An Assessment of OECD Health Care System Using Panel Data Analysis

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Abstract

The health care delivery system of twenty five OECD nations is analyzed in this paper. This study seeks to assess the significance of various factors contributing to life expectancy and infant mortality for the 1990-2002 period. A fixed-effects panel data model was used to examine the factors influencing life expectancy and infant mortality. More specifically the impact of economic, institutional, and social factors in determining the dependent variables are measured and evaluated.

1. Introduction

Expenditure on health and healthcare has escalated considerably in the OECD countries especially due to advancement and dissemination in medical technologies, population ageing and rising public demand. Health expenditure as a percentage of GDP was around 8.5% in 2002. In 1984, the average per capita health care expenditure of the OECD countries was $870 (with purchasing power parity adjustment). This figure rose to $2144 in 2002. Relative to the overall mean of the OECD countries, per capita health care expenditure growth has doubled compared to economic growth in the U.S. over the past 20 years. Lately, due to concerns over national security, there is an increasing trend in the OECD nations to reallocate resources from health care spending to expenditures related to security threats.

Figure 1 shows the comparison of life expectancy and health care expenditures for OECD countries in 2002. While trying to minimize healthcare costs, both developed and developing nations are making an effort to improve access to and quality of health care services for their citizens. Thus, identifying the relative role of various factors contributing to health care outcome is essential in understanding the issue and devising relevant policies to address it.

The majority of research on OECD health systems has focused on correlations between health care expenditures and economic performance of the member countries. These studies attempted to assess factors contributing to health using qualitative measures. Quantitative studies on the subject are limited, and a majority of the existing studies have used either time series or cross section analysis.

The objective of this paper is to apply the panel data model to measure and assess the importance of factors determining the two commonly accepted measures of health care outcomes: life expectancy and infant mortality. In this study, the factors used as independent variables are divided into economic, institutional, and social aspects. The aim of the study is to look at the comparative significance of each of the factors in determining life expectancy and infant mortality. The rest of the paper is structured as follows: section 2 presents a literature review and section 3 outlines the data and empirical methodology. Section 4 discusses the empirical findings, followed by conclusions in section 5.

2. Literature Review

The health care system plays a vital role in any economy as discussed in a study by Bloom et al. (2003). There are studies that concentrated on the relationship between income inequality (using GDP per capita as a proxy) and health care in different countries (Preston, 1975; Deaton, 1999; Pritchett and Summers, 1996; Subramaniam et al, 2002; Asafu-Adjaye, 2004; Murthy, 2006; Cutler et al., 2006; Alsan et al., 2006). However, Bloom and Canning (2007) extended Preston's (1975) work and questioned the appropriateness of using GDP per capita as a proxy for economic well-being. In this study, health care expenditure is used as an alternative.

There are a number of recent comparative analyses of health care systems in the literature. Among the studies, only a few focused on the correlations between health care outcomes; i.e., life expectancy and infant mortality, and the contributing elements such as institutional, economic and social factors. None of the other OECD studies in the literature concentrated on these factors.

The magnitude of correlation between health care expenditure and GDP has been tested and reported by some published research. MacDonald and Hopkins (2002) using the OECD samples, confirmed a strong correlation between the two variables cited above and suggest the presence of unit root in both GDP and health care expenditure data. Okunade et al. (2004) by calibrating annual growth rate of OECD health care expenditure data, tested the stationary nature of health care expenditure and illustrated the advantages of using jackknife re-sampling method for short time series. They further argue that the health care spending growth is driven by economic and institutional factors. In addition, Carrion-I-Silvestre (2005) using OECD panel data, verified the presence of structural breaks for real per capita health care expenditures and real per capita GDP.

To assess the elasticities of healthcare expenditure and GDP, Okunade and Suraratdecha (2000) used maximum likelihood estimates of the Box-Cox transformation regression model. They concluded that health care expenditures and GDP elasticities among OECD nations showed that health care is not a luxury commodity. A similar study by Anindya (2005) using OLS technique on OECD data for the period of 1990-98, confirmed the earlier findings of health care as being a non-luxury service among the fifteen-nation sample. Using health production function for the United States, Thornton (2002) contended that additional medical care utilization is ineffective on improving health as measured by life expectancy and mortality rate. Thus, this suggests that policies to promote health in the U.S. should focus on socioeconomic status and lifestyle.

