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NÚMERO 212

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**LIFE EXPECTANCY CONDITIONS THE ECONOMIC
GROWTH DISTRIBUTION**

Abstract

We show that when the distribution of economic growth is classified by life expectancy, significant and changing structural features emerge. The period 1960-1980 shows a non-linear dependence of average growth on life expectancy for which low health slows growth below some threshold. The period 1980-1998 shows emerging income stratification and a greater impact of health, low health countries growing negatively. The non-linear, non-time-homogenous results are much more interesting and significant than those obtained for health in cross-country regressions.

Resumen

Mostramos que cuando se clasifica el crecimiento económico de los países de acuerdo a la esperanza de vida, se evidencian características estructurales cambiantes significativas. El periodo 1960-1980 muestra una dependencia no lineal del crecimiento promedio respecto de la esperanza de vida. Niveles bajos de salud frenan el crecimiento debajo de cierto umbral. El periodo 1980-1998 muestra una estratificación emergente del ingreso y un mayor impacto de la salud, en el que países con bajos niveles de salud tuvieron un crecimiento negativo. Estos resultados no lineales y no homogéneos en el tiempo son mucho más interesantes y significativos que los que se obtienen para la salud en las regresiones típicas.

Introduction

We show that when the distribution of economic growth is classified by life expectancy, significant and changing structural features emerge. The period 1960-1980 shows a non-linear dependence of average growth on life expectancy for which low health slows growth below some threshold. The period 1980-1998 shows emerging income stratification and a greater impact of health, low health countries growing negatively. The non-linear, non-time-homogenous results are much more interesting and significant than those obtained for health in cross-country regressions.

1. Health and economic growth

The correlation between health and income is well known. Preston (1975) showed that life expectancy is positively correlated with income, with higher levels of life expectancy achieved for equivalent levels of income in later periods. The impact of income on health has been further corroborated by Pritchett and Summers (1996). Nevertheless, the causal relation between health and income runs in both directions. Fogel (1994) finds that a third of the economic growth in Great Britain during the last 200 years can be accounted for by increased nutrition and health. Empirical studies including health indicators in cross-country convergence models have found evidence of a positive, significant, and sizable influence of life expectancy on economic growth (e.g. Barro, 1991). Mayer (2001a) shows that health has had a long-term impact on economic growth in Latin America during the period 1950-1990. Microeconomic research has focused on the role of health in human capital investment and returns (see Strauss and Thomas in the *Handbook of Development Economics* and Schultz, 1999, for surveys). The validity that has been established for anthropometric measures of population health such as height and weight now rivals that of aggregate measures of income as standard of living indicators (e.g. Steckel, 1995).

The long-term mutually causal interrelation maintained by health with income has led important decision making bodies such as the World Bank (1993) and the Pan American and World Health Organizations (WHO, 1999) to ask how and to what extent health achievements affect economic development, so as to establish the policy implications for development.

The purpose of this letter is to note that when economic growth is classified by life expectancy, the resulting conditional distributions are significantly different. We find for the periods 1960-1980, 1980-1998, that life expectancy is an important and significant predictor of average attained economic growth. During both periods, average growth was significantly lower for countries with low life expectancies. These countries grew even slower during the second period, compared both to the

first period and to healthier countries. The findings suggest the existence of a long-term health-related poverty or slow-growth trap. They are also consistent with the recent stratification of income that other studies have found (e.g. Quah, 1997) and suggest that health may be involved in the underlying mechanisms. Our descriptive results demonstrate the impact of life expectancy on economic growth much more clearly than convergence studies, and reveal the presence of important non-linearities and of heterogeneity over time. The increased influence of health that we detect may be linked with the increased share of human capital in production in the last two decades.

