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Health Expenditures and Global Inequalities in Longevity

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SUMMARY

Longevity is a key health and development indicator used for cross-country comparisons. Evidence on the effects of country health expenditures on longevity is mixed. We evaluate the heterogeneity in country health expenditure effects throughout the life expectancy distribution worldwide during 2006–11 using quantile regression and an assembled dataset on 175 countries that includes both historic as well as recent data on life expectancy. Our goal is to evaluate the effects of health expenditures across quantiles of the country-level life expectancy distribution to understand whether increasing expenditures are associated with changes in longevity disparities between countries. We find significant heterogeneity in expenditure effects on life expectancy. The largest returns from increased spending are at the left margin of the life expectancy distribution. The results suggest that increasing health spending in countries with low life expectancy may have important returns to life expectancy and significantly diminish global inequalities in longevity and development by reducing the spread of the world's life expectancy distribution.

1. Introduction

Life expectancy is an important marker of population health which is commonly used in estimations of country-level health production functions (Zweifel, Breyer, & Kifmann, 2009). Life expectancy is also one of the key indicators of economic development together with literacy rates and GDP per capita (Dowrick, Dunlop, & Quiggin, 2003). Despite substantial increase in longevity over the 1960s and the 1970, life expectancy started to diverge across countries with different levels of development in the 1980s and, especially, during the 1990s (Ram, 2006). Increasing national spending on health is commonly discussed as one potential intervention for achieving population-wide gains in longevity. However, previous literature has produced mixed results on the effects of population-level health expenditures on average life expectancy across countries.

The mixed empirical evidence summarized below suggests that health expenditure effects on life expectancy may vary between countries, possibly due to differences in population characteristics and economic factors that modify health expenditure effects. This also indicates that health expenditures may have heterogeneous effects between countries at different locations of the world's life expectancy distribution. Such heterogeneity would indicate that global changes in health expenditures would not only shift the world's average life expectancy but also modify the range of (and, thus, disparity in) life expectancy worldwide.

In this paper, we employ quantile regression and a unique country-level dataset to evaluate the heterogeneity in country health expenditure effects at various locations of the world's life expectancy distribution. More importantly, we examine how the spread of the countries' life expectancy distribution changes with spending in order to understand whether increasing expenditures are related to a decrease or increase in the disparities between countries that have low life expectancies and those that have higher life expectancy. To our knowledge, this is the first study to formally evaluate the heterogeneity in returns to life expectancy from health expenditures for countries at different rankings on the world's life expectancy distribution and to investigate the effects of spending on global disparities in longevity.

In the literature that has examined health expenditures and longevity, health expenditures are overall found to be positively related to life expectancy in developed countries (Baltagi, Moscone, & Tosetti, 2012). In one of the earliest studies, Wolfe (1986) finds that when life-style (smoking, drinking, traffic accidents, and occupational hazards), inflation, and population size are accounted for, health expenditures have a positive effect on life expectancy in a sample of developed countries. Shaw, Horrace, and Vogel (2005) evaluate the effects of pharmaceutical versus other

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health expenditures per capita (in addition to other population health characteristics such as smoking, alcohol consumption, and dietary intake) on life expectancy at age 40 and 65 years in 19 OECD countries. The authors report that pharmaceutical spending has a positive effect on life expectancy and that other health expenditures have no significant effect; however, the effect of pharmaceutical spending is sensitive to accounting the age distribution of a given country. Aísa, Clemente, and Pueyo (2014) recently find no conclusive effect of overall health expenditures on life expectancy among OECD countries, although they find an overall significant positive effect from public health expenditures. Crémieux, Ouellette, and Pilon (1999) and Crémieux *et al.* (2005) find that lower health spending is associated with a decrease in life expectancy in relatively homogeneous Canadian provinces. Akkoyunlu, Lichtenberg, Siliverstovs, and Zweifel (2009) find that public health expenditures per capita (together with a measure of pharmaceutical innovation) are associated with higher life expectancy in the United States.

In contrast, the relationship between health spending and life expectancy is less certain for developing countries. Some studies suggest that health spending improves life expectancy in less developed settings. For example, Anand and Ravallion (1993) show that public health spending per person is related to a smaller shortfall of life expectancy from 80 years in a sample of 22 developing countries. Similarly, Husain (2002) finds an increase in life expectancy with health expenditures in a sample of 91 developing countries. Ssozi and Amlani (2015) report overall positive and significant effects from health expenditures on life expectancy in nations in Sub-Saharan Africa, but they find larger effects on more immediate outcomes including nutrition, immunizations, and infections. In contrast, some studies do not suggest an important role for health spending in improving life expectancy in developing countries. For example, McCarthy and Wolf (1999) find that health expenditures are not well predictive of life expectancy in Africa, compared to access to health services, clean water, sanitation, and education. Similarly, Kabir (2008) reports that per capita health expenditures are not a significant predictor of life expectancy in 91 developing countries.

