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Wage and labor supply effects of illness in Côte d'Ivoire and Ghana: instrumental variable estimates for days disabled [1]

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Abstract

Sickness should make individuals less productive, but there are problems in measuring this effect. First, how is adult morbidity measured in a household survey? Second, how is the impact of morbidity on productivity inferred, if earning is partly used to improve health? Self-reported functional activity limitation due to illness is considered an indicator of morbidity for wage earners and self employed people. To deal with both the measurement and joint determination problems, an instrumental variable estimation approach is used, where local food prices and health services instrument for disability days that reduce wages by at least 10% and hours by 3% or more. © 1997 Elsevier Science B.V.

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1. Introduction

The economic consequences of health improvement are widely assumed to be beneficial, but empirical estimates of these benefits are biased by errors in measurement, simultaneity of health and earnings, omitted variables, and health heterogeneity (Lee, 1982; Bartel and Taubman, 1986; Mitchell and Butler, 1986;

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Strauss, 1986; Deolalikar, 1988; Thomas and Strauss, 1996). This paper implements methods for estimating, without bias (conditional on measurement error being random and instruments being valid), the effect of adult morbidity on labor productivity in two countries of West Africa. Evidence for the association of morbidity with labor supply and annual earnings is also reported. This assessment is a lower bound on the personal welfare losses caused by poor adult health, because it neglects the private pain and suffering of the sick and the welfare losses imposed on kith and kin.

The connection between mortality and morbidity is reviewed in Section 2. A conceptual framework for studying the statistical determinants and consequences of adult health is presented in Section 3 [2]. Measures of disability from contemporary household surveys of Côte d'Ivoire and Ghana are described in Section 4. Estimates of the effects of disability on wage, hours, and earnings functions are reported in Section 5. Section 6 reviews the findings and indicates where more research on this subject would be useful.

2. Measurement of morbidity and its relation to mortality

The difference between life expectancy at birth in low- and high-income countries has narrowed markedly from 1950 to 1990 from roughly 24 years to 12 years (Omran, 1971; Preston, 1980; United Nations, 1991; Schultz, 1995). The underlying reduction in mortality in this period is attributed to the control of infectious and parasitic diseases and improvements in nutrition. Reductions in morbidity in the world's low-income populations might also be expected, if mortality and morbidity were determined by similar social, economic, and technical factors. But there appears to be less agreement on how morbidity varies across countries or over time than about mortality, or its determinants or consequences.

Decreases in age-specific mortality can contribute to increases in morbidity, if the increases in longevity allow a disproportionate share of the less healthy to survive (e.g., Pearson, 1887; Riley, 1990). Time series data from preindustrial populations suggest that an inverse relationship can be found between mortality and subsequent morbidity as suggested by the 'population heterogeneity' hypothesis (Alters and Riley, 1989). In contemporary high-income societies, medical

[2] Because infant and childhood death rates are demonstrably high, and the proportion of the population in these young age groups is relatively large, due to high fertility rates, childhood diseases and illnesses have received the greatest attention in African public health initiatives in the last decade. In a continent where women have received a small fraction of the basic education allotted to men, maternal health and female education programs have also begun to receive priority. Adult morbidity and diseases are expected to receive increasing study in the 1990s as health priorities shift (Jamison and Mosley, 1991).

technologies are also available to extend life, without necessarily increasing the quality or disability-free length of life (Crimmins et al., 1989). Morbidity in low-income countries today is rarely studied in conjunction with mortality and socioeconomic conditions, because there is little agreement on how to reliably measure adult health (Strauss et al., 1995).

Self-reported morbidity or health status may be subjectively affected by an individual's social and cultural background given his or her objective clinical health. This 'cultural conditioning' provides an alternative explanation for why self-reported morbidity rates could increase while the expected length of life increases. The cultural conditioning hypothesis emphasizes that the threshold of what is considered 'good' health varies systematically across a society; individuals from more educated, wealthy, and socially advanced groups have a heightened sensitivity to the limitations imposed on them by their health status. They will therefore have an increased propensity to report themselves and their family as being ill or in poor health, holding constant for their objective or clinically confirmed health status. According to this view, self-reported morbidity may not be an appropriate guide for the design of public health policy. The relevance of clinical morbidity is not denied, but subjective self-reporting of health should be used with caution (Johansson, 1991; Caldwell et al., 1990; Waldron et al., 1982). How, then, can adult health be studied in low-income countries?

2.1. Issues and tradeoffs in the measurement of morbidity

The epidemiological measurement of morbidity has two objectives. First, what self-reported questions on health status reliably replicate the distribution of clinically confirmed indicators of health status [3]? Second, what self-reported indicators of health status have the greatest 'power' to statistically test hypotheses about the relationships between health status and outcomes? If these two objectives conflict, how is the tradeoff to be adjudicated? Moreover, most measurement studies of morbidity are based on high-income countries and focused on chronic disabilities among the elderly. The problems of measurement of acute spells of morbidity among labor-force-aged adults in low-income countries may differ from morbidity among the elderly in high-income countries who exhibit chronic disabilities brought on often by degenerative diseases. Research is consequently needed to design adult health status questions to evaluate health conditions and welfare policies in developing countries (Kroeger, 1985; Palloni, 1990; Strauss et al., 1995).

Self-reported functional activity limitations are more reliable indicators of

[3] Some surveys in the US have shown self-evaluations of health status to be significant predictors of subsequent mortality while controlling for baseline physical health status (Idler (1991); Idler and Kasl (1991)). Indeed, they were found to be more reliable than clinical examinations on this account.

clinically confirmed health status when they relate to more specific functional activity limitations [4], rather than more general role activity limitations (Stewart et al., 1987). On the other hand, the statistical 'power' to test hypotheses is higher if measures of functional limitation relate to a more common occurrence, such as inability to climb stairs, rather than a rarer limitation, such as inability to walk (Rogers et al., 1979). This suggests that a more common functional activity limitation may be preferred for statistical modelling, whereas preference for replicability may lead to studying rarer and more restricted limitations.

In the Living Standard Measurement Surveys of Côte d'Ivoire and Ghana, which are analyzed in this paper, the health module (4Q1) asks "Have you had any illness or injury during the past four weeks?" This is followed up, if answered affirmatively, by an inquiry of "How many days during the past four weeks did you suffer from this illness or injury?" Then the respondent is asked "For how many days during the past four weeks were you unable to carry on your usual activities because of this illness or injury?" (see footnote 5 of Schultz and Tansel, 1992).