Anderson and Hussey (2001) using OECD data focused on how performance of the health care systems varied among the twenty-nine members. In a five-nation (New Zealand, UK, US, Canada, and Australia) study, Blendon et al. (2003) found that a significant number of citizens are unhappy with their health care system. Anell and Willis (2000) suggest that instead of expenditure measures, using a resource profile is more desirable alternative for an international comparison of health care systems. Anderson et al. (2003) revealed that differences in health care spending patterns between the U.S. and the rest of the OECD member nations are mostly explained by higher prices in the U.S.

Mirmirani and Mirmirani (2005) concentrated on the efficiency of OECD health care systems using Data Envelopment Analysis (DEA), a linear programming technique which ranked member nations according to their respective DEA scores. For the period of investigation (1990-2000), the efficiency results were mixed. Although some nations had high ranking in both measures of health care outcomes, none had been ranked as inefficient for both measures. On the other hand, some members have improved

efficiency in life expectancy, but had done poorly in infant mortality, or visa versa. Evans et al. (2001), with a sample of 191 countries worldwide, conducted a comparative efficiency of national health care systems. Using life expectancy as health output, and health expenditures and average schooling as inputs, they conclude that increasing resources result in improved health. In addition, more efficient use of resources can also contribute to the overall health care of a nation. Shaw et al. (2005) investigates the impact on changes in life style and pharmaceutical expenditure on life expectancies among OECD countries. With a specified cohort of the population; i.e., males and females at the age of 40 (for the period of 1960-1999), they find that increasing pharmaceutical expenditure, lowering tobacco consumption and increasing fruit and vegetable consumption have noticeable and positive but different impact on life expectancies of the observed population.

3. Empirical Methodology

3.1. Data and Variables

The study uses annual data from OECD Health Data 2004. Countries under investigation include all OECD member nations except Korea, Luxembourg, Norway, Slovak Republic and Turkey. These countries were excluded due to many missing observations. The concentration of the paper is for the period of 1990-2002. Running a time series analysis of individual countries for 12 years is not statistically advisable (less than 30 sample size). So, we decided to pool the data and run a panel data analysis for 25 OECD countries.

The variables used in the regression and their definitions are given in this section. In the first regression, the dependent variable is life expectancy at birth for the total population. It was estimated using the unweighted average of life expectancy of men and women. Life expectancy represents the typical number of years that a person at that age can be anticipated to live, presuming that age-specific mortality levels stay constant. In the second regression, the dependent variable is maternal and infant mortality. It encompasses the number of deaths of children under one year of age that occurred in a given year, expressed per 1000 live births.

The independent variables used in the regressions are: medical technology (computed tomography scanners per million populations), health employment (practicing physicians' density per 1000 people), in-patient utilization per capita (number of acute care bed days), prevention immunization (% of measles children immunized 2000), total expenditure on health per capita (US$ PPP), alcohol consumption in litres per capita, and educational level (school expectancy years). Table 1 and 2 provides acronyms, descriptions, expected signs, and justifications for using the variables in the two regressions. Like alcohol consumption, another common factor that influences health status of any nation is the prevalence of smoking. However, because of limitation on data availability, we are unable to include any proxy of smoking in our study. Also, we encountered similar constraint in incorporating measures of income inequality, i.e. GINI coefficient. As indicated earlier in the literature review, using real GDP per capita for capturing inequality between nations may not be appropriate for this study (see Bloom and Canning (2007) for details).

