1-1-2015

Dynamics In Health Care Expenditures For Emerging And Developed Countries

Edmundo Roman Reyes
Wayne State University,

DYNAMICS IN HEALTH CARE EXPENDITURES FOR EMERGING AND DEVELOPED COUNTRIES

by

EDMUNDO REYES

DISSERTATION

Submitted to the Graduate School

of Wayne State University,

Detroit, Michigan

in partial fulfillment of the requirements

for the degree of

DOCTOR OF PHILOSOPHY

2015

MAJOR: ECONOMICS

Approved by:

_____

Advisor Date

_____

_____

_____

_____

DEDICATION

To my wife for her full and unconditional support and for being a true believer of my dreams. To Tristan and Santiago, for those weekends that they sacrificed to let me work on this dissertation. To my parents and siblings for the pressure, without knowing, they put on me to finish. To my parents-in-law for the support provided in achieving this dream.

ACKNOWLEDGMENTS

I would like to acknowledge and thank to Dr. Li Way Lee , Dr. Gail Jensen and Dr. Janet Hankin for their support in completing this dissertation.

I would like to specially thank Dr. Allen Goodman, for his unconditional support and mentorship, for his intellectual guidance and for being an exceptional person in helping me to complete my dissertation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1. Introduction

This study analyzes the dynamics in health expenditures (HE) for a selected group of emerging and developed economies in the OECD. To examine the differences in dynamics between emerging and developed countries, this analysis is divided into two studies, in the following sequence. First, we analyze the short run dynamics and stability between HE and gross domestic product (GDP) in a simple demand model where only these two monetary measures are included. An econometric technique is applied to take care of the stationarity issues that might be present in these two series.

The second part of the sequence looks at other potential factors that could explain differences in dynamics between emerging and developed economies. The additional factors used in this part of the study are measures on the health area, such as health care activities, health care resources and health status. The idea is to explore if these components might explain differences in dynamics between emerging and developed economies using cluster analysis.

The developed economies examined here are Germany, United Kingdom, United States, Switzerland, Canada, and Japan, and the emerging economies are Korea, Mexico, Turkey, Czech Republic, Hungary and Poland. Among the twelve countries studied here, per capita spending on healthcare increased from $1057 in 1990 to $3124 in 2010. Among the emerging economies per-capita spending rose from $383 to $1456, while among the developed countries, the increase was from $1748 to $4792. The United States spends the most, followed by Switzerland.

The share of health expenditures as a part of GDP is growing over time. For example, for the case of the US, the share was 12.4% in 1990, and it went up to 17.6% in

2010. Most economies spend substantial amounts of their resources on the health sector, and strong growth in this sector seems to be present across all economies.

Developed economies tend to spend larger shares of GDP than emerging economies. This might allow them to have better planning on the health sector and, therefore, be less sensitive in the short run.

As mentioned at the beginning of this section, there are two main purposes of this work and they are broken up into two studies. The purpose of study 1 is to test and quantify the hypothesis that in the short run HE in developed economies are less sensitive to changes in GDP, compared to emerging economies, using a time series framework.

When studying health expenditures we can observe that governments are heavily involved in the financing and production of health for the countries in our sample. Even though the US public spending in the health sector is among highest, it is not as large relative to its total spending in health since the government only covers approximately 48% of the total spending. These observations put in perspective the level of resources placed in the health sector. More spending does not necessarily mean a better level or quality of care. The US provides an exceptional example of this since the US has not shown higher quality or better health outcomes compared to other countries within the OECD group (Docteur et al. 2003).

The purpose of study 2 is to analyze if countries with the highest level of expenditures, resources and activities on health have the best health outcomes. The US case would suggest that this is not necessarily true. Using cluster analysis, we look at the dynamics on health care in a broader way by including not only “monetary” measures but also measures that can potentially quantify the efficiency of a country in producing health

outcomes. We study in some degree at how efficient these countries are in producing health outcomes with regards to their level of spending, health resources and use of those health resources. We take a closer look to the US and explain the factors that make it so different than other countries.

CHAPTER 2. Short-Run Dynamics in Health Care Expenditures for Emerging and Developed Countries: How different are we?

2.1. Introduction

Health expenditures have been growing rapidly in the last few years for the group of countries in the Organization for Economic Cooperation and Development (OECD). Policy makers are eager to know what factors drive this dramatic long-term trend in health expenditures. For the OECD countries, per capita health expenditures tripled between 1990 and 2010. In particular, for the sample studied here that includes six emerging and six developed economies, average per capita total spending on health increased from $1057 in 1990 to $3124 in 2010[1], with the United States as the leader, followed by Switzerland.

There seems to be a pattern for developed economies to spend more on health, as a share of their gross domestic product (GDP), compared to emerging economies. The question in this paper is how these two groups of countries differ in their characteristics of health spending with respect to their GDP in the short run. To answer this question, the paper analyzes the short term elasticity and the speed to adjust deviations from gaps between health expenditures (HE) and GDP for these two groups of countries.

Newhouse (1977), in one of the first attempts to explain the relation between health expenditures and GDP, found a positive relationship between these two variables. In particular, he concluded that the income elasticity of medical care exceeds one, categorizing healthcare as a luxury good. These conclusions were drawn from the thirteen developed countries in his sample.

Similar previous studies focused on the simple demand model and also estimated the income elasticity for HE. Gerdtham and Jonsson (2000) and Hansen and King (1996) provide

[1] Expenditures are expressed in US dollars using purchasing power parity. Source: OECD Health Data 2012.

a comprehensive review of these first generation studies. In general, the conclusion from these studies is that healthcare can be viewed as a luxury good. The relationship between HE and GDP is strong in these studies. However, the findings of this first generation literature should be interpreted with caution, given the lack of knowledge regarding stationarity issues that might be present within the time series they employed.

Nelson and Plosser (1982) found empirical evidence that most of the aggregate economic series are non-stationary in levels, which means that the process of the series does not have a constant mean, constant variance, and the autocorrelation is not time invariant. Therefore, using ordinary least squares (OLS) methods to relate non-stationary variables to each other is not appropriate, and may yield biased estimates of the relationship, even when those estimates are highly significant.

In a seminal study Hansen and King (1996) focused on testing the stationarity of the HE and GDP series for a sample of developed countries. They found that these series are non-stationary; however, they did not find strong evidence of cointegration between them. They concluded that the series are non-stationary in levels; therefore, caution must be taken when using OLS methods to explain the relation between HE and GDP.

More recent studies have drawn on the ideas of Hansen and King (1996). The studies vary in their inclusion of more or fewer control variables and in their methods for cointegration depending on the nature of whether the sample is analyzed, as a panel data set, or on a country-by-country basis. As a result, the findings are mixed and some studies actually find evidence of cointegration[2]. Additionally, none of the studies compare emerging and developed economies with a further error correction model as it is done in this study.

To keep the analysis simple, the relation is restricted to HE and GDP only as other studies might have included population over 65, private spending, public spending, as well as

[2] See Gerdtham and Jonsson (2000) for a comprehensive review of this literature.

other institutional variables, such as the use of primary care "gatekeepers", methods of remunerating physicians in the ambulatory care sector, how patient/reimbursement payment method is carry out, total supply of doctors, and other similar measures[3]. As noted by Gerdtham and Jonsson (2000) a common and extremely robust result in these international comparisons is that the effect of GDP is clearly positive and significant on HE, and this result is robust regardless of the variables included to estimate the model.

This paper compares the short-run dynamics and the speed of adjustment between emerging and developed economies in a time series model using an error correction model in a country-by-country analysis. We might expect emerging countries to be different to developed countries in the health sector. Obvious differences in the level of spending exist, but also structural differences are present between these two groups of countries that may force them to react differently in the short run. Sometimes providing basic care in emerging countries may become a challenge when it is not for developed economies.

This study contributes to the literature in four ways. First, it differs from the previous studies in that it compares emerging and developed economies. Second, it focuses on short-run dynamics rather than just looking at the long term relations. Third, individual testing is employed consistent with the idea established in Hansen and King (1998). Panel data is very restricted in the sense that it is a one time shot in the first step of the analysis when looking for the integrated order of the series. Therefore more can be gained by a careful country-by-country analysis (see Hansen and King (1998) for further discussion). Moreover, individual country studies are more pure in theory in order to analyze policy issues if the interest is to study the effects of country-specific health policy and at the same time allow us to obtain individual measures that otherwise are not possible to be attained from a panel data

[3] The inclusion of more variables does not affect the statistical value of the income elasticity or its statistical significance; see Attella et al. (2006) and Gerdtham and Jonsson. (2000).

framework. Finally, it shows evidence of the weakness of considering healthcare as homogeneous among countries. A country-by-country analysis avoids the risk of assuming the homogeneity of healthcare and preferences among countries since in fact, health might be valued differently across countries[4], as it is concluded in this study.

The remainder of the paper is organized as follows. In section 2.2, the data are described. In section 2.3, health spending patterns are examined for the sample studied here. Section 2.4 covers the different methods and some empirical results for the behavior of the series. Section 2.5 covers the main results and interpretations for the findings and finally, section 2.6 addresses discussion.

2.2 Data

The data used come from the Organization for Economic Cooperation and Development (OECD) Health Data 2012. They cover the period 1960 to 2010 for most countries. For the majority of emerging countries the data are more restricted by the availability in their series. The analysis is carried out for six developed and six emerging economies. Developed and emerging economies are compared to study how these two sets of countries differ in their dynamics for HE with respect to GDP.

The classification of the economies into developed and emerging is done according to the Financial Times Stock Exchange website.[5] The developed economies examined here are Germany, United Kingdom, United States, Switzerland, Canada, and Japan, and the emerging economies are Korea, Mexico, Turkey, Czech Republic, Hungary and Poland.

[4] As it was pointed by Clemente et al. (2004) the homogeneity hypothesis is a quite restrictive and; furthermore, unrealistic assumption for health economics.

[5] www.ftse.com/Indices/FTSE_Index_Standards/Downloads/results.pdf

These six developed countries were chosen for their relevance in the literature, and because mixed results have been reported for them regarding the effects of GDP on HE. The patterns of health expenditures are analyzed in the next section for the sample employed in this study.

2.3 Patterns in Health Expenditures under Purchasing Power Parity

Among the 12 countries studied here, per capita spending on healthcare increased from $1057 in 1990 to $3124 in 2010, or by 196%. Among the emerging economies per-capita spending rose from $383 to $1456 (a 298% increase), while among the developed countries, the increase was from $1748 to $4792 (a 174% increase). The United States spends the most, followed by Switzerland.

Figure 2.1 shows how spending on healthcare as a share of GDP behaved between 1990 and 2010 for each country. In the most recent year of the data, the share of health spending in developed countries was higher than in emerging countries. The patterns observed could be due to pressures on the demand for the health sector, or it might simply reflect a change in the preferences, as per capita income rises. That is, people or countries for that matter may value more health spending than consumption spending on other goods and services as income rises. If this is the reason for the long term trend in health expenditures, it is a consumer choice, based on consumer maximization theory that should be optimal. However, policy makers are also studying cost containment policies that might reflect the supply side or other factors rather than consumer preferences that might be helping the drive up in health spending.

Figure 2.1. Spending on health as a share of GDP between 1990 and 2010.

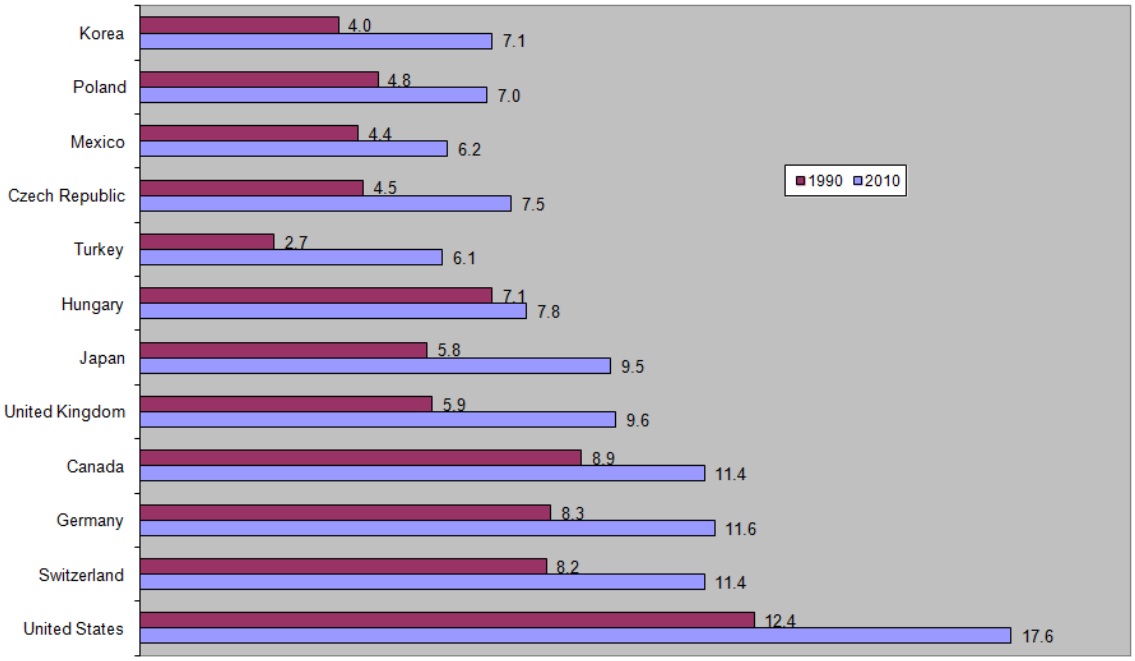


Figure 2.1. Spending on health as a share of GDP between 1990 and 2010. Expenditures are expressed in US dollars using Purchasing Power Parity. Source: OECD Health Data 2012.

As it can be observed from Figure 2.1, Korea was spending 4.0% of its GDP on health in 1990, and by 2010 it was already spending 7.1%. As we move down in Figure 2.1, it can be noticed that the bottom countries are developed economies; therefore, developed economies seem to be prioritizing spending on health rather than other types of consumption or investment in the long run. For example, for the case of the US, the share was 12.4% in 1990, and it went up to 17.6% in 2010. Most economies spend substantial amounts of their resources on the health sector, and strong growth in this sector seems to be present across all economies.

Developed economies tend to spend larger shares of GDP than emerging economies. This might allow them to have better planning on the health sector and, therefore, be less sensitive in the short run.

Figure 2.2. Public and total per capita expenditure for emerging and developed economies.