The duration of illness in the last four weeks is assumed to contain more information about health status than merely the occurrence (binary) of such an event [5]. Here, illness is considered only if it is severe enough to prevent the individual from engaging in 'usual' activities. If the tasks undertaken or routines carried out may be voluntarily adapted to an individual's current physical health limitations, the threshold of a disabling illness is more elastic and presumably measured with less precision (Pitt et al., 1990). For certain groups of workers, the distinction between a disabling and a nondisabling illness may be less a matter of their own choice, and analysis of this group might provide a more accurate appraisal of the consequences of poor adult health.

It has long been noted that labor market institutions can affect the incentives for reporting disabling illness, and complicate the task of interpreting disability data (Brundage, 1930). We do not have piece-rate and time-rate wages on workers to implement the approach of Foster and Rosenzweig (1993, 1994) to moral hazard and monitoring the productivity of workers with regard to their nutritional/health status. Information on the reduced productivity of the self-employed who are ill is known to the self-employed, but cannot be readily inferred by the researcher. Self-employed and family workers are more likely to be able to vary the nature

[4] More specific limitations are related to self-care (e.g., feeding, toilet), mobility, and physical activities (e.g., running, walking, climbing stairs, etc.). But these functional limitation variables have been designed to measure chronic health conditions among the disabled and elderly, and their usefulness to assess acute health conditions as a limitation on engaging in productive work is infrequently mentioned in the literature.

[5] This measure of illness duration has the property that spells are not always complete, if they are continuing at the date of survey, and they may start before the reference period. These problems of estimating expected duration are not pursued here. See Schultz and Tansel, 1992.

and intensity of their work to accommodate whatever burden of disabling illness they experience without halting work altogether. What they decide to report as a disabling illness is therefore subject to more uncertainty. Employers of time-rate wage workers can learn the health status and productivity of their workers only through costly monitoring, or by paying an efficiency-wage premium that makes job loss a credible threat, if the worker is caught concealing a disabling illness. Moreover, if tasks of wage workers are interdependent, such that the depressed productivity of one sick worker lowers the output of other workers, e.g., on the assembly line, the employer has an added incentive to curb this form of shirking. We hypothesize, therefore, that disabling illnesses will be reported with less error and be less subjectively biased in the case of wage workers than the self-employed, although the problem of measurement error is not likely to be eradicated even among wage workers.

In addition, hourly earnings or a wage rate cannot be measured as confidently for self-employed as for wage earners, and cannot be measured at all for family workers (Vijverberg, 1988). Since both the disability and wage variables in our model are poorly measured or unobserved for many self-employed in family enterprises and home production workers, who constitute the majority of the population in these countries, only wage earners and separate self-employed for whom a wage could be determined are used to estimate the wage function. This procedure is expected to introduce sample selection bias and will be assessed accordingly (van der Gaag and Vijverberg, 1987).

There are, of course, many dimensions to health which we have been unable to incorporate. For example, Thomas and Strauss (1996) estimate, in a large sample of urban Brazil, the impact on wages of height, body mass index, calorie and protein intakes, treating all but height as endogenous and identified by relative food prices. Schultz (1994), moreover, finds that even the exogeneity of height in the wage function can be rejected, identified by relative food prices and health infrastructure. Our omission of other possible indicators of health could overestimate the wage impact of illness as measured, days disabled, if it were positively correlated with the other omitted dimensions of poor health that were also depressing wages. The contribution of this paper is to investigate a different dimension of health status that is not strictly based on nutrition, the number of days of acute disabling illness in the prior four-week reference period, and treat the duration of this illness as endogenous and identified by relative food prices and local health infrastructure.

3. A model of health production and productivity

The current health status is produced over a lifetime starting with preventive investments of parents in nutrition and disease-reducing interventions for their children, through the current medical care to reduce the severity and duration of current acute and chronic illnesses. These health inputs, I, and heterogenous health endowments of the individual, G, that are not affected by family or individual behavior, combine to determine the individual's current health status, h^* [6]:

$$h^* = h^*(I,G,\epsilon_1), \tag{1}$$

where ϵ_1 is an error in this health production function (Rosenzweig and Schultz, 1983). Since the indicator of current health is self-reported, h, it may diverge from actual health by a measurement error, e:

$$h = h^* + e, \tag{2}$$

where e is assumed to be a random variable that is uncorrelated with the other determinants of health or modeled forms of behavior.

The individual maximizes a single period utility function over a lifetime, where value is assigned to current health, h^*, nonhealth-related consumption bundle, C, and annual time allocated to nonwage activities, H_2:

$$U = U(h^*, C, H_2). \tag{3}$$

Eq. (3) is maximized subject to the constraints of the money budget, time, and health production function Eq. (1):

$$Y = IP_I + CP_C = WH_1 + V + \mathrm{PE},$$

$$T = H_1 + H_2, \tag{4}$$

where Y is real income, P's are relative market prices, W is the market wage rate, V is current annual household wealth income, PE are transfers from parent endowments. T is total available time, and H_1 is wage work per year. If utility were time-separable, this framework could be reformulated to several periods without changing our results.

[6] It is useful to think about health as a dynamic process, which we have abstracted from. There are beneficial persisting effects of improved diet and of mitigation of diseases in childhood, including those experienced during uterine development which can be proxied by height (Tanner, 1981; Waaler, 1984; Martorell and Habicht, 1986; van Wieringen, 1986; Fogel, 1991). Current nutrition, climate, health environment, medical inputs, and physical activity levels all combine to sustain health given height, and is often proxied by the body-mass-index (BMI). Because we cannot observe input behavior and input prices that would impact distinctly on either early childhood or contemporary adult health outcomes, they are not separated in our analysis. For the majority of the sample, the current residential community is also that in which the individual was born and grew up, and therefore, if the relative cross regional structure of community health conditions and food prices are persistent over time, the current health effects of community variables we observe at the time of the survey may embody the effects of these variables on both early childhood as well as contemporary adult health (Strauss and Thomas, 1995; Thomas et al., 1991).

