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**Article**

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and D. Sul, "Nominal Exchange Rates and Monetary Fundamentals: Evidence from a Small Post-Bretton Woods Panel," *Journal of International Economics*, 53 (1) February 2001, pp. 29-52.

<sup>19</sup> Y. Cheung, M. D. Chinn and A. G. Pascual, "Empirical Exchange Rate Models of the Nineties: Are Any Fit to Survive?" NBER Working Paper No. 9393,

December 2002.

<sup>20</sup> Y. Cheung and M. D. Chinn, "Integration, Cointegration, and the Forecast Consistency of Structural Exchange Rate Models," *Journal of International Money and Finance*, 17 (5) (1998), pp. 813-30.

<sup>21</sup> These results are confirmed in a related paper which also assesses in-sample fit. See Y. Cheung, M. D. Chinn and A. G. Pascual,

"What Do We Know about Recent Exchange Rate Models? In-Sample Fit and Out-of-Sample Performance Evaluated," mimeo (October 2002), forthcoming in P. DeGrauwe, ed., *Exchange Rate Economics: Where Do We Stand?* Cambridge: MIT Press for CESifo.

## Health, Income, and Inequality

Angus Deaton\*

Richer, better-educated people live longer than poorer, less-educated people. According to calculations from the National Longitudinal Mortality Survey which tracks the mortality of people originally interviewed in the CPS and other surveys, people whose family income in 1980 was greater than \$50,000, putting them in the top 5 percent of incomes, had a life-expectancy at all ages that was about 25 percent longer than those in the bottom 5 percent, whose family income was less than \$5,000. Lower mortality and morbidity is associated with almost any positive indicator of socioeconomic status, a relationship that has come to be known as "the gradient." African-Americans have higher but Hispanic Americans lower mortality rates than whites; the latter is known as the "Hispanic paradox," so strong is the presumption that socioeconomic status is protective of health. Not only are wealth, income, education, and occupational grade protective, but so are several more exotic indicators. One study found that life-spans were longer on larger gravestones, another that winners of Oscars live nearly four years longer than those who were

nominated but did not win.

Many economists have attributed these correlations to the effects of education, arguing that more educated people are better able to understand and use health information, and are better placed to benefit from the healthcare system. Economists also have emphasized the negative correlation between socioeconomic status and various risky behaviors, such as smoking, binge drinking, obesity, and lack of exercise. They have also pointed to mechanisms that run from health to earnings, education, and labor force participation, and to the role of potential third factors, such as discount rates, that affect both education and health.

Epidemiologists argue that the economists' explanations at best can explain only a small part of the gradient; they argue that socioeconomic status is a *fundamental cause* of health. They frequently endorse measures to improve health through manipulating socioeconomic status, not only by improving education but also by increasing or redistributing incomes. Fiscal policy is seen as an instrument of *public health*, an argument that is reinforced by ideas, particularly associated with Richard Wilkinson, that income inequality, like air pollution or toxic radiation, is itself a health hazard. Even if economic policy has no direct effect on health, the positive correlation between health and economic status implies that social inequalities in

wellbeing are wider than would be recognized by looking at income alone.<sup>1</sup>

### Income and Education among Cohorts and Individuals

Christina Paxson and I<sup>2</sup> looked at the relationship between health and economic status among American birth cohorts. We focused on the idea that health is determined by an individual's income relative to other members of a reference group whose membership typically is unobserved by the analyst. Even if income inequality has no direct effect on health, the fact that the reference groups are not observed means that the slope of the relationship between health and income depends on the ratio of the between-to-within group components of income inequality. For example, if doctors' health depends on the income of other doctors, and economists' health on the income of other economists, then the health-to-income relationship in the pooled data will flatten if the average incomes of the two groups pulls apart.<sup>3</sup>

Among birth cohorts there is a strong protective effect of income on mortality; the elasticity of mortality rates with respect to income is approximately -0.5. These estimates are consistent with estimates from the individual data in the National Longitudinal

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Mortality Study (NLMS), and show much the same pattern over the life cycle, with income most highly protective against mortality in middle age, in the mid-40s for women and the mid-50s for men. Although it is difficult to test for reverse causality in the cohort data, we can experiment in the NLMS by looking at the effects of income at the time of interview on the probability of death over an interval some years later, thus eliminating or at least reducing the effects of including in the sample people who are already sick, and whose income is already reduced by the illness that will later kill them. Somewhat surprisingly, there is only a small reduction in the estimated protective effects of income as we move the death interval forward from the date of interview.

