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ECONOMIC GROWTH, HUMAN CAPITAL INVESTMENT, AND HEALTH EXPENDITURE: A STUDY OF OECD COUNTRIES

KOYIN CHANG

Department of Healthcare Information and Management, Ming Chuan University
Taoyuan 333, Taiwan
koyin@kchang.net

AND

YUNG-HSIANG YING*

Institute of Interdisciplinary Studies, National Sun Yat-sen University
Public Policy Research Center, National Sun Yat-sen University
Kaohsiung 804, Taiwan
yying@mail.nsysu.edu.tw

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Abstract

Studies have shown that increase in health care expenditure is related to the income level and economic growth of a country. But a theoretically optimal level of health expense and an optimal growth rate are rarely investigated. This paper assumes that health expenditure is a gross investment in human capital and follows the usual characteristics of investment in the Solow growth model. Based on Solow, a theoretical model is developed to discuss the role of health capital in economic growth. The model shows that convergence is present between poorer and wealthier countries when both physical and health capitals are considered. In the empirical analyses, this paper first estimates the optimal steady state product level based on the method of Mankiw, Romer and Weil (1992). Secondly, the optimal steady state health expenditure amounts are projected assuming that the steady state situation automatically achieves the Golden Rule consumption maximization result driven by the free market force. The results show that most of the studied 15 OECD countries have excessive health expenditure for approximately the past two decades. Some of the countries show a decreasing pattern of overspending and finally reach the optimal level. But a few of them do not show a format of cost containment for controlling health expenditure.

Keywords: human capital investment, optimal health expenditure, economic growth
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* Corresponding author.

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I. *Introduction*

The long-term increase of healthcare expenditure raises a great concern about the allocation of public resources. In many countries, accurately projecting the trend of healthcare expenditure growth and finding an optimal expenditure level have become critical tasks. Extensive literature has already discussed the means of cost containment.[1] Studies have also shown that healthcare expenditure is closely related to a country's GDP level.[2] As income increases, health expenditure is no longer just the issue of life and death, but is meant to improve quality of living. Even though there is no unanimous conclusion in the literature, when analyzed on the basis of an aggregate demand function, health services in most of the developed countries are observed to be luxury goods[3] for which spending increases faster than the growth of income.[4] For this reason, it could be imprudent to conclude that health spending is soaring beyond control merely on the basis of the number figure of healthcare expenditure or the ratio of healthcare expenditure to GDP. Since the income level is in general increasing across countries over time, healthcare expenditure has to follow an increasing pattern across countries as well. What really matters is actually whether it increases within a reasonable range. Thus, this paper investigates whether countries really overspend and to what extent they overspend in healthcare.

In order to understand and predict health expenditure growth, this paper builds a theoretical growth model that explains the importance of health expenditure to human capital followed by a set of projection models that incorporate the factors of GDP growth and spending on national healthcare, which is considered as an investment in human capital. A hypothetical steady-state healthcare expenditure is projected to be the base case of the optimal expenditure level for each county at different time periods. This base is then compared with the actual expenditure level. In reality, a steady state does not exist since technologies, environmental conditions, and policies of each country are constantly changing. But in the very short run, both the physical and human capital growths are assumed to be fixed. The hypothetical steady state condition for each period in each country can be simulated given the growth conditions as static. This paper thus projects the health expenditure level around its "pseudo" steady state. Comparison between the projected level and the actual level will give government authorities better understanding of the appropriateness of their health policies. The empirical analyses also provide information on the determinants and the structure of healthcare expenditure. By applying the projection models provided in this study, a government authority may have a clear and reliable guide to decision-making for future healthcare and other social welfare policies.

The result of the study shows that for most of the studied OECD countries, the health

[1] See, for example Feldstein (1973), Scitovsky and Snyder (1972), Beck and Horne (1980) Scheffler (1984), Greene and Bunselman (1986), and Gerdtham et at. (1992).

[2] See, for example, Whynes (1992), McCoskey & Selden (1998), Hansen & King (1996, 1998), Newhouse (1977, 1987), Parkin et al.(1987), Govindaraj et al. (1997), Jayasinghe et al. (1998), Van der Gaag & Barham (1998), Cowan et al. (1996), King (1996), Burner & Waldo (1992; 1995).

[3] For more discussion of whether health is a luxury or necessity good, please see Clemente, Marcuello, Montañés and Pueyo (2004), Getzen (2000).