Economic theory would also suggest that health expenditure effects are likely to vary between countries. In particular, one could theorize that increasing health spending in countries that have low life expectancy would bring a larger marginal return to increasing longevity than ones that have higher life expectancy since healthcare may substitute for the lower level of other inputs and enabling factors that are needed for optimal production of population health in the former countries. If improved healthcare can partially compensate for lower levels of other inputs and enabling factors relevant for health such as human capital, wealth, and environmental infrastructures, countries in which life expectancy is low may benefit more from the same amount of increase in health expenditures than those with higher life expectancy.

Following this hypothesis, increasing health expenditures per capita by a small amount may result in much higher returns to life expectancy in countries with low life expectancy where several low-cost improvements in health may still be achieved by treating and preventing infectious diseases that are strongly tied to poor sanitary and economic conditions. In contrast, the same increase in health spending in countries with high life expectancy is unlikely to result in a similar life expectancy gain since the well-established public health and environmental infrastructures and advanced medical technology have already resulted in significant health and longevity improvements (Cutler, Rosen, & Vijan, 2006). Such a heterogeneity does not only occur because of the diminishing marginal returns of health spending, but due to the possibility of substitutions between spending and other economic, social, cultural, and environmental inputs for health. Such substitutions are much less possible in high life expectancy countries than those at lower ones. Therefore, simply accounting for diminishing marginal returns of spending in mean-effect models does not address this heterogeneity. Furthermore, evaluating this heterogeneity cannot be achieved by studying a selective sample of developed or developing countries as stratifying based on the life expectancy distribution will result in sample selection bias (Heckman, 1979).

In the presence of such heterogeneity, focusing on the at-mean effect for the "average" country as done previously would be suboptimal. We employ quantile regression to evaluate this heterogeneity and changes in the spread of the life expectancy distribution. This model is especially useful when substantial heterogeneity exists between the top and bottom parts of the conditional distribution of the outcome (Ram, 2006). In our case, quantile regression estimates spending effects at multiple quantiles of the life expectancy distribution using the *entire* sample of countries for each estimation (and not stratified subsamples), thereby avoiding the sample selection bias from estimating the expenditure effect in subsamples that are essentially stratified by life expectancy ranges as previously done. A particular advantage of quantile regression is that it can be used to trace how the range of the world's life expectancy distribution (not just a single moment like the median) changes with health expenditures. Therefore, we can infer how health expenditures affect disparities in life expectancy worldwide depending on whether they increase or decrease the spread of the life expectancy distribution. We are also attentive to the potential problem of endogenous spending. Controlling for various forms of endogeneity in robustness checks does not modify the main findings.

2. Methods

(a) Estimation approach

Several studies in economics starting from Auster, Leveson, and Sarachek (1969) have estimated health production functions using aggregate data on mortality rates or life expectancy in regions/countries (Zweifel *et al.*, 2009). These models typically estimate life expectancy (or mortality rate) as a function of socioeconomic factors (e.g., income, education), medical inputs (e.g., health expenditures), and other relevant population factors (e.g., demographics). We followed this long tradition in our model specification but employed quantile regression estimation. In particular, our model was based on a country-level analysis of the country's life expectancy as a function of its per capita spending on health, controlling for several measurable economic and demographic characteristics that are conceptually relevant; the country is the unit of the analysis. We evaluated the effects of spending separately for female and male life expectancy because gender stratification (Williamson & Boehmer, 1997) and differences in health and disease epidemiology by gender may modify expenditure effects on life expectancy.

We first modeled the conditional quantiles of life expectancy as follows:

$$LE_{it} = Q\left(\alpha^q + \beta_1^q HE_{i,t-11} + \beta_2^q HE_{i,t-11}^2 + \mathbf{X}_{i,t-1}\psi^q + \mathbf{R}_i\mu^q\right) \quad (1)$$

where for country i in year t, LE is life expectancy, HE is health expenditures per capita, and $\mathbf{X}$ is a vector of 8 demographic and economic control variables described below. Given the substantial variability of life expectancy across regions, we also included 6 WDI regional dummies in vector $\mathbf{R}$ to capture some of the main differences in political and environmental settings and further rule out possible spurious effects of health spending on life expectancy.[1]

[1] The list of regions includes East Asia & Pacific, Europe & Central Asia, Latin America & Caribbean, Middle East & North Africa, North America, South Asia and Sub-Saharan Africa.