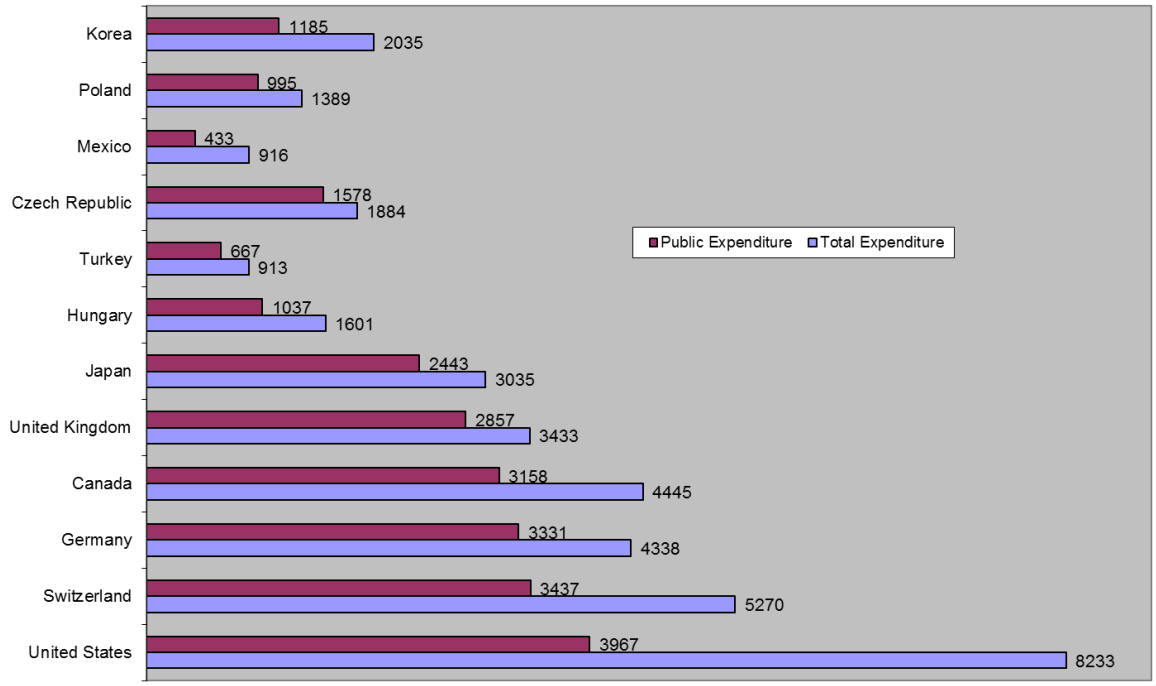


Figure 2.2. Public and total per capita expenditure for emerging and developed economies expressed in US dollars using Purchasing Power Parity. Source: OECD Health Data 2012.

Another important insight is to distinguish how much of this spending is financed by governments. Figure 2.2 shows the share of the expenditure in health that is covered by public spending in 2010. Governments are heavily involved in the financing and production health for the countries in our sample. For the US, the total amount of public spending is the highest. For the year 2010, US public spending roughly equaled to the public spending from Korea, Poland, Mexico, Turkey and Hungary combined.

Even though US public spending in the health sector is the highest, it is not relative to its total spending in health since the government only covers approximately 48% of the total spending. This could indicate the consumer preferences on the health sector; even when the

government does not cover most of it, in the aggregate consumers are willing to pay for it in order to increase their consumption in this sector[6]. If we take a closer look at the private spending in the US[7], we can observe that the amount spent in the US by the private sector is roughly equal to the total private spending from Korea, Poland, Mexico, Turkey, Czech Republic, Hungary, Japan, UK and Germany combined. These observations put in perspective the level of resources that are placed in the US health sector. More spending does not necessarily mean a better level or quality of care. The US provides an exceptional example of this since the US has not shown higher quality or better outcomes compared to other countries within the OECD group (Docteur et al. 2003).

In the following section the methods and empirical results on the behavior of the series are explained and examined. The methods cover a three-step process in order to examine the main question in this paper. Each of the three-step processes is covered in the following subsections.

2.4. Methodology and Some Empirical Results

Unit Roots: Augmented Dickey Fuller Test

The relationship between HE and GDP has always been controversial, and the conjectures are mixed. When time series are involved in these studies, stationarity issues become relevant. Time series are integrated of order *d*, commonly written as I(*d*), and they must be differentiated *d* times in order to obtain stationarity. One might find a strong correlation among variables that are unrelated just because of the nature of the processes they

[6] In the US most people have no government coverage; therefore, the large non-public spending in the US is simply basic insurance through private markets plus supplements to government. However, this still shows the willingness to pay of the US people.

[7] This is just the gap between total expenditure bar and public expenditure bar from Figure 2.2.

follow, but this might arise from a common trend rather than reflect a valid statistical correlation between the variables.

In order to analyze the short-run dynamics between HE and GDP, an error correction model is adopted. As a first step the procedure involves testing the series for stationarity, and if evidence of non-stationarity is uncovered, then a cointegration test is needed to find a cointegrating vector for the variables, which would give evidence of the presence of a long term relation between HE and GDP. If further evidence of cointegration exists, then an error correction model is appropriate to analyze the short-run dynamics between these two variables.

As it was mentioned earlier, this issue has been already addressed in the literature; however, it seems that there have not been attempts to explain and compare the short-run dynamics between emerging and developed economies in a further error correction framework. This exercise will show how different or alike the short-run dynamics are for these two groups of countries. Furthermore, the findings will report country-specific estimates for the short-run elasticity and compare them among the countries.

The first step in the analysis includes testing our series for unit roots. In order to take on this step, the Augmented Dickey Fuller test (ADF) is used to control for a possible serial correlation that might be present in the series. The ADF test examines the parameter β in the equations below. Failure to reject that β is statistically different than zero would provide evidence of a unit root process in the series. Each of the series was tested for unit roots in levels and differences for HE and GDP in the context of the following two equation model:

$$\Delta he_t^c = \alpha^* + \theta^* t + \beta^* he_{t-1}^c + \sum_{j=1}^{p} \gamma_j^* \Delta he_{t-j}^c + \mu_t^c \qquad (1)$$

$$\Delta gdp_t^c = \alpha + \theta t + \beta gdp_{t-1}^c + \sum_{j=1}^{p} \gamma_j \Delta gdp_{t-j}^c + e_t^c \qquad (2)$$

where he_t^c is the natural logarithm of per capita health expenditures for country *c*, gdp_t^c is the natural logarithm of the per capita GDP of country *c*, $\Delta he_{t-j}^c = he_{t-j}^c - he_{t-j-1}^c$, similarly for Δgdp_{t-j}^c, and t indicates time (see Engle and Granger (1987)), *p* is the number of lags that yield serially uncorrelated residuals, and μ_t^c and e_t^c are the country-specific error terms, with a process of zero mean. Finally, $\alpha, \theta, \beta, \gamma, \alpha^*, \theta^*, \beta^*, \gamma^*$ are the parameters to be estimated.

When testing for the levels and differences it becomes relevant to discuss whether to include an intercept and a trend in the test. The criterion for the inclusion of a trend and intercept in the test is done by looking at the series. All the series in are tested for a trend and intercept, the results of these tests set the rule for the specification of the ADF test in differences[8]. When applying the ADF test, the Akaike information criterion (AIC) was used to control for the possibility of serial correlation[9].

Results for the ADF test on the HE and GDP series are presented in the following table. Table 1 presents the results for developed and emerging economies.

[8] By doing this a trend stationary process would not be confused with a unit root. This exercise was difficult to do in early studies using a panel analysis framework, since usually they would report results with trend and without trend, and most of the time would imply very different results; see Hansen and King (1996).

[9] There are different criteria that can be used in order to control for serial correlation, namely, the Akaike Information criterion (AIC), the Schwarz criterion (SC), and the Hannan-Quinn criterion (HQ). The maximum lags considered here are eight since the data are of annual frequency (see Murray and Nelson (2000)). Here, the AIC criterion is used; however, SC and HQ give the same or very close selection of lags for all the series. As most econometric literature suggests, when using annual data usually one or two lags will be enough to control for serial correlation. For the sample it was found that most of the series have this characteristic.

Table 1. Unit Root Tests Using the Augmented Dickey Fuller Test for Developed and Emerging Countries

Country	Type of country	GDP Process	HE Process
Canada	Developed	I(1)***	I(1)**
Germany	Developed	I(1)***	I(1)***
Japan	Developed	I(1)**	I(1)***
Switzerland	Developed	I(1)**	I(2)***
UK	Developed	I(1)***	I(1)***
US	Developed	I(1)***	I(2)***
Czech Republic	Emerging	I(2)***	I(1)**
Hungary	Emerging	I(2)*	I(2)***
Korea	Emerging	I(2)***	I(2)***
Mexico	Emerging	I(1)***	I(1)***
Poland	Emerging	I(1)**	I(1)**
Turkey	Emerging	I(1)***	I(1)***

Null hypothesis: there is a unit root.
* Null hypothesis rejected at 10% significance level
** Null hypothesis rejected at 5% significance level
*** Null hypothesis rejected at 1% significance level

From this table it can be concluded that there is evidence of integrated processes in the variables. For most series their integrated process is of order one, unit root process I (1), and for some the order is two, I (2). That is, for the series that show an integrated process of order one, the series would be differentiated once in order to get a stationary process; however, for those that show an integrated process of order two, the series would have to be differentiated twice in order to get a stationary process.

For developed countries such as Germany, the United Kingdom, Canada, and Japan, unit roots in HE and GDP are present; in other words, the variables are not stationary in levels, they are stationary in first differences. For the US and Switzerland, the GDP series are stationary in differences, but the HE series are an integrated process of order two; that is, the difference in difference of the series becomes stationary. These aspects of the behavior of the series will mark the methodology of how the series would be related. For example, it would

not be correct to relate the HE and GDP in the levels for the US and Switzerland when testing for cointegration since the test requires the variables to be integrated of the same order. In the particular cases of these two countries, the level of GDP will be related to the growth rate of HE since both the GDP level and the HE growth rate follow I (1) processes.

Table 1 also shows that for emerging economies such as Mexico, Turkey and Poland, a unit root process in HE and GDP series is present. Hungary and Korea exhibit a second order integrated process in their HE and GDP series; as a result, a relation for these two countries cannot be established in terms of levels, but rather can be derived for the growth rates of the variables. For the Czech Republic, a unit root in HE and a I(2) process in GDP are present. This might be thought as of the opposite phenomenon that is present for the US and Switzerland. For the Czech Republic, GDP is growing faster relative to HE, and the only way to relate them would be with the GDP growth rate and the HE in levels.

The evidence from Table 1 indicates that the series in our sample are not stationary, consistent with the findings of Hansen and King (1996). Now the next step in modeling these series can be implemented. A cointegration test is employed to inspect the existence of a long run relation between HE and GDP, in order to study the short-run dynamics. The following subsection describes this method.

Cointegration: the Engle-Granger Methodology

Our interest centers on whether there is a long run relationship between HE and GDP. More specifically, we wish to formally test whether HE and GDP are cointegrated. The Engle-Granger methodology is adopted for this test (see Engle and Granger (1987)). If the variables show a stochastic trend, they need to be differentiated to impose stationarity. In the case if this linear relation is itself stationary, then this will represent a long term relation between the variables.

The idea is that OLS yields super-consistent estimators of the cointegrating parameters α and γ in equation three below if in fact the series are cointegrated. From this part of the model, a long-run income elasticity can be derived and analyzed, but this exercise has been done extensively in previous literature and it is not the purpose of this study. However, the cointegration test is a necessary step in order to show evidence of a long term relation between the variables and to further be able to use an error correction model to analyze the short-run dynamics. The procedure involves estimating the following simple equation, where the variables are defined as before:

$$he_t^c = \alpha + \gamma gdp_t^c + \eta^c{}_t \qquad (3)$$

The pioneer work on the relation between HE and GDP assumed a simple demand relation like this for the two variables and concluded that the elasticity on health was usually larger than one[10]. Next, in order to determine if the variables are cointegrated, an ADF is applied to the estimated residuals by using the following specification:

$$\Delta\hat{\eta}_t^c = \rho_1\hat{\eta}_{t-1}^c + \sum_{i=1}^{n}\rho_{i+1}\Delta\hat{\eta}_{t-i}^c + \varepsilon_t^c \qquad (4)$$

Where $\Delta\hat{\eta}_t^c = \hat{\eta}_t^c - \hat{\eta}_{t-1}^c$ and is derived from the cointegration equation three. The procedure involves testing the parameter ρ_1 in the equation above. A failure to reject that $\rho_1 = 0$ will imply that the residuals contain a unit root; therefore, HE and GDP will not be cointegrated. On the other hand, indication of a cointegrating vector between the variables will provide evidence that a long term relation exists. Notice that if the error term is not stationary, there is no statistical reason to believe that a long term relation exists between these two variables.

[10] When this is done for the countries that present I(1) processes in HE and GDP; it is found that the elasticity of health expenditures is larger than one for all of these countries, and specifically slightly larger on average for developed economies.

This procedure is used for Germany, the United Kingdom, Canada, Japan, Mexico, Turkey and Poland, since it was found that their series for HE and GDP follow a unit root process. As it was mentioned above, the specification of the model changes if the persistence in the series behaves different than a unit root, say, I(2). For example, for Korea and Hungary, it was found that the HE and GDP series are integrated of order two. In this case, the interest is to find a relation between the growth rates of the variables rather than a relation in levels as it was the case for countries mentioned above. Therefore, the interpretation is in terms of growth rate relations since the difference in logs for the variables are used. The specification of the model for Korea and Hungary are described in Part A of the appendix.

For the US and Switzerland, a particularly mixed process has been found. There is a unit root process in GDP, but an integration process of order two in the HE series. In this case, the relation is established between the growth rate of HE and the levels of the GDP. This is very interesting since it is not possible to establish a long term relation between the levels of HE and GDP for these two countries which are in fact the two countries leading in the expenditure on health as a share of their GDP, as it was shown in Figure 2.1. At first glance this could suggest that HE are expected to be growing faster than GDP for these two economies since there is no way to establish, at least empirically, a long term relation between the levels of these two variables for these two countries. This would reinforce the idea that these two countries are more markedly moving to a choice behavior where they value more health consumption than consumption in other goods. The procedures for these two countries are described in Part A of the appendix.

For the case of the Czech Republic, a unit root in HE has been found, but an integration of order two in the GDP series. Here the relation is between the levels of HE and the growth rate of GDP, and the model specification is also described in Part A of the appendix.

In implementing the empirical model, it is worth noticing that it does not directly relate variables that are I(1) to variables that are I(2), which would require among other things to determine if the variables are multicointegrated. For example, suppose that variable W_1 is I(d_1) and variable W_2 is I(d_2), with $d_2 > d_1 = 1$; if that were the case; although, it is possible to find combinations between these two variables that are integrated of different orders, this is not how in this paper the relation between HE and GDP is meant to be established. When the variables that follow I(2) order are transform into growth rates, these growth rates follow an integrated order of one, that is they are I(1) processes; therefore, it is appropriate to relate them to other I(1) series in a simple cointegration framework.

Results for these tests are presented in Table 2 for developed and emerging countries.