The individual's wage per hour of work is related to health status, acquired skills such as education, E, and changes in endowments associated with aging, summarized by Mincer (1974) as a quadratic in years of postschooling experience, X, (defined as age-schooling-seven), and other unobserved forms of human capital transfers that are proxied by parent education and occupation [7]:

$$W = W(h^*, E, X, \mathrm{PE}, \epsilon_2). \tag{5}$$

The wage function is identified by the exclusion of wealth, V, and community health and relative price variables, P_I and P_C.

Current health may exert several effects on labor supply, through income and substitution effects associated with its impact on wages in Eq. (5), and by changing the disutility of wage relative to nonwage activities, i.e., it may be more painful for a sick person to perform wage work than nonwage activities [8]. Labor supply can be viewed as a choice that is conditioned on all lifecycle endowments, prior prices, wages and experiences, in which case the effects of adult health on labor supply are not identified. To estimate the effects of health on labor supply,

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[7] The recent empirical literature on nutrition and productivity finds positive and significant effects of better nutrition on productivity or wages. Empirical estimation of such relationships involve complex issues, however. Strauss (1986), Deolalikar (1988), Sahn and Alderman (1988), Behrman and Deolalikar (1989) and Haddad and Bouis (1991) suggest that nutrition related indicators might be important in determining productivity of the individuals. For a given state of healthiness, those with greater calorie intakes or better anthropometric indicators are more productive or receive higher wages. Strauss shows the positive effect of calorie availability on family agricultural productivity. Sahn and Alderman do the same in a wage equation for Sri Lanka where average calorie intake is instrumented by food prices, household composition and household assets. Deolalikar uses weight for height in addition to the calorie intake as explanatory variables in the wage equation. He finds a significant coefficient of weight for height but not calorie intake, and concludes that medium-run effects of better nutrition are important, while short-run effects are insignificant. The findings of Haddad and Bouis in Southern Philippines are consistent with this conclusion. In their study, higher agricultural wages appear to result from greater height (which is a cumulative measure of good nutrition and absence of infection in early childhood) rather than from short-run (calorie intake) or medium-run (weight for height) proxies of nutritional status.

[8] The effect of health on labor supply includes several conceptually distinct components. First, increases in an individual's wage rate due to better health, according to Eq. (5), elicits an income-compensated own-wage response, which should theoretically increase the labor supply. Second, the wage gain is associated with an income effect that is weighted by hours worked, which would decrease labor supply, if nonwork activities such as leisure are a normal good. Third, improved health may increase the capacity to engage in work, perhaps by reducing the disutility associated with work relative to nonwork activities. The first and third effects of improved health would increase labor supply, whereas the second effect would decrease labor supply in proportion to hours of work and thus be more negative for full-time wage workers than for part-time workers. The direct association between health and labor supply, and therefore on earnings, is an understatement of the productive benefits of health, because it ignores the value of the probable income-induced increase in nonwork activities.

identification is achieved here by assuming that the community health and food price variables affect labor supply only through their effect on current health status, but we allow parent education and occupation to affect labor supply, directly through unobservable transfers of human capital and gifts [9]:

$$H_1 = H_1^s(h^*, E, X, V, \mathrm{PE}, \epsilon_3). \tag{6}$$

Similarly, subject to the same identifying restrictions, an estimate of the total effect of current disability on earning can be obtained using:

$$WH_1 = WH_1^s(h^*, E, X, V, \mathrm{PE}, \epsilon_4). \tag{7}$$

It is not possible to estimate here the health production function (Eq. (1)) because many potentially relevant health inputs that accumulate over an adult life are unobserved, along with their relevant prices needed to consistently estimate the health production function. The unobserved individual health endowment that is captured in the error is likely to be correlated with health input demands, i.e., $\mathrm{cov}(I, \epsilon_1) \neq 0$ (Rosenzweig and Schultz, 1983). This paper reports estimates of the wage (Eq. (5)), hours (Eq. (6)), and earnings (Eq. (7)) equations conditional on disability days. It is expected that the errors in these three equations, ϵ_2, ϵ_3, ϵ_4, will be correlated with that in the health production function, ϵ_1, because of unobserved variables, and reverse causality of income increasing health inputs. Errors in measuring current health status, particularly by a self-reported variable, may also possibly downward bias the estimated effects of health on productivity in Eqs. (5)–(7). They are consequently estimated by instrumental variable methods, where the household wealth (V), community health infrastructure (P_I), and local food prices (P_C) are instruments in the wage equation and are assumed uncorrelated with the error ϵ_2. Since wealth may influence hours and earnings, the identifying variables for the labor supply and earnings equations are community health and food price variables.

Control variables are also included in the wage, hours and earnings equations for the individual's education, postschool experience, parent education and occupation, region of residence, distance to market, rainfall, and interactions between the time of year that the survey was collected (whether it was during or immediately after the two rainfalls that contribute to a resurgence of malaria) and the local severity of the malaria health problem.

[9] It is possible that local relative food and health prices could also influence labor supply, implying that we could not identify the labor supply parameters. Relying only on health infrastructure (prices) for identification did not fundamentally change the estimates. See also the discussion of the potential use of longitudinal data in the conclusion of the paper.

Regional and seasonal dummy variables are expected to capture some of the effect of nutritional variation on productivity (Behrman and Deolalikar, 1989). Seasonal malnutrition has been particularly high in the Northern, Upper East and Upper West regions of Ghana and Côte d'Ivoire. However, survey work indicates that adult males and females (other than pregnant and lactating women and preschool and school-age children) receive adequate nutrition except during the rainy seasons and close to harvest (Sarris and Shams, 1991).

Because W, H_1 and WH_1 are only observed when the individual participates as a wage earner or separately self employed, $P = 1$, a probit model, is assumed to determine the sample selection rule:

$$\text{Prob}(P = 1) = \text{Probit}(E, X, V, \text{PE}, P'\text{s}, \epsilon_5), \tag{8}$$

where ϵ_5 is normally distributed.

Household wealth, V, is a variable, suggested by economic theory, that is expected to raise the individual's reservation wage and thereby reduce the probability of working as a wage earner. However, in this case, wealth is assumed exogenous to wage offers. Wealth may be accumulated from the individual's own savings, which could then be a positive function of wages. In this case, wealth might be expected to be positively associated with labor supply and ϵ_5. The household wealth variable is excluded from Eq. (5), but included in Eqs. (6) and (7), and in the probit Eq. (8). Joint maximum likelihood methods are used for estimation (Heckman, 1979; Greene, 1981) and wealth is negatively associated with the wage-earner probit as expected if it were exogenous.