3.2. Regression Analysis

For the panel data analysis, the data set consists of i = 1,…..,N cross sections (number of groups), and several points of time series for each group t = 1,….,T(i), or a cross section of N time series each of length T(i). Panel data analysis can be divided into fixed effects (FE) and random effects (RE) models[1]. FE model is also known as least squares with group dummy variables. In the FE model, variation across groups (individuals) or time is confined in shifts of the regression function; i.e., changes in the intercepts. On the other hand, the RE model treats the individual effects as a random component of the error term. The RE model assumes a structure on the error term, and a feasible generalized least-square technique determines the parameters. The major drawback of the RE model is the assumption that the unobserved individual effect is uncorrelated with the observed regressors. GLS estimation yields biased and inconsistent parameters in the presence of such correlation. The RE model is appropriate when correlated omitted variables are not an issue. The estimation technique that best fit the data were chosen based on Likelihood ratio, Breush and Pagan's LM test, and Hausman's Chi-squared statistics. The FE model turned out to be the best specification.

The fixed effects regression specification was estimated in the form of:

$$Lit = \eta_1 \delta_{1it} + \eta_2 \delta_{2it} + \ldots\ldots\ldots + \beta' Q_{it} + \mu_{it}$$

where Lit is the average life expectancy (or infant mortality in the second regression) in country i =1,……, N, year t = 1,….,T(i).

Q_{it} is the vector of independent variables.

δ_{jit} is the group specific year dummy variables.

η_i is the individual specific constant or the country effect.

μ_{it} is a classical disturbance term with $E[\mu_{it}] = 0$, $var[\mu_{it}] = \sigma^2_{\mu}$.

4. Empirical Results

The primary objective of this study is to identify the determinants of life expectancy and infant mortality in the OECD countries. Our goal was to be as inclusive as possible by incorporating independent variables that are relevant as well as considering variables from the existing health care literature. In choosing the variables, comprehensive factors that directly and indirectly (social) influence health care outcomes have been considered. However, some variables were dropped (smoking and GINI coefficient) due to missing data for the period of this study.

In Table 3, regression results of the FE of life expectancy for 25 OECD countries are reported. Life expectancy was regressed on various independent variables using panel data. The signs of the parameter estimates of all the variables in the life expectancy regression were as expected. Six of the seven variables (except ALCO) were statistically significant at the 5% level or better. Table 4 presents regression results of the FE of infant mortality for 25 OECD countries. Three of the seven variables were statistically significant at the 5% level or better. With the exception of CT scan as a proxy for medical technology (TECH) and alcohol consumption (ALCO), all other variables in the infant mortality regression followed the expected sign. Nevertheless, neither of the two variables cited earlier were statistically significant at the 5% level.

[1] See Chamberlain (1982, 84), Hsiao (2004) and Baltagi (2005) for a comprehensive analysis of panel data.

Parameter estimate of health employment (PHYS) was strongly significant (at 1% level) in influencing life expectancy and infant mortality in OECD countries. The empirical estimate of PHYS was the most significant in both regressions, which connote that the availability of the health care personnel is really crucial. This indicates that larger number of physicians means better access to health services - especially in rural areas, and shorter waiting times for medical attention, lead to better health care delivery. Thus, investment in health related human capital especially physicians and nurses has a greater impact on improving life expectancy and reducing infant mortality. Looking at the data, one observes significant differences in numbers of practicing doctors and nurses per 1000 population among OECD countries, ranging from less than two to more than four. Our empirical results indicate that scarcity of health related human capital will have a substantial adverse impact on life expectancy and infant mortality in many OECD countries.

Preventive immunization (IMMUNI) was significant (at the 1% level) in both the regressions. However, immunization plays a more important role in reducing infant mortality than increasing life expectancy. The data showed that on average OECD countries only spend less than 3 percent of total health expenditure on preventive health awareness programs[2]. Our regression results suggest that even with current low health expenditure on preventive medicine, such investment have a relatively high impact on influencing life expectancy and infant mortality. According to the OECD Indicators 2005, awareness of better life-style alternative will significantly increase life expectancy. It is evident that 38% of people in OECD countries die because of heart diseases and strokes due to lack of public consciousness on diet, exercise and healthy food choice. In-patient utilization (PATIENT) as a proxy for health services utilized was a fairly important factor in the life expectancy regression but statistically insignificant in the mortality regression.