Table 2. Cointegration Tests for Developed (D) and Emerging (E) Countries

Country (Type)	t-statistic	Result
Canada (D)	-2.9985***	Cointegration
Germany (D)	-3.5668***	Cointegration
Japan (D)	-3.7568***	Cointegration
Switzerland (D)	-4.7620**	Cointegration
United Kingdom (D)	-3.4773***	Cointegration
United States (D)	-4.4729***	Cointegration
Czech Republic (E)	-2.7674**	Cointegration
Hungary (E)	-4.5877***	Cointegration
Korea (E)	-5.1578***	Cointegration
Mexico (E)	-4.4233**	Cointegration
Poland (E)	-5.0872***	Cointegration
Turkey (E)	-2.1777*	Cointegration

Null hypothesis: there is a unit root.
* Null hypothesis rejected at 10% significance level
** Null hypothesis rejected at 5% significance level
*** Null hypothesis rejected at 1% significance level

Table 2 shows consistent evidence for cointegration in the entire sample of countries; the *t*-statistic for the residuals in the cointegration test are below the critical values. The more negative value for this test, the stronger the cointegration evidence at some level of confidence. This provides evidence that these residuals are stationary; therefore, it can be concluded that HE and GDP are cointegrated. Of course, not all the long term relations are in levels as it was mentioned above. For all the countries in the sample the results for cointegration are affirmative. These results can be used to specify a more general dynamic model, namely an error correction model, which is described in the following subsection.

Error Correction Model

The idea of the error correction model is expressed in equation five below. The third term on the right is the long run relationship between HE and GDP that was established in the previous section. It is also called the error correction term, and the parameter on this term will help to calculate how fast departures from the equilibrium will be corrected in the short run. Additionally, the error correction model will allow studying the short-run income elasticity of HE with respect to GDP for this sample. In this model the error correction term ($he^c_{t-1} - \gamma gdp^c_{t-1}$) is derived from the cointegration estimation model in the previous section. In the following equation the error correction model is expressed and the rest of the variables are defined as before.

$$\Delta he^c_t = \lambda + \theta \Delta gdp^c_t + \varphi \underbrace{(he^c_{t-1} - \gamma gdp^c_{t-1})}_{\hat{\eta}^c_t} + u^c_t \qquad (5)$$

In this framework the short-run income elasticity is dictated by the parameter θ in the independent variable for GDP. This coefficient will indicate the magnitude of the income elasticity in the short run. On the other hand, the coefficient φ captures the other part of the

dynamics and it can be interpreted as the speed of adjustment. In other words, the fluctuations from the long run equilibrium will be corrected by (φ x 100)% in the next period. Note that direct convergence necessitates that φ be negative, which will indicate dynamic stability of the model. If there is a gap in the current period between HE and GDP, then if $he^{c}_{t-1} > \gamma gdp^{c}_{t-1}$, HE in the previous period has overshot the equilibrium; since φ is negative, this term will push back HE towards equilibrium. If, on the other hand, $he^{c}_{t-1} < \gamma gdp^{c}_{t-1}$, then the term stimulates a positive adjustment in pushing HE back towards equilibrium.

The specification of the empirical model described above in equation five is appropriate for the series that present unit roots for both HE and GDP. However, as it was described in section 4.1, not all the series follow integration of order one. Therefore, if we want to establish an error correction model, the specification of the model is different for such series, but at the same time consistent with how the cointegration model was established in the previous section. For example, in the case of Korea and Hungary, the HE and GDP series are integrated of order two. In this case the error correction model will be expressed in term of growth rates for the series.

For the US and Switzerland the empirical model is expressed in terms of the growth rate for HE and the levels of GDP.Finally for the Czech Republic the model is expressed in terms of the growth rate for GDP and the levels of HE. All these model specifications are described in Part B of the appendix.

In the next section the estimation results for this part of the model are presented.

2.5 Results

In this section the empirical results from the error correction model are presented and discussed. Table 3 shows the results for these procedures for developed and emerging countries.

Table 3. Error Correction Model Results

Panel A. Countries with I(1) in both HE and GDP.

Country	Type of country	Specification of the model	Short-run elasticity (θ)	Speed of adjustment (φ)
Canada	Developed	HE, GDP	0.1955*	-0.0660*
Germany	Developed	HE, GDP	0.2335*	-0.0759**
Japan	Developed	HE, GDP	0.6719***	-0.0707*
UK	Developed	HE, GDP	0.1983*	-0.2274***
Mexico	Emerging	HE, GDP	0.8165***	-0.5014***
Turkey	Emerging	HE, GDP	0.0678	-0.0105
Poland	Emerging	HE, GDP	0.5723***	-0.5626***

Panel B. Countries with mixed processes.

Country	Type of country	Specification of the model	Short-run elasticity (θ)	Speed of adjustment (φ)
Switzerland	Developed	HE Growth rate, GDP	0.0678	-0.6114***
US	Developed	HE Growth rate, GDP	0.1488*	-0.6270***
Hungary	Emerging	HE and GDP Growth rates	1.1973***	-1.0527***
Korea	Emerging	HE and GDP Growth rates	0.4826***	-0.9649***
Czech Republic	Emerging	HE, and GDP Growth Rate	0.2957	-0.1968***

* Significant at the 10% level
** Significant at the 5% level
*** Significant at the 1% level

The values of the parameter φ give the implications for the short-run dynamics of HE and GDP with respect to a correction in the gap between them. It is important to notice that direct convergence necessitates that φ be negative, and the results are consistent with this for the countries in the sample[11], which give the indication of dynamic stability of the model.

[11] Except for the case of Turkey which is close to zero and insignificant.

Table 3 in Panel A shows that for Canada, if the HE are above the GDP for one point with respect to the long term relation, then HE are expected to fall the next period and correct the gap by 6.6%. For the case of Germany the speed of adjustment would be 7.59%, for Japan 7.07% and for the UK 22.74%.

For the case of Mexico, in Panel A, the speed of adjustment is 50.14% and is much higher with respect to Canada (6.6%) or Germany (7.6%). Similarly, for the case of Poland the speed of adjustment is 56.26% and indicates that the HE-GDP gap will adjust faster compared to Canada or any other developed country in Panel A of Table 3.

For the cases of the US and Switzerland, in Panel B, the coefficient of this parameter is 62.7% and 61.14% respectively. From Panel A it can be concluded that developed countries will have a lower speed of adjustment than emerging economies, so the estimates for these two aforementioned countries could in principle contradict the findings in Panel A; however, for the US and Switzerland the speed of adjustment is in terms of the growth rate in HE with respect to the GDP level, which is the reason why this parameter is larger for these two developed countries. These particular findings will be further discussed when both the short-run elasticity and the speed of adjustment effects are jointly analyzed.

For the cases of Korea and Hungary, the speed of adjustment is around unity, where the relation is measured in terms of growth rates for both GDP and HE; therefore, it is expected that deviations from these two variables would be corrected in full by the next period. It would be hard to believe that growth rates would significantly deviate from period to period. We should not expect to observe large deviations across growth rates and if in any case the gap would be corrected in full by the next period, indicating also that these deviations would not likely be persistent. There has to be more structural changes to believe that the growth rates will deviate from their long run relation, and even though, if deviations

come from the supply side they will not be persistent. Finally, for the Czech Republic the speed of adjustment is 19.68%.

The error correction coefficient is significant for 11 out of 12 countries in the sample[12]. These results are consistent with those obtained from the cointegration tests discussed in Section 4.2, which confirms the existence of a long term HE-GDP cointegration relationship.

The speed of adjustment varies among the countries in the sample; furthermore, by comparing emerging versus developed economies for those where GDP and HE levels were used to set the long term relation (Panel A), it can be observed that the speed of adjustment on average is 11% for developed economies, while for emerging economies is on average 53.2%[13]. The speed of adjustment of emerging economies is larger than developed economies; this could indicate that developed economies would take longer to correct deviations in the short run (or will correct a smaller amount of the deviation) from the long term path compared to emerging economies. These differences in the estimates of the speed of adjustment might reflect structural factors for the different set of economies, perhaps related to the fact that developed economies are less sensitive to short run fluctuations on GDP since they do not have an urge to meet unmeet health care service deficiencies that might be present in emerging economies.

With respect to the short-run income elasticity, it can be noticed from the coefficient θ on the variable for GDP that on average the HE elasticity is smaller for developed economies. In fact, the short-run elasticity is 0.5637 on average for emerging economies while for developed countries is 0.2526. Nevertheless, it is more appropriate to consider only

[12] Turkey is the only case where the error correction term was not significant. The reason might come from the marginal significance in the cointegration test for this country, as it was the country with the lowest significance when testing for a long term relation.

[13] Turkey is not included here since the parameter is not significant.

the economies from Panel A, where the levels of the variables are measured to construct the long term relation. In this case, the income elasticity is still larger on average for emerging economies (0.6944) [14] compared to the developed countries (0.3248).

From this interesting result it can be concluded that on average, health in the short run responds more in emerging than in developed economies to changes in income, and health care should not be thought of as the same for emerging as for developed economies, especially in terms of applying policies to stimulate HE in the short run.

It is also important to notice that even among developed economies the income elasticity is different for this group of countries. This evidence shows that panel data studies which try to analyze pooled samples (in their short-run elasticities) from developed groups might not be accurate in their conclusion since we could end up with some countries biasing the elasticity results. Gerdtham and Jonson (2000) reported a short-run elasticity of 0.2 for a panel of OECD countries; however, they did not report any individual country estimates.

Similarly, it can be concluded that the short-run elasticity varies for the emerging economies too. For instance, Poland has an elasticity of 0.5723 while Mexico has an elasticity of 0.8165. In the next section results from the previous discussion are analyzed graphically.

2.6 Discussion

In Figure 2.3 the short-run elasticity and the speed of adjustment estimates are jointly analyzed. The results from Table 3 can be used to study the reactions for the different countries when a shock on GDP affects HE.

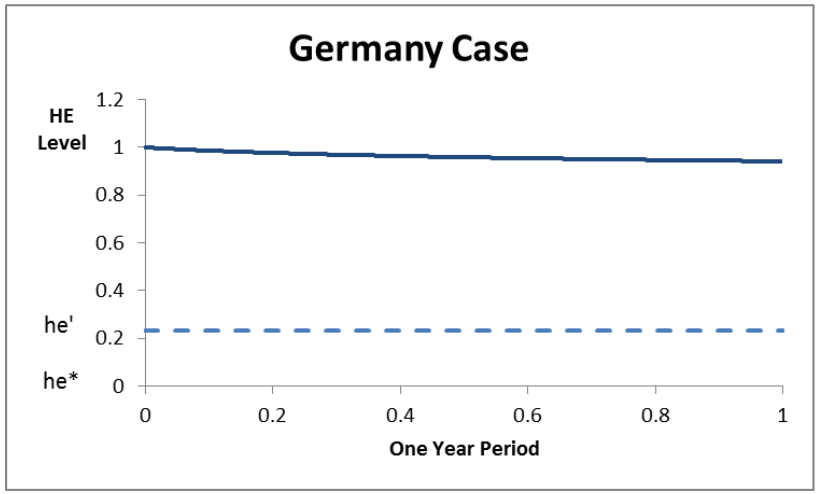
[14] The coefficient is not significant for Turkey

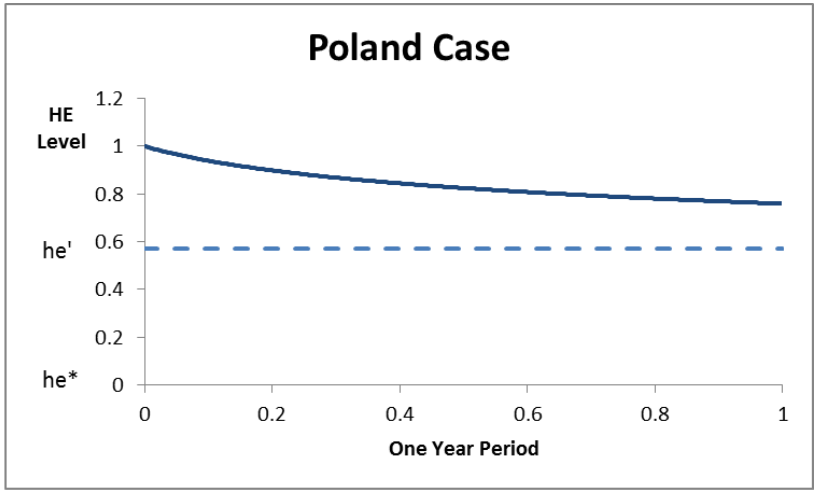
Suppose a random shock on GDP that for the sake of comparison purposes bring the same effect on HE for both emerging and developed economies. If from the results of Panel A, we compare one emerging and one developed country we can see how different would be the effect of a GDP shock. Let's focus on Germany and Poland to illustrate this example. For Germany the speed of adjustment was calculated at 7.59%, and the short-run elasticity was 0.2335; for Poland the speed of adjustment was 56.26% and the short run elasticity was 0.5723. As we can see from Panel A in Figure 2.3, the reaction of both countries is different.

Assuming that the shock induces the same initial effect on HE for both countries, Germany would take a smaller initial level reaction carried by the short-run elasticity compare to Poland, and that effect is indicated by the new level line *he'*. The other part of the dynamics is also different, and that is the effect induced by the error correction term. As we can see from Figure 2.3, the emerging country will catch up with the long equilibrium faster than the developed country. Keep in mind that this is a short term illustration, whether the effect of the shock is temporary or permanent depends obviously whether it is a supply or demand shock. If permanent the new level of HE will stay at the new *he',* and if temporary it will come back to the original level *he**.

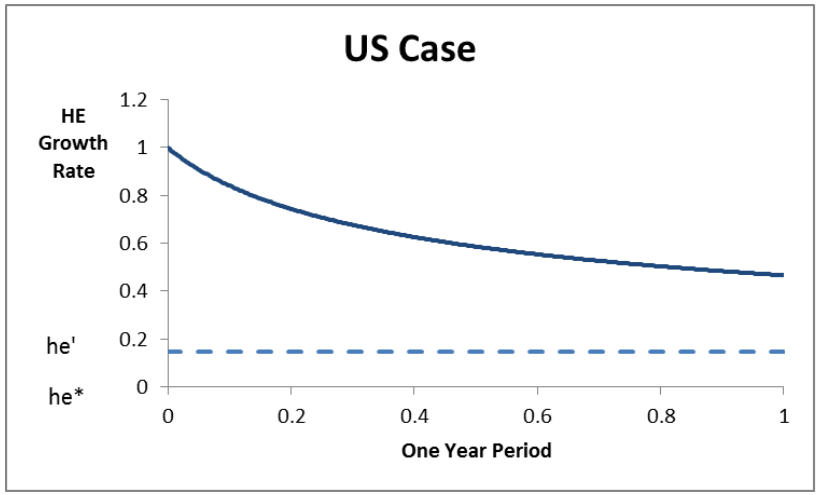
However, if *he'* reverts to the original level *he**, because the shock was temporary, then we would expect that the speed of adjustment would keep working towards restoring the long run equilibrium. It would be hard to say how this speed will actually perform in terms of the correction after the first period, for example we would not expect the speed of adjustment to be constant for the future adjustment periods since the measures obtained here are for the short run.

