Notes on Health and Development

Econ 570

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1. Introduction

Relationship between health and gdp growth is important and works in both directions. This is very important for development and transition because health outcomes are measured much better than national income. More important, however, health can be an important factor in economic performance. What makes analysis complicated – and interesting – is that economic performance also impacts on the health environment.[1]

2. A Brief Survey

Life expectancy has risen dramatically during the 20th century (and the 19th too). This must be important for assessments of GDP and for assessing the determinants of GDP. I consider the former below with the concept of *full income*. The latter point is worth noting, however.

2.1. Health and Growth

The effect of economic growth on health is well known. Because the demand for health care is income elastic, rising per-capita income leads to increasing expenditures on health care and improved health status. But the reverse link – from improved health care to economic growth has recently drawn increasing attention. Understanding this link is crucial to the project, though it is difficult due to the presence of causation in both directions.

The natural mechanism that relates health status to economic performance is human capital theory. Health status is a component of an individual's human capital. Poor health reduces both the quality and quantity of labor supply. It also results in low levels of human capital accumulation. Low growth results in poor health outcomes. We will do a comparative

[1] This reverse causality makes estimating the causal effect of health on economic performance difficult, but work in the area usually identifies the effect through timing; using childhood health and nutrition inputs as a determinant of adult wages or taking population health in, say, 1960 as a factor influencing economic growth during 1960–95.

cross-country study for transition economies, with comparisons to similar income-level non-transition economies.

Growth and health are correlated. Health is a normal good so greater income leads to greater expenditure on health care. But the reverse is also true: health status has an effect on growth. Improved health increases the quantity and the efficiency of labor. Improved health not only reduces lost time due to illness. It also increases the intensity of work from a given quantity of labor.[2] It is an investment in human capital, and it increases the return to investing in human capital.[3]

Improvements in health have both level and growth rate effects on per-capita income. Level effects from improved health result from increases in effective labor inputs.[4] Improved health contributes to this in two ways: First by increasing the supply of labor input due to less time missed due to disease. Second, by the increase in the efficiency of labor input due to improvements in the quality of labor when individuals are healthier.[5] Growth rate effects occur because a lower incidence of disease increases the (private and social) rates of return to human capital investment, which, in turn, leads to higher rates of economic growth.

Modern growth theory [Cf. Aghion and Howitt (1998)] distinguishes two channels through which human capital accumulation affects the growth rate.

- One approach – in the tradition of Lucas – argues that differences in growth rates of per-capita income are driven by differences in rates of human capital accumulation. It is straightforward to show how improvements in health increase the return to human capital accumulation, and thus have a direct effect on the growth rate.

- In the second approach – "Schumpeterian" – differences in the level (stock) of human capital affect the capacity of the economy to innovate and catch up with more advanced

[2] Improved health also affects the choice of occupation. Improved allocation of labor can thus result from improvements in health.

[3] Improvements in health status enhance the return to investing in human capital the same way that business insurance increases physical investment.

[4] Economic historians have estimated that up to 50% of the increase in British per-capita income 1790-1950 due to improved nutrition [Fogel (1994: 388)].

[5] Greater nutrition, for example, increases the proportion of energy ingested that can be metabolized – "Atwater effects" [Fogel (1994: 386)].

countries. Since the stock of human capital is correlated with the level of health achievement, it is again straightforward to explain the growth impact of health performance. Although for technological growth is it the extremes that matter, or the average? Probably the extremes.

This suggests that there may be increasing returns to health investment. Improved health leads to more investment in human capital and faster growth in per-capita income. But faster growth in income leads to greater expenditures on health, and thus improved health status. A virtuous circle results.[6]

- Azariadis-Drazen model has an externality from human capital accumulation, but this could come from health.

Some evidence on the role of health on economic growth comes from cross-country regressions. Controlling for other determinants of economic growth, Bloom and Sachs (1998: table 6) show that an increase in life expectancy in 1965 of one percent accounted for an acceleration in GDP per-capita growth of 3% for the subsequent quarter century. One must be careful in assessing this finding, however, as causation runs both ways and life expectancy is an endogenous variable. Still, the finding is suggestive and begs for analysis that can sort through the complications of simultaneity.

If life expectancy in low and middle income countries increases from 44 years in 1960 to 64 years in 2001 then this must help explain increases in per-capita income. People can work harder and longer, even before we consider any behavioral implications of this.

- this is equivalent to an increase in labor-augmenting technical change, at least during the transition to the new level of health. It should raise the steady state capital-labor ratio, measured in efficiency units, and thus accelerate growth in transition.