One would expect higher per capita health care expenditure would improve the overall health in the society. Our empirical results indicate that the level of health care expenditure among OECD countries has been an important factor in extending life expectancy but does not have much impact on lowering infant mortality. Alcohol consumption (in litres per capita aged 15 and over) (ALCO) is commonly regarded as one of the health risk factors in the health care literature. However, it is noteworthy that in our analysis, the estimates were not statistically significant at the 5% level in both regressions. Perhaps one argument could be the fact that the methods in measuring alcohol consumption differ across OECD countries as mentioned in the data. As expected, educational level (EDU), used as an indicator of health awareness, was significant at the 5% level in both the regressions.

Overall, the panel data regression results provide some useful information on the healthcare assessment. For life expectancy as a dependent variable, supply of physicians, inpatient hospital bed days, overall financing of the health care, technology, preventive care, and education level, have played an important role. Judging from the regression coefficients, we concluded that the most influential factor is hospital bed days, followed by supply of physicians and education level. The proxy for social factor, alcohol consumption was not statistically significant.

However, for the infant mortality regression, empirical results were somewhat different. Physician supply, immunization and education are factors that were

[2] Health at a Glance - OECD Indicators 2005 can be found at http://www.oecd.org/health/healthataglance

statistically significant. This result follows the common perception that lowering the mortality rates requires pre- and post-natal care and services. Among those, education, preventive care and availability of physicians are commonly cited in the literature. The estimated coefficients revealed that the most influential factor determining infant mortality rate is the supply of physicians, followed by the level of education and immunization. As in life expectancy regression, contrary to the findings of other studies, alcohol consumption is statistically insignificant in the infant mortality regression. One plausible explanation is the non-uniform definition and measure of alcohol consumption among OECD countries. The measurement complexity stems form the fact that different countries have varied consumption preferences for alcohol beverages. For example, wine is preferred alcohol in France compare to beer in Germany. Also, beverages have a different degree of alcohol contents within and among OECD countries.

The empirical results suggest that supply of physicians and education levels are highly significant and the determining factor in both the life expectancy and infant mortality regressions. Policy implications that can be drawn from this study are as follows. One key component of improved health is education; particularly the education of mothers on child care and health, both in prenatal and neonatal stages. A recent study on infant mortality in the United States released by the US Department of Health and Human Services (2006) shows that comparatively mothers who received education on prenatal care had five times more chances for their babies to survive.

This study confirmed that supply of physicians (particularly primary care physicians), and investment in medical training and education should be prioritize in the OECD national healthcare policy. Emphasis on preventive care is another key element to improve healthcare in any given country. According to a report by the World Medical Association (2005), among different aspects of preventive care, effective immunization policy plays a crucial role in the national healthcare system.

Lately, social service provisions in industrialized nations such as education, defence, national security, social security and retirement plans draw considerable public attention. Significant and continuous rise in health care costs further add to the social and political tensions of the citizens. Reform and restructuring of healthcare are among a few policy initiatives that these nations have been trying to implement as a way to control their health care industries. Before devising any policy initiatives or restructuring plan, it is important to know the role of various factors that determine the health outcome.

Other policies that have direct link to the overall national health are those addresses social norms and practices. For example, Japan is ranked much higher on infant mortality rate and life expectancy than the United States. The disparity is explained by problems related to teenage pregnancy and obesity rates (CommonDreams.org, 2006). Dietary habits and more relaxed abortion regulations in Japan are cited as important factor explaining such disparities. Other social norms that contribute to the differences in the life expectancy and mortality among nations are policies on homicide and other serious crimes, environmental regulations, and social support for the elderly population.

