

# **An investigation of the factors affecting medical expenses: The case of Taiwan's NHI implementation**

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## **Abstract**

This paper uses annual data for Taiwan from 1970 to 2003 to examine the factors affecting medical expenses. The results are as follows: (1) after the implementation of the National Health Insurance system, the average per capita health care spending increased significantly, by about 16%. (2) The income elasticity of health care spending is greater than 1, which means that it is a luxury good. This is in contrast with the findings of other Taiwanese studies, but supports the results in the foreign literature. (3) Increasing the number of physicians may cause “supply-induced demand”, but other explanatory variables may also affect this. (4) Taiwan has an aging population, and the proportion of ageing population has a positive correlation with health care expenditure. (5) Universal health insurance might lead to an ex post moral hazard.

**JEL classification numbers:** I13, I11, D82

**Keywords:** moral hazard, health care spending, supply-induced demand

## **1 Introduction**

A universal National Health Insurance (NHI) system has been in place in Taiwan since March 1995. However, due to the rapid ageing of the population, coupled with advances in medical technology, the demand for medical care is rising, along with the related costs. All other things being equal, health insurance income will eventually be lower than the related health insurance spending, and

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the health insurance system will thus face a financial crisis. It is thus necessary to address the issue of health care financing in this context.

Taiwan's NHI can reduce the cost of medical treatment for patients, and this may lead to a so-called "moral hazard", as people may have little incentive to reduce the amount of resources they use (Pauly, 1968; Leu, 1986). This article will thus explore whether the implementation of NHI has affected health care expenditures in Taiwan.

Using the data for the period 1970 to 2003, the following issues are examined in this work. 1. whether health care spending is a necessity or a luxury using the income elasticity of health care spending. 2. Whether an increase in the number of physicians produces induced demand. 3. Whether there is a positive correlation between the proportion of ageing population in Taiwan and health care spending. 4. Whether the popularity of the NHI system has led to a moral hazard. 5. Whether the relationship between health care and health care spending varies with the implementation of the NHI system.

The rest of this paper is divided into five parts, as follows. Section 1 introduces this study, followed by the literature review in Section 2. Section 3 presents the methodology used in this work, then Section 4 presents the results of the empirical research. Section 5 then ends this paper with a conclusion.

## 2 Literature review

### 2.1. Cross-sectional study

In examining 13 OECD countries in similar levels of economic development, Newhouse (1977) discusses the relationship between real income (as measured by gross domestic product) and the medical expenses. The empirical findings indicate that the R-square is almost 90% in all the regression analysis examined, and the elasticity of medical expenses is larger than one, and thus health care is a luxury good. This study was the first to examine what factors affect health care spending, an issue that has been taken up by many subsequent scholars. "Non-institutional" factors have been shown to play a large role in explaining medical expenses (Leu, 1986). Newhouse (1977) also reports similar findings. After adding several other factors, Gerdtham et al (1992) report the following results. First, national income per capita, level of urbanization, degree of government intervention and the capitation payment all have a positive impact on real income, but real income is still the most important factor. Next, health care is a luxury good, and in general the effects of government intervention on real income are not high. Finally, the high average amount of unpaid medical expenses leads to the high average health care expenditure.

These earlier works were all cross-sectional comparative studies among different countries, and they did not consider exchange rates and relative

purchasing power. Therefore, some biases may exist in their results. After considering exchange rates, Parkin et al. (1987), Gerdtham and Josson (1991), and Hitiris and Posnett (1992) find that the main source of real income is medical expenses and medical expenses are a luxury good, and that non-real income variables have a very small influence on medical expenses.