[6] A crucial question for transition economies is whether such a process works in reverse when there is a negative shock to the economy. Transition has led to a decline in health performance and in per-capita income. Will the feedback from health to growth lead in this case to a vicious circle? The effects of health on growth take very long periods to manifest, but the key question is whether the current deterioration in the health system will have long-lasting effects on economic performance in transition economies.

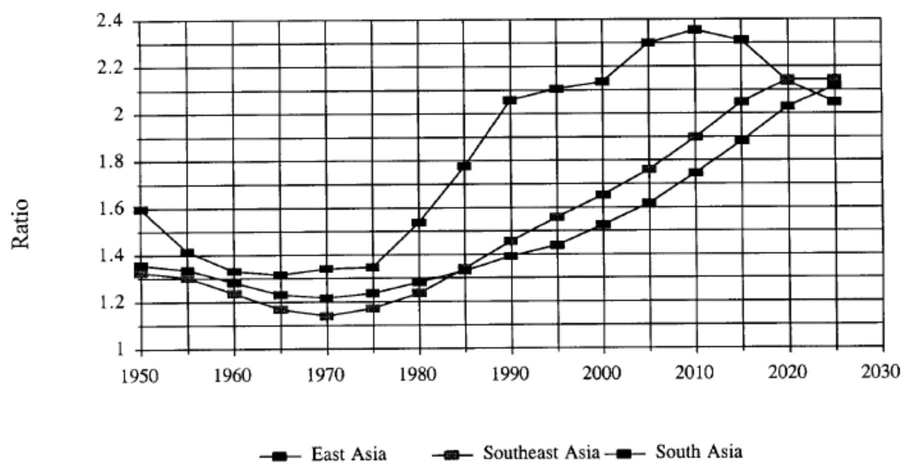

Figure 1: Ratio of Working-Age to Non-Working Age Population

So in cross-country regressions differences in life expectancy may explain differences in performance. We should use initial levels of life expectancy as a conditioning variable. Initial income is insufficient. Two countries with equal y but unequal life expectancies ought to produce different growth outcomes. This is very important if these life expectancies also impact on the choices of subsequent policies.

Notice that if there is a lag between improvements in health and increases in income then conditioning becomes all the more important. For then, countries with good health but low incomes would be predicted to grow faster than otherwise similar economies.

This is clearly the case for East Asian countries. Much recent evidence attributes this growth to rapid accumulation of factor inputs, labor, human capital, and physical capital. All of these are impacted by health issues. Life expectancy, for example, rose from 39 years in 1960 to 67 in 1990. The ratio of working-age people (15-64) to dependents (0-14 and over 65) rose from 1.3 to over 2. See, for example, figure 1 This meant more factor inputs and more savings that could be plowed into capital.[7] Greater life expectancy led to greater saving for retirement. Greater life expectancy led to more human capital accumulation.

Asia's demographic transition followed the stylized model by starting with a decline in

[7] Of course this is not a steady-state effect but it had a major growth impact precisely when growth accelerated.

mortality rates.

- By the late 1940s, the crude death rate had begun to decline very rapidly throughout much of Asia. The decline proceeded most rapidly in East Asia and was accompanied by an increase in life expectancy from 61.2 to 74.6 years from 1960 to 1992. Similar declines occurred in Southeast and South Asia, where life expectancy improved from 51.6 to 67.2 years and from 46.9 to 60.6 years, respectively.
- In the 1950s and 1960s, most of the aggregate decline in mortality was driven by declines in mortality among the youngest cohorts (Bloom and Williamson 1997).
- There are a number of possible explanations for the rapid decline in child mortality in Asia in the middle of this century.
  - One possibility is that in the 1940s Asia escaped from some four or five decades of relative isolation, ushering in an era of transfer and diffusion of new public health programs, technologies, and techniques. For example, the medical advances that were implemented in postwar Asia had been accumulating on the technological shelf for at least two decades: penicillin , sulfa drugs, and bacitracin in 1943; streptomycin was isolated in 1943, etc.
  - With the advent of these and other drugs, diseases that had once killed hundreds of thousands, and even millions, became treatable at low cost. In addition, the pesticide DDT became available in 1943.[8]
- Another possibility is that increased agricultural productivity and trade in food both improved nutrition sufficiently to lower infant mortality dramatically in less than a decade and did so everywhere in Asia. This may be true, but it seems unlikely given that the magnitude and timing of the decline in mortality were so similar everywhere in Asia, regardless of level of development and agricultural productivity.

