 D_1 + \delta_2 D_2 + \mu D_3 + u_{it}$$
$$(i = 1, \cdots\cdots, n) \quad (t = 1, \cdots\cdots, T)$$

Standard assumptions are the same as in the basic model.

First, I performed a panel data analysis of the model after removing the dummy variables, and estimated the fixed effects and random effects models. I performed the Hausman test using the 9-country / 9-year panel data. The null hypothesis, that individual effects

Table 5 9-country / 9-year panel data set (1993-2001)
Dependent variable: Real health care prices

Independent variable	Coefficient	Standard deviation	P-value
Public expenditure on health (as % of total expenditure on health care)	−0.0030	0.0010	0.0051
Tobacco consumption (% of population age 15 and over who are daily smokers)	0.0056	0.0021	0.0091
Practicing physicians, density per 1,000 population	−0.0045	0.0336	0.8940
Infant mortality rate, deaths per 1,000 live births	0.0038	0.0073	0.6059
Percent of population age 65 and over	0.0120	0.0038	0.0026
Per capita GDP (USD)	−0.0000025710	0.0000001526	0.0964
Country dummy variable 1 (advanced economy)	−0.0534	0.0430	0.2192
Country dummy variable 2 (intermediate economy)	0.0195	0.0134	0.1488
Time dummy variable	0.0192	0.0114	0.0956
Constant	1.0010	0.1999	<0.0001

Mean value of dependent variable [standard deviation]: 1.0271 [0.06421]
Coefficient of determination: 0.6367

are uncorrelated with other independent variables in the model, is rejected at a P-value of 0.035, indicating that the fixed effects model is preferable to the random effects model. Having adopted the fixed effects model, we set the dummy variables specified in the health care price model so as to increase the model's explanatory power.

Table 5 shows the panel data regression results for the health care price model using the 9-country / 9-year panel data on annual growth rate of real health care prices over the past five years (deflated with the GDP deflator). The estimated auto-correlation of the disturbances is small, and thus not a problem.

With regard to the country dummy variables in Table 4, D_1 is set at 1 for the top four advanced economies (out of nine countries) based on per capital GDP, infant mortality rate and physicians per 1,000 population, and set at 0 for the rest. Country dummy D_2 is set at 1 for the next three intermediate economies, and set at 0 for the rest. The time dummy variable is set at 1 for the first four-year period, and set at 0 for the next five-year period.

In the results, public expenditure on health (as % of total expenditure on health) has an estimated coefficient of −0.00300 and P-value of 0.005, indicating that this factor notably restrains real health care prices. In particular, since pharmaceutical prices are characterized by asymmetric information, lower prices might be achieved by having the government set pharmaceutical prices, instead of having individual health insurers, health care service providers, and consumers negotiate prices with pharmaceutical companies.

The F-test rejects the null hypothesis (that the model has no explanatory power) with a p-value of 0.000.

Notes

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