Paxson and I also look at the respective roles of education and income in protecting health. In both cohort and individual data, income and education are protective when analyzed separately. Taken together, the picture depends on the level of aggregation. In the *individual* data, the effect of each is robust to allowing for the other, which is consistent with the view that both education and income promote health in different ways. Education makes it easier to use and benefit from new health information and technologies and income makes life easier more generally, reducing stress and wear and tear, for example by having help to look after the children, or the money to buy first class travel. In the *aggregated* cohort data, income and education are more highly correlated than in the individual data, so it is harder to distinguish their effects. Nevertheless, we find that, conditional on education, increases in cohort average income are hazardous to health, a finding that is consistent with other evidence of hazardous effects of income variation over the business cycle.<sup>4,5</sup> Parallel work on British birth cohorts also shows a protective effect of education, although an additional year of schooling is much less protective in Britain than in the United States.<sup>6</sup> Still, cohort income is never estimated to be protective of cohort mortality in Britain, whether analyzed in isolation or in competition

with education. Interestingly, analysis of MSA averages shows similar results to the American birth cohorts; cities with higher average education or higher average income have lower mortality, but conditional on average income, the correlation between income and mortality is negative.<sup>7</sup> The contrast between the effects of income in the individual and aggregate data remains an important unresolved puzzle.

## Inequality, Race, and Health

Why might income inequality be a health hazard, and what accounts for the fact that people die earlier in American states and cities where income inequality is higher? If income is protective of health, and the relationship is concave, then redistribution from rich to poor will improve aggregate health, although this effect appears to be too small to explain the geographical patterns in the United States. If health depends on *others'* incomes, for example if health is linked to *relative* deprivation, then income will be protective of health for individuals, and income inequality will be hazardous to health in the aggregate.<sup>8</sup> But if the NLMS is used to look at the probability of death as a function of income for white males and females on a state by state basis, there is no evidence of any link between the estimated coefficients and state-level measures of income inequality.

Darren Lubotsky and I<sup>9</sup> have investigated the relationship between income inequality, race, and mortality at both the state and metropolitan statistical area level. In both the state and the city data, mortality is positively and significantly correlated with almost any measure of income inequality. Because whites have higher incomes and lower mortality rates than blacks, places where the population has a large fraction of blacks are also places where both mortality and income inequality are relatively high. However, the relationship is robust to controlling for average income (or poverty rates) and also holds, albeit less strongly, for black and white mortality separately. Nevertheless, it turns out that race is

indeed the crucial omitted variable. In states, cities, and counties with a higher fraction of African-Americans, white incomes are higher and black incomes are lower, so that income inequality (through its interracial component) is higher in places with a high fraction black. It is also true that *both* white and black mortality rates are higher in places with a higher fraction black and that, once we control for the fraction black, income inequality has no effect on mortality rates, a result that has been replicated by Victor Fuchs, Mark McClellan, and Jonathan Skinner<sup>9</sup> using the Medicare records data. This result is consistent with the lack of any relationship between income inequality and mortality across Canadian or Australian provinces, where race does not have the same salience. Our finding is robust; it holds for a wide range of inequality measures; it holds for men and women separately; it holds when we control for average education; and it holds once we abandon age-adjusted mortality and look at mortality at specific ages. None of this tells us why the correlation exists, and what it is about cities with substantial black populations that causes both whites and blacks to die sooner.

In a review of the literature on inequality and health, I note that Wilkinson's original evidence, which was (and in many quarters is still) widely accepted showed a negative cross-country relationship between life expectancy and income inequality, not only in levels but also, and more impressively, in changes. But subsequent work has shown that these findings were the result of the use of unreliable and outdated information on income inequality, and that they do not appear if recent, high quality data are used. There are now also a large number of individual level studies exploring the health consequences of ambient income inequality and none of these provide any convincing evidence that inequality is a health hazard. Indeed, the only robust correlations appear to be those among U.S. cities and states (discussed above) which, as we have seen, vanish once we control for racial composition. I suggest that inequality may indeed be important for

health, but that *income* inequality is less important than other dimensions, such as political or gender inequality.<sup>10</sup>