2. Attained economic growth conditional on life expectancy

Our cross-country life expectancy data is obtained from the Barro Lee data set. For the income data we use purchasing power parity income per capita from the World Bank.¹ The balanced sample includes 110 countries for the period 1960-1980 and 94 countries for 1980-1998. Let $LE_{1,j,1960}, \dots, LE_{5,j,1960}$ be dummy variables equal to one when the 1960 life expectancy of country j lay in the intervals $[30, 40)$, $[40, 50)$, $[50, 60)$, $[60, 70)$, $[70, \infty)$ respectively, and zero otherwise. Define the corresponding variables for 1980. We estimate the simultaneous system of equations

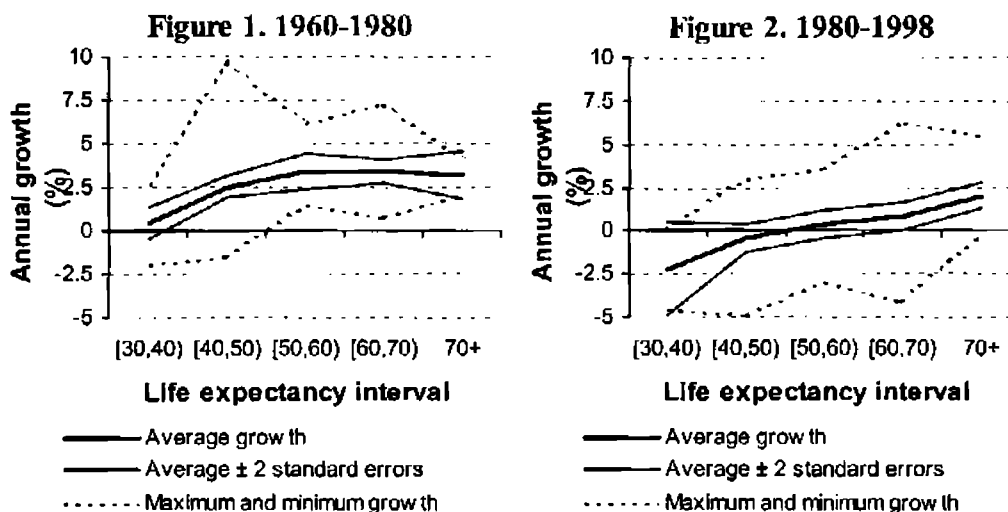
$$g_{1960-1980,j} = \alpha_{11} LE_{1,j,1960} + \dots + \alpha_{51} LE_{5,j,1960} + u_{j1} \quad (1)$$

$$g_{1980-1998,j} = \alpha_{12} LE_{1,j,1980} + \dots + \alpha_{52} LE_{5,j,1980} + u_{j2} \quad (2)$$

using ordinary least squares, where $g_{1960-1980,j}$, $g_{1980-1998,j}$ are the average annual growth rates of income per capita for the periods 1960-1980 and 1980-1998. Thus, $\alpha_{11}, \dots, \alpha_{51}, \alpha_{12}, \dots, \alpha_{52}$, are the means of the distributions of attained economic growth for each period, conditional on initial life expectancy lying in the interval defining each corresponding dummy variable.

We use a system of regressions to estimate the conditional means because they supply standard errors for their estimates and Wald tests for the significance of the differences between any of the means. It is noteworthy, however, that the R^2 obtained for each regression, 0.24 and 0.23, is quite high for estimates of economic growth, confirming that the health indicators carry a considerable amount of information.

Annual Economic Growth According to Initial Life Expectancy
(Average, significance, maximum and minimum)



Figures 1 and 2 show graphs of a) the coefficients of the first and second equations; b) their significance, by plotting lines 2 standard errors above and below; and c) the maximum and minimum growth rates for each life expectancy interval.¹ Tables 1 to 3 in the Appendix show the results of applying the Wald test for the equality of coefficients by pairs for each equation and by pairs for corresponding coefficients in both equations. These results corroborate the significance of the shapes of Figures 1 and 2, and of the differences between them.

