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Reexamining the red herring effect on healthcare expenditures☆

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ABSTRACT

Considerable prior research argues that time to death, not population aging, explains the growth of healthcare expenditures. The objective of this study is to shed light on this debate by presenting new evidence on the red herring hypothesis. This study adopts quantile regression analysis to reexamine variations of the red herring effect on healthcare expenditures in Taiwan over the period 2005–2009. Findings show that population aging estimates decrease from positive to negative along quantiles for the whole sample and become insignificant across most quantiles for the subsample of people aged 65 and over. For whole sample and subsample of people aged 65 and over, proximity-to-death coefficients are significantly positive in most quantiles. Moreover, time-to-death estimates show a substantial upward trend towards date of death. In particular, quarters one and two prior to death produce a significant positive impact on healthcare expenditures at the highest healthcare expenditure quantiles. The new empirical evidence from this study provides a more complete picture of the red herring effect on healthcare expenditures.

1. Introduction

Along with economic development, technological advancement in medicine and biotechnology, improvements in hygiene (Thakur, Hsu, & Fontenot, 2012), and gradual population aging, both Taiwan and the Organization for Economic Cooperation and Development (OECD) countries are facing the problem of rapidly rising national healthcare expenditures (HCEs). Fuchs (1999) and Jenson (2007) point out that the growth rate of HCEs exceeds that of GDP in OECD countries over the past three decades. According to the OECD Health Data 2010, the median value of HCEs-to-GDP ratios for OECD countries increases from 8.35% in 1980 to 11.90% in 2008. Understanding HCEs increase causes may assist efficient healthcare policymaking and resources allocation.

Among factors determining HCEs, researches by Denton and Spencer (1983), Barer, Evans, Hertzman, and Lomas (1987), and Marzouk (1991) identify population aging as a major driver of increasing HCEs. Bradford and Max (1997) show that annual healthcare costs for the elderly are approximately four to five times those for people in their early teens. Meerding, Bonneux, Polder, Koopmanschap, and van der Maas (1998) indicate that healthcare costs are the lowest for children, rise slowly throughout adult life, and increase exponentially after age 50.

However, several studies argue that age itself does not explain growth in HCEs after controlling for income or time-to-death (TTD) (Felder, Meier, & Schmitt, 2000; Wickstrøm, Serup-Hansen, & Kristiansen, 2002; Zweifel, Felder, & Meiers, 1999). This evidence suggests the existence of a “red herring” in HCEs. To avoid potential collinearity and causality problems, Zweifel, Felder, and Werblow (2004, 2009) adopt instrumental variables method and conclude that TTD is more important than population aging in explaining high and rising HCEs. Larsson, Kåreholt, and Thorslund (2008) support the red herring hypothesis by evaluating the effect of age and TTD on healthcare for older people in Sweden and conclude that TTD has twice the impact of actual age. Despite positive evidence for the red herring hypothesis, Karlsson and Klohn (2011) use mortality rates to measure TTD effect on HCEs and show aging to be the main predictor of Swedish social care expenditures.

Apart from Swedish evidence of the red herring hypothesis testing, Stearns and Norton (2004), Shang and Goldman (2008), and Weaver, Stearns, Norton, and Spector (2009) use an American data set and find that TTD is the main driver of HCEs and age has limited predictive power. Polder, Barendregt, and Oers (2006) find that HCEs in the last year of life are 13.5 times higher than those in previous years are. However, De Meijer, Koopmanschap, Bago d'Uva, and van Doorslaer

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(2009) conclude that age effect remains relevant in Dutch context and TTD cannot causally affect HCEs and might act as a red herring. There is also evidence on the red herring hypothesis using aggregate data. Bech, Christiansen, Khoman, Lauridsen, and Weale (2011) examine the relationship among population demographics, life expectancy and HCE costs for the EU-15 group of countries. They show that life expectancy is a better predictor of HCEs.

Although the theoretical concept of TTD seems to be quite intuitive, the academic debate over its validity in relation to the content of HCEs remains controversial and empirical evidences from previous studies differ. Most studies on individual HCEs focus on estimating averages over age and use Ordinary Least Squares (OLS) models to explore determinants. However, French and Jones (2004) examine time-series and cross-sectional properties of health costs and find that health cost shocks have a large effect on lifetime wealth, and lognormal distribution fits the overall cross-section but understate the risk of a catastrophic health cost shock. Brown and Finkelstein (2008) also evidence the uneven distribution of long-term care amongst individuals. Moreover, De Nardi, French, and Jones (2010) show that both level and volatility of HCEs increase sharply with age. HCEs tend to fluctuate strongly in the course of patients' lives and vary significantly among individuals.

The problem of using OLS regression models for analyzing HCEs is that the model implicitly assumes that the elasticity of output with respect to the factors is constant through time or across samples. As an alternative to OLS regression, this study uses quantile regression (QR) to examine the heterogeneous effects of population aging on HCEs in Taiwan over the period 2005–2009. QR analysis allows researchers to estimate covariate effects at different points of distribution, and specifically to determine whether aging elasticities are cross-sectionally different (Wang, Yu, & Liu, 2013; Yu, 2011). Findings show that population aging estimates decrease from positive to negative along quantiles for the whole sample and become insignificant across most quantiles for the subsample of people aged 65 and over. For whole sample and subsample of people aged 65 and over, proximity-to-death coefficients are significantly positive in most quantiles. Moreover, TTD estimates show a substantial upward trend towards date of death. In particular, quarters one and two prior to death produce significant positive impact on HCEs at the highest HCE quantiles. The new empirical evidence from this study provides a more complete picture of the red herring effect on HCEs and sheds new empirical insight on the debate of the red herring hypothesis by Zweifel et al. (1999).

