

An Analysis of Health Care Expenditure in Washington State

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Introduction

The health care expenditure is an indispensable spending for a government; however, concerns are growing that the share of the healthcare expenditures will get larger and larger in the budget. Therefore, an insightful understanding to the dynamics of the health care expenditure can provide an invaluable policy implication.

The research on health care expenditures has been active for decades. One focus is to identify the main explanatory variables and their influences on healthcare spending (Sen, 2005; Baltagi and Moscone, 2010). These researches all uniformly suggest the significant effects of the income (per capita GDP) on healthcare expenditure; meanwhile, non-income factors, such as population age profile, number of physicians and life expectancy are found to be influential. However, these studies do not have the conclusive results on how the non-income factors impact the healthcare expenditures. So simply borrowing the idea from other studies may not work in applied practices.

While there exist a large number of studies explain the expenditure variation, relatively few studies have been done on the expenditure growth. In theory, the examination of level difference identifies the variables that affect the spending amount, while the examination of growth rates indicates which variables facilitate a greater growth of the expenditure. Therefore, a policy recommendation should be based on the research on level and growth.

This study focuses on the healthcare expenditure of Washington State in both level and growth aspects. We try to include the variables considered in the earlier research if the data is available. Besides those conventional variables, recent studies have suggested the existence of the expenditure inertia, i.e., the expenditure of the previous year has significant explanatory power on the expenditure of the current year, so we include the lagged dependent variable in the models. The technological change is playing a very important role in healthcare sector, we include the technology progress in this analysis due to its cost-increasing nature.

Through investigating Washington State healthcare expenditure, we try to determine the factors that affect the expenditure in either level or growth. The ultimate goal of this analysis is to provide valuable information for decision makers.

Model and Data

In this research, as mentioned in above section, we will examine the determinants in level and growth of healthcare expenditure. The model (1) defined below is in level, which is a familiar one in the literatures of healthcare expenditure.

$$HE_t = \beta_0 + \beta_1 * Td + \beta_2 * PI_t + \beta_2 * PHE_t + \beta_2 * POP65_t + \beta_2 * UR_t + U_t \quad (1)$$

where $t = 1, 2, \dots, T$ denotes the time index, and U is the error term.

The dependent variable is the per capita healthcare expenditure (HE) in logarithm form of Washington State. The per capita income (PI) and the ratio of the population of age 65 and over to the total population (POP65) are the two fundamental variables in the model and are always used in the similar studies, both are also in logarithm form.

Recent literature suggests the existence of expenditure inertia effect, i.e., the past expenditure passes its impact onto the current expenditure (Okunade and Suraratdecha, 2000). Therefore, we include the lagged healthcare expenditure (PHE) as one explanatory variable. Another important control variable is the unemployment rate (UR). After all, healthcare expenditure is the consumption behavior for healthcare services and products, we include the UR to examine the impact of economy status on the expenditure. Earlier researches (Mosca, 2006) suggests that a rise in UR has a negative impact on human health and hence raises the healthcare expenditure. With currently on going COVID-19 pandemic leading to large-scale of layoff, investigating the impact of unemployment on the healthcare expenditure has important and practical implication from policy perspective. Finally, as Newhouse [5] pointed out, medical care technology change in the healthcare sector has a dramatic influence on health expenditure. However, measuring the technological advance is difficult. Thus, we take an indirect and simple approach. Borrowing the idea from Crivelli *et al.*, we include a linear time trend variable in the model to approximate the effects of the medical care technologies. When a multiple linear regression model is applied to the time series variables, if any variable contains a time trend, the regression usually yields a spurious result. An easy fix is to add a time trend variable. Given the facts that the series of PI and HE have strong linear trends, adding time trend in the model also has important technical necessity. Except the time trend variable T_d , the other control variable UR and PHE are in logarithm. Therefore, the estimated coefficients can be interpreted as the standard elasticities.

While the analysis of level differences explains the degree to which the variables contribute to the expenditure; the analysis of growth rates indicates which factor characterizes a greater growth of health expenditure. For an insightful and comprehensive understanding to the dynamics of the healthcare expenditure, we should not be based solely on its level studies. Understanding the trajectory of growth of healthcare expenditure is as important as understanding to level analysis. Mode (2), developed to examine the growth of healthcare expenditure, is given below.

$$dLHE_t = \beta_0 + \beta_1 * dLPI_t + \beta_2 * dLPHE_t + \beta_3 * dLPOP65_t + \beta_4 * dLUR_t + \varepsilon_t \quad (2)$$

where $t = 1, 2, \dots, T$ denotes the time index.

The dependent variable $dLHE$ is the log difference of the health expenditure, i.e. the healthcare expenditure growth rate; in a similar fashion, $dLPI$, $dLPHE$, $dLPOP65$, and $dLUR$ are the log differences of the variables PI, PHE, POP65 and UR respectively.

The dataset includes 4 variables over the period from 1991 to 2014 based on the data availability. The per capita healthcare expenditure data is from Kaiser Family Foundation (KFF) health policy research website www.kff.org. The population data is provided by the population unit of forecasting division of Office of Financial Management. The unemployment rate data is from U.S. Bureau of Labor Statistics. The variables statistics are listed in in table 1.