Panel A. Countries with I(1) in both HE and GDP





Panel B. Countries with mixed processes



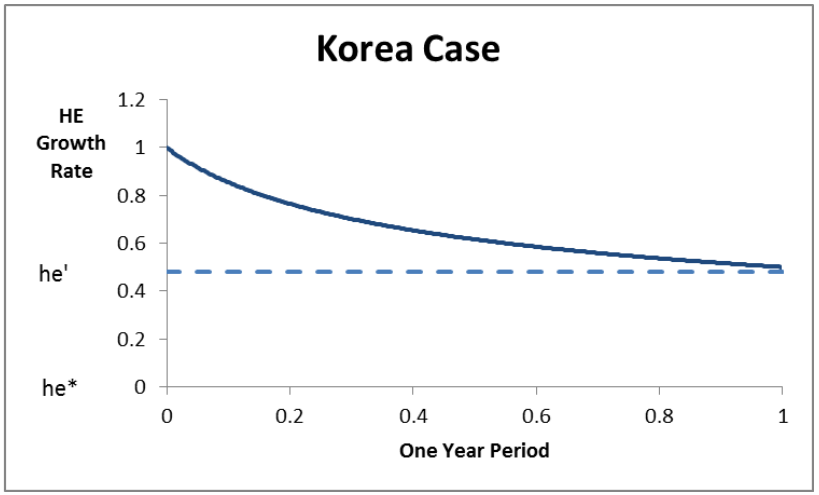


Figure 2.3. Short-run elasticity and the speed of adjustment

On the other hand, from Panel B in Figure 2.3, if we take a look to the US case, the conclusion should be interpreted differently, as the specification of the model was established in terms of the growth rate of HE and the GDP level. In this sense deviations of HE from the long term relation to GDP are expected to be corrected faster than if these deviations were in levels to levels. For example, if the growth rate of HE for the US has overshot the equilibrium, then we would expect that the remaining gap, after the short-run elasticity effect, would be corrected by 62.70% in the following period.

Suppose that the unexpected shock on GDP that induce a large contemporaneous reaction in HE; however, if we look at how growth rates are defined, it is obvious that the effect would not be persistent in the HE growth rate. The HE growth rate is defined as $Ghe_{t+1} = (he_{t+1} - he_t)/he_t$, then the shock will increase HE to a new level he_{t+1}, where $he_{t+1} > he_t$ then, the correction mechanism will work to bring back HE growth rate to the long term equilibrium. Furthermore, it is hard to believe that the shock in GDP would induce an effect or change for the growth rate overtime, even if this shock is permanent, that is the shock will not likely to deviate he_{t+2} way farther from he_{t+1} so that the possible change on he_{t+2} compare to he_{t+1} will not be significantly large but rather small if at all; therefore, the adjustment mechanism will correct most of the deviation from the long equilibrium fast for this country.

In Panel B for the case of Korea, since the model was specified in terms of growth rates for both HE and GDP, the reactions would be different. Deviations from the long run HE-GDP relation would be corrected in full by the next period, it would not be expected that growth rates will significantly deviate from period to period.

Overall, these results suggest that developed economies have some form of better planning in addressing health consumption since given a change in income; they will be less sensitive to direct the extra income to the consumption of health in the short run. As for emerging economies, the reaction will be bigger since a higher proportion would be dedicated to this sector in the short run.

Although we might expect that developed economies will spend more in the long run, they are not that sensible in the short run, this could indicate that these economies focus more on a better long run planning than a short run impact, where the emerging economies have not yet cover this long run planning and therefore react more in the short run.

Another interesting result that also can be concluded here is that for the cases of the US and Switzerland, HE are growing and presumably growing faster than GDP; since we fail to relate these two variables in levels in the long run, as it was only possible to establish a relation with in the growth rate of HE and the level of GDP. This is not necessarily an anomaly since as it was pointed out; it might just be the reflection of an overall change in preferences towards health consumption instead of consumption in other goods. Specifically, for the case of the US, about 52% of these expenditures are covered privately, and they are not financed directly by the government.

This fact has important implications for the performance of the health sector since policies should focus more on efficiency of public and private combined allocations instead of trying to find the “right level of spending” since there is no clear answer to that. On one hand, cost control policies might induce fear in rationing. And on the other hand,

more spending do not necessarily means a better level or quality of care. The United States has the highest level of spending in health care from the OECD group and, from what was established in this paper, that pattern does not seem to be changing in the near future. Irrespective of that fact, the US does not present better quality and outcomes in that sector compared to other countries within the OECD (Docteur et al. 2003).

As shown here, it is imperative to treat countries individually when modeling health care-related time series since as it can be concluded here, the behavior of every country with respect to their short-run dynamics varies greatly and especially between emerging and developed economies.

Structural changes are to be made first to set the basis of a better health sector for emerging economies, and only after that policy makers from these countries might “think” about -but not do- implementing or mimicking developed country policies.

CHAPTER 3. Health Care Dynamics for Emerging and Developed Countries: A view beyond Health Expenditures and a careful look at the U.S.

3.1 Introduction

Health expenditures have been growing rapidly over the past several decades for the countries within the Organization for Economic Cooperation and Development (OECD). For the OECD countries, per capita health expenditures tripled between 1990 and 2010. In particular, for the sample studied here that includes six emerging and six developed economies, average per capita total spending on health increased from $1057 in 1990 to $3124 in 2010[15], with the United States as the leader, followed by Switzerland.

There seems to be a pattern for developed economies to spend more on health as a share of their Gross Domestic Product (GDP), compared to emerging economies. This might allow them to have better or more resources and at the same time let them be able to produce superior health outcomes than their counterparts.

When we have compared these countries in terms of health spending with respect to their GDP, we have observed that emerging economies differ in terms of the dynamics or sensitivity compared to developed economies. An emerging country will show more similarities to another emerging country than a developed one and vice versa. In this paper instead of focusing only on "monetary" measures, we would like to explore if this segmentation is consistent if we consider other measures on the health area, such as health care activities, health care resources and health status.

[15] Expenditures are expressed in US dollars using purchasing power parity. Source: OECD Health Data 2012.

In studying differences between emerging and developed countries we expand the analysis by using a grouping technique called clustering. We seek to compare emerging to developed countries, to analyze the similarities or dissimilarities among these two groups.

In cluster analysis the objective is not to allocate countries to a known group, as the numbers of groups, as well as their component parts, are unknown. To group countries by several measures two cluster methods that will be described later are employed. The results can show obvious similarities among countries and others that are not so obvious. As it could be erroneously assumed in the health sector that "more [resources] means better [outcomes]", we want to show here that this is not always the case; to be precise, countries with the highest expenditure levels , resources, and health-related activities do not necessarily have the best health outcomes.

The attempt of this study is to enrich the way we compare these two set of countries by exploring the health sector in a broader way. That is, we want to look in some degree at how efficient these countries are in producing health outcomes with regards to their level of spending, health resources and use of those health resources.

As we can imagine, the health sector is not a simple linear equation with health outcomes in one side and health expenditures on the other, if it were, we would expect that those countries with the highest level of expenditures will experience the best health outcomes. Unfortunately, the equation is considerably more complicated. One of the first components of the equation will be a measure of efficiency, which will be hard to structure. We will also examine measures on quality of health

services, access to care, price structures, the proper size of the health sector possibly measured with the right number of resources per population, which might include among other things, doctors, nurses, hospitals, beds, etc. In this paper we attempt to give some structure to this equation.

Most of the literature on efficiency focuses on comparing private versus public systems in terms of providing health care. Even when international comparisons are restricted to these types of comparisons. Mobley et al. (1998) look at hospital size and average lengths of stay; they find that in the particular case of Norwegian versus Californian hospitals, the public highly regulated Norwegian hospitals are more efficient than the highly competitive and unregulated Californian hospitals especially in the long run. Hollingsworth (2003) offers a great review of papers that look at efficiency between private and public systems. It concludes that public versus private structures are more efficient in providing health care, however most of this literature does not consider the efficiency of production of health which should be more important if the aim of health care is to produce better health outcomes.

The obvious approach, in considering health outcomes is to look at crude indicators, as mentioned in Häkkinen et al. (2007), "… *the main disadvantage of outcome measures based on crude indicators of health status is that the latter depends on many other factors than public health care spending. Controlling for other influences is non-trivial. When available, measures of ADs [Avoidable Deaths] do not suffer from this drawback. Mortality is, however, an incomplete measure of the health*

care outcomes since it does not account for the quality of life and/or disability of living but sick persons ..."

At a country level we can identify the determinants of health such as income, education, social conditions that shape health outcomes, but at the same time individual behaviors and other unmeasurable elements also play an important role. These individual behaviors are affected by a complex matrix of elements and the interactions of elements within this matrix. For example, reporting good health can be easily segmented by income, when 47% of households report having "good health" for incomes between $20,000 and $40,000, at the same time 71% report "good health" on those households with incomes of $80,000 or more (and the relation is monotonic for income versus health status). Measures like these are relatively easy to capture, but measures on elements like type of future in terms of standard of living, stress levels at work, discrimination, sense of security in a community environment also affect health outcomes and are harder to measure. In the literature that studies "excess death" these hard-to-measure elements, after controlling for typical determinants of health, play a role in explaining excess mortality.

On the one hand, the availability of resources for a country should influence the capability to produce better health outcomes; that is, having a greater level of resources should in principle increase the odds of having an overall healthier country. On the other hand, if it makes sense to think that health care can alleviate the diseases and illnesses, it does not make sense to think that the scarcity of health care or

resources for that matter is the cause of those diseases and illnesses. Aspirin can alleviate the pain, but the lack of Aspirin is not the cause of that pain.

In this study we segmented the data in three periods. The idea of segmenting the data is to add some dynamic to the evolution of the patterns on the production of health. For example, Häkkinen et al. (2007) in a static view of infant mortality vs. total health spending, find that the US and Poland will have extremely different levels of spending (with a gap of around $5,000 of total health spending, US $ PPP per capita) and almost identical infant mortality rates (around 7 deaths per 1000 live births). In this study we'll see that this segmentation of the data help to visualize how these patterns change over time. To be specific, we will see that for the period 1990-2010 the US performs better than Poland in terms of infant mortality, for the period 2000-2010 our findings are consistent with those of Häkkinen et al. (2007), and by looking at the period 2005-2010 we can observe that US is slightly improving in the infant mortality rate compared to Poland but compared to the level of health expenditures is hard to justify the difference in terms of efficiency.

As described above, looking at the health sector requires studying more than only few metrics. Here we try to look at different measures that presumably can embody a more robust structure of the health sector, by no means is it exhaustive but it is complete at some level when we compare countries. We view the health sector as a production model as it has been seen in other areas in the economy. Income will reflect the affordability from one country to create and pay for a health sector. We also look at how much countries compare in allocating to this sector, how many resources

they have to produce health, how efficient they use those resources and ultimately how good they are in producing health outcomes.

In principle, we have seen that developed countries have a higher level of spending as well as resources dedicated to the health sector. It is reasonable to assume that they should have more use of these resources and therefore a higher expected level of better health outcomes.

The remainder of the paper is organized as follows. In section 2, describes the data and section 3 describes methods for the two different types of cluster analysis. Section 4 covers the results and interpretations for the findings and finally, section 5 addresses conclusions.

3.2 Data and Measures on Health

The data used come from the Organization for Economic Cooperation and Development (OECD) Health Data 2012. The analysis examines six developed and six emerging economies to compare how these two sets of countries get grouped.

The classification of the economies into developed and emerging is done according to the Financial Times Stock Exchange website.[16] The developed economies examined here are Germany, United Kingdom, United States, Switzerland, Canada, and Japan, and the emerging economies are Korea, Mexico, Turkey, Czech Republic, Hungary and Poland.

[16] www.ftse.com/Indices/FTSE_Index_Standards/Downloads/results.pdf

The following four categories of measures are taken into consideration:

1. Health Expenditures (all in US $PPP)

- Total health expenditure per capita
- Public health expenditure per capita
- Out-of-pocket expenditure on health per capita
- Pharmaceutical expenditure per capita

2. Health Care Activities (services or utilization):

- Doctor consultations per capita
- Hospital discharge rates, all causes, per 100 000 population
- Average length of stay, all causes, days
- Average length of stay for acute myocardial infarction (AMI), days
- Average length of stay for a normal delivery, days

3. Health Care Resources

- Physicians, density per 1 000 population
- Nurses, density per 1 000 population
- Hospital beds, density per 1 000 population
- Curative (acute) care beds, density per 1 000 population
- Psychiatric care beds, per 1 000 population
- MRI units, per million population
- CT scanners, per million population

4. Health Status

- Life expectancy at birth, female population
- Life expectancy at birth, male population
- Life expectancy at birth, total population
- Life expectancy at 65 years old, female population
- Life expectancy at 65 years old, male population
- Infant mortality rate, deaths per 1 000 live births
- Potential years of life lost (PYLL), all causes, female population
- Potential years of life lost (PYLL), all causes, male population
- Causes of mortality: Suicides, deaths per 100 000 population

The data is segmented in three different sampling periods. The first one from 1990 to 2010, the second is from 2000 to 2010 and the last one is from 2005 to 2010.

The purpose of this segmentation is to study if the clusters change over time. In the next section the methods are described.

3.3 Methods

In terms of clustering analysis, two methods are the most popular and they are included in this section. The first is hierarchical clustering, and the second is K-means clustering.

Hierarchical Clustering

In this particular case, hierarchical clustering will start with each country as its own cluster. In the following step the process calculates the distance given the variables considered and combines the two clusters that are closer. The process continues until there is only one cluster left containing all the countries. A "tree structure", called *dendrogram*, shows the evolution of the process. There are different rules to calculate the distance for the clusters: Average, Centroid, Complete, Single and Ward. The analysis here uses the Ward rule since it is the most common rule used in this type of analysis.

Given our set of N countries $P = \{p_1, p_2, \ldots, p_N\}$ are clustered based on a distance function:

$$D_{ij} = \frac{\left\| \overline{X}_i - \overline{X}_j \right\|^2}{\frac{1}{N_i} + \frac{1}{N_j}} \qquad (6)$$

where D_{ij} is the distance between clusters c_i and c_j, $\overline{X}_i$ is the mean vector for cluster c_i, N_i is the number of observations in cluster c_i, $\left\|\overline{X}_i - \overline{X}_j\right\|^2$ is the squared Euclidean distance between clusters c_i and c_j.

D_{ij} calculates the distance between two countries added up over all the measures on health and based on that it creates a hierarchical tree on the set of countries P, such that:

$$P: c_i, c_j \subset \text{P and } c_i \cap c_j = \varnothing \quad (7)$$

The initial set of clusters is equal to the number of countries in our data set, in this case $c_i = p_i \ \forall \ i$ where $i = 1, 2, ...N$. That is, we start with a set of N singletons clusters $\theta=(c_1, c_2, ...c_N)$. Then we find a pair of countries or clusters for this case (c_i, c_j) such that:

$$D_{ij}(c_i, c_j) \leq D_{i'j'}(c_{i'}, c_{j'}) \ \forall \ c_i \neq c_j \in \theta \quad (8)$$

The old clusters (c_i, c_j) are merged in to a new cluster $c_h = c_i \cup c_j$, the old set $\theta=(c_1, c_2, ...c_N)$ is now $\theta=(c_1, c_2, ...c_{N-1})$. The process on the algorithm now calculates the distances among the new set of clusters in Θ the algorithm stops until $\theta=(c_1)$.