[4] See, for example, Newhouse (1977), Leu (1986), Gerdtham et al. (1992).

expenditure per effective unit of labor exhibits an increasing pattern over time for both the actual and projected values with the growth rate slower for the former one than the latter one. When healthcare expenditure is measured in terms of the share of GDP, the growth pattern is strong for the projected optimal value (with the exceptions of Spain and Greece) but the actual spending ratio is quite constant for almost all countries. In both measures, the actual values are consistently above the projected optimal value, indicating that the economy as a whole overspends in healthcare for almost all countries. The gaps between the actual and projected values present a decreasing pattern for most of the countries, though. Some even overlap gradually together, which means that the cost containment tasks for those countries have been successful.

The remainder of the paper is organized as follows. In the next section, a growth model with health as human capital is developed. Then the policy implication from the theoretical part is introduced in Section 3. Section 4 presents the empirical results. Finally, Section 5 provides concluding remarks.

II. *The Model*

Mushkin (1962), Becker (1964), and Fuchs (1966) pointed out that health capital is one component of the stock of human capital. Thus, in the modern growth model, it enters into the production function of an economy:[5]

$$Y(t)=F(K(t), H(t), L(t), t) \tag{1}$$

where Y(t) is the flow of output produced at time t, K is the physical capital, H is the health capital, and L is labor. The production function depends on time, t, to reflect the effects of technological progress. For simplicity, we assume a one-sector production technology in which output is a homogeneous good that can be consumed, C(t), invested in K, $I_k(t)$, to maintain or create new units of physical capital, K(t), or invested in H, $I_h(t)$, to maintain or create better health capital, H(t). In a closed economy, output equals income, and the amount invested equals the amount saved. Let s_k and s_h be the fraction of output that is saved (saving rate) for physical capital and health capital, respectively. Also assume that δ_k and δ_h are the corresponding depreciation rates. The next increase in the stock of physical capital and the health capital at a point in time equals gross investment less depreciation:

$$\begin{aligned}\dot{K}&=s_k \cdot F(K, H, L, t)-\delta_k \cdot K\\ \dot{H}&=s_h \cdot F(K, H, L, t)-\delta_h \cdot H\end{aligned} \tag{2}$$

where · denotes differentiation with respect to time, and $0 \leqq s_k,\ s_h \leqq 1$. To use the per effective unit of labor format, the above equations can be rewritten as follows:

$$\begin{aligned}\dot{k}&=s_k \cdot f(k, h)-(n+g+\delta_k) \cdot k\\ \dot{h}&=s_h \cdot f(k, h)-(n+g+\delta_h) \cdot h\end{aligned} \tag{3}$$

[5] Assuming the production function is neoclassical, meaning the following three properties are satisfied: First, F(.) exhibits positive and diminishing marginal products with respect to each input, second, F(.) exhibits constant returns to scale, and third, the Inada conditions.

where n is the growth rate of population and g is the growth of technology. In the steady state of the Solow model, in which the various quantities grow at constant rates, both $\dot{k}$ and $\dot{h}$ are equal to zero, meaning that the per effective unit of labor variables—k, h, y, and c—do not grow in the steady state, and the levels of variables—K, H, Y, and C—grow in the steady state at the rate of the population growth, n.

Transitional Dynamics

To see the effect of capital accumulation over time, the growth rates of these two types of capital are derived by dividing both sides of eq. (3) by the corresponding capital stock:

$$\gamma_k = \dot{k}/k = s_k \cdot f(k, h)/k - (n + g + \delta_k) \tag{4.1}$$

$$\gamma_h = \dot{h}/h = s_h \cdot f(k, h)/h - (n + g + \delta_h) \tag{4.2}$$

In the graphic presentation, the first term in the right side of the equation 4.1 (4.2) shows, for a given level of capital (health) stock, a downward-sloping curve that asymptotes to infinity as k(h) is zero and approaches zero as k(h) moves towards infinity. The second term exhibits a horizontal line. Thus the vertical distance between the curve and the line equals the growth rate of physical capital (health stock) per person. At the steady state, the growth rate of k(h) is zero implying that the crossing point corresponds to the steady state, which in our model exists and is unique.[6] As a result, for an economy with more abundant capital, the growth rate of the corresponding capital decreases. It approaches zero in the steady state and turns negative if the capital stock is more than the steady-state per effective unit of labor capital stock.

$$k^* = \frac{s_k f(k, h)}{(n + g + \delta_k)}, \quad h^* = \frac{s_h f(k, h)}{(n + g + \delta_h)} \tag{5}$$