Table 1. Summary statistics 1991- 2014

Variable	Mean	SD	Max	Min
HE	4894	1814	7913	2522
PI	44691	5874	54148	34928
POP65	0.1194	0.0075	0.1410	0.1123
UR	0.06563	0.0148	0.09979	0.0467

Analysis Result

Notice model (1) is linear regression model with time series variables. There potentially exists a spurious regression issue which usually leads to unreliable estimation and inference. However, the con-integration test, here we use Engle-Granger Cointegration Test. The test P- value is 0.01, smaller than 0.05 significance level suggesting cointegration holds. KPSS test is also used against the residuals and the test does not reject the null hypothesis of the residual being stationary. Therefore, model (1) provide statistically reliable result; although we should be cautious when the sample size is relatively small. Table 2 presents the estimation results.

Table 2. Model 1 results

	Estimate	Standard Error	T Value	P value
Intercept	-4.809914	1.637327	-2.938	0.00920
TD	-0.007482	0.006919	-1.081	0.29461
PI	0.515483	0.155334	3.319	0.00406
POP65	0.004975	0.126782	0.039	0.96916
UR	0.044790	0.024815	1.805	0.08882
PHE	0.948834	0.097293	9.752	2.23e-08
R-square	0.9188			
Adjusted R-square	0.9184			
F-Statistic	2756 on 5 and 17 DF, P-value : < 2.2e-16			

The estimated coefficient of PI, i.e., income elasticity corresponding to per capita income, is 0.52, smaller than unity, indicating that healthcare service is a necessary good. More specifically, a 1% point increase in per capita income leads to healthcare expenditure increase by 0.52%, the estimator is statistically significant at 5% level.

Population profile is a central issue on the research of healthcare expenditure. The rate of population POP65 is not significant, a finding agreeing to some recent studies [7]. The estimated coefficient has the expected positive sign. Incidentally, 1% increase of POP65 will raise healthcare expenditure by 0.005%.

The estimated coefficient of PHE is 0.95 and statistically very significant, indicating that the healthcare expenditure shows a very strong inertia effect. With 1% increase of previous expenditure, the current total healthcare expenditure is expected to increase by 0.95%.

The estimator of unemployment rate has an expected sign and significant at 0.1 level. A 1% increase in the unemployment rate leads to healthcare expenditures rising by about 0.045%. This suggests that employment is not only directly related to the whole macro economy, but also related to healthcare expenditure. Considering ongoing COVID-19 pandemic causing large layoff, this finding has very important policy implications.

The time trend TD, which is used to capture the impact of technical progress, surprisingly has a negative sign, and is of very small magnitude and statistically very insignificant. This may be due to our modest time dimension of data.

For model (2), as explained in section 2, the variables are in log difference form. Differencing is generally used to transform the nonstationary variables to stationary variables. In fact, the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) does not reject the null hypothesis of stationarity of the variables in model (2). The estimated results for model 2 are presented in Table 3.

	Estimate	Standard Error	T Value	P value
Intercept	0.02435	0.01370	1.777	0.0934
PI	0.44820	0.21909	2.046	0.0566
POP65	0.05625	0.30601	0.184	0.8563
UR	0.08283	0.03858	2.147	0.0465
PHE	0.32957	0.21942	1.502	0.1514
R-square	0.351			
Adjusted R-square	0.1983			
F-Statistic	3.298 on 4 and 17 DF, p-value: 0.0471			

Table 3. Model 2 results

The per capita income has the biggest impact on the growth of the expenditure, and is statistically significant at 0.1 significance level. 1% increase in the growth of rate per capital income will increase the growth rate of healthcare expenditure by 0.45%. The second biggest contributor to the healthcare expenditure growth rate is the unemployment rate, the estimated coefficient is 0.0828, even significant at 0.05 level. It is worthy to notice that unemployment rate is an important variable determining the level and growth of the healthcare expenditure.

The estimator of the POP65 has positive sign, but insignificant even at 0.1 level. We can conclude that the increase of the growth rate of old population does not necessarily boost the growth of the expenditure, which is in line with previous studies ([6] Fengping Tian etl). This is counterintuitive, but it shows the necessity of the empirical study.

The inertia impact is not significant either in the growth, and this finding is partly consistent with previous studies ([6] Fengping Tian etl). Implementing quantile regression, Tian found that inertia impact was not significant at the 0.90 and 0.95 quantiles but significant at lower lever, and overall impact is not determined.

Conclusion

This study examined the determinants of the healthcare expenditure both in level and growth of Washington State. One determinant of central interest was the age profile represented by the ratio of population of age 65 and over to the total population, our study suggested that the aging did not necessarily contribute to increase of healthcare expenditure both in level and growth rate.

Another focus was the per capital income. We found that an increase of the per capita income led to the increase of the healthcare expenditure; and the higher growth rate of the per capita income would contribute to a higher growth rate of the expenditure. The impact from per capita income were statistically significant in level and growth. Our finding justified the well-established facts that GDP was one of key determinants in healthcare expenditure.

The expenditure inertia was very significant in expenditure level, suggesting that the expenditures dynamics maintain the earlier momentum. However, its significance disappeared in growth. The unemployment rate, were both significant in level and growth. Therefore, addressing the unemployment issue is critical in healthcare, save for its direct impact on economy growth. With current COVID-19 pandemic leading to large-scale layoff, our study suggested that the healthcare expenditure was expected to increase with a higher rate.

Due to data availability, we could not examine the impact from "Baumol variable". The "Baumol variable" was a theoretic determinant in healthcare expenditure literature, and was defined as the difference between real wage growth and productivity growth. The data size used in this study is of modest size if not too small, which is likely the reason that we could not detect the technological change's impact. In addition, for the potential endogeneity issue, the instrumental variables estimation should be implemented, and it usually yields more credible results than OLS. A future study can be conducted to address these issues.

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