[8] To cite just one example, DDT spraying in the late 1940s dramatically reduced the incidence of malaria in Sri Lanka: the crude death rate declined from 21.5 to 12.6 between 1945 and 1950, with the most precipitous drops in the most malarial areas (Livi-Bacci 1992).

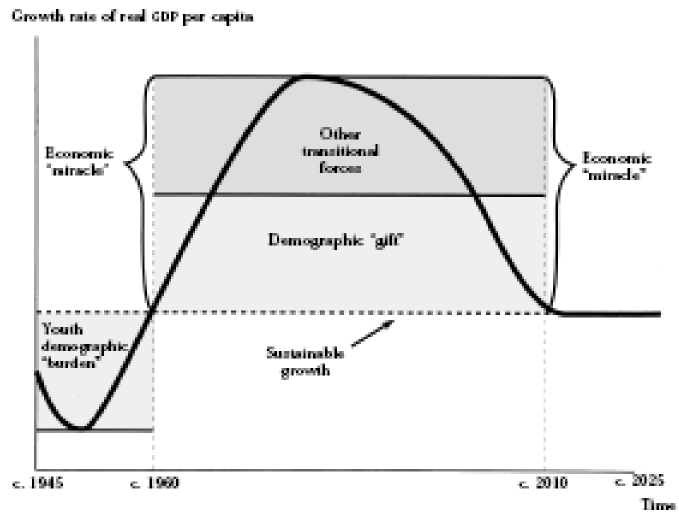

Figure 2: A Stylistic Model of East Asian Miracle

- In any case, fertility soon fell as child survivor rates rose.

What occurs then is the dynamics of demography as in figure 1. In the early period dependency increases and growth slows. Then by the 80's the dependency ratio reverses.

- in the early stages of the demographic transition, rising youth dependency burdens and falling shares of working-age adults diminish the growth of per capita income. As the transition proceeds, falling youth dependency burdens and rising shares of working-age adults promote the growth of per capita income. The early burden of having few workers and savers becomes a potential gift: a disproportionately high share of working-age adults. Later, the economic gift dissipates, as the share of elderly rises.

- Thus growth is first slowed due to the burden and then accelerates due to the dividend. The idea is given in figure 2

2.1.1. Bloom and Williamson

There point is that changes in demographics can alter the growth rate. So if countries go thru favorable demographic changes this leads to a dividend.

- Define the growth rate of per-worker output as $y_{it} = \ln\left[\frac{Y_{it}}{Y_{i,t-1}}\right]$, then the growth rate over the interval $t, t+k$ is

$$y_{i,[t,t+k]} = \frac{1}{k}\ln\left[\frac{Y_{i,t+k}}{Y_{it}}\right] \tag{1}$$

from the neoclassical growth model we assume that growth is a function of the distance from steady state:

$$y_{i,[t,t+k]} = -\lambda\left[Y_{it} - Y_i^*\right] \tag{2}$$

where $\lambda > 0$ and Y^* is the steady-state level of output per worker.

- We assume that $Y^* = \beta X$, where X is a matrix with z determinants of the steady state.

- We are interested in per-*capita* income growth, but we have an expression for per-*worker* growth. We note that the former can be written as

$$\widetilde{Y} \equiv \frac{Q}{N} = \frac{Q}{L}\frac{L}{N} = Y\frac{L}{N} \tag{3}$$

If we take logs and differentiate with respect to time, then

$$\widetilde{y} = y + g_L - g_N$$

- Suppose we estimate a Barro-type cross-country regression for *per-capita* output. Then we have

$$y_{i,[t,t+k]} = \pi_1 X + \pi_2 Y_{it} + \pi_3 g_L - \pi_4 g_N \tag{4}$$

where clearly π_1 and π_2 depend on the speed of convergence λ. The important point is that in steady-state $g_L = g_N$ so we should expect $\pi_3 = -\pi_4 = 1$. Hence, normally we ignore this effect – net demographic effects wash out.

- But if the economy is demographically unstable, then there could be something from these last two terms.

- many years ago demographers worried that too high a dependency ratio would slow growth. But it could also be the case that per-capita output can accelerate if $g_L > g_N$. Notice that this could happen due to increased nutrition, or due to changing demographics.

- both the sources of population growth and the stage of the demographic transition do matter:
  - both a decline in child mortality and a baby boom raise the share of young dependents in the population;
  - a decline in mortality among the elderly increases the share of the retired dependent age cohort;
  - immigration raises the working-age population (because it self-selects young adults);
  - and improved mortality among the population at large has no impact on age structure at all.