Two features of this framework should be noted. The first is the simultaneous equation approach to estimating the effect of morbidity on productivity. The estimation of a wage equation that includes measures of health status, h, will therefore be biased by the feedback effect of income on health, probably overstating the one-way effect of health on productivity. Local prices of food were used by Strauss (1986) as instrumental variables for calorie consumption by family labor in a family farm production function. Errors in measurement of morbidity is a second reason for using instrumental variables where the identifying instruments are local relative prices of food, local climate, health infrastructure, and disease environment, and the time costs required to obtain medical care. Because a nonlinear effect of morbidity or health on productivity is expected, a quadratic function in days disabled is estimated.

The second feature of this framework is that it provides a method to decompose the impact of health on wages and hours. The primary payoff to health investments is to raise the marginal productivity of people. However, it is widely observed, at least for full-time male participants, that wage increases tend to be associated with decreases in their hours of work per year (Pencavel, 1986). If the wealth effect associated with wage changes on labor supply is also negative in low-income settings (Schultz, 1981), the gross effect of health on annual earnings underestimates the gain in productive potential associated with an improvement in health.

The measure of market wage gain due to health used here neglects the increase in leisure or home production that healthier, full-time workers are likely to consume [10].

In addition, the entry of persons into wage earning activities may be affected by their expected morbidity. There is no a priori reason to assume that a healthier worker is more productive in a wage job than in family or self-employment [11].

4. Morbidity in Côte d'Ivoire and Ghana

4.1. West African health conditions

The World Bank (1993) presents measures of global burden of disease in terms of disability-adjusted life years (DALYs) lost which combines the loss of life from premature death with the loss of healthy life from disability. Among the regions of the world, in 1990, the DALYs lost per 1000 population were highest in the sub-Saharan Africa region due mostly to infectious and parasitic diseases where malaria, respiratory infections and diarrheal diseases ranked the highest, in this order. With regards to the age pattern, after declining from very high childhood levels, the DALYs loss reached a peak in the 15–44 age group for both men and women, suggesting the need to analyze the causes and consequences of prime age adult morbidities.

Morrow (1984), Morrow et al. (1982) and GHAPT (1981) estimated for Ghana the incidence and duration of diseases and other health problems in the early 1980s. Although the level of Morrow's estimates of healthy days lost per person per year have limitations, they reasonably rank morbidity problems in Ghana. Malaria, pneumonia, and bronchitis are major, readily identifiable, causes of death

[10] Suppose the effect of wealth on labor supply is negative, as would be expected if time not working for wages is a normal good whose demand increases with wealth, V, then the income-uncompensated wage effect is algebraically smaller in absolute value than the appropriate income-compensated wage effect. In this case, the labor supply and earnings effects of health are downward biased measures of the potential productivity.

[11] This could occur if the skills and training for workers in wage employment were more specific to their jobs than in workers in family or self-employment. Wage workers would then be less readily substituted for each other without sacrificing output in firms than would workers in family enterprises. Firms would then have an added incentive to hire persons who are less likely to be unable to work because of illness, over and above the incentives that families also confront to employ healthy workers and thus to raise the health stock of their own family members. If this hypothesis is correct, there should be an increased motivation to invest in health capital as the workforce acquires more specific training and the share of wage and salary workers in the economy increases.

as well as morbidity, and tuberculosis claims about half to a quarter as many lives as does malaria or pneumonia, according to Patterson (1981) [12].

There are even fewer estimates for Côte d'Ivoire ranking diseases and health conditions as a cause of death, illness or disability. Measles, diarrhea, pneumonia, malaria, tetanus, pertussis and meningitis are reported in this order as the most frequent causes of death in the first month of life in the Boundiali region of Côte d'Ivoire in 1981–1982 (Sokal et al., 1988). Doctors and individuals are required to register certain illnesses in Côte d'Ivoire, and in 1980 the most frequent of these registered diseases was treponematoses (a spirochete), followed by measles, onchocerciasis, schistosomiasis, leprosy and tuberculosis, whereas malaria, which is hyperendemic and widely regarded to be the most serious disease throughout West Africa, is not an illness for which registration is required (Remy, 1988, p. 71).

The information on major causes of adult morbidity is more limited, with much of the effort of preventive health channeled into care of children and expectant mothers in an effort to reduce the relatively high levels of infant, childhood, and maternal mortality. Malaria is not only a common cause of childhood mortality, but also of pregnancy wastage and adult morbidity, as it manifests itself in recurring, disabling bouts of high fever.

4.2. Prevalence of morbidity in Côte d'Ivoire and Ghana

In this section, indicators of morbidity and disability in Ghana and Côte d'Ivoire are reported, as derived from Living Standards Measurement Surveys (LSMS) collected during the late 1980s. A characteristic of the LSMS surveys in Côte d'Ivoire and Ghana was that half of the respondents of the initial waves were reinterviewed in the subsequent waves. We combined the three years of the LSMS from Côte d'Ivoire for 1985 to 1987, for a sample of about 40000 persons, and then eliminated the individuals who were reportedly reinterviewed, reducing the working sample by about one-third (Ainsworth and Munoz, 1986). The percentage ill and injured in the last four weeks falls from about a quarter in the preschool age group to a sixth for boys and girls aged 5 to 14, and then rises to about one-fifth for women and men aged 15 to 39. Among those over age 39, the proportion having been ill or injured is substantially higher, or about two-fifths. The average number of days ill for females and males is 2.2 and 2.5 for those aged 0–4 years, 1.2 and 1.6 for those aged 5–14 years, 1.6 and 2.2 for those aged 15–39 years, and 6.1 for those aged 40 and more. Approximately half of the days that Ivorians

[12] Cause-specific death rates for childhood diseases are not estimated reliably at the national level, but undoubtedly include malaria, measles, diarrhea, tetanus and pertussis. They have been assessed with more precision in limited study areas, such as in the Danfa project (Newmann et al., 1991). Analysis of health surveys also suggest that measles remains a major source of child mortality, and one that child immunization programs can reduce substantially, even in a malnourished population (Clemens et al., 1988).