5. Conclusion

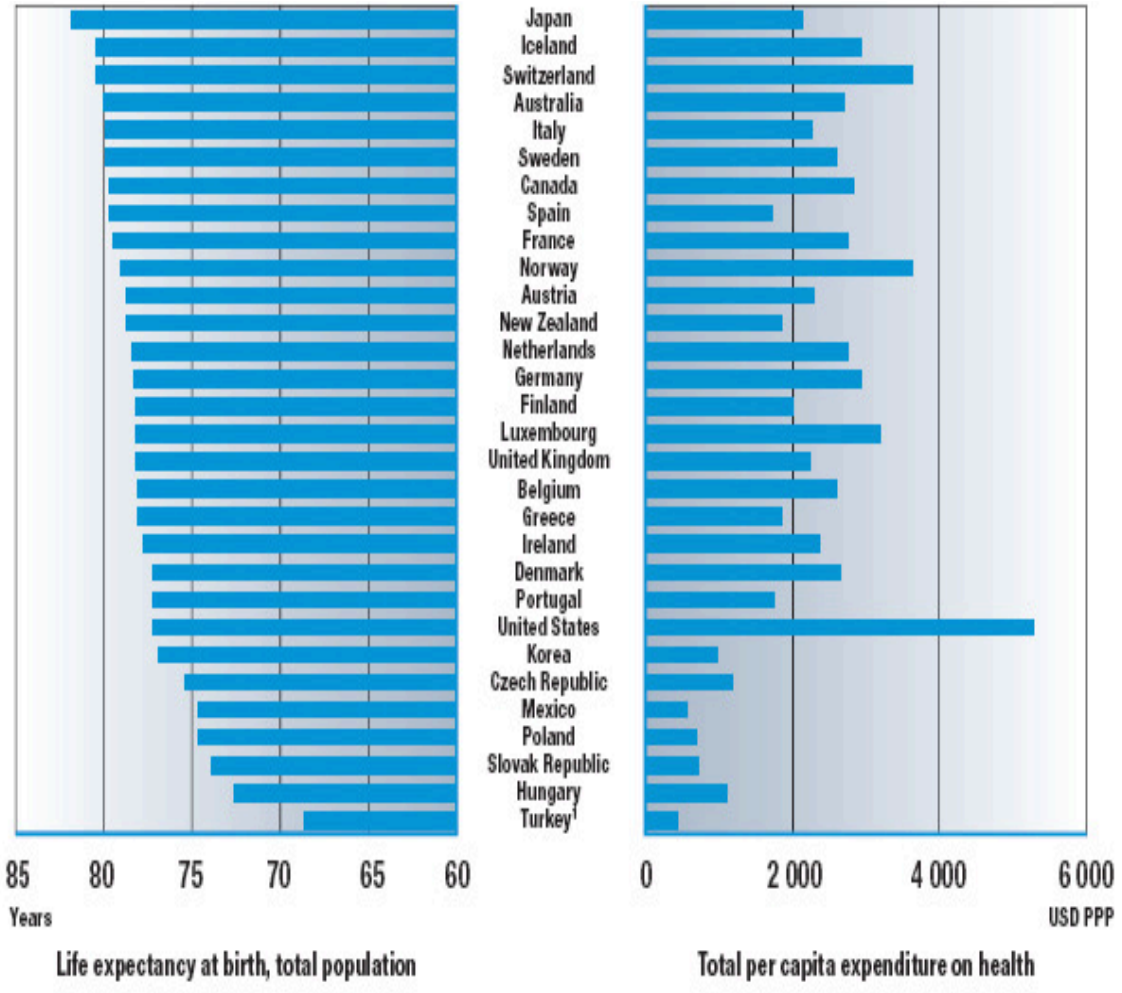
The health care delivery system of twenty five OECD nations is analyzed in this paper. This study seeks to assess the significance of various factors contributing to life expectancy and infant mortality for the 1990-2002 period. A fixed-effects panel data model was used to examine the factors influencing life expectancy and infant mortality.

More specifically the impact of economic, institutional, and social factors in determining the dependent variables are measured and evaluated.

The majority of research papers on national health care systems have concentrated on the two commonly accepted outcomes, life expectancy and infant mortality. However, the OECD-focused studies tend to assess cross variations of the health outcomes among individual member nations. The limited number of existing studies that concentrated on the factors influencing life expectancy and infant mortality had some drawbacks. The studies were limited in their approach (qualitative) or scope (either time horizon or the number of countries investigated). In this paper, we attempted to address the shortfalls mentioned above.