## 2.2 Time series analysis

In recent years, many scholars in various countries have examined the main factors affecting health care spending using time series analysis. Using data for 22 OECD countries from 1970 to 1991, Gerdtham et al. (1998) report the following results: (1) There is a positive correlation among real income, cigarette consumption and health care expenditure; and (2) health care expenditure is a necessity rather than luxury good. However, these results may be due to the non-stationary characteristics among these variables, leading to spurious regressions. Therefore, after considering both co-integration and an error correction model, Murthy and Ukpolo (1994) examine US data over the period 1960~1987, and obtain the following results: (1) Health care is a necessary good, and not a luxury. (2) Population aging and health care expenditure are positively correlated. (3) The number of physicians is positively associated with health care spending (Hansen & King, 1996). Also using co-integration analysis, Gerdtham and Lothgren (2000, 2002) find a long-term relationship between the health care spending and income. Using Swiss data and regression analysis, Zweifel et al. (1999) find that average life expectancy is a more important factor than population aging with regard to health care spending. Using US data for the period 1982~1990, Newhouse (1992) finds that changes in the effects of both demand- and supply-side variables were caused by technological innovations during this time.<sup>4</sup>

## 3 Methodology

### 3.1. Data sources and variable estimation

Based on the previous literature, this study assumes that the following variables have significant effects on per capita health care expenditure: (1) The demand side: the degree of population aging and level of real income. (2) The supply side: the provision of universal health insurance and the number of physicians compared to the total population. Annual data from 1970 to 2003 is used in this study, and all variables are scaled by the natural logarithms. The variables are defined below, and the related data sources are given:

#### 3.1.1 The average health care expenditure per person (*HCE*)

The NHI system in Taiwan has been adopted since 1996, and the main source of

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<sup>4</sup> The main variables are the degree of population aging, real income, universal health insurance, physician population, and the relative price of medical services.

data for this is the “Republic of China Statistical Yearbook”, as published by the Directorate General of Budget, Accounting and Statistics.

### 3.1.2 The demand side

#### a. Degree of population aging (*OLD*)

Grossman (1972) states that the health depreciation rate of individuals will accelerate as they are ageing, and thus the need for medical treatment will increase. Medical expenses should thus increase with the degree of population ageing. The data used to assess this is taken from the “Republic of China Statistical Yearbook”, as noted above. The degree of population ageing is defined as the population aged 65 or older divided by the total population in a given year.

#### b. Real income (*GDP*)

As national income grows the demand for health care will increase, and this will then raise health care expenditures. The data to measure this are taken from the Ministry of Education AREMOS economic statistics database, “Taiwan Area National Income Repository.” Real income is defined as the ratio of GNP divided by the population of this country in a given year.

## 3.2 The supply side

### 3.2.1. Universal health insurance (*INSURE*)

The provision of universal health insurance reduces the direct medical costs, further giving individuals little incentive to reduce health care spending. The data on universal health insurances is taken from the following databases: (1) The number of men in employment is obtained from the Central Trust of “Public Servants’ Insurance Statistics” and the Bureau of Labor’s “Taiwan and Fujian Area Labor Insurance Statistics”. (2) Details of the implementation of the National Health Insurance system are taken from the statistics published by the Central Bureau of National Health Insurance. This is measured as follows:

$$\text{Universal health insurance} = \begin{cases} \frac{\text{The total number of agricultural and fishery workers participated in public insurance}}{\text{The total population for the year}} & ; \text{ Before the implementation of the NHI} \\ \frac{\text{The total number of health care participated in the referendum}}{\text{The total population for the year}} & ; \text{ After the implementation of the NHI} \end{cases} \quad (1)$$

### 3.2.2 Health insurance implementation (*I*)

After the implementation of after-service health insurance the popularity of such insurance has increased, and this may also increase the related moral hazard, further raising health care spending. As the universal health insurance system in Taiwan started on 1995/03, the year 1995 will be used as a cutoff point. *I* is 1 before 1995, and 0 otherwise.

### **3.2.3 Number of doctors per 10,000 persons (*Doctor*)**

The number of doctors per 10,000 individuals is defined as ratio, the total number of doctors divided by the total population in Taiwan multiplied by 10,000.