For the per effective unit of labor output of the economy along the transition, the growth rate is given by

$$\begin{aligned} \gamma_y = \dot{y}/y &= \left\{ \frac{df(k, h)}{dk} \cdot \dot{k} + \frac{df(k, h)}{dh} \cdot \dot{h} \right\} / f(k, h) \\ &= \frac{k \cdot f_k(k, h) \cdot \gamma_k + h \cdot f_h(k, h) \cdot \gamma_h}{f(k, h)} \\ &= sh(k) \cdot \gamma_k + sh(h) \cdot \gamma_h \end{aligned} \tag{6}$$

where $i \cdot f_i(.)$ is the income per person earned by owners of capital i, $i = k$ or h. Thus $i \cdot f_i(.)/f(.)$ is the share of this income in total income per person, $sh(i)$. Substituting equation (4.1) and (4.2) into the above equation, one obtains

$$\gamma_y = s_k \cdot f_k(k, h) - (n + g + \delta_k) \cdot sh(k) + s_h \cdot f_h(k, h) - (n + g + \delta_h) \cdot sh(h) \tag{7}$$

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[6] Since $n + \delta_k > 0$ and $s_k \cdot f(.)/k$ falls monotonically from infinity to zero, the curve and the line intersect only once.

We follow Mankiw Romer and Weil (1992) in assuming that both capitals are depreciating at the same rate δ. Differentiating with respect to capital i and combining terms, we then obtain

$$\frac{\partial \gamma_y}{\partial i} = \frac{f_{ii} \cdot i\gamma_i - f_i(n+g+\delta)[1-sh(i)-sh(j)] + f_{ij} \cdot j\gamma_j}{f(k, h)} < 0 \tag{8}$$

We then suppose that the cross effect of the two capital f_{ij} is small enough and negligible, and that the growth rate of capital i is nonnegative, which is true for almost all observable data for the OECD countries. Then the impact of i on γ_y is negative, meaning that as capitals accumulate, the growth of output level slows down.[7]

The Golden Rule of Capital Accumulation

For a given production function and given values of n, g, and δ, there is a unique steady-state value k* for each value of the saving rates s_k, s_h. The steady-state level of per effective unit of labor consumption is $c^* = f[k^*(s), h^*(s)] - (n+g+\delta)[k^*(s) + h^*(s)]$. The quantity of c* attains its maximum when the derivative vanishes, that is, when

$$\begin{aligned} [f_k(k^*, h^*) + f_h(k^*, h^*) - (n+g+\delta)] \cdot \frac{dk^*}{ds_k} &= 0 \\ [f_k(k^*, h^*) + f_h(k^*, h^*) - (n+g+\delta)] \cdot \frac{dh^*}{ds_h} &= 0 \end{aligned} \tag{9}$$

Since $dk^*/ds_k > 0$ and $dh^*/ds_h > 0$, the terms in brackets must equal zero. We denote that k and h satisfy the above condition as k_{gold} and h_{gold} for the maximum of c*. The corresponding saving rate can be denoted as s_{kgold} and s_{hgold}, and the associated level of steady-state per effective unit of labor consumption is given by

$$c_{gold} = f(k_{gold}, h_{gold}) - (n+g+\delta)\ k_{gold} - (n+g+\delta)\ h_{gold}. \tag{10}$$

The above equation implies that saving rates higher than s_{kgold} and s_{hgold} would be inefficient because higher quantities of per effective unit of labor consumption could be obtained at all points in time by reducing the saving rates. However, if the saving rates fall lower than s_{kgold} and s_{hgold} then the steady-state amount of per effective unit of labor consumption can be increased by raising the saving rates. This rise in the saving rates would reduce current consumption during part of the transition period. The optimal saving rates depend on how households weigh today's consumption against the path of future consumption. Thus, the optimal investment in health capital and physical capital is determined by this Golden Rule.

III. *Policy Implication and Tendency of Convergence*

The above theoretical model explains the phenomena that in poorer countries where physical capital and health stock are low, we are more likely to observe faster economic growth

[7] If $\gamma_i < 0$, then the sign of $\partial\gamma_y/\partial i$ is ambiguous for a general form of the production function. However, when the economy is close to its steady state, then the magnitude of γ_i will be small and $\partial\gamma_y/\partial i < 0$ will hold even if $i > i^*$.

than the richer countries. Equation 5 shows that the steady state capital stocks are determined by the saving rates of the corresponding capital and the output level, $f(k, h)$. For wealthier countries, the steady state capital stock is larger; health stock and quality of life in turn are valued more heavily than in the poorer countries. If the government introduces a new policy that raises the saving rate of the economy, then the steady-state per capital stock will increase and the current growth rate of capital will also temporarily increase. As k or h increases, the economy moves towards the new steady state while the growth rates of capital stocks fall and approach zero.[8] Each country at a different time period has a different income level. The investments in k and h for each country at different times with different income levels result in different rates of economic growth. From the previous section, we expect a negative relationship between investment and the rate of economic growth. Hence, for wealthier countries we expect the optimal investment level to be higher than in poorer countries. If a country is continuously growing, then its optimal investment level also needs to be continuously increasing.