- Because an economy's productive capacity is linked directly to the size of its working-age population relative to its total population, distinguishing between the two components when exploring the impact of demographic change on economic performance seems natural and worthwhile.

Consider then Bloom and Williamson's table 3 which confirms that the growth of the working-age population has a powerful, positive impact on growth of GDP per capita, while growth of the total population has a powerful negative impact after controlling for other expected influences.

- Consider the results reported in column 1b of table 3.
  - The coefficient on the growth rate of the working-age population is positive, statistically significant, and large in magnitude: an increase of 1 percent in the growth

Table 3. *The Effects of Growth in the Population and the Economically Active Population on Economic Growth, 1965–90*

Variable	*1a*	*1b*	*2a*	*2b*
Growth rate of economically active population, 1965–90	1.95	1.46		
	(0.38)	(0.34)		
Population growth rate, 1965–90	−1.87	−1.03		
	(0.43)	(0.40)		
Difference in growth rates[a]			1.97	1.68
			(0.38)	(0.35)
GDP per capita as a ratio of U.S. GDP per capita, 1965 (logged)	−1.36	−2.00	−1.39	−1.97
	(0.21)	(0.21)	(0.21)	(0.22)
Log life expectancy, 1960		3.96		2.94
		(0.97)		(0.97)
Log years of secondary schooling, 1965	0.50	0.22	0.50	0.28
	(0.16)	(0.14)	(0.16)	(0.14)
Natural resource abundance	−4.86	−2.35	−4.86	−2.57
	(1.2)	(1.0)	(1.1)	(1.1)
Openness	2.06	1.92	2.00	1.72
	(0.40)	(0.32)	(0.38)	(0.33)
Quality of institutions	0.23	0.20	0.22	0.15
	(0.08)	(0.07)	(0.08)	(0.07)
Access to ports dummy	−0.35	−0.64	−0.31	−0.40
	(0.34)	(0.27)	(0.32)	(0.27)
Average government savings rate, 1970–90	0.14	0.12	0.14	0.13
	(0.03)	(0.03)	(0.03)	(0.03)
Tropics dummy		−1.31		−1.20
		(0.30)		(0.31)
Ratio of coastline to land area		0.24		0.23
		(0.11)		(0.12)
Constant	−2.46	−19.5	−2.28	−14.3
	(0.79)	(4.3)	(0.69)	(4.1)
Adjusted R^2	0.76	0.86	0.78	0.85
$F(1, 68)$[b]	0.22; Prob > F = 0.64			
$F(1, 64)$[b]		9.03; Prob > F = 0.003		

Note: The dependent variable is the growth rate of real GDP per capita in 1965–90 in purchasing power parity terms. Estimates are from ordinary least squares. The sample size is 78 economies (see the appendix). Standard errors are reported in parentheses.

a. Growth rate of the economically active population minus growth rate of the total population, 1965–90.

b. Test of the null hypothesis that the population growth rate equals the negative of the growth rate of the economically active population between 1965 and 1990.

Source: Authors' calculations.

Figure 3:

rate of the working-age population is associated with an increase of 1.46 percent in the growth rate of GDP per capita.

- The coefficient on the growth rate of the total population is negative, statistically significant, and almost as large: an increase of 1 percent in the growth rate of the overall population (effectively, the dependent population, since the empirical specification holds fixed the growth rate of the working-age population) is associated with a decrease of 1.03 percent in the growth rate of GDP per capita.

- One should worry about reverse causality here: from economic growth to demographic – but when they use instruments their estimates do not change.

- They also show that if the dependency group is broken down into youth and elderly that the *former* are a larger drag. The seemingly dependent elderly contribute more to growth than the dependent youth – good for Russia if true.

- How large is the contribution of demographic change to economic miracle? They say large.
  - two channels
    - increase in hours worked per person
    - increase in savings (but very hard to control for endogeneity here)

2.2. Full Income

These considerations also imply that GDP may not be the best measure of welfare. Consider two economies with similar GDP's but different health levels. They clearly do not produce similar levels of welfare for their inhabitants (nor will projections of the future be the same). To adjust for this, some researchers use estimates of the value of a statistical life (VSL). The latter is derived from observed willingness to pay to reduce risk.[9] Using this one can look at changes in "full income" by adding the value of changes in annual mortality rates (calculated using VSL's) to changes in gdp per-capita. These studies tend to give a different view on inequality: *full income* inequality fell sooner in the developing world than income inequality itself. Some studies find strong evidence for full-income convergence, even if there is evidence of divergence in gdp per-capita.