K-means

The K-means method is a special case of the Expectation Maximization Algorithm, in this case the K-means method will look for *k* number of clusters, it will set *k* points in the data as "country seeds" and then it will iterate around those "seeded countries" to assign the following country to a particular "seed", then new centers are calculated for each clusters and the next country is assigned to a cluster. The process continues until the clusters become steady.

K-means will classify in this case our countries by the health measures of interest. Given the set of countries $P = \{p_1, p_2, \ldots, p_N\}$ the algorithm will assign the countries to a set of clusters.

First the initial "country seeds" s_j^i are calculated in such a way that they are positioned as far away as possible from each other. For the initial set of clusters $\phi^0=(c_1^0, c_2^0, \ldots c_k^0)$ the centroids or seeds are calculated as:

$s_j^i = \frac{1}{\left|c_j^i\right|} \sum_{x \in c_j^i} x$ where $j=1,2,\ldots k$ and i is the i^{th} iteration of the process.

Then each country in the data set is associated with the nearest centroid in the following way:

$$c_j^{i+1} = \left\{ x \middle| d(x, s_j^i) \le d(x, s_{j'}^i) 1 \le j' \le k \right\} \quad (9)$$

$$\phi^{i+1} = \left\{ c_j^{i+1} \middle| 1 \le j \le k \right\} \quad (10)$$

The calculation for the new possible "seed" gets iterated i times until the clusters created by the algorithm become stable. The K-Means algorithm presented here aims to minimize the within-cluster sum of squares

$$\arg\min_c \sum_{j=1}^{k} \sum_{x \in c_j} \left\| x - s_j \right\|^2$$

The analysis will start by studying the measures described in the section *Data and Measures on Health*. We will refer to the "developed-emerging rule" as the "DE-rule" where developed and emerging countries are grouped together by the cluster analysis. Each group of measures will be analyzed separately with the purpose of finding patterns within each group of measures. The next step will be to apply the analysis on all measures as a group expecting to observe if the health expenditure

measures are still strong enough to segment the groups in a developed-emerging pattern, that is, if the clusters formed follow “DE-rule”. For each part of the exercise a dendrogram or a plot of the clusters will illustrate the groups formed and also the sample period in question. In the next section we show the results.

3.4 Results and Discussion

Grouping countries by different measures will form distinct groups; but as it was mentioned above, an expected pattern will not always be followed. Next we show the results from the cluster analysis by different measures on the health area.

Health expenditures

The initial step is to do the analysis separately for the four categories of measures being studied. When we include only health expenditures, the first segment of measures, the number and members of the clusters are not unexpected. The clusters are divided in two groups with developed countries in one group and emerging countries on the other, which is the natural number of clusters defined by the algorithm. This further confirms the fact that developed economies are similar in allocating more resources on health expenditures as a share of their GDP. Not surprisingly, if we set the number of clusters to three, the US and Switzerland form one cluster and separate from the other countries, as the two countries with the highest health expenditures as a share of GDP. Figure 3.1 shows the results from this part of the analysis. The horizontal lines next to the name of the countries reflect the level of the variables considered. From Figure 3.1 we can observe that the main drivers of the

segmentation are health expenditures as a total and public health expenditures. The clusters in these measures do not change regardless of the sample period, and we can conclude that over time developed economies consistently spend more resources on health than emerging economies.

Figure 3.1. Dendrogram health care expenditures measures 1990-2010 sample

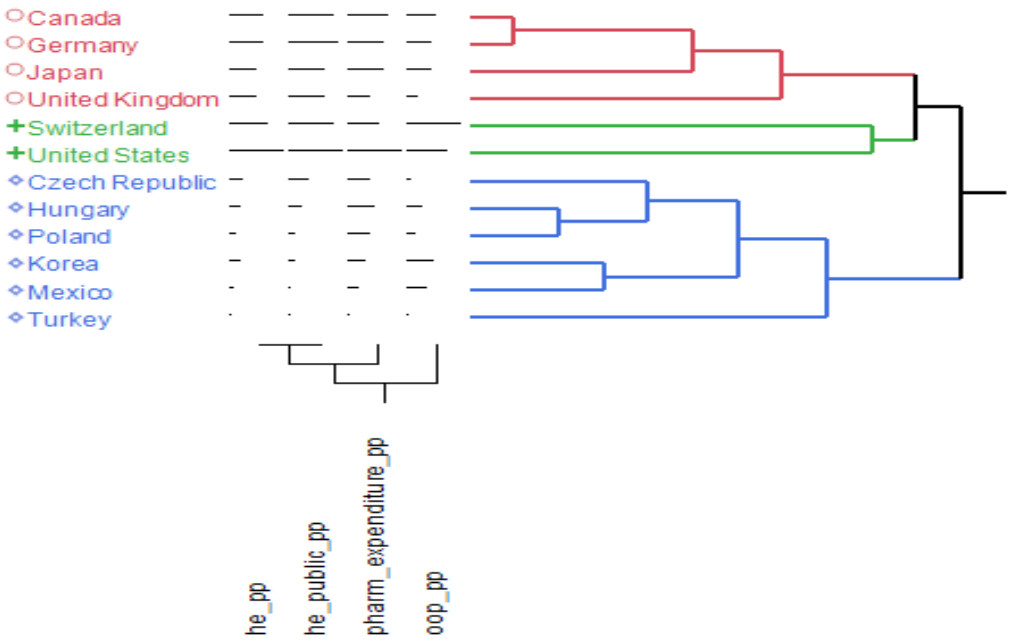


Figure 3.1. The cluster analysis is on measures of health expenditures between 1990 and 2010. Expenditures are expressed in US dollars using purchasing power parity. Source: OECD Health Data 2012. Here he_pp is total health expenditures per capita, he_public_pp is public health expenditures per capita, pharm_expenditure_pp is pharmaceutical expenditures per capita and opp_pp is out-of-pocket expenditures per capita.

As asserted above, the health sector is not a simple linear equation, with health outcome in one side and health expenditure on the other. If it were, we would expect that those countries with the highest level of expenditure will experience the best health outcomes. In the next sub-sections we attempt to study the other components of this equation.

Health care activities

In this part of the paper we study health care activities which include: doctor consultations, hospital discharge rates, average length of stay, average length of stay for acute myocardial infarction, and average length of stay for a normal delivery. These activities can be viewed as the use of resources available to create better health outcomes.

When the analysis is done using the variables in health care activities, the clusters that are formed do not follow "DE-rule". The US gets grouped with Mexico and Turkey for the measures under this category. Figure 3.2 shows these results, with the main drivers for these outcomes being the level of doctor consultations and average length of stay for delivery and all other causes. Another interesting result from this part of the analysis is the cluster formed by Germany, Switzerland and Korea. The main reason for this cluster is the patterns on average length of stay for all causes, but especially for average length of stay for acute myocardial measure as the cluster seems to allocate more on this average length of stay (ALOS) measure. Analyzing the 2000-2010 sample period the only change we observed is that Poland gets grouped with Germany and Switzerland (results are not shown here), besides that, the rest of the countries remained in the same clusters.

Figure 3.2. Dendrogram Health Care Activities 1990-2010 Sample Period

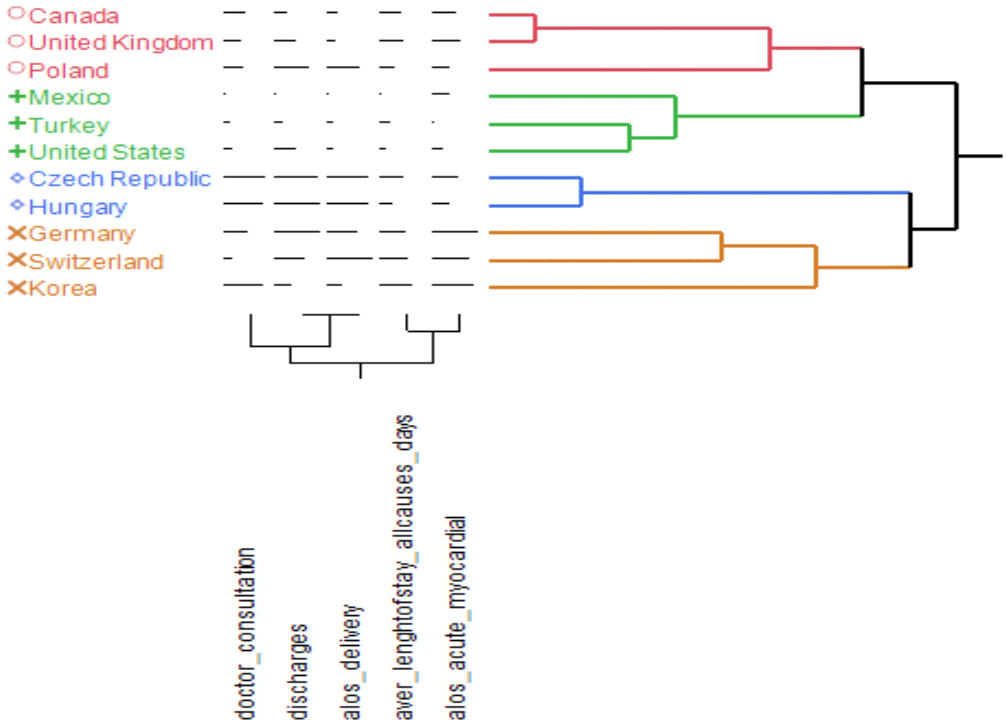


Figure 3.2. The cluster analysis is on measures of health care activities between 1990 and 2010. Japan is left out in this part of the analysis by the lack of data. Source: OECD Health Data 2012. Here doctor_consultations is doctor consultations per capita, discharge is hospital discharge rates, all causes, per 100,000 population, alos_delivery is average length of stay for a normal delivery in days, aver_lenghtofstay_allcauses_days is average length of stay for all causes in days, and alos_acute_myocardial is average length of stay for acute myocardial infarction in days.

One of the main observations of the last decades is that the US spends more than any other country on health. Therefore it is natural to question: Are we sicker? Do we go to the doctor more often? Probably the reason why the US spends more is that simply utilizes more services than other countries. However, as it can be observed from Figure 3.2, the level of doctor consultations, discharges and the ALOS measures indicate that in fact Americans do not go to the doctor in excess, or even as often as other countries, as a matter of fact, we are in the lowest level of doctor consultations next to Mexico and Turkey. Figure 3.2 gives a solid demonstration on where we stand in terms of health care utilization. So if we spend more, “it’s the prices, stupid” as

pointed out by Anderson et. al (2003). We will come back to this point when analyzing health care resources in the next sub-section.

Health care resources

Now we turn into analyzing health care resources which include: physicians, nurses, hospital beds, acute care beds, psychiatric care beds, MRI units, and CT scanners. These are the resources available as inputs to produce health. Having ample levels of these resources does not necessarily mean that the access is equal across different segments of the population. Obstacles for segments of the population might be barriers in the form of cost/out-of-pocket and access to these resources.

By looking at the variables on health care resources, we notice that "DE-rule" does not follow and two groups that are formed are particularly interesting. Figure 3.3 shows the US and Switzerland grouped together and Japan as a singleton cluster. The leading factors on the results might be the measure on CT and MRI units. The US and Switzerland lead the others on health expenditures, and CT and MRI are two expensive resources on health, and the use, set up and how much is charged for this technology will not have the same impact on expenditures. To clarify this point let's examine the cost of the following procedures for different countries[17]:

- The cost of an Angiogram procedure on average is $914 in US compared to $218 in Switzerland and $35 in Canada.
- The cost of a CT scan for abdomen is $630 in US, $437 in Switzerland, $124 in Canada and $175 for UK.
- The cost of a CT scan for the head is $566 in US, $328 in Switzerland, $124 in Canada and $175 for UK.
- The cost of an MRI is $1,121 in US, $928 in Switzerland and $335 in UK.

[17] Source: New York Times article called "Paying Till It Hurts" by Elisabeth Rosenthal. http://www.nytimes.com/interactive/2014/health/paying-till-it-hurts.html

Figure 3.3. Dendrogram Health Care Resources 1990-2010 Sample Period

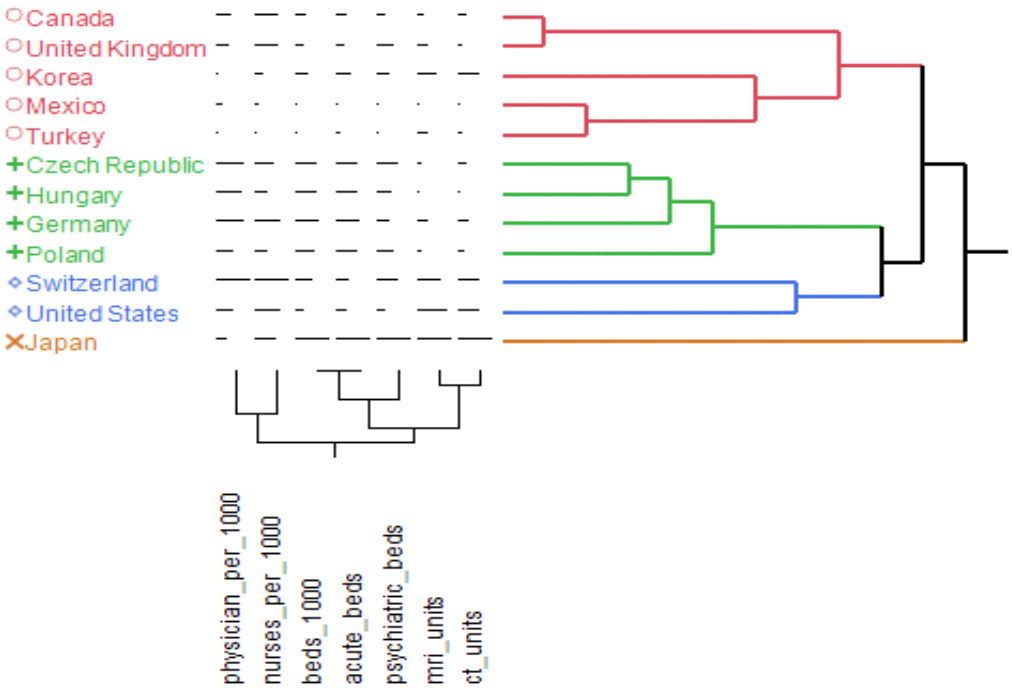


Figure 3.3. The cluster analysis is on measures of health care resources between 1990 and 2010. Source: OECD Health Data 2012. Here physician_per_1000 is physicians density per 1000 population, nurses_per_1000 is nurses density per 1000 population, beds_1000 is hospital beds density per 1000 population, acute_beds is curative (acute) care beds density per 1000 population, psychiatric_beds is psychiatric care beds per 1000 population, mri_units is MRI units per million population, and ct_units is CT scanners per million population.