## **4 The empirical results**

### **4.1. The basic descriptive statistics**

Table 1 shows that the individual data are generally subject to the assumption of normality. The average per capita health care spending was about four times higher before the implementation of NHI (20,320.37 / 4,944.444) than after it, the proportion of the population ageing was about twice as high after the implementation than before (0.0831/0.04674). The average per capita income in real terms was almost three times higher before the implementation of NHI (401,473.9341/166,879.74) than after. The insurance coverage ratio great four-fold after the implementation of NHI (0.9608/0.2244), while the average number of physicians per capita doubled.

The average per capita income in real terms increased from 64,824 in 1970 to 444,842 in 2003, a seven-fold rise in 33 years, while the proportion of the population ageing increased by about three-fold (0.091095/0.029706). The average number of doctors per capita increased four times (0.002054/0.0005), and the sodium retention ratio also increased from 10% to 98%. The average growth rate of per capita health expenditure rose 17-fold over the 33 years from 1970 to 2003. With increases in the quality of life and personal income, people will pay more attention to their health, and thus health-related spending increases. Of course, both technological improvements and growth in the ageing population can explain the rise in health care spending. The statistics reported above indicate that after the implementation of NHI in Taiwan health care expenses grew much faster than the economy in in real terms. We can thus see that growth and income cannot fully explain the majority of health care spending, in part because of the population ageing in this period (with the elderly accounting for about 10% of the total population), and a substantial increase in insurance rates. The growth in the number of doctors also may explain the rise in medical spending, via so-called “the doctor supply-induced demand”. However, advances in medical science and technology also play important roles in the rise in spending.

Table 1: The descriptive statistics

Variable	Mean	Median	Stdev.	Skewness	Kurtosis	Jarque-Bera Test
<b>Panel A: Before 1995</b>						
HCE	4944.44	3840.04	3343.56	1.17	3.26	5.78*
OLD	0.046	0.044	0.012	0.47	2.03	1.88
GDP	166879.74	143923.68	78311.65	0.53	2.06	2.09
INSURE	0.22	0.18	0.11	0.49	1.81	2.47
DOCTOR	0.0009	0.00091	0.0003	0.41	2.06	1.64
<b>Panel B: After 1995</b>						
HCE	20320.37	21117.09	3151.37	0.39	1.83	0.74
OLD	0.08	0.08	0.005	0.008	1.87	0.47
GDP	401473.93	411244.88	35680.49	-0.46	1.92	0.76
INSURE	0.96	0.96	0.01	-1.57	5.14	5.44*
DOCTOR	0.0018	0.0018	0.0001	0.04	1.6	0.73
<b>Panel C: Overall period</b>						
HCE	9014.54	4998.91	7612.37	0.81	2.14	4.78
OLD	0.056	0.052	0.019	0.3	1.69	2.92
GDP	228978.2	202183	125718.3	0.36	1.72	3.1
INSURE	0.41	0.28	0.34	0.81	1.95	5.29*
DOCTOR	0.0012	0.0011	0.0004	0.21	1.72	2.56

Note: \*denotes significant at the 10% level

#### 4.2 Multi-collinearity analysis

The results of the KPSS test (which includes both intercept and trend terms), show that all the variables are significant at the 0.05 level with the exception of  $\ln(\text{GDP})$ . The results are generally consistent with the basic assumptions of the traditional least squares method, but may need to be evaluated to detect their residuals in the following regression equation. A high degree of col-linearity between these explanatory variables may lead to the biased empirical results, the multicollinearity between these variables are needed to be examined. Table 2 shows significant multicollinearity among these variables (all the correlation coefficient values are above 0.97), so only the simple regression analysis are examined in the following regression analysis.

Table 2: Multicollinearity analysis

Variable	Mean	Median	Stdev.	Skewness	Kurtosis	Jarque-Bera Test
<b>Panel A: Before 1995</b>						
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Note: \*denotes significant at the 10% level

#### 4.2. The regression analysis<sup>5</sup>

The ARCH test is executed for the regression equation to examine whether the heterogeneity of variance is an issue. The empirical results show that ARMA (1,1) -GARCH (1,1) model is an appropriate form in estimating regression equations.