A permanent improvement in the level of technology has similar, temporary effects on the per effective unit of labor growth rates. An upward shift in the production function means an upward shift in the $s_i \cdot f(k, h)$ curve. As a result, a temporary rise in the growth rate of the corresponding per effective unit of labor capital stock is observed. In the long run, the permanent improvement in technology generates higher levels of k, h, and y, but the growth rates are all gradually decrease toward zero as the economy approaches steady state.

IV. *Empirics*

In order to investigate the optimal rate of health investment of an economy, this paper uses healthcare expenditure as the proxy in evaluation. The optimal rate exists when the economy grows toward the consumption-maximization steady state, or the Golden Rule status. As mentioned earlier, steady state may not exist in reality due to constantly changing technology, cultural shifts, political movements, and change in preference in the countries. However, a hypothetical steady state is projected assuming that shift factors freeze at a snapshot in the time span, which is made possible by employing a panel regression model with fixed country and fixed time effects, so that only investments in physical and human capital stock are changeable to lead the economy towards the steady state. Much of the previous literature emphasizes the cointegration nature of health expenditure and national income level (Gerdtham, Lothgren, 2000, and Clemete, 2004). This paper, however, uses a different approach since healthcare expenditure is determined by many other variables, such as health status of a country, environmental factors, population growth, and economic growth, that are stationary and not cointegrated with healthcare expenditure. In addition, since the main issue of this paper is to discuss the steady-state outcome, a fixed-effect regression approach adjusted by autoregressive command is suitable. In addition, since this paper primarily focuses on investment in health capital, when projecting the steady state optimal investment amount, further restriction is imposed by assuming that growth rates for all variables are zero. To

[8] The effect can be shown by differentiating equation (6.1) and (6.2) with respect to corresponding capitals. The result shows that both $\partial\gamma_k/\partial k$ and $\partial\gamma_h/\partial h$ exhibit negative values.

empirically test the Golden Rule status, the optimal investment amount is assumed to be on the trend of the regression function. Thus, the empirical parts are twofold. First, a steady state output level is estimated for each country in each period of time. This steady state is assumed to be in the optimal Golden Rule status supposing that all countries automatically maximize their utility through market forces. Second, a two-stage least square method is applied to estimate the health expenditure equation, assuming growth rate of health investment is endogenous since it is subject to the economies' social and political conditions. By so doing, the hypothetical optimal steady state health expenditure amount can be predicted when the growth rates of variables are zero and when the level of output is at the imputed steady-state output level.

1. The Empirics of Steady State

The first part of the empirical analyses is to predict the optimal steady-state output level. We adopt from the seminal paper of Mankiw, Romer, and Weil (1992) and assume that depreciation rates for physical and human capitals are the same. From equations (4.1) and (4.2), we then obtain the steady-state output equation as follows:[9]

$$\ln(y^*) = \ln A(0) + gt - \frac{\alpha+\beta}{1-\alpha-\beta}\ln(n+g+\delta) + \frac{\alpha}{1-\alpha-\beta}\ln(s_k) + \frac{\beta}{1-\alpha-\beta}\ln(s_h)$$

where y* is the steady state output level per working labor, A(0) is the initial technology, and α and β are the coefficients for physical and human capitals, respectively, from the production function. In our regression for steady state y*, other than education, which Mankiw, Romer, and Weil include, health stock is also a major concern. Thus, we include both education and health variables in the empirical model. Data of 15 OECD countries are used for the time span from 1980 to 1998.[10] We employ the data of real GDP at the constant 1995 price level as y, the ratio of total capital to GDP as s_k, the ratio of education expenditure for primary and secondary schools to GDP as s_{edu}, the ratio of health expenditure to GDP as s_{health}, the three-year moving average[11] of population growth rate as n, and assume $g+\delta$ to be 0.05 as suggested by Mankiw, Romer, and Weil (1992). After running a panel fixed-effect regression method with country-specific and time-specific effects under control, we obtain (t statistics are in parentheses):

$$\underset{}{ln(y^*)} = 5.119 + \underset{(14.48)}{0.315\, ln(s_k)} + \underset{(13.87)}{0.544\, ln(s_{edu})} - \underset{(-4.88)}{0.832\, ln(n+g+\delta)}$$

$R^2 = 0.941$

$$ln(y^*) = -23.761 + \underset{(13.07)}{0.165\, ln(s_k)} + \underset{(2.04)}{0.053\, ln(s_{edu})} + \underset{(3.48)}{0.132\, ln(s_{health})} - \underset{(-2.09)}{0.191\, ln(n+g+\delta)}$$

$R^2 = 0.943$

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9 Assuming the production function is $Y(t) = K^{\alpha}H^{\beta}(AL)^{(1-\alpha-\beta)}$, and $A = A(0)e^{gt}$.