## Social versus Medical Determinants of Health

Most of the work on inequality, income, and health looks at cross-sectional or geographic data, with the time-series relatively unexplored. Paxson and I<sup>6</sup> look at income, income inequality, and mortality over time in the United States and the United Kingdom. The postwar period usefully can be broken in two. In the quarter century up to the early 1970s, there was steady productivity growth, with mean and median income growing in parallel, and very little change in income inequality. After 1970, in the United States, productivity growth was much slower; although there was a good deal of income growth at the top of the income distribution, real median family income stagnated or fell. Slow income growth was accompanied by rapid growth in income inequality. The United Kingdom shared the rise in income inequality, which was even more marked than in the United States, but did not experience the same slowdown in the growth of real incomes. If income and income inequality are important determinants of mortality decline, and even allowing for some background trend decline in mortality, then the United States and the United Kingdom should have similar patterns of mortality decline up to the early 1970s, followed by slower decline after 1970, particularly in the United States which had an unfavorable trend in both growth and inequality. But the data show precisely the reverse. Mortality decline accelerated in both countries after 1970, and there is no obvious difference in the patterns in the two countries. Indeed, the most obvious distinction between Britain and the United States is that changes in trends start a few years earlier in the United States. These findings suggest that, as argued by Cutler and Meara,<sup>11</sup> changes in mortality over the last half century in the two countries have been driven, not by changes in income and income inequality, but by changes in

risk factors or in medical technology, with the changes being adopted more rapidly in the United States.

## The Origins of the Gradient

The two way mechanism between income and health is generally difficult to disentangle, but Anne Case, Lubotsky, and Paxson<sup>12</sup> eliminate the channel that runs from health to income by focusing on children where the correlation between their poor health and low family income cannot be attributed to the lower earnings of the children. Using several large, nationally representative datasets, they find that children's health is positively related to household income, and that the relationship between household income and children's health status becomes more pronounced as children grow older. A large component of the relationship between income and children's health can be explained by the arrival and impact of chronic health conditions in childhood; children have much the same health status at birth, but adverse health shocks are more effectively reversed by children in better-off households. Children's health is closely associated with long-run average household income, and the adverse health effects of lower permanent income accumulate over children's lives, so that the children of poorer parents arrive at the threshold of adulthood with lower health status and educational attainment — the latter, in part, as a consequence of poor health. Case, Lubotsky, and Paxson speculate that poorer health and consequent lower educational attainment may compromise poor children's earnings ability in adulthood, and that the gradient in adults is likely a product of poor health status and low income in childhood.

## Health Status and Economic Status in South Africa

In many ways, that income should be an important determinant of health is more plausible in poor countries

than in rich ones. When many people do not have enough money to buy food, adults and children often suffer the short and long-term effects of a poor diet, and parents who do not have enough money to feed their children report severe consequences for their own wellbeing. Anne Case has used data from a new integrated survey of health and economic wellbeing in South Africa to examine the impact of the South African old age pension on the health of pensioners, and of the prime aged adults and children who live with them.<sup>13</sup> Her work finds evidence of a large causal effect of income on health status — working at least in part through sanitation and living standards, in part through nutritional status, and in part through the reduction of psychosocial stress. The pension is used to upgrade household facilities, some of which have consequences for health. The household's water source being on-site and the presence of a flush toilet are both significantly more likely, the greater the number of years of pension receipt in the household. In addition, the presence of a pensioner in the household on average reduces the probability of an adult skipping a meal by 20 percent, and the presence of two pensioners reduces the probability by 40 percent. All adults in the survey were asked about depression, which is inextricably linked to stress and health status. For households pooling income, the presence of pensioners significantly reduces reported depression, and the effect is larger the greater the number of pensioners. Governments interested in improving health status may find the provision of cash benefits to be one of the most effective policy tools available to them. And cash provides a yardstick against which other health interventions can be measured.

Case finds that limitations in activities of daily living (ADLs) are associated with worse health status among the elderly and near elderly in South Africa, and that limitations for women are associated with larger erosions in health status than are those for men. Pensioners with limitations in ADLs report better health status than do older adults with the same limitations but who do not receive the pension. In



addition, older adults in larger households report better health status with limitations in ADLs than do other older adults. These results are consistent with a model in which money (in the form of a pension) brings help (purchased or volunteered) when respondents cannot dress or bathe by themselves.