Based on Eq.(1), there was a significant increase in health care spending after the implementation of NHI (per capita health care spending increased on average 16.826%). The low cost of medical treatment for individuals may lead to an ex post moral hazard. Of course, this may also be due to technological or medical advances.

The results of Eq.(2) indicate that population ageing was related to a significant

<sup>5</sup> Because of the multicollinearity among variables exists, not all the variables are included in these explanatory variables simultaneously to avoid problems in estimating the coefficients.

increase in health care spending, although the rate of increase was less than the increase in medical expenses. When the population ageing increases by 1%, then medical expenses per capita will increase by 0.6%. As Taiwan now has an ageing population, the government should carefully consider how to provide such individuals with appropriate medical care while avoiding significant substantial increases in spending.

The results of Eq.(3) show that the rate of increase in per capita medical expenses was much larger than the increase in personal income in real terms, with income increasing by 1%, and the average per capita health care spending rising by about 1.3%. The health care is a luxury good, in contrast to earlier Taiwanese studies but in line with much research carried out in other countries. Health care spending will increase as the income increases.

The results of Eq.(4) show that medical insurance expenses increased significantly, although the rate of increase was less than that seen for average personal medical expenses. An increase of 1% in insurance coverage ratio led to about a 0.3% increase in the average health care spending. One possible explanation for this is that the expansion of the insurance system for medical services has produced a rise in prices and quality over the last years, resulting in a significant increase in medical expenses.

Table 3. The regression analysis

The regression equation:  $\ln(\hat{HCE}_y) = \hat{\alpha}_0 + \hat{\alpha}_1 I_y + \hat{\alpha}_2 \ln(OLD_y) + \hat{\alpha}_3 \ln(GDP_y) + \hat{\alpha}_4 \ln(INSURE) + \hat{\alpha}_5 \ln(DOCTOR)$

Eq.	Intercept	I	Ln(OLD)	Ln(GDP)	Ln(INSURE)	Ln(DOCTOR)	R <sup>2</sup>
(1)	14.47**	0.16**					0.9976
(2)	13.86**	0.05**	0.65**				0.9976
(3)	-7.64**	0.12**		1.33**			0.9958
(4)	15.97	-0.14**			0.28**		0.9971
(5)	3.83**	0.26**				0.98**	0.9937

Note: \*denotes significant at the 10% level

The results of Eq.(5) show that the increase in the number of physicians per million people was far below the average rate of increase in health spending per capita. As the number of physicians increased by 1%, the average per capita health spending increased by only 0.9%, the above results support the previous phenomena, doctor supply induced demand. Large hospitals in Taiwan have recently purchased many innovative medical devices, and all hospitals and clinics have seen a substantial increase in the number of doctors. This has raised the issue of the waste of medical resources, which needs to be addressed to solve the NHI's financial problems.



## 5 Conclusion

This paper uses data for the period, 1970 to 2003 to explore the factors affecting medical expenses in Taiwan. First, based on the KPSS test, no significant trends among the five variables exist (with the exception of the average individual real income), the results of this work are significantly different from those presented in the previous literature. After adding the appropriate lags and the residual heterogeneity correction, the following empirical results are obtained.

(1) After the implementation of NHI in Taiwan, the average per capita health spending increased significantly (an increase of approximately 16%). (2) The income elasticity of health care spending is greater than 1, and thus it is a luxury good. (3) The increase in the number of physicians may have led to supply-induced demand; (4) The increase in the proportion of the elderly population is positively related to the amount health care spending. (5) Universal health insurance might lead to an ex post moral hazard, but other variables are suggested to be used. (6) The relationships among these variables and health care spending in Taiwan still exist even after the system was introduced.

The relationship between rising medical expenses and the establishment of an NHI system is encouraged to examine in the future research. In addition, since this article uses annual data, future research could use data with a higher frequency, such as monthly data, in order to examine the issues raised in this work.

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