The selection of life expectancy and/or infant mortality as a proxy for health care outcome poses a challenge for researchers in the field. It has been noted that while a nation is receiving high marks for its achievements in prolonging life expectancy, they may be marginal on the infant mortality gains. This is of particular concern when such measures are used for international comparisons. For example, Mirmirani and Mirmirani (2005) consider the same health care outcomes as in this study and ranks efficiencies of OECD members. The study suggests that there may not be a correlation between the two outcomes. As a remedy, future research needs to concentrate on a single, uniform yet comprehensive health care outcome that is constructed from the available data.

Figure 1: Comparison of Life Expectancy at Birth and Health Expenditure in 2002 for OECD Countries



1. Expenditure data for Turkey refer to 2000.

Source: OECD Health Data 2005, June 2005

Table 1: Variables, Descriptions, and the Relationships with Life Expectancy

Acronym	Description	Expected sign	Rationale
TECH	Medical technology -- computed tomography scanners per million population	+	CT scan is a proxy for better access to disease diagnosis, thus higher life expectancy.
PHYS	Health employment -- practicing physicians density /1000	+	Higher physician's density, better health care for society.
PATIENT	In-patient utilization-- acute care bed days number per capita	−	High in-patient utilization indicates poor health, which means lower life expectancy.
IMMUNI	Prevention Immunization-- measles % children immunized 2000	+	Immunization is a preventive measure, increases life expectancy.
HEXP	Total expenditure on health per capita (US$ PPP)	+	Higher health expenditure will improve health services available, thus higher life expectancy.
ALCO	Alcohol consumption litres per capita (age 15+)	−	High alcohol consumption implies high health risk, less life expectancy
EDU	Educational level School expectancy Years	+	Higher literacy rate increases health awareness, therefore longer life expectancy.

Table 2: Variables, Descriptions, and the Relationships with Mortality

Acronym	Description	Expected sign	Rationale
TECH	Medical technology -- computed tomography scanners per million population	−	Better access to medical technology results in lower mortality.
PHYS	Health employment -- practicing physicians density /1000	−	More medical resources results in better health care for society, thus lower mortality.
PATIENT	In-patient utilization-- acute care bed days number per capita	−	High in-patient utilization indicates poor health, leads to high mortality.
IMMUNI	Prevention Immunization-- measles % children immunized 2000	−	Immunization as a proxy for preventive medicine results in lower mortality.
HEXP	Total expenditure on health per capita (US$ PPP)	−	Higher health expenditure will improve health services available, thus lower mortality.
ALCO	Alcohol consumption litres per capita (age 15+)	+	High alcohol consumption implies higher health risk for mothers, therefore leads to high mortality.
EDU	Educational level School expectancy Years	−	Higher literacy rate create better health awareness, therefore lower mortality.

Table 3: Empirical Results of Life Expectancy

	Coefficient	T-Statistics
TECH	0.0349**	2.189
PHYS	1.2245***	4.806
PATIENT	-1.5172***	-4.835
IMMUNI	0.0213**	2.551
HEXP	0.0004**	2.015
ALCO	-0.0031	-0.040
EDU	0.1851***	4.322
R^2	0.9845	
Adjusted R^2	0.9796	
F-Value	202.28 ***	

Note: ***, and ** denotes significance at the 1%, and 5% levels respectively.

Table 4: Empirical Results of Infant Mortality

	Coefficient	T-Statistics
TECH	0.0459	0.731
PHYS	-2.4649**	-2.461
PATIENT	1.2225	0.991
IMMUNI	-0.0819**	-2.496
HEXP	-0.0002	-0.273
ALCO	-0.0003	-0.001
EDU	-0.4852***	-2.883
R^2	0.9322	
Adjusted R^2	0.9109	
F-Value	43.89***	

Note: ***, and ** denotes significance at the 1%, and 5% levels respectively.

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