Also, not only the CT and MRI procedures are more expensive in the US, for example:

- The total hospital and physician cost for appendectomy is $13,851 in US, $4,782 in Switzerland and $3,408 in UK.
- The total cost for a normal delivery is $9,775 in the US, $4,039 in Switzerland and $2,641 in UK.
- The total cost for C-section is $15,041 in the US, $5,186 in Switzerland and $4,435 in UK.
- The total cost for knee replacement surgery is $25,637 in the US, $11,954 in Switzerland and $7,833 in UK.
- The total cost of hip replacement is $40,364 in the US, $9,574 in Switzerland and $11,889 in UK.
- The total cost of bypass surgery is $73,420 in the US, $17,729 in Switzerland and $14,117 in UK.

As Anderson et. al (2003) pointed out, prices must be the reason, and even if their hypothesis was not entirely accurate, we can assume that prices are playing a big role on how much the US spends on health care. In the next sub-section we look at health status measures.

Health status

In this part of the study we examine health status measures which include: life expectancy at birth for different segments of the population, infant mortality rate, and potential years of life lost for males and females, and causes of mortality. These are the evaluation measures on how good countries are in producing health based on the use and resources that they have available.

In terms of all these health status measures, Japan is the leader. In Figure 3.4, by looking at these measures, Japan shows the best performance in all variables within the sample, and then it gets grouped with Switzerland and Canada. These results might justify somehow the size of the health sector in terms of health expenditures for Switzerland. If we look at the rest of the measures on health status, Mexico, Poland and Hungary rank the worst in the pool of these countries.

The US is ranked the worst of the developed countries. It is not a secret that for the US infant mortality, life expectancy and survival rates for heart attack are not better than the OECD average.

If we focus on the measure of potential years of life lost and infant mortality, Figure AA.3.9 (in the appendix) shows that Japan is performing better in these health status measures than all other countries. The “DE-rule” seems to apply except surprisingly for the case of the US. The emerging economies of Czech Republic and

Korea take a lead over the US. Even if we exclude infant mortality from these measures the structure does not change, except for a switch between Poland and Hungary (results not shown here); the US is still behind Czech Republic and Korea. This might reveal to some degree the lack of efficiency or efficacy of the US health system.

Figure 3.4. Dendrogram Health Status Measures 1990-2010 Sample Period

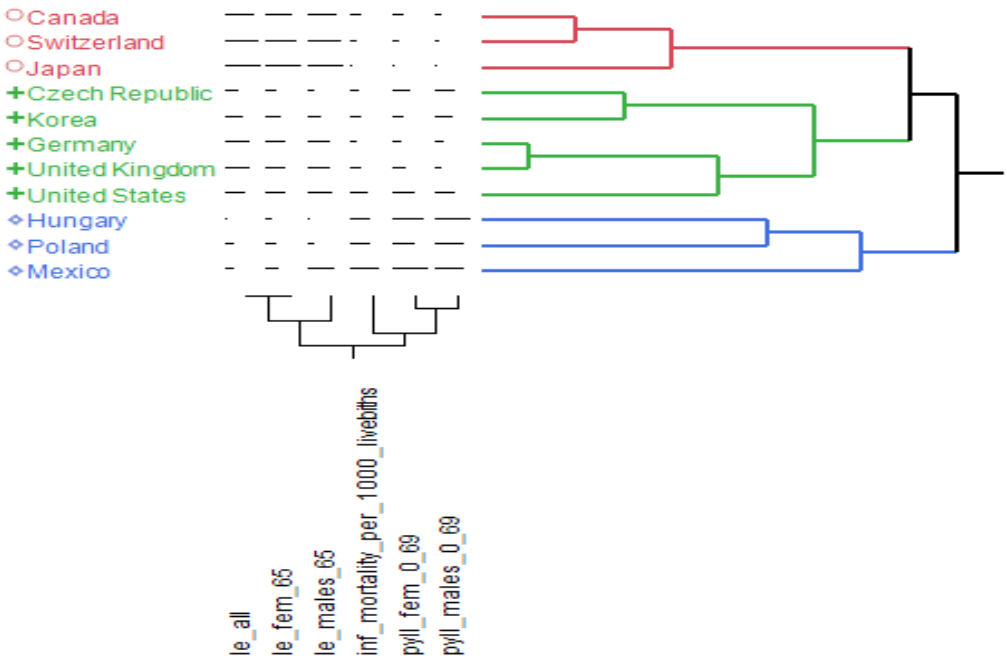


Figure 3.4. The cluster analysis is on measures of health status between 1990 and 2010. Source: OECD Health Data 2012. Here le_all life expectancy at birth total population, le_fem_65 is life expectancy at 65 years old female population, le_males_65 is life expectancy at 65 years old male population, inf_mortality_per_1000_livebirths is infant mortality rate deaths per 1000 live births, pyll_fem_0_69 is potential years of life lost all causes female population, and pyll_males_0_69 is potential years of life lost all causes male population.

Overall measures

When we take into account all the measures in all the categories, the clusters that get formed follow the "DE-rule". The order of the clusters are the same regardless of the sample period used. Health expenditures seem to weight strong enough to

dictate the patterns of the cluster formation as is shown in Figure 3.5. It is important to notice that if we were to restrict the number of clusters to three, Japan will form a single cluster and the results will be driven by the outstanding health outcomes. On the other hand, if we were to restrict the number of clusters to be 4, Turkey and Mexico will form their own cluster and the results will be driven by the poor performance on health outcomes.

Figure 3.5. Dendrogram Overall Measures of Health 1990-2010 Sample Period

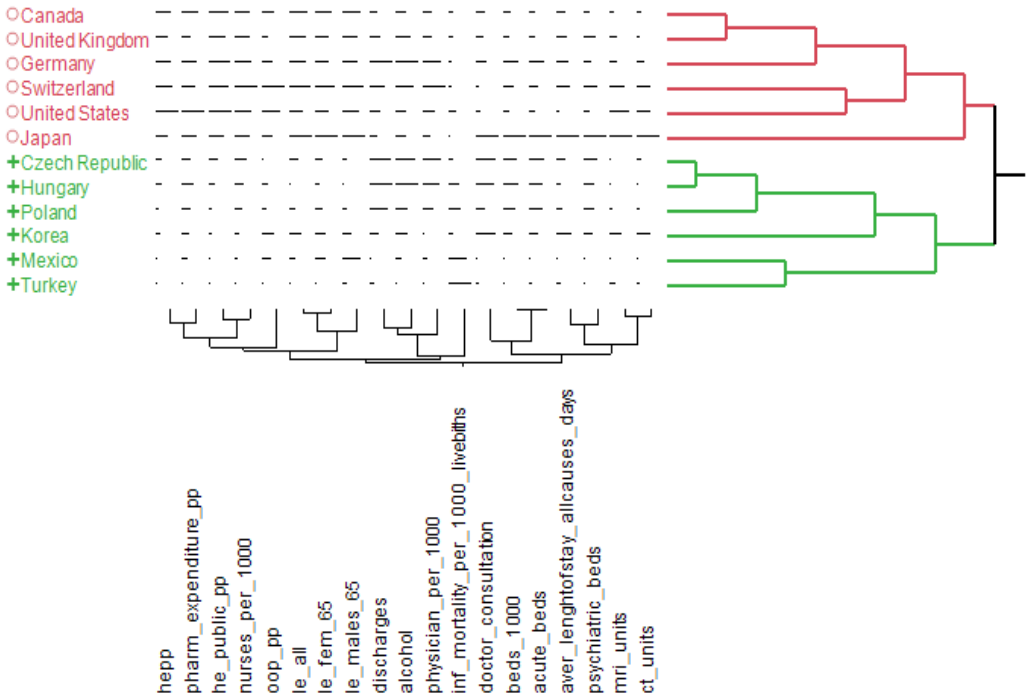


Figure 3.5. The cluster analysis is on all measures of health between 1990 and 2010. Source: OECD Health Data 2012. All variables are defined as before.

A good idea after having a solid knowledge of the data and the behavior of the clusters should be to separate the data into the natural number of clusters. The hierarchical cluster method might not be the best option to attain this objective. On the other hand, K-Means detect outliers that might be present in the data. K-Means gives a better perspective to judge the cluster formations when the data is plotted on a

3D graph. When creating the 3D plot, we use Principal Component Analysis to simplify the structure of the data and be able to create the plot.

Using K-Means analysis and restricting the number of clusters to be two, the groups are very disperse from the seeded center of the clusters, therefore we let the algorithm to select the appropriate number of cluster and the results are shown in Figure 3.6. The groups that are formed using K-Means procedure give a better assignment of the clusters. Five clusters are formed, the US and Switzerland are still together, also we can see why Japan will be the first cluster to be formed under the hierarchical procedure; it seems that the outstanding health outcomes, health resources and health care activities make Japan unique enough to be grouped by itself. The only group that does not follow the “de-rule” is the group formed by Germany, Canada and Korea; we will address this point when we talk about Figure 3.7. The rest of the groups are formed following the “DE-rule”.

Figure 3.6. 3D Plot Overall Measures of Health 1990-2010 Sample Period

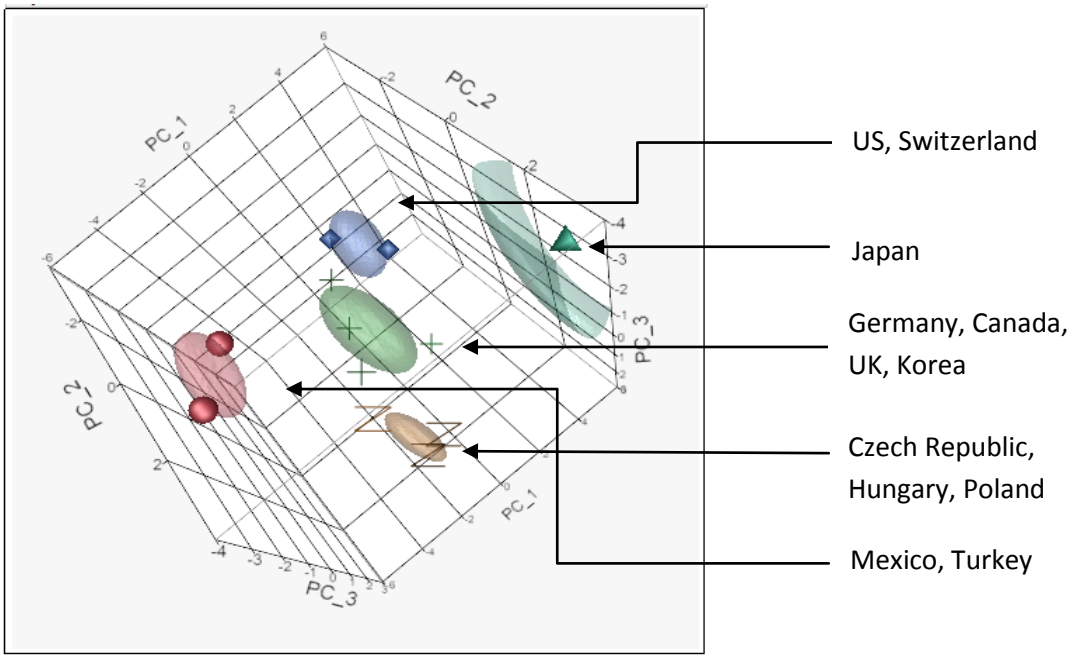


Figure 3.6. The cluster analysis is on all measures of health between 1990 and 2010. Groups are formed as follows: ♦US, Switzerland; + Germany, Canada, UK, Korea; ● Mexico, Turkey; **Z** Czech Republic, Hungary, Poland; ▲Japan. Source: OECD Health Data 2012.

If we leave health expenditure measures out of the clustering analysis but take into account all the other measures, we can see that the dynamics of the clusters formation change, but not drastically for the 1990 - 2010 sample period, as it is show in Figure 3.7. The only "switchers" are the US and Germany, still this result is very interesting in the sense that the US is the big spender, and as such is no longer grouped with Switzerland. The clusters remain constant over the different sample periods with the exception of Korea. As it was pointed out in Figure 3.6, Korea does not follow the "de-rule". Over the different sample periods, Korea is improving in its health outcomes compared to other countries within the samples studied here; in fact, Korea is more likely to form a cluster with Japan for the 2005-2010 sample period than with Germany or Canada.

Figure 3.7. 3D Plot Non-monetary Measures of Health 1990-2010 Sample Period

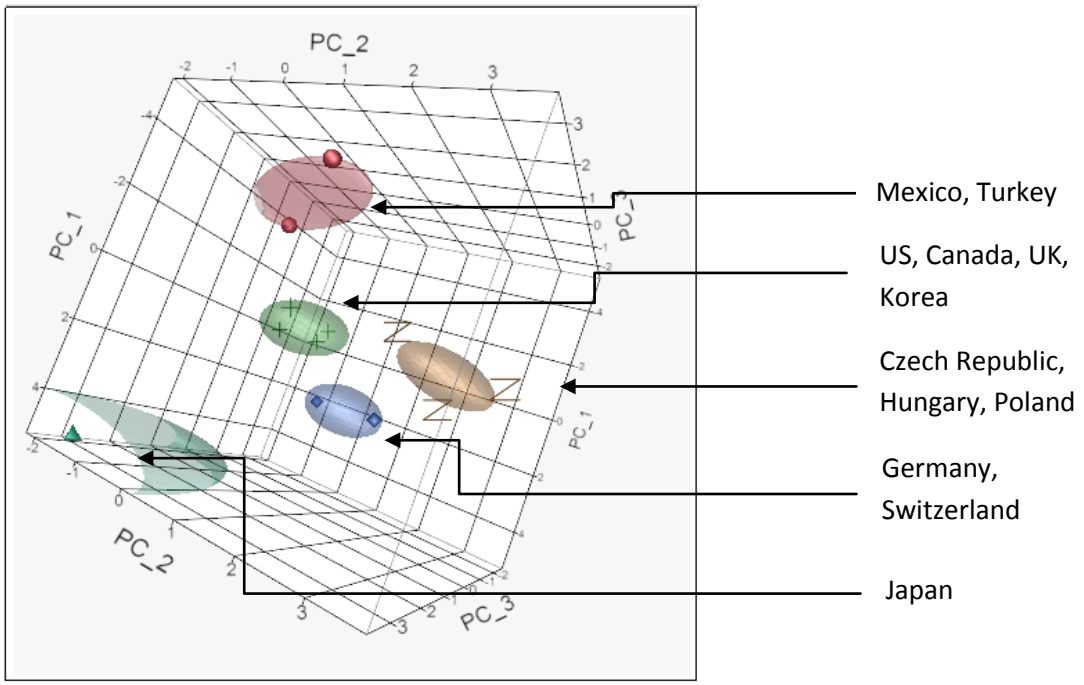


Figure 3.7. The cluster analysis is on non-monetary measures of health between 1990 and 2010. Groups are formed as follows: ♦ Germany, Switzerland; + US, Canada, UK, Korea; ● Mexico, Turkey; **Z** Czech Republic, Hungary, Poland; ▲Japan. Source: OECD Health Data 2012.

