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Why has under-5 mortality decreased at such different rates in different countries?☆

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ABSTRACT

Controlling for socioeconomic and geographic factors, under-5 mortality (5q0) in developing countries has been declining at about 2.7% per year, a high rate of 'technical progress'. This paper adduces theoretical and empirical reasons for rejecting the usual specification of homogeneous technical progress across countries and uses a panel of 95 developing countries for the period 1970–2000 to explore the consequences of heterogeneity. Allowing country-specific rates of technical progress sharply reduces the estimated income elasticity of 5q0 and points to country variation in technical progress as the principal source of the (large) cross-country variation in 5q0 decline. Education levels and physician coverage also contribute and are less affected than income of allowing country variation in technical progress. The paper concludes by decomposing 1970–2000 5q0 decline into its different sources for each country.

"The rapidity with which the death rate has declined in most of the underdeveloped areas . . . has been unprecedented. It has never been matched at any time in the now advanced countries . . . it seems clear that the great reduction of mortality in underdeveloped areas since 1940 has been brought about mainly by the discovery of new methods of disease treatment applicable at reasonable cost [and] by the diffusion of these new methods. . . The reduction could be rapid because it did not depend on general economic development or social modernization. . . Though in the literature on public health there is still great lip service paid to the necessity of general economic improvement and community welfare in the control of disease, the truth is that many scourges can be stamped out with none of this. . .". (Davis, 1956)

1. Introduction

The 20th century differed dramatically from previous history in two critically important domains. First, the rapid economic growth that had begun in the 19th century in the countries of the North Atlantic diffused widely around the globe while continuing in the countries where it originated (Maddison, 1999; DeLong, 2000). Second, human mortality rates plummeted. Again, the changes began in the North Atlantic countries in the 19th century but remained modest until the 20th, during which they accelerated and spread to most of the world (Easterlin, 1996, 1999). Life expectancies typically doubled, entailing major immediate improvements in human welfare, dramatic declines in fertility and, in consequence, transformations of the age structures of populations and their economic environment.

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Subsequent to Solow's (1957) assessment of the long-term determinants of income growth in the US, investigators have generated a huge literature on both proximate and deeper-seated determinants of economic growth and on the sources of its variation across countries. Far less attention has been paid to the causes of the mortality transformation, perhaps because its magnitude and rapidity remain less widely known—or are judged less important. Yet, arguably the welfare significance of mortality reduction at least matches that of income growth, and understanding its sources is correspondingly imperative.[1]

Most analysts agree that advances in science and technology underpinned the 20th century transformations of income and mortality levels. Models of economic growth rely heavily on technological progress (defined as changes in total factor productivity) to account for economic growth (Solow, 1957; Boskin and Lau, 2000; Easterly and Levine, 2003). Preston (1975, 1980) and Fuchs (1974) provided early quantitative assessments of the central importance of technical progress for life expectancy increases, something anticipated in the Kingsley Davis quote with which this paper begins. While life expectancy and per capita income correlate across countries at any given time, particularly at low income levels, Preston stressed how much average life expectancy has been increasing over time at any given level of income. Some recent econometric works, however, attribute substantial explanatory power to income variations (see Pritchett and Summers, 1996; Filmer and Pritchett, 1999). Yet many middle-income countries today have life expectancies above 75 years with per capita income levels close to what the US had had around 1900, when US life expectancy was only about 49 years. This simple fact supports a deeper investigation of technical progress in health.

In this context, technical progress is more than just changes in the sophistication of drugs, devices and techniques of medicine. It includes improvements in public health provision and private health practices which affect the adoption of the best techniques.[2] Recent research has either given little emphasis to technical progress—in part simply because much of the research is cross-sectional and therefore ignores developments over time—or it has assumed the rate of technical progress to be constant across countries. But countries differ in how close their health systems come to utilizing the best technology or practice available: the catch-up with the technical frontier may be country-specific. Our purpose in this paper is to model and measure this heterogeneity explicitly.