During the period 1960-1980 countries with initial life expectancies less than 50 grew slower than countries with higher life expectancies. The less their life expectancy the less they grew. Countries with life expectancies above 50 grew at an average annual rate of approximately 3.3%, which diminished somewhat insignificantly for higher life expectancies. Hence during this period a non-linear threshold relation held between health and economic growth. Together with the twin-peaked nature of the cross-country distribution of life expectancy over the period 1960-1997, and with the dynamic invariance of the low life expectancy peak (Mayer, 2001b) this suggests the presence of a health-related poverty or slow-growth trap for low levels of health. The mean growth rates are consistent with convergence during this period only for countries with life expectancies above 50.

During the period 1980-1998 countries grew faster the higher their initial life expectancies. Countries with life expectancy less than 50 grew negatively, while countries with life expectancies above 70 grew significantly higher than the rest at 2%. Countries in each life expectancy interval grew significantly less than during the

previous 20 year period, especially for life expectancies below 70. Thus the two periods being described are qualitatively very different. The observed average growth rates are consistent with the emerging cross-country income stratification mentioned above. A possible explanation for the change in dynamics may be the entry into a period of rapid technological change. Life expectancy may be a determinant, or an indicator, of educational levels. This relation, an increasing dependence for technological absorption on the levels of skill of wider sectors of the population, and the reduction of real wages for the unskilled at the world level during the eighties and nineties, may underlie the divergent growth pattern observed across levels of health. In addition, health may be a part, or an indicator, of the social infrastructure that Hall and Jones (1999) allude to so as to explain productivity differences between countries.

3. Concluding remarks

The results of our simple descriptive analysis are stronger and deeper than those found by convergence studies. The classification of economic growth by life expectancy levels indicates a strong, qualitative interaction of health with economic growth, and yields more significant results than can be obtained classifying growth by income or education. Countries with low life expectancies grew less during 1960-1980 and had negative growth during 1980-1998. During the first period we observe a non-linear relation between health and economic growth that is consistent with a health-related poverty or low growth trap. In the second period we observe slower growth and even larger differences in the average growth of countries at different life expectancy levels. The observed growth rates are consistent with an emerging stratification of income. They imply divergence and are inconsistent with convergence.³ To explain them it is necessary to understand *negative* growth and its connection with health. A full understanding of the empirical facts found by classifying economic growth according to life expectancy levels requires understanding how health influences economic growth and the mechanisms that have produced income divergence in the last two decades.

Appendix. Tables of results of the Wald coefficient tests

Wald test of equality for regression coefficients by pairs

(p values to three decimals)

Table 1. Coefficients for 1960-1980

=	α_{21}	α_{31}	α_{41}	α_{51}
α_{11}	0.000	0.000	0.000	0.001
α_{21}		0.125	0.041	0.375
α_{31}			0.963	0.765
α_{41}				0.711

Table 2. Coefficients for 1980-1998

=	α_{22}	α_{32}	α_{42}	α_{52}
α_{12}	0.207	0.068	0.031	0.002
α_{22}		0.170	0.029	0.000
α_{32}			0.410	0.002
α_{42}				0.026

Table 3. Comparison of the coefficients for both periods

$\alpha_{11} = \alpha_{12}$	$\alpha_{21} = \alpha_{22}$	$\alpha_{31} = \alpha_{32}$	$\alpha_{41} = \alpha_{42}$	$\alpha_{51} = \alpha_{52}$
0.061	0.000	0.000	0.000	0.123

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¹For the 1960 and 1980 life expectancies we use the averages of the two average life expectancies given by Barro Lee in their well-known database. The World Bank data can be found at <http://www.worldbank.org/research/growth/GDNdata.htm>.

²The number of countries in each life expectancy interval is 17, 41, 14, 30, 8, for the first and 2, 22, 21, 27 for the second period.

³Indeed, if lower health, through its correlation with lower income, implies through convergence higher economic growth, the impact of health as measured by the coefficients α_2 is an underestimate. An analysis including both convergence and health-related divergence effects requires careful modeling of what would in effect be a health-related poverty or slow-growth trap. Here we prefer to remain at the descriptive level.