If we now consider the most cited measures of health outcomes within the literature, namely, life expectancy and infant mortality, and at the same time we relate this to health expenditures, the resulting clusters followed by a K-Means analysis give us very interesting cluster formations. Results are shown in Figure 3.8; the most important result is that the US is grouped by itself. There is no other country as the US in terms of the level of expenditures and the two outcomes of interest.

Figure 3.8. 3D Plot Selected Measures of Health 1990-2010 Sample Period

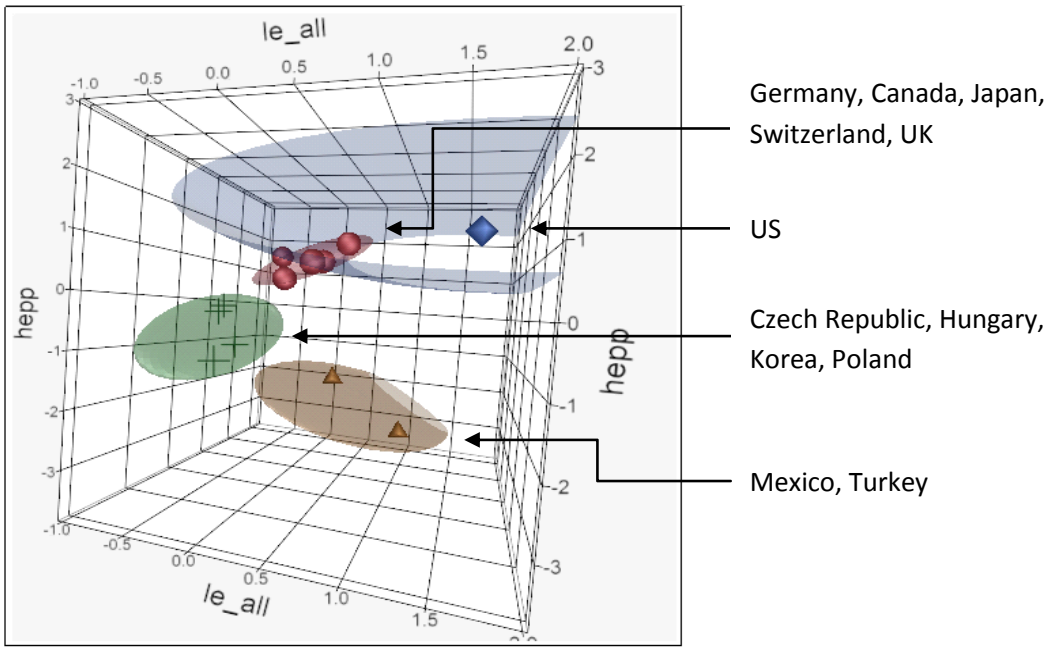


Figure 3.8. The cluster analysis is on health care expenditures, life expectancy and infant mortality between 1990 and 2010. Groups are formed as follows: ♦ US; ● Germany, Canada, Japan, Switzerland, UK; + Czech Republic, Hungary, Korea, Poland; ▲ Mexico, Turkey. Source: OECD Health Data 2012.

We further analyzed health expenditures versus infant mortality to expand on what is found in Häkkinen et al. (2007) in a static view of infant mortality vs. total health spending, where they found that the US and Poland will have extremely different levels of spending and almost identical infant mortality rates. Figure AB.3.10 (in the appendix) shows that the US is getting worse on infant mortality compared to other countries. By looking at Figure AB.3.10 Panel A which is for the sample period of 1990-2010, the US is below two emerging countries in terms of infant mortality; by looking at Panels B and C, the US is already below four emerging countries and obviously all the developed countries as well. Also, looking at Panel B in Figure AB.3.10, makes us think about the US, Turkey and Mexico being the only OECD

countries that do not have some form of universal health coverage (although, Mexico established a universal healthcare program in November 2008).

The results for HE and life expectancy (not show here) can illustrate that US has the highest level of expenditures and not the highest, or even close, level of life expectancy. These patterns do not change over the different sampling periods.

Certainly, the US is doing something different and it points to outcomes that do not appear to be commensurate with the level of expenditures. As we mentioned above the US pays the most for health services. In addition, if we look at the best paying salaries in the US, it is not “C-level” executives that are making the most, on average, the health sector is leading by far according to the Bureau of Labor Statistics Occupational Employment and Wage Estimates survey, March 2013. One could argue that the pay reflects the risk and responsibility acquired with the job, but is the risk in the health sector artificially overcompensated in terms of the wage rather than on markets forces? If that is the case, a system as such has too much to wish for.

CHAPTER 4. Conclusions

4.1 Conclusions Study 1

This study sought to analyze the short-run dynamics in health expenditures for a group of developed and emerging economies. It began by showing that the time series for HE and GDP are non-stationary. Cointegration tests further reveled there exists a long term relationship between HE and GDP for developed and emerging countries. As this relation holds then discrepancies between HE and GDP are just temporary, and they would be expected to hold and prevail in the long run.

The error correction model confirmed that convergence exists between HE and GDP, and a path is found that can differentiate developed and emerging countries. In particular, developed economies tend to show a smaller speed of adjustment compared to emerging economies, and it takes longer for developed economies to correct deviations from the long term path.

This paper also calculated the short-run income elasticity between HE and GDP for each of the countries examined, and found that the short-run elasticity tends to be larger in emerging economies. Even when the levels of HE and GDP series are isolated, the income elasticity is still larger, on average, in emerging economies.

Finally, it was also observed that emerging countries behave differently, compared to developed economies, with respect to healthcare spending in the short run; therefore, a word of caution should be taken when implementing policies related to the healthcare sector. Even more important, this study suggests that mimicking the policies or social programs relate to the health sector is a risky strategy for emerging countries since each

country may react differently to the same type of policy. Structural restrictions will apply differently to each country; therefore, policies should apply to efficiency rather than rely more heavily on cost-control.

4.2 Conclusions Study 2

The results from this part of the analysis show an important feature about the health sector; in order to evaluate or make comparisons among countries, the health sector as a whole with all its factors and determinants need to be taken into account. Furthermore, this analysis shows at some basic level that some countries might have established their health sector more efficiently, in terms of the way they produce health outcomes.

The way the segmentation is formed revealed interesting characteristics of the health sector, e.g., if we only focus on monetary measures and resources the results might be very different than when we incorporate other measures that take into account how much we are using those resources and how efficiently those resources are in producing good health outcomes.

Despite the view, we can observe from this paper that the health sector already is complex, and it is becoming more complex with all the external factors that influence it, policy, access rules, salaries, prices, out-of-pocket structures and government interventions, to name a few. Here, we only look at it in terms of a simple input/output scheme. For example, prices might be playing a very important role on the level of spending, which can be affected by policy, and efficiency as well as rules that impact the out-of-pocket structure for different countries. Moreover, when we

looked at the health care activities in this paper, the access to care seems to be more restricted in some countries than others regardless of the resources available.

For the particular case of the US, being the top country in terms of the percentage of the GDP that is assigned to the health sector and still being ranked 30th in life expectancy leads to concerns. It would be unfair to only blame the allocation and use of resources in the health sector, when we are not able to eat, exercise and follow bad health behaviors at the individual level, then, it might be wise to assign resources that aim at these objectives in specific areas of the population. The affluent sector in the economy already takes "good decisions", on average, to stay healthier; the challenge is to influence the other side where more education needs to be induced in order to achieve a healthier country.

The cost of health care in the US affects taxpayers at the consumer level when nearly half of the population gets the services on health through the government, and also affects employers for those that cover employees and have to pay high premiums.

Is the new reform helping the shape of the US in the health sector? Maybe, however the point of this paper is to examine how efficient the health sector is in producing health.

When we rank low in life expectancy and when we have infant mortality rates that are worse than countries with far less resources, maybe the answer is towards assigning more resources on shaping the lifestyle for Americans, the way the doctors and the health sector are stimulated and compensated, then in that way we can attack the underlying disease and not the symptoms.

More spending does not lead to better health outcomes, when we observe that the best 10 salaries are within the health sector in the US. When a government that is heavily influence by lobbyist in the health sector, maybe there is room for regulation that is effective, a regulations that underweights the lobbyists and weights more on the wellbeing of its population.

Countries should expect to spend more on the health sector as people age, richer countries chose to spend more on health than other goods, there seem to be no good or effective attempts in the US health sector to rationalized health care, the viewers of benefits outweighing the cost of health care have no chance to defend the point when Americans are not healthier than other countries spending as much or less. The symptoms of the US health sector have to do with uneven quality of care, coverage, swelling costs, bad individual behaviors and a government that is heavily influenced by lobbyists[18]. Furthermore, when the out-of-pocket is low for a sector that is covered, but extremely high for a sector that is not covered, the system is set up to create more health disparities among its population. As we saw some of the procedure costs in the results section, we can appreciate that uninsured Americans cannot afford medical attention at these prices.

In order to experience good health outcomes as a country, it is not needed to spend a lot on health care, and if one segment of the problem are the prices, then it might be justified to have and effective government intervention (not influenced by

[18] The Center for Responsive Politics reports that the health-care industry spent over $487 million lobbying on health care issues in 2013. No other industry sector spent more lobbying Congress and the federal government. The industry has consistently spent lobbying around $500 million per year since 2008.

lobbyists) to regulate the price market, now if the private sector is going to be happy or not with that, that would be a completely different story.

APPENDIX A

Part A. Cointegration model

The procedure to estimate the cointegration model for Korea and Hungary is as follows, but the idea is the same, specifically testing for a stationary process on the residuals to verify for a long term relation between the variables.

$$Ghe_t^c = \alpha + \gamma Ggdp_t^c + \eta_t^c$$

$$\Delta\hat{\eta}_t^c = \rho_1\hat{\eta}_{t-1}^c + \sum_{i=1}^{n}\rho_{i+1}\Delta\hat{\eta}_{t-i}^c + \varepsilon_t^c$$

where Ghe_t^c is the health expenditures growth rate for country *c*, $Ggdp_t^c$ is the GDP growth rate for country *c* and $\Delta\hat{\eta}_{t-j}^c = \hat{\eta}_{t-j}^c - \hat{\eta}_{t-j-1}^c$, and $\hat{\eta}$ is collected from the cointegration equation. Therefore, the interpretation is in terms of growth rate relations since the difference in logs for the variables are used. Therefore, if a cointegration relation is present here, then it is in terms of the growth rates for these two series.

For the US and Switzerland, a particularly mixed process is present. There is a unit root process in GDP, but an integration process of order two in the HE series. In this case, the relation is established between the growth rate of HE and the levels of the GDP. The procedure for these two countries is as follows. The variables for the model are defined as before.

$$Ghe_t^c = \alpha + \gamma gdp_t^c + \eta_t^c$$

$$\Delta\hat{\eta}_t^c = \rho_1\hat{\eta}_{t-1}^c + \sum_{i=1}^{n}\rho_{i+1}\Delta\hat{\eta}_{t-i}^c + \varepsilon_t^c$$

For the case of the Czech Republic, a unit root in HE has been found, but an integration of order two in the GDP series. Here the relation is between the levels of HE and the growth rate of GDP, and the procedure is as follows

$$he_t^c = \alpha + \gamma Ggdp_t^c + \eta_t^c$$

$$\Delta\hat{\eta}_t^c = \rho_1\hat{\eta}_{t-1}^c + \sum_{i=1}^{n}\rho_{i+1}\Delta\hat{\eta}_{t-i}^c + \varepsilon_t^c$$

Part B. Error correction model

In the case of Korea and Hungary, the HE and GDP series are integrated of order 2. In this case the error correction model is specified as follows

$$\Delta Ghe_t^c = \lambda + \theta\Delta Ggdp_t^c + \varphi(Ghe_{t-1}^c - \hat{\gamma}Ggdp_{t-1}^c) + u_t^c$$

where the new term $\Delta Ghe_t^c = Ghe_t^c - Ghe_{t-1}^c$ represents differences of the growth rate series, and the long run relation, $Ghe_{t-1}^c - \hat{\gamma}Ggdp_{t-1}^c$, is expressed in terms of growth rates, since the series are integrated of order two.

For the US and Switzerland, particularly mixed processes was found. I(1) for GDP and I(2) for HE, in this case the relation is established between the growth rate of HE and the level of GDP. The procedure is as follows

$$\Delta Ghe_t^c = \lambda + \theta\Delta gdp_t^c + \varphi(Ghe_{t-1}^c - \hat{\gamma}gdp_{t-1}^c) + u_t^c$$

here the long run relation, $Ghe_{t-1}^c - \hat{\gamma}gdp_{t-1}^c$, is expressed in terms of the growth rate for HE and the levels of GDP, and the rest of the variables are defined as before.

Finally for the Czech Republic the specification is the following.

$$\Delta he_t^c = \lambda + \theta\Delta Ggdp_t^c + \varphi(he_{t-1}^c - \hat{\gamma}Ggdp_{t-1}^c) + u_t^c$$

where the long run relation, $he_{t-1}^c - \hat{\gamma}Ggdp_{t-1}^c$, is expressed in terms of growth rate for GDP and the levels of HE, and the rest of the variables are defined as before.

Part C. Trending behavior of some of the series

Figure AA.2.4 shows the intercept and trending behavior of some of the series. For example, in the case of the United Kingdom the series of HE display an intercept and a trend in levels, as for the difference of the series only an intercept but not a time trend is present. In contrast, for Switzerland the difference series for GDP and HE shows no clear evidence of an intercept or a trending behavior.