Table 1
Average number of days disabled because of illness or injury in last four weeks, by sex, age, education and rural–urban residence: Côte d'Ivoire 1985–1988 (number of survey respondents in parentheses)

Sex, age and rural/urban residence	Educational level				
	All levels of education	None	Some primary	Some middle	Some secondary
All males					
Age 15–39: Rural	1.04 (2913)	0.91 (1482)	1.38 (907)	0.91 (411)	0.49 (78)
Urban	0.73 (3658)	0.52 (1037)	0.94 (772)	0.87 (1185)	0.55 (113)
Age 40 or more:					
Rural	4.44 (2084)	4.52 (1880)	3.86 (181)	2.95 (21)	1.00 (2)
Urban	2.73 (1213)	3.13 (773)	2.78 (247)	1.24 (117)	0.78 (76)
All females					
Age 15–39: Rural	1.37 (3717)	1.38 (2882)	1.36 (692)	1.09 (139)	0.25 (4)
Urban	1.16 (4031)	1.09 (1963)	1.31 (966)	1.10 (856)	1.24 (246)
Age 40 or more:					
Rural	3.83 (2487)	3.84 (2471)	2.40 (15)	0.0 (1)	–
Urban	2.74 (1185)	2.80 (1104)	1.95 (40)	1.62 (29)	2.92 (12)
Males in wage labor force					
Age 15–39: Rural	1.30 (751)	1.35 (422)	1.30 233)	1.30 (73)	0.30 (23)
Urban	0.83 (1096)	0.82 (273)	0.98 (246)	1.09 (283)	0.46 (294)
Age 40 or more:					
Rural	2.31 (1245)	2.28 (1096)	2.58 (133)	1.80 (15)	2.00 (1)
Urban	1.39 (771)	1.55 (460)	1.40 (159)	0.96 (91)	0.87 (61)
Females in wage labor force					
Age 15–39: Rural	1.55 (713)	1.47 (597)	2.11 (104)	0.33 (9)	0.33 (3)
Urban	1.18 (757)	0.93 (597)	1.74 (160)	1.50 (147)	0.61 (71)
Age 40 or more:					
Rural	2.60 (675)	2.62 (670)	0.0 (5)	–	–
Urban	1.80 (440)	1.87 (385)	0.96 (24)	0.57 (21)	3.50 (10)

Source: Côte d'Ivoire Living Standard Survey, 1985–1987.
Totals for all persons do not always add up to the totals in Table 3 because a few persons did not report their education and are excluded from the subsequent analysis.

report ill are classified by them as sufficiently severe to preclude them from engaging in 'usual' activities, i.e., work in the labor force, home, or in school (Schultz and Tansel, 1992, Table 1).

We combined the two years of the LSMS from Ghana for 1987–1988 and 1988–1989, for a sample of about 30 000 persons (Glewwe, 1987). Reinterviewed respondents could not be eliminated in Ghana, because the individual codes were not retained to match persons. The proportions of the Ghanaian population reporting an illness or injury in the last four weeks is somewhat higher than in

Table 2
Average number of days disabled because of illness or injury in last four weeks, by sex, age, education and rural urban residence: Ghana 1987–1989 (number of survey respondents in parentheses)

Sex, age and rural/urban residence	Educational level				
	All levels of education	None	Some primary	Some middle	Some secondary
All males					
Age 15–39: Rural	1.19 (2092)	1.07 (541)	1.55 (295)	1.17 (1066)	1.06 (190)
Urban	0.90 (1696)	0.70 (221)	0.91 (185)	1.06 (928)	0.59 (362)
Age 40 or more:					
Rural	2.55 (1230)	270 (635)	2.87 (90)	2.33 (215)	1.09 (43)
Urban	1.26 (736)	1.90 (331)	2.63 (57)	1.30 (262)	0.74 (111)
All females					
Age 15–39: Rural	1.25 (2188)	1.06 (1034)	1.80 (351)	1.25 (751)	1.65 (52)
Urban	1.05 (1891)	0.83 (551)	1.45 (257)	1.01 (861)	1.31 (222)
Age 40 or more:					
Rural	2.32 (1191)	2.34 (1052)	2.25 (67)	1.77 (66)	5.67 (6)
Urban	1.81 (772)	1.90 (555)	1.38 (53)	1.55 (130)	1.91 (34)
Males in wage labor force					
Age 15–39: Rural	1.40 (1077)	1.28 (273)	1.54 (151)	1.42 (568)	1.39 (85)
Urban	0.95 (809)	0.94 (83)	1.10 (73)	1.13 (493)	0.32 (160)
Age 40 or more:					
Rural	1.78 (571)	1.92 (319)	1.60 (56)	1.85 (159)	0.50 (36)
Urban	0.95 (488)	1.23 (183)	1.27 (44)	0.74 (182)	0.62 (79)
Females in wage labor force					
Age 15–39: Rural	1.40 (802)	1.46 (346)	1.61 (144)	1.21 (300)	2.08 (12)
Urban	1.13 (778)	1.13 (195)	1.57 (115)	1.05 (373)	0.88 (95)
Age 40or more:					
Rural	1.70 (514)	1.67 (427)	1.25 (36)	1.87 (45)	5.67 (6)
Urban	1.60 (336)	1.65 (212)	1.38 (32)	1.47 (68)	1.92 (24)

Source: Ghana Living Standard Survey, 1987–1989 (the first year and one-half).
Totals do not add up to those in Table 3 because these figures reflect only the first year and one-half of the survey and exclude persons not reporting their education.