After introducing our data sources, we explore country-specific technical progress in the decline of under-5 mortality rates or 5q0 (the number of deaths before the fifth birthday per thousand live births). To facilitate estimation, we replace previously used OLS or fixed effects models with hierarchical (or multilevel, varying-effects) models. These models are next used to assess possible correlates of rapid technical progress in mortality decline at the country level. The paper then decomposes improvements in 5q0 into its country-specific constituents, including both country-level determinants explored in previous research and the country-specific rate of technical progress and its determinants.

2. Data

Our data set contains observations for 95 low- and middle-income countries for up to seven five-year intervals between 1970 and 2004. A variable value for a specified year is the average for that country of the data available for that and the following 4 years (so GDP in 2000 is the average of GDP from 2000 to 2004). Eighty-seven countries have data on all the variables in our models and we use only these for some of our results. The countries are listed in Web appendix Table D1. The main variables we use are described in Table 1.

We obtain our 5q0 measure from Rajaratnam et al. (2010).[3] The income variable is real gross domestic product (GDP) per capita in 2000 international dollars from the Penn World Tables (Heston and Summers, 1996; Summers and Heston, 1991), with some missing data interpolated.[4] The educational measure is the average number of years of schooling for women aged between 25 and 34 (Lutz et al., 2007). We also use the number of physicians per 100,000 people, taken from the United Nations (1950–2009) as collected in Banks (2010).

We use a set of geographical and policy variables constructed by Harvard University's Center for International Development to generate improved models of the determinants of economic growth rates, in order to see if they also predict country-specific rates of mortality decline. Gallup et al. (1999) measure the percentage of a country's population living in the geographical tropics (our variable TROPICS) and within 100 km of a coast or navigable waterway (COASTAL). Economic openness (OPENNESS) is the (time-invariant) percentage of years between 1965 and 2003 that the country's economy was considered open estimated in Wacziarg and Welch (2007), which builds on similar work by Sachs and Warner (1995). We also include a health policy measure as a potential determinant of technical progress. The coverage of a child's third immunization with the diphtheria, pertussis, and tetanus vaccine (DPT3) in 1986 (Lim et al., 2008) provided a natural indicator of the extent to which a country's health services are early adopters of powerful mortality reducing technologies.

Table 1 shows that between 1970 and 2000 per capita income and the average female education level both roughly doubled. The average 5q0 was 143 in 1970 and 62 in 2000. The mean decline across all countries over that period was 3.4% per annum. It should be noted that the cross-country *variation* in the rate of 5q0 decline is itself quantitatively important. Fig. 1 displays its distribution. As the histogram shows, there is a dramatic spread across countries. Eight countries reduced 5q0 by less than 0.5% per year, while 11 countries had an annual rate of reduction greater than the 4.3% required to meet Millennium Development Goal 4 (MDG-4), which is to reduce 5q0 by two-thirds between 1990 and 2015.

[1] Easterlin (1996) and Crafts (2000) placed an emphasis on mortality transformation that is comparable to their emphasis on economic growth in their retrospectives on the unprecedented changes in the human condition during the 20th century, whereas DeLong (2000), for example, places far more exclusive emphasis on the growth of income (and on the availability of altogether new material goods). When reasonable estimates of the dollar value of mortality reduction are added to the value of material output growth, however, 20–50% of the growth in total economic welfare has been attributed to mortality reductions for different countries in different eras. Usher (1973) provided the first such estimates; Mokyr and Stein (1997) provided estimates for high-income countries in the late 19th and early 20th century; Nordhaus (2003) provided recent estimates for the US; and Jamison et al. (2013) concluded mortality decline's annual value in low- and middle-income countries to have been worth over 1% of GNI in the period 1990–2011.

[2] Adams et al. (2003) used micro-data to more closely study the causal path between socio-economic variables and improved health. Cutler et al. (2006) provided an excellent recent review of the determinants of health.

[3] The correlation coefficients by year between this series, from UNICEF (2009) and from the 1999 World Development Indicators range from 0.994 to 0.998 depending on the year (authors' calculations). Hill and Amouzou (2006) provided a thoughtful discussion of the difficulties in measuring 5q0, and how those can be addressed.

[4] In Web appendix A we test our model using different data sets for income (measured both by PPP and by the "Atlas Method"), education, physicians per capita, and country samples and find our results to be consistent across these choices of variables.