To that end, Section 2 introduces research methodology and model. Section 3 presents and discusses empirical results. Section 4 concludes with some remarks.

2. Research methodology

Research on factors determining HCEs usually uses simple or multivariate OLS regression analysis model on the basis of time-series or cross-sectional data. Unlike OLS, QR models allow for a full characterization of the conditional distribution of the dependent variable. Thanks to De Nardi et al. (2010) findings, this study adopts QR analysis to reexamine the heterogeneous effect of HCEs determinants in Taiwan.

Koenker and Bassett (1978) introduce QR, seeking to complement classical linear regression analysis by estimating all parts of the response distribution conditional on the predictor variable. QR analysis provides a more comprehensive characterization of the effects than that by OLS regression. Bao, Lee, and Saltoğlu (2006) support that the main advantage of QR over classical regression is its ability to analyze the whole distribution. Classical regression merely considers central distribution. QR can help to create whole pictures for understanding the relationship between variables for which effects may vary with outcome levels. In addition, QR is more forgiving than OLS because of its being relatively insensitive to outliers and avoiding censoring problems (Conley & Galenson, 1998). Bassett and Koenker (1982) extend median model so that model is applicable to the calculation of the quantiles, their QR does not make any distribution assumptions regarding population, and parameter estimation works nonparametrically.

QR is about looking at conditional quantiles—that is, modeling quantiles of the conditional distribution of the response variable in the form of functions of observed covariates. QR uses least absolute deviations (LAD) method to minimize errors' absolute values. The model for a median linear regression is:

$$y_i = x_i\beta_\theta + \varepsilon_{\theta i}$$

where the assumption is median$(\varepsilon_{\theta i} \mid x_i) = 0$ (specifically, half of errors are positive and half are negative, but they need not average zero as in linear regression). Consequently, the concept above is expandable to any quantile—the 75th percentile, 95th percentile, etc. The estimate involves minimizing the sum of asymmetrically weighted residuals.

$$\min_{\beta}\left[\sum_{t|y_t \geq x_t\beta} \alpha|y_t - x_t\beta| + \sum_{t|y_t < x_t\beta} (1-\alpha)|y_t - x_t\beta|\right]$$

where α is a parameter $(0 < \alpha < 1)$ that represents quantile size, and is also the quantile α of the above variable for examining in QR. When $\alpha = 0.5$, QR is the median regression. Since on this occasion the values of α and $1 - \alpha$ are both 0.5, the above equation changes to $\sum_t |y_t - x_t\beta|$, indicating that values above and below median values get the same weights. To meet the objective, this study follows Zweifel et al. (2004) model and applies QR analysis to investigate the heterogeneous effect of population aging on HCEs in Taiwan over the period 2005–2009. Especially, government projections have a great concern for expenditures dramatic increase on average at stage of TTD. Predictions of future cost distributions (on the basis of regressions omitting TTD as an explanatory variable) will suffer an upward bias if technology or other social factors continue to prolong life. This study justifies reassessment of the value of TTD inclusion in HEC models.

QR model is as follows:

$$\log HCE_i = \beta_{\theta 0} + \beta_{\theta 1}A_1 + \beta_{\theta 2}A_i^2 + \beta_{\theta 3}Sex_i + \beta_{\theta 4}(A_i \cdot Sex_i) + \sum_{q=1}^{7} \gamma_{\theta q} Q_{qi} + \varepsilon \quad (1)$$

where $i = 1, 2, \ldots, n$ represents sample individuals and θ denotes the θth conditional quantile of each distribution. For all case studies, this research derives and uses the 5th, 25th, 50th, 75th and 95th quantiles for validation. The dependent variable in this study is the log-transform HCE for individual i. Main independent variables in this study are patient age (A) and sex (S). Sex is a Boolean variable for gender that takes the value 1 for female and 0 for male. This model also contains the age square to capture a potential nonlinear relation with HCE. A-by-Sex is the term for interaction between age and gender that allows regression lines for men and women to have different slopes. TTD variable is the qth quarter prior to death (Q) with the eighth quarter as the base period.

For comparison purpose, this study runs truncated regression (TR) model with the same variables and samples on the non-zero observations to avoid bias in estimates from OLS model use. As usual with medical spending data, data sets include individuals with zero HCEs. The classical least squares estimator, as is well known, suffers a bias in the presence of truncation. TR model is more efficient than OLS model in this case. The following equation shows TR model:

$$\log HCE_i = \beta_0 + \beta_1 A_1 + \beta_2 A_i^2 + \beta_3 Sex_i + \beta_4(A_i \cdot Sex_i) + \beta_5\lambda + \sum_{q=1}^{7} \gamma_q Q_{qi} + \varepsilon \quad (2)$$

where λ is the inverse Mills ratio that probit model use generates.