Côte d'Ivoire, in all age groups, or 30–40%. The age pattern is similar in the two countries, declining from an elevated level in infancy to a low for school-aged children, rising sharply only after middle age. Individuals in Ghana also report that in about half of their ill days, they were unable to engage in their usual activities. Differences between men and women in reported morbidity are not salient, although in both countries the incidence of morbidity for women exceeds that for men during the childbearing years (age 15–39). Differences in mortality between men and women are not a notable feature of the few life tables available for

Table 3
Means and standard deviations of variables for alternative samples in Côte d'Ivoire and Ghana age 15 to 65, men[a]

Variables in Côte d'Ivoire/Ghana	Côte d'Ivoire			Ghana		
	All persons	Workers	Wage earners	All persons	Workers	Wage earners
Sample size	6166	2080	1047	5541	3743	1460
Dependent variables						
Log wage per hour[b]		5.37 (1.57)	5.98 (1.24)		3.33 (1.26)	3.69 (.882)
Log hours per year		7.40 (.726)	7.47 (.705)		7.12 (.824)	7.28 (.854)
Log earnings per year		12.8 (1.60)	13.4 (1.30)		10.5 (1.38)	11.0 (1.09)
Days inactive due to illness in past four weeks (disabled days)	1.59 (5.01)	2.41 (5.96)	1.17 (3.85)	1.31 (3.50)	1.44 (3.52)	1.09 (2.98)
Predicted disabled days (OLS Table 6)	1.77 (1.84)	1.92 (1.94)	1.17 (1.68)	1.11 (1.22)	1.40 (0.862)	1.09 (0.642)
Independent variables						
Years of schooling completed[c]						
Primary	2.82 (2.89)	2.80 (2.89)	4.33 (2.60)	4.20 (2.65)	4.00 (2.74)	4.88 (2.26)
Middle	0.930 (1.57)	1.04 (1.68)	1.90 (1.90)	2.18 (1.87)	2.18 (1.91)	2.89 (1.73)
Post-middle	0.288 (1.14)	0.52 (1.63)	0.999 (2.16)	0.696 (1.99)	0.705 (2.10)	1.38 (2.85)
Post-schooling years of experience	20.5 (16.2)	28.1 (14.8)	21.2 (11.8)	17.8 (15.6)	22.2 (14.8)	19.3 (13.1)
Household assets[b] $(\times 10^{-6})$						
Business	0.710 (11.7)	0.706 (13.4)	0.374 (8.80)	0.0807 (2.53)	0.0484 (1.78)	0.00919 (0.055)
Value of land	6.99 (49.8)	6.50 (52.1)	0.726 (6.14)	0.234 (1.20)	0.223 (1.25)	0.109 (0.586)
Savings	0.523 (4.48)	0.384 (2.60)	0.358 (1.23)	0.0279 (0.298)	0.0218 (0.209)	0.0176 (0.052)
Unearned income	0.161 (0.721)	0.113 (0.56)	0.150 (0.646)	0.00272 (0.018)	0.00241 (0.017)	0.00390 (0.247)
Tontines/Susu	0.00479 (0.037)	0.00514 (0.035)	0.920 (0.048)	0.00183 (0.0084)	0.00206 (0.0092)	0.00273 (0.0098)
Dowry	0.0461 (1.26)	0.0457 (1.25)	0.462 (1.25)	0.00477 (0.107)	0.00401 (0.094)	0.00435 (0.0709)

Region, rainy / dry seasons and malaria interactions[d,e]						
North-rainy	0.161	0.152	0.0955	0.0801	0.0871	0.0356
North-dry	0.0959	0.0914	0.0745	0.0949	0.0898	0.0370
South-rainy	0.516	0.515	0.567	0.538	0.542	0.603
Malaria * North-rainy	0.0310	0.0327	0.00573	0.0584	0.0657	0.0116
Malaria * North-dry[f]	0.00454	–	–	0.0491	0.0524	0.0089
Malaria * South-rainy	0.0245	0.0149	0.00764	0.225	0.234	0.141
Distance to markets in km.[g]	1.86 (4.76)	1.76 (4.47)	0.405 (2.34)	4.83 (10.4)	4.87 (10.3)	2.32 (7.18)
Rainfall (in cm/year)	107 (18.4)	109 (19.0)	115 (18.0)	126 (35.0)	125 (36.0)	117 (40.8)
Local market prices						
Beef/eggs	0.826 (0.126)	0.824 (0.127)	0.805 (0.091)	24.3 (3.50)	24.3 (3.47)	25.7 (3.06)
Fish	0.448 (0.168)	0.443 (0.151)	0.431 (0.116)	523 (116)	523 (111)	529 (108)
Rice/maize	0.296 (0.235)	0.326 (0.253)	0.384 (0.292)	61.7 (8.90)	61.7 (8.39)	63.6 (7.89)
Onions	0.251 (0.109)	0.257 (0.118)	0.221 (0.094)	373.0 (128)	376 (128)	374 (124)
Peanut butter	0.415 (0.179)	0.423 (0.184)	0.368 (0.112)	147 (24.4)	147 (24.1)	151 (22.7)
Palm oil	0.643 (0.329)	0.625 (0.383)	0.634 (0.372)	176 (41.0)	177 (39.9)	189 (40.3)
Manioc/Cassava	0.0751 (0.045)	0.0746 (0.044)	0.0924 (0.045)	26.7 (4.88)	26.7 (4.78)	27.7 (4.42)
Bananas	0.0833 (0.042)	0.0830 (0.041)	0.0886 (0.036)	48.1 (16.6)	48.5 (16.4)	48.6 (15.2)
Tomatoes				681 (58.8)	681 (57.0)	691 (57.3)
Sugar				153 (18.8)	154 (18.5)	155 (17.2)
Antibiotic				4.51 (.556)	4.15 (.558)	4.20 (.515)
Health infrastructure						
Distance to the closest hospital/clinic inkm.	9.03 (13.8)	7.73 (12.4)	2.497 (9.26)	6.50 (11.0)	6.84 (11.3)	2.67 (7.20)
Distance to the closest doctor/nurse in km.	9.07 (13.3)	8.04 (12.9)	1.75 (6.10)	5.91 (11.0)	5.94 (10.9)	2.22 (6.83)

Table 3 (*continued*)