3. Implications for Other Work

This is interesting because of the settler mortality instrument. Recall the idea is that settler mortality is correlated with institutional choice, but not with other factors that predict

[9] Suppose, for example, a worker requires (and is paid) \$500 a year of additional pay to accept a more risky but otherwise similar job, where the increase in the mortality rate is 1 in 10,000 a year, the value placed on reducing risk by this magnitude is simply \$500. The value of a statistical life is defined as the observed amount required to accept a risk divided by the level of the risk—that is, in the example we have chosen, the VSL would be $\frac{\$500}{(1/10{,}000)} = \$5,000,000$, a number in the range of estimates for the United States today. Willingness to pay to avoid risks rises, not surprisingly, with income. A reasonable range of values for a country's VSL appears to be 100–200 times GDP per capita, with values estimated in richer countries more likely to occur toward the high end of the range.

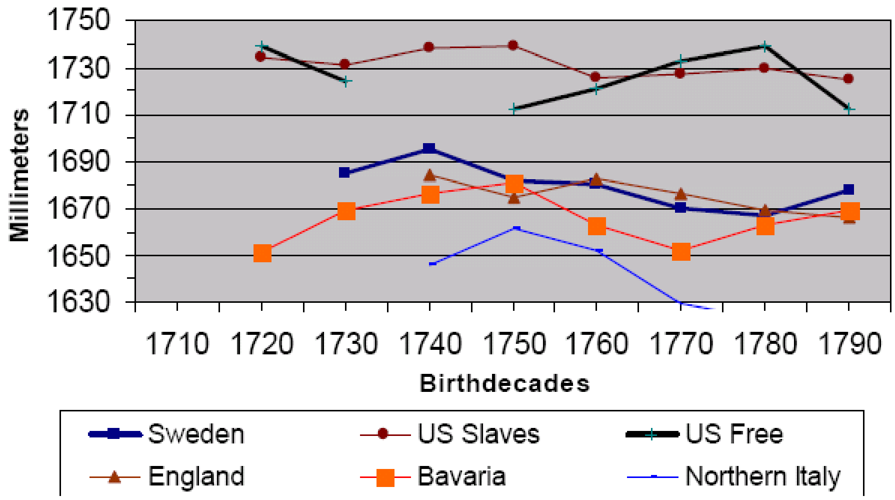

Figure 4: International Comparison of Adult Heights

growth in income in later centuries. The results on health may, however, alter how we view this.

Consider that low settler mortality implies greater average health levels. Less disease. This leads to better anthropometric outcomes. Healthier people can work longer and harder. This directly raises per-capita income.

- The average height of soldiers who fought in the American Revolutionary War was an astonishing 173 cm (68 inches), well above European standards for a very long time to come (see Figure 4). This result made it clear that the abundant natural resources of parts of the New World, combined with the propitious disease environment, low population density, and productivity of the American population, conferred considerable – until then unknown - biological advantages on its inhabitants. Even American adult slaves were tall by modern standards. Indeed, they were about as tall as American urban workers. More importantly, those born on American soil were actually taller – had a higher nutritional status-than the African populations from which they originated.

- Anthropometric research on heights is very interesting because heights are very related to the disease environment. Eradication of early childhood disease is an important contributor to increased height.

Moreover, healthier environments will impact on agents' behavior decisions. Healthier agents accumulate more human capital. They also save more for retirement (important precisely for the echo when population starts to rise). This creates a better economic environment for adoption of new technologies. Greater savings plus more educated workforce.

- Glaeser, et al. suggest that colonialists brought better human capital with them (rather than institutions). In addition, I am arguing that better health environments allowed for further human capital accumulation in such regions
- The Glaeser et al. effect is that the initial stock of human capital is negatively correlated with SM. I am arguing, in addition, that the ability to accumulate hc is negatively correlated with SM.

Thus, even if colonists imposed the same institutions in dense and sparsely populated areas we would expect on (predicted-) health outcomes alone that the sparsely populated regions would do better because of the better health environments. This further suggests that the appropriate test would require estimating the impact of institutions as the residual effect once the better health environment is accounted for.

- notice that that human capital effect on growth, like that of institutions, is going to occur with a lag because human capital becomes important for growth later in the process (i.e., during industrialization), just like institutions.

We might also expect that fdi will be related to health outcomes. But this could clearly be related to settler mortality and flow for the same reason. If regions had high settler mortality they may get less fdi. Improvements in health would then lead to more fdi, and to subsequently higher growth. Lags could be long, however.