Figure AA.2.4. Intercept and trending behavior is shown for some of the series in the data

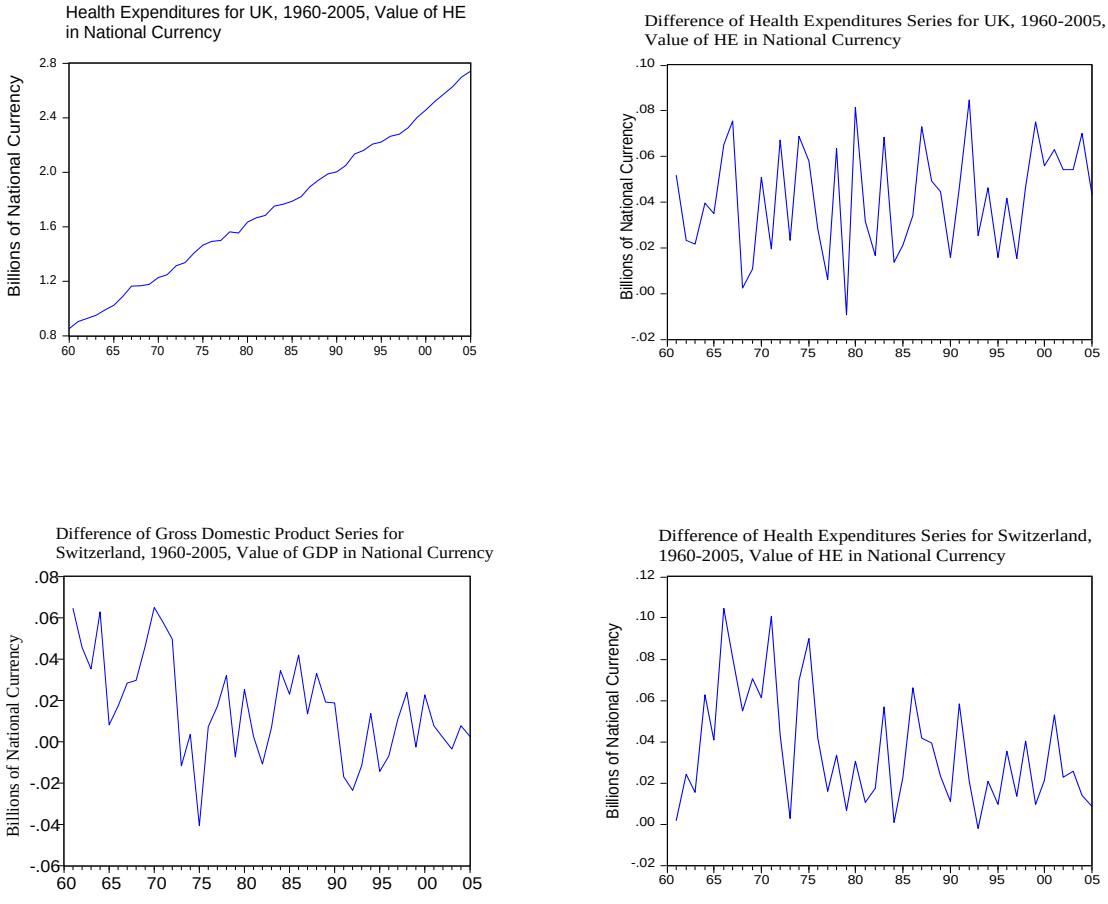


Figure AA.2.4. Intercept and trending behavior is shown for some of the series in the data. Source: OECD Health Data 2012.

APPENDIX B

Figure AB.3.9. Dendrogram selected health status measures 1990-2010 Sample Period

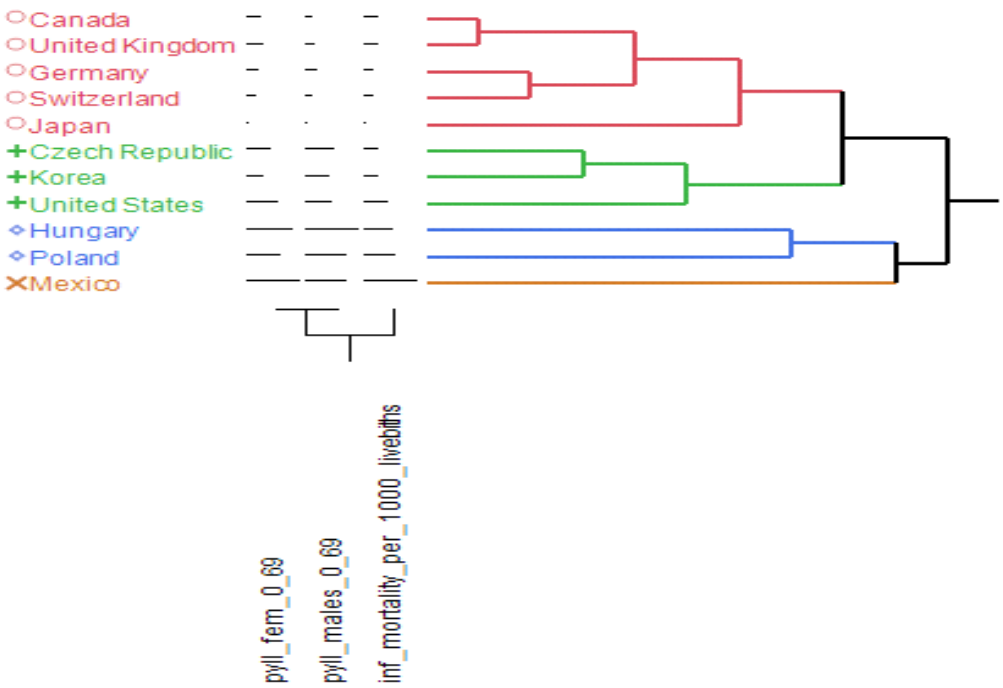
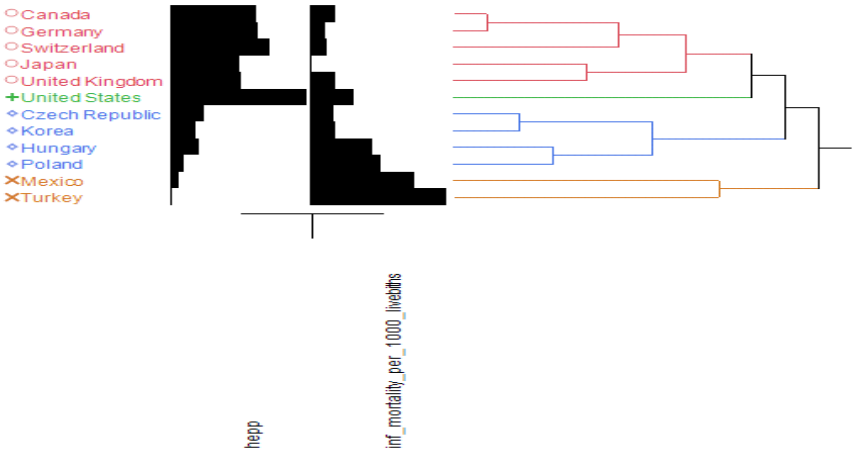


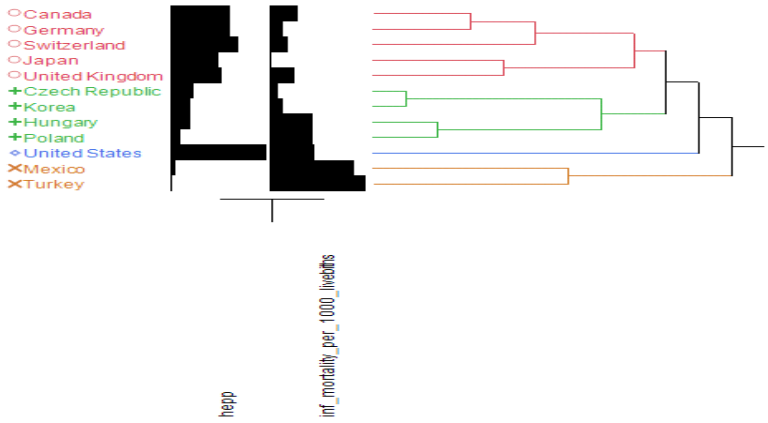
Figure AB.3.9. The cluster analysis is on selected health status measures between 1990 and 2010. Source: OECD Health Data 2012. Here pyll_fem_0_69 is potential years of life lost all causes female population, pyll_males_0_69 is potential years of life lost all causes male population, and inf_mortality_per_1000_livebirths is infant mortality rate deaths per 1000 live births.

Figure AB.3.10. Health Expenditures and Infant Mortality

A. Dendrogram 1990-2010 Sample Period



B. Dendrogram 2000-2010 Sample Period



C. Dendrogram 2005-2010 Sample Period

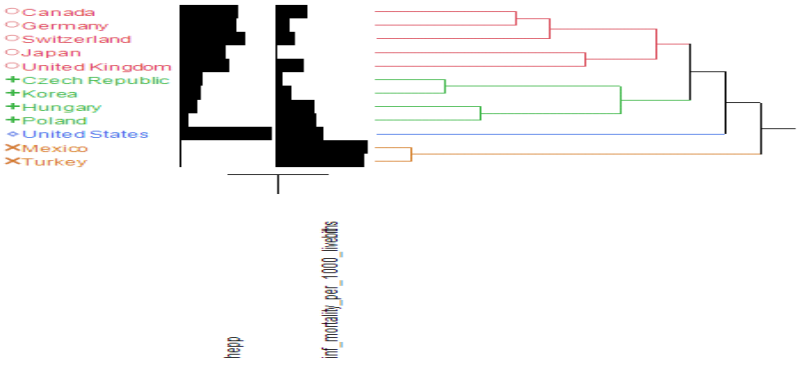


Figure AB.3.10. Cluster analysis is on health care expenditures and infant mortality between 1990 and 2010. Source: OECD Health Data 2012.

REFERENCES

Alcacer, J., Dezso, C., Zhao, M., 2014. Location choices under strategic interactions. *Strategic Management Journal,* forthcoming.

Atella, Vincenzo and Marini, Giorgia, 2007. Is Health Care Expenditure Really a Luxury Good? Re-Assessment and New Evidence Based on OECD Data, Rivista di Politica Economica vol. 97(2), pages 87-120.

Blomqvist, A. G. and Carter, R. A. L., 1997. Is health care really a luxury?, Journal of Health Economics 16(2):207-29.

Jesús Clemente, J., Marcuello, C., Montañés, A. and Pueyo, F. 2004. On the international stability of health care expenditure functions: are government and private functions similar? Journal of Health Economics 23(3):589-613.

Dickey, David A. and Fuller, Wayne A. 1979, "Distribution of the Estimators for Autoregressive Time Series with a Unit Root", Journal of the American Statistical Association 74, 427-431.

Dickey, D. and W. Fuller. 1981. Likelihood Ratio Tests for Autoregressive Time Series with a Unit Root. Econometrica, 49: 1057-1072.

Docteur, E. and Oxley, H. Health-Care Systems: Lessons from the Reform Experience. OECD Health Working Papers (2003)

Enders, W., 1995. Applied Econometric Time Series. Wiley, New York.

Engle, R. and C. Granger. 1987. Co-integration and Error Correction: Representation, Estimation and Testing. Econometrica, 55: 251-276.

Gerdtham, U.-G. and B. Jonsson, International comparisons of health expenditure: Theory, data and econometric analysis, in: Handbook of Health Economics, eds. A.J. Culyer and J.P. Newhouse (North-Holland, Amsterdam, 2000).

Gerdtham, U.-G. and M. Löthgren. 2000. On Stationarity and Cointegration of International Health Expenditure and GDP. Journal of Health Economics 19: 461-475.

Häkkinen, U. and I. Joumard (2007), "Cross-Country Analysis of Efficiency in OECD Health Care Sectors: Options for Research", OECD Economics Department Working Papers, No. 554, OECD Publishing.

Hansen, P., and A. King, 1996. The determinants of health care expenditure: A cointegration approach. Journal of Health Economics 15, 127–137.

Hansen, P. and A. King. 1998. Health Care Expenditure and GDP: Panel Data Unit Root Test Results – Comment. Journal of Health Economics 17: 377-381.

Hollingsworth, B. (2003), “Non-Parametric and Parametric Applications Measuring Efficiency in Health Care”, Health Care Management Science, Vol. 6, pp. 203-218.

Klomp J, de Haan J., 2010 Measuring health: a multivariate approach. Soc Indicators Res. 96:433–57.

McCoskey, S.K. and T.M. Selden. 1998. Health Care Expenditure and GDP: Panel Data Unit Root Test Results. Journal of Health Economics 17: 369-376.

Mobley, L.R. and J. Magnussen (1998), “An International Comparison of Hospital Efficiency: Does Institutional Environment Matter?” Applied Economics, Vol. 30, pp. 1089-1110.

Murray C. and Nelson C. 2000. The uncertain trend in U.S. GDP. Journal of Monetary Economics, Volume 46, Issue 1, Pages 79-95

Nelson, C.R., Plosser, C.I., 1982. Trends and random walks in macroeconomic time series: some evidence and implications. Journal of Monetary Economics 10, 139-162.

Newhouse, J.P., 1977. Medical care expenditure: A cross-national survey. The Journal of Human Resources, Vol. 12, No. 1 (Winter, 1977), pp. 115-125

ABSTRACT

DYNAMICS IN HEALTH CARE EXPENDITURES FOR EMERGING AND DEVELOPED COUNTRIES

by

EDMUNDO REYES

August 2015

Advisor: Dr. Allen Goodman

Major: Economics

Degree: Doctor of Philosophy

This paper analyzes the dynamics on health care expenditures and health outcomes for emerging and developed countries. The first part of the study focus on the short-run dynamics in health care expenditures for six emerging and a selected group of six developed economies of the OECD group. An error correction model is utilized for the analysis. Results for the presence of a long term relation are consistent within the sample. In addition, direct convergence is found to be consistent as well. The speed of adjustment is larger for emerging economies than for developed economies, which indicates that developed economies would take longer to correct deviations from the long term path compared to emerging economies. When looking at short-run income reactions, developed economies are less sensitive than emerging economies. In particular, short-run elasticity is more than two times larger for emerging economies. These results also suggest that developed economies may have some form of better planning in addressing health consumption. The results provide

evidence that emerging countries react differently from developed economies with respect to health care spending; therefore, health care should not be considered the same for emerging as for developed economies, and these implications should be realized for policy evaluations.

The second paper analyzes the dynamics in health care for six emerging and a selected group of six developed economies of the OECD group. Cluster analysis is utilized for the study. In this study we look at the dynamics on health care in a broader way by including not only “monetary” measures but also measures that can potentially quantify the efficiency of a country in producing health outcomes. We study in some degree at how efficient these countries are in producing health outcomes with regards to their level of spending, health resources and use of those health resources. We take a closer look to the US and explain the factors that make it so different than other countries. The results show that developed and emerging countries are not grouped together when we take into account other factors that influence the health sector.

AUTOBIOGRAPHICAL STATEMENT

EDUCATION

Ph.D. in Economics, Wayne State University, Detroit, MI 2015
M.S. in Economics, Arizona State University, Tempe, AZ 2002
B.A. in Economics, Universidad Autonoma de Nuevo Leon, Monterrey, Mexico 1999

RESEARCH INTERESTS

Health Economics, Econometrics, Financial Economics.

PROFESSIONAL EXPERIENCE

Credit Risk Manager, Credit Acceptance Corp, Southfield, MI *Jan 2013-Present*
- Develop optimization models to reduce risk and increase profits

Econometrician, Ford Motor Credit, Dearborn, MI *Sep 2010-Jan 2013*
- Developed econometric models to optimize business decisions

Instructor, Department of Economics, Wayne State University *Jan 2010-May 2010*
- Taught Principles of Microeconomics

Research Assistant, Wayne State University Institute of Gerontology *Sep 2007- Dec 2009*
- Develop models to account on health disparities for minorities in the U.S. Create models to explain dynamics on health expenditures for states within the U.S. and country level comparisons.

Instructor, Department of Economics, Wayne State University *Sep 2006-May 2007*
- Taught Principles of Microeconomics and Macroeconomics

PUBLICATIONS

"Price Differences between Dual-class Stocks: Evidence from Mexico" (with Magali Valero and Manuel Gómez). Journal of International Finance and Economics 8(4), 2008.

"Recomendaciones de Analistas Financieros: Un Estudio del Mercado Mexicano" (Analysts' Recommendations: A Study of the Mexican Market) (with Magali Valero). Paper in: La Economía Mexicana en 19 Miradas (The Mexican Economy in 19 Looks), Editorial Porrua Hnos. Mexico.