Variables in Côte d'Ivoire/Ghana	Côte d'Ivoire			Ghana		
	All persons	Workers	Wage earners	All persons	Workers	Wage earners
Community health problems [d]						
Malaria	0.0860	0.0543	0.0143	0.428	0.444	0.235
Diarrhea	0.103	0.0606	0.0191	0.155	0.166	0.0884
Measles and chicken pox	0.110	0.0659	0.0210	0.263	0.270	0.171
Water-sanitation and transportation	0.0376	0.0125	0.00955	0.190	0.184	0.0925
Anti-malaria campaign in the last 5 years	–	–	–	0.285	0.299	0.171
Immunization campaign in the last 5 years	–	–	–	0.483	0.488	0.263
State level public health expenditures appropriated per person in 1987						
Preventative services				91.8 (21.0)	92.8 (20.3)	91.1 (17.8)
Curative services				220.0 (78.6)	222.3 (76.9)	241.4 (80.8)
Parental background						
Mother's years of schooling	0.195 (1.19)	0.0654 (0.655)	0.126 (0.915)	1.17 (3.20)	0.675 (2.43)	1.13 (3.14)
Father's year of schooling	0.905 (2.68)	0.542 (2.05)	0.899 (2.59)	3.15 (5.28)	2.34 (4.67)	3.35 (5.32)
Father's schooling unknown [d]	0.0063	0.0091	0.0124	0.0108	0.0075	0.0103
Mother's work agricultural	0.530 (0.499)	0.581 (0.494)	0.441 (0.497)	0.622 (0.485)	0.657 (0.475)	0.503 (0.500)
Father's work agricultural	0.668 (0.471)	0.803 (0.398)	0.736 (0.441)	0.666 (0.472)	0.709 (0.455)	0.582 (0.494)

sub-Saharan African populations (United Nations, 1982; Waldron, 1983; Timaeus, 1993) [13].

Tables 1 and 2 compare the estimated morbidity for segments of the two populations for which mortality rates are often noted to differ. Urban areas tend to report lower mortality, more educated mothers have lower family mortality, and when it can be estimated, more educated adults have lower mortality risks. Tables 1 and 2 tabulate the average days disabled for all persons and only for wage earners for Côte d'Ivoire and Ghana, by sex, age, rural/urban areas, and education.

[13] Timaeus (1993) reports that the average level of adult mortality in sub-Saharan Africa is high compared to the rest of the world and slightly higher for men than for women. In Côte d'Ivoire, the survivorship from age 15 to 60 is 0.65 for men and 0.74 for women, while in Ghana, the same survivorship probabilities are somewhat higher (0.78) for men and (0.88) for women.

Notes to Table 3:

[a] Standard deviation reported in parenthesis beneath variable mean.

[b] Wages, earnings, assets and prices are measured in CFA Francs in Côte d'Ivoire and in Cedis in Ghana. They are adjusted for inflation during the survey period in both countries. See text for further details. The official currency equivalents were US$1 = 449 CFA Francs as of 1985 and US$1 = 147 Cedis as of 1987.

[c] The motivation for breaking down education into three categories in Table 3 is as follows. Primary schools provide six years of education and middle schools take four years is both countries. Post middle schooling consists of three years of high school, and then tertiary levels of education in Côte d'Ivoire. In Ghana post middle schooling consists of five years of high school, two years of sixth form, and then tertiary levels of education. A major educational reform introduced in 1989 in Ghana reduced the seventeen years of pre-university education down to twelve years. Although primary level enrollment ratios are about the same in both countries, the secondary level enrollment ratios are substantially higher in Ghana than in Côte d'Ivoire.

[d] Standard deviation suppressed for dummy variables where it is $=\sqrt{M(1-M)}$, where M is the mean. South-Dry is the suppressed category in regressions in both countries.

[e] The clusters are classified as North or South according to their geographic location. In Ghana Northern, Upper West and Upper East are included in the North. The remaining counties are included in the South. These were Western, Central, Greater Accra, Eastern, Volta, Ashanti and Brong-Ahafo. In Côte d'Ivoire North included the following clusters. Biankouma, Bondoukou, Bouake, Bouna, Boundiali, Dabakala, Ferkessedougou, Katiola, Korogho, Mankono, Odienne, Seguela, Tingrela, Touba, Zuenoula, Mibahiakro, Sakassou. The South included the following clusters: Abengourou, Abidjan, Aboisso, Adzope, Agboville, Agnibilekrou, Banagalo, Beoumi, Bongouanou, Bouafle, Daloa, Danane, Daoukro, Dimbokro, Divo, Gagnoa, Grand-Lahou, Guiglo, Issia, Lakota, Man, Oume, San-Pedro, Sassandra, Sinfra, Soubre, Tabou, Tanda, Tiassale, Toumodi, Vavoua, and Yamoussoukro.

[f] Small population cell becomes empty in worker and wage earner samples in Côte d'Ivoire and are suppressed in regressions.

[g] The variable 'distance to market' is a measure of the distance either to a permanent or periodic market in kilometers. If there is either a permanent or a periodic market in the community, this distance is set equal to zero. Distance to the closest hospital/clinic and the distance to the closest doctor/nurse are computed in a similar manner.

Morbidity is generally higher in rural than in urban areas, and increases sharply for older individuals in rural areas. Among persons with at least a primary education, morbidity tends to decline with further education, although the small numbers in the samples of more educated persons (see cell sizes in parentheses), particularly at older ages in rural areas, add to sampling variability. The 'cultural conditioning' hypothesis (Johansson, 1991), which would lead one to expect higher morbidity among urban, more educated elites, does not receive support from these data, although there are several cases where some primary schooling is associated with higher morbidity than for those with no schooling (e.g., Côte d'Ivoire males aged 15–39). Within the wage-earner subsample (lower panels Tables 1 and 2), there is no tendency for the more educated to report more disabled days, as we expected, perhaps due to the different contractual incentives associated with wage versus self-employment (Schultz and Tansel, 1992).

Multiple regression is then used to summarize the patterns of disabled days in Tables 1 and 2, with coefficients estimated on number of years of education completed by the individuals at the primary, middle, and secondary or higher levels, controlling for the individual's age, rural/urban residence, and several aspects of the local health infrastructure, food prices, climate and region (Cf. Table 3). The suspicious positive relationship between adult education and reporting disabled days is then eliminated by restricting the analysis to wage earners. There may, of course, still be a subjective reporting bias in the morbidity data even for wage earners (Sindelar and Thomas, 1991) [14].

The fraction of adults whose primary employment is for wages is relatively small in these two populations, however. Only 4.1% of the women in Côte d'Ivoire and 7.5% in Ghana are wage earners, whereas for men about one in four or five are wage earners. Any analysis of the effect of morbidity on wage productivity for West African women must rely on a relatively small, and potentially unrepresentative, sample. The following analysis of morbidity and wage rates, hours and earnings is consequently limited to men. Estimates for the smaller samples of women are reported in Schultz and Tansel (1992).