10 The data sources include OECD Health Data 2000 and OECD Main Economic Indicators, Historical Statistics, 1960-1997. But the data before 1979 have serious missing data problems.

11 The moving average of population growth can eliminate year-specific shocks for the birth spur.

When comparing the two estimates, we find that the two regression results are quite different in terms of the coefficients. Since the health variable — $\ln(S_{health})$ has significance in the second formula, the first one clearly has an omitted variable problem. When the omitted variable has positive correlation with the existing variables, the existing ones will be overestimated, which is what we see for the above first regression equation. When we compare the results of the second formula to some other literature, we find high similarity.[12] Therefore, for the following estimate the second equation is used.

2. The Estimate for Health Expenditure

A range of studies, including Culyer (1990), Gerdtham et al. (1992), Hitiris and Posnett (1992), Hitiris (1997), Zewifel et al. (1999), Richardson and Roberstson (1999), Moise and Jacobzone (2003) and Jönsson and Eckerlund (2003), have been trying to discuss the determinants of health expenditure across countries. Their regression attempts to control for a variety of both 'background' and 'institutional' influences, including income, demography and fiscal constraints. Starting from these premises, the empirical literature on health expenditure per capita has specified three main sources of determinants: (i) income; (ii) demographic factors describing the population age structure; and (iii) other exogenous factors such as rate of inflation, the nature of the health care system, stock of health care structure (such as manpower, hospital beds, etc) and non-medical health determinants of the population.[13] In the regression of this paper, we also include these three categories. Income variable is described as GDP (y).[14] For demographics, we did not use young or old population ratios as most of the literature has done.[15] Instead, crude mortality rate, urban population ratio, population density and population growth are used to describe a country's general demographic information. The exogenous factors that are included in our estimate regression are threefold:

D: nature of the health care system—public sector provision,[16] insurance coverage

E: Environmental variables—water pollution,[17] location (in Asia or not)

Z: the stock of health care structure—health employment, bed number

Since the main purpose of this paper is to project the steady state optimal investment amount, our regression equation needs further inclusion of the growth variables so that the Golden Rule status of investment amount can be estimated at the snapshot when these growth rates approach zero. As a result, the growth rate of GDP and the growth rate of health expenditure are included to capture a nation's dynamic transition. None of the previous

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[12] McDonald and Roberts (2002), for example, find that the results for OECD countries have the coefficients 0.173, 0.067, and -.225 for investment, education, and $(n+g+\delta)$ respectively. The coefficients for health variables in the two studies are different, though. McDonald and Roberts use life expectancy as their health indicator, which has been criticized by Knowles and Owen (1995) as crude. One possible approach is to proxy health capital by the proportion of income spent on health inputs. Thus we use the ratio of health expenditure to GDP instead.

[13] For more detailed information, please see Hitiris and Posnett (1992).

[14] GDP adjusted by purchasing power parity (PPP) is used in this paper to reflect a constant consumer price in different countries.

[15] According to Getzen (1992), rising health expenditure and rising ages are the result of an indirect relationship with other variables. Also Moise and Jacobzone (2003) indicate there is little correlation between per capita health expenditure and percentage of population aged over 65.

[16] Share of total health expenditure that is covered under public programs.

[17] percentage points of total BOD emissions and organic water pollutant emissions level, kg per day.

literature has ever employed these variables in health expenditure analyses. Hence, we hope the idea of this paper will add to the existing literature some novelty and robustness in the health-expenditure related field.

To estimate the optimal health expenditure for each country at different time periods, the regression equation is estimated by a panel fixed-effect Tobit model to account for the positive nature of health expenditure:

$$HE_{i,t}=f(HEG_{i,t},\ dy_{i,t},\ y_{i,t},\ h_{i,t},\ k_{i,t},\ D_{i,t},\ E_{i,t},\ Z_{i,t}),$$

where HE_{it} denotes health expenditure per effective unit of labor for the ith country in year t as the proxy for gross health stock investment, HEG denotes the per effective unit of labor growth rate of health care expenditure, y denotes GDP per capita, dy denotes the growth rate of GDP, and D, E, Z denotes the above-mentioned exogenous variables. Since this is panel data, the time and country dummy variables are used to fix the time and country-specific effects. The data include 15[18] OECD countries with a time frame of 19 years. However, missing data are sporadic; the number of available observations left for regression is only 202.[19]

To obtain the steady-state health expenditure amount, the two-stage least square method[20] is employed treating the growth rate of health expenditure as endogenous since this is the variable we primarily focus on when inducing the steady state value and it is determined by many other social, political, and environmental factors. By definition, the steady-state level occurs when the growth rate of the variable approaches zero. Thus, it can be obtained by substituting the steady-state output level for the output level and suppressing the growth rate of per effective unit of labor health expenditure and growth rate of GDP, thus setting them in effect equal to zero.