<sup>1</sup> A. S. Deaton, "Policy Implications of the Gradient of Health and Wealth," *Health Affairs*, 21 (March/April 2002), pp. 13-30.

<sup>2</sup> A. S. Deaton and C. Paxson, "Mortality, Education, Income and Inequality among American Cohorts," NBER Working Paper No. 7140, May 1999, and in D. A. Wise, *Themes in the Economics of Aging*, Chicago: University of Chicago Press, 2001, pp. 129-65.

<sup>3</sup> A. S. Deaton, "Inequalities in Income and Inequalities in Health," NBER Working Paper No. 7141, May 1999, and in F. Welch, *The Causes and Consequences of Increasing Inequality*, Chicago: University of Chicago Press, 2001, pp.

285-313.

<sup>4</sup> C. J. Ruhm, "Are Recessions Good for your Health?" NBER Working Paper No. 5570, May 1996, and in *Quarterly Journal of Economics*, 115 (2000), pp. 617-50.

<sup>5</sup> U. Gerdtham and C. J. Ruhm, "Deaths Rise in Good Economic Times: Evidence from the OECD," NBER Working Paper No. 9357, December 2002.

<sup>6</sup> A. S. Deaton and C. Paxson, "Mortality, Income, and Income Inequality among British and American Cohorts," NBER Working Paper No. 8534, October 2001, and forthcoming in D. A. Wise, ed., *Perspectives on the Economics of Aging*, Chicago: University of Chicago Press, forthcoming.

<sup>7</sup> A. S. Deaton and D. Lubotsky, "Mortality, Inequality and Race in American Cities and States," NBER Working Paper No. 8370, July 2001, and *Social Science and Medicine*, forthcoming.

<sup>8</sup> A. S. Deaton, "Relative Deprivation, Inequality, and Mortality," NBER Working Paper No. 8099, January 2001.

<sup>9</sup> V. R. Fuchs, M. McClellan, and J.

Skinner, "Area Differences in Utilization of Medical Care and Mortality among U.S. Elderly," NBER Working Paper No. 8628, December 2001.

<sup>10</sup> A. S. Deaton, "Health, Inequality, and Economic Development," NBER Working Paper No. 8318, June 2001, and in *Journal of Economic Literature*, (41) (March 2003), pp. 113-58.

<sup>11</sup> D. M. Cutler and E. Meara, "Changes in the Age Distribution of Mortality over the 20th Century," NBER Working Paper No. 8556, October 2001.

<sup>12</sup> A. Case, D. Lubotsky, and C. Paxson, "Economic Status and Health in Childhood: the Origins of the Gradient," NBER Working Paper No. 8344, June 2001, and *American Economic Review*, 92 (5) (2002), pp. 1308-34.

<sup>13</sup> A. Case, "Does Money Protect Health Status? Evidence from South African Pensions," NBER Working Paper No. 8495, October 2001, and in D. A. Wise, ed., *Perspectives on the Economics of Aging*, Chicago: University of Chicago Press, forthcoming.

## Patents

Jean O. Lanjouw\*

The past twenty years have seen very significant changes in U.S. patent law and policy, strengthening the rights of inventors and significantly expanding those rights across the globe. The United States has broadened areas in which patents can be received, notably software, genetic information, and business methods; has instituted a new unified Court of Appeals for the Federal Circuit to hear appeals on patent cases from all district courts;

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and has given universities and government laboratories the right to patent and license the output of publicly-funded research. Bilateral negotiations and, more recently, international treaties also have led other countries to revise their patent systems. In particular, NAFTA and the intellectual property component of the treaty establishing the World Trade Organization - WTO - (known as TRIPS) extensively harmonized and extended patent rights internationally. Jaffe discusses these changes and surveys related empirical studies.<sup>1</sup>

The domestic patent reforms have been driven by the emergence of new areas of research and commerce, and by the view that a healthy knowledge-

based economy requires strong protection of intellectual property (IP). At the same time, however, serious concerns have arisen. My work on the patent system as an institution has focused on two such areas of concern. The first is the large and growing costs associated with litigating patent rights. The second is the extension of patent rights on pharmaceuticals to countries in the developing world where drug access is already limited by extreme poverty.

## Patent Enforcement

Dealing with patent disputes is part of business life for most firms, but it is