To ensure the robustness of the empirical results, two types of health expenditure measures are employed as the dependent variables: the ratio of health expenditure to GDP and the real health expenditure per effective unit of labor in logarithms, measured at purchasing power parity (PPP) level, with regression results presented in the first and second columns, respectively, of Table 1. Both results have quite consistent signs for each of the explanatory variables. The negative sign of the mortality rate suggests that if the society considers health a less important issue they would then spend less money on it, which would result in a less hygienic environment and hence a higher mortality rate. The negative sign for the unemployment rate implies that a society with a lower employment level would devote less money to health and the government also would have less money for public health expenditure. The more densely populated countries and the countries with higher population growth also cannot afford much health expense. On the other hand, the countries with higher health capital such as hospital beds and health personnel require higher health expenditure. That signals either that such countries value healthcare more highly or that the countries spend larger amounts of money to maintain the human health and physical capital stocks.

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[18] The selection of these 15 countries is based on the availability of data.

[19] For data after 1980, each country still has different lengths of available data for all variables. However, this does not affect the result of our analysis since the missing data is sporadic. When using interpolate and extrapolate methods to test the data set, similar results are generated. Hence, only the results from the original data set are reported. For this reason, we hope that the concerns about missing data problem can be minimized, if not totally eliminated.

[20] The method of panel Tobit is applied since the health expenditure level is left-censored to be larger than zero.

TABLE 1. REGRESSION RESULTS

Variables	Share of GDP	HE Per Capita
Mortality Rate	−0.044(−1.04)	−0.009(−1.85)**
Urban Pop.	−0.112(−1.19)	0.011(0.98)
Unemployment rate	−0.068(−2.82)***	−0.012(−4.45)***
Pop. Growth	−0.002(−0.71)	−0.001(−2.23)***
Pop. Density	−2.626(−6.10)***	−0.242(−6.66)***
Bed number	2.650(4.61)***	0.450(7.04)***
Physical Capital	0.096(0.41)	0.033(1.23)
Health Employment	0.507(5.33)***	0.062(5.47)***
GDP	−6.798(−4.08)***	−0.148(−0.78)
Coverage	2.253(7.50)***	0.169(5.60)***
$Coverage^2$	−0.013(−7.41)***	−0.001(−5.80)***
Public HE Share	−1.199(−3.11)***	−0.211(−4.66)***
Public HE $Share^2$	8.125(2.72)***	1.534(4.36)***
Water pollution	−0.186(−1.90)**	−0.050(−4.85)***
Org. Water Pollution	−0.000(−7.12)***	−0.000(−6.88)***
Growth rate of GDP	−0.312(5.94)***	−0.042(−6.81)***
Asia	1.406(1.33)	−0.167(−1.32)
Growth rate of HE	0.442(4.88)***	0.060(5.80)***
Prob＞F	0.000	0.000
Wald Chi^2 (48)	2988.17	27915.10
Log Likelihood	−67.59	370.11
Observation	202	202

Note: a. GDP, Bed Number, Health Employment are in logarithms. All else are in percentage. Asia is a dummy variable indicating countries located in Asia.
b. The t-statistics are in parentheses.
c. *, **, and *** denote 10%, 5%, and 1% level of significance, respectively.

The coefficients of growth rate of GDP present a negative sign for both regression equations at the 1% significance level. This result supports our theoretical prediction from equation 8. Specifically, for a one percent increase in the growth rate of GDP, the share of health expenditure in GDP decreases by 0.31 percent, ceteris paribus, from the first regression, and decreases by 0.04 percent for per effective unit of labor health expenditure from the second regression (the dependent variable is in natural logarithmic form). As mentioned earlier, the richer countries tend to have a lower rate of GDP growth than the poorer but they value healthcare and quality of life more heavily so that their optimal health expenditures are larger. As a result, the negative relationship is expected.

The coefficient of GDP, however, has a negative sign in the regression of share of GDP. This seems to contradict the previous argument and the previous literature. Usually richer countries tend to have lower growth rate and higher health expenditure. But when the growth variables are held constant, higher GDP level implies fewer resources in percentage of GDP that can be devoted to health expenditure, indicating that health expenditure as a share of GDP converges as GDP increases and, hence, societies adjust toward optimal amounts for investment as economies grow. This effect is significant in the regression of the share of Health Expenditure in GDP—a one percent increase in GDP causes the share of HE in GDP to decrease 6.79 percent, holding all other variables constant. The coefficients for health policies also exhibit expected results. A higher ratio of people covered by health insurance encourages

FIG. 1. RELATIONSHIP BETWEEn REAL HE PER EFFECTIVE UNIT OF LABOR AND PROJECTED STEADY STATE VALUE

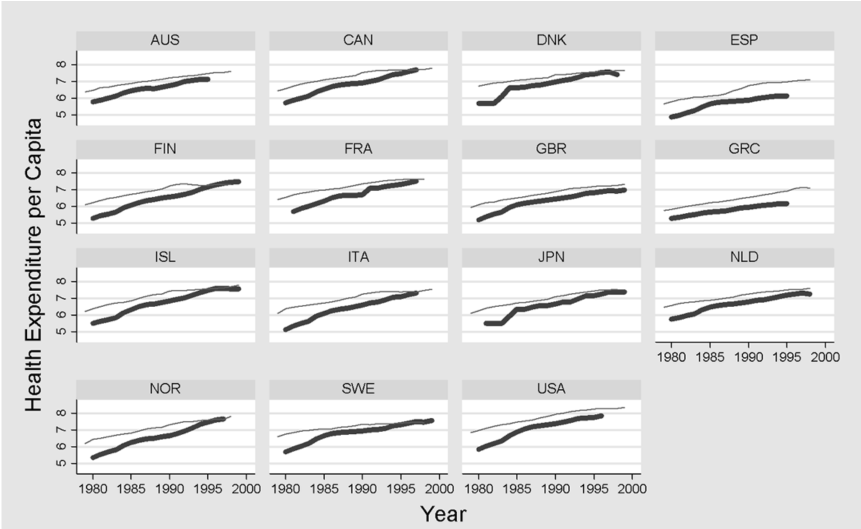
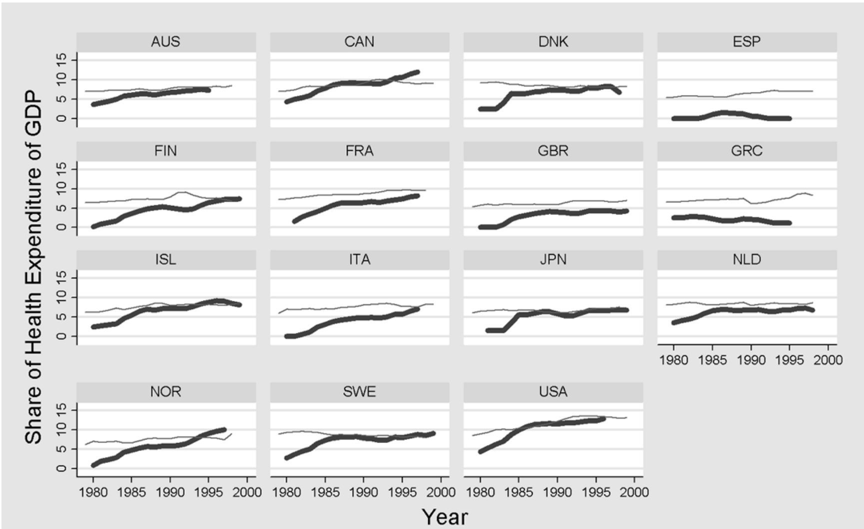


FIG. 2. RELATIONSHIP BETWEEN THE ACTUAL FRACTION OF HE IN GDP AND PROJECTED VALUE



Note: Thin line — actual value
Bold line — projected value

the nation's health expenditure. But a larger share for public health expenditure results in smaller total national health expenditure in both regression results. The plausible explanation is that a country has better control over health spending through a centralized system. The environmental variables also play significant roles in both of the regressions. The negative signs may be explained by the same reason as the negative sign of the mortality rate.

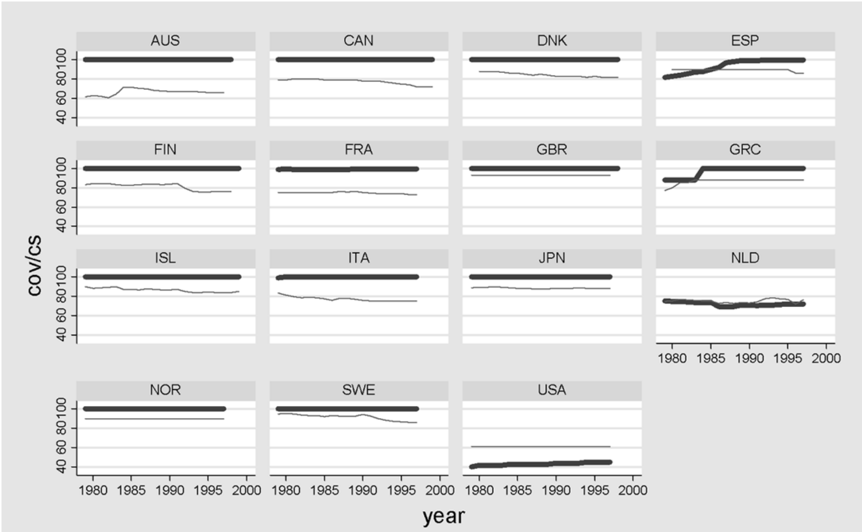
The main idea for this paper is to understand the trend of health expenditures for the OECD countries and to compare them to the steady-state optimal amount of health expenditures for each country. In order to do so, the projected optimal steady-state expenditure amount is imputed for each country at possible time periods. The results are shown in Figures 1 and 2. The former presents the actual real health expenditure per effective unit of labor measured at PPP basis with comparison to its estimated optimal value and the latter one presents the health expenditure as share of GDP also compared to the estimated optimal share. The bold line represents the estimated value and the thin line is the actual value. Both figures present consistent results. Almost all countries exhibit a higher level of actual health expenditure than the projected value, meaning that overspending in health expenditure is generally present. Looking closely at the graphs, we observe that for some countries these two lines move closer over time and finally overlap together such as for Canada, Denmark, Finland, Israel, Italy, Japan, Norway, and Sweden. This shrinkage in the gaps implies that those countries have carried out the health expenditure containment process successfully. Even though both the thin line and the bold line in both figures for the above countries show increasing trends over time, the projected optimal steady state value increases at a faster rate than the actual expenditure level. For some other countries such as France, Netherlands, the UK and the US, the amount of overspending is also decreasing but the healthcare expenditure has not yet reached the optimal amount. Thus, for these countries, further control of health expenditure is needed. For the rest of the countries, Spain and Greece, there is no sign of shrinkage in the gaps, meaning that in the past two decades, health consumption is consistently over- spent. In particular, health expenditure per effective unit of labor has been overspent by an average 34% and 46% for Spain and Greece, respectively, in the past two decades. If measured by the share of health expenditure in GDP, the average actual shares are 4.97% and 6.19% for Spain and Greece, respectively. But their corresponding optimal rates are only 0.52% and 2.00%. These data strongly suggest that both countries re-evaluate their health policy and find more stringent cost containment methods. Interestingly, the insured rates in these two countries increased dramatically in the 1980s to about 100 percent of the late 1980s while the public sharing rate for Greece has stayed constant and decreased for Spain (please refer to Figure 3). If government is more efficient in controlling spending, then these two countries may consider vesting more control in the central system. Another traditional way of cost containment is to increase the co-payment amount for patients.[21] Both approaches might be considered by relevant health authorities when reviewing their health policies for future reform plans.

V. *Conclusion*

This study applies economic growth theory to explain the long-term increasing nature of healthcare expenditure in a growing economy. Health consumption can be considered as an investment in human capital since it improves labor's working ability by promoting worker reliability, energy and attention. Since healthcare has been treated as a "luxury good" in many

[21] Some price control methods are also introduced by Barros and Xavier (2002).

Fig. 3. Share for Public Health Expenditure and Insured Rate



Bold line — the insured rate
Thin line — the share of public health expenditure in total health expenditure

studies, it is plausible to assume that investment in health is subject to a diminishing marginal return and that convergence between rich and poor countries is present. A theoretical model following the Solow growth model is developed in this paper to explain the convergence and the increasing nature of the investment in either physical or human capital. The traditional thinking of merely looking at the expenditure or investment amount and deciding which is soaring beyond control is arbitrary. On the other hand, the optimal investment amount has to be determined by considering the whole economy's growth situation.

The empirical analysis employs 15 countries from OECD to compare the actual health expenditure and the theoretically projected Golden Rule steady-state expense level. The results of the regression analyses are consistent with conventional predictions. The comparison between the actual and projected values indicates the presence of overspending for most of the countries. Some countries show signs of success in cost containment from the shrinkage between the actual and the projected optimal amount over time. Others appear to have unapparent cost containment plans such as Spain and Greece. It is hoped that this study can provide guidance for the government authorities in planning health policies relative to healthcare expenditure.

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