5. Estimation of the effects of health in wage and labor supply functions

The empirical specification of the model for estimating the impact of disabled days on wages, hours and earnings involves four distinct issues. First, what

[14] The community questionnaire employed in these surveys asks about the time required to reach a number of medical care providers. Regrettably, these are crude measures of access and price of health services, and they tend to be highly correlated, reducing their value as multiple predictors of health status. To incorporate more extensive information on the quality, diversity and price of medical services in the local community, the LSMS respondents may be linked to another survey of health facilities conducted in Côte d'Ivoire in 1988 and in Ghana in 1989, but the sample is reduced by one-third in Côte d'Ivoire and by almost three-fifths in Ghana (Schultz and Tansel, 1992).

exogenous variables are determinants of 'disabled days'? Individual characteristics (education, postschooling experience), assets, parent characteristics, community relative (food) prices, regional residence and climate characteristics, and community health conditions are all included as potential determinants of days disabled. It is assumed that current residence is exogenous, and therefore community characteristics are uncorrelated with the errors in the health and wage functions. There are two possible reasons for this assumption to be invalid. Individuals may migrate to regions that have preferred characteristics, imparting a systematic association between tastes and local characteristics (Schultz, 1988). The placement of public programs could also be guided by the health endowments of a region or its population, and not be independent of the health or wage that would otherwise be observed (Rosenzweig and Wolpin, 1986). We are unable to treat migration and program placement as endogenous, and doubt that this is the most serious problem in understanding the effects of health on adult productivity.

Second, which of these health status determinants can be excluded from the wage, hours and earnings equations to permit identification? Assets, community (food) prices and health infrastructure are excluded from the wage equation, whereas only the community prices and health conditions are excluded from the hours and earnings equations [15].

Third, if the estimation of health effects on worker productivity are based only on a censored sample of persons who report either wage rates or hours, what additional variables might enter the sample selection decision rule that would not contribute to the determination of wages or hours? These exclusion restrictions should increase the power of the sample selection correction procedure that is employed here. Assets and prices in the wage equation, and prices in the hours and earnings equations identify the selection correction for being in the worker sample.

Fourth, it is hypothesized that the response to a questionnaire about disabled days is a more reliable indicator of health status for wage earners than for other adults. In this case, what variables might enter the sample selection rule for being a wage earner and not affect health status (disabled days)? We could provide no reasonable exclusion restrictions here and have consequently relied only on the functional-form restriction of normality in the error of the wage-earner probit model to identify the Heckman (1979) two-stage estimates of the disabled days equation.

[15] Parent characteristics were also considered in previous work as a determinant of child nutrition and health status (e.g., Behrman and Wolfe, 1987; Schultz, 1994), and were therefore tentatively excluded from the wages and hours equations as an additional basis for identification, without changing the results substantially (Schultz and Tansel, 1992). See also [9].

5.1. Data and variable definitions

The means and standard deviations of all variables are reported in Table 3 for all males, wage earners plus self-employed for whom wages could be determined, and wage earners. In both countries, the majority of the population live in the southern and rainy areas, while wage earners are disproportionately concentrated in urban areas. Indeed, the majority of wage earners in Côte d'Ivoire reside in the capital, Abidjan, while about a third in Ghana live in Accra [16].

Wage rates are inclusive of payments in kind. They are first deflated for regional price differences, in particular, for the capitol cities versus other areas. Then, since the surveys are collected over two to three years, the wages reported by the respondent are further adjusted for the national price level during the month of the survey [17].

The productivity effects of adult morbidity may not be semi-log linear as with schooling years in the wage equation. Fig. 1 illustrates that wage earners report different numbers of disabled days, yet a considerable majority have no disabled days in the reference period. To test for deviations from the linear specification, we assess the incremental explanatory contribution of including the squared value of disabled days in the wage equation.

Three other specifications were considered to describe this potentially nonlinear relationship between disabled days and productivity. First, the occurrence of any disabling illness in the last four weeks might adequately summarize adult health. Under this hypothesis, a probit equation was fit to this binary outcome (Cf. Fig. 1), and the predicted probability of being disabled was included in the productivity functions. This specification explained less of the variance in productivity than the linear model summarized below. Second, a logistic transformation for the fraction

[16] The probability of migration from rural to urban areas in low-income countries is higher for the more educated. A major fraction of the private market returns to education is associated with the outmigration of those who obtain schooling in low-income regions of their country (Schultz, 1988). Holding constant for region of current residence tends, therefore, to understate the effect of education on wages, by removing the gains achieved by the educated through interregional migration. To the extent that health investments, also yield complementary returns through migration, the estimates reported in this paper of the returns to health on wages are lower-bound estimates, because they control for region and therefore interregional migration. The lower levels of disability noted earlier in urban areas (Tables 1 and 2), even within an educational level, may reflect both, selectively attracting to urban areas healthier individuals, as well as the greater private resources and public subsidies for health care in urban areas. Similarly, Behrman and Birdsall (1983) find in Brazil that social rates of return to school quality are larger than those to school quantity suggesting that part of the high returns of migrants may be due to better school quality at destination.

[17] Wages are expressed in terms of prices prevailing in the first month of the Ghana survey, i.e., September 1987 (Glewwe, 1987), and in terms of average prices for all of 1985 in Côte d'Ivoire (Ainsworth and Munoz, 1986). A monthly price index was not available for Côte d'Ivoire, but since the rate of inflation was less than 10 percent per year from 1984 to 1988, the annual rate of inflation was assumed to be uniform over the twelve months from June of one year to July of the next.

Fig. 1. Proportion of labor force group reporting a specific number of days disabled in the last four weeks.

Table 4
Disabled days and disabled days squared estimated by ordinary least squares for the male wage earners samples: Côte d'Ivoire, 1985–1987 and Ghana, 1987–1989[a]

Explanatory variables[b] in Côte d'Ivoire/Ghana	Côte d'Ivoire		Ghana	
	Disabled days	Disabled days squared	Disabled days	Disabled days squared
Years of schooling completed				
Primary	−0.0229 (0.36)	−0.164 (1.12)	−0.0774 (1.15)	1.92 (1.56)
Middle	0.0341 (0.36)	1.14 (0.52)	0.0482 (0.57)	0.726 (1.54)
Post middle	−0.0978 (1.42)	−0.757 (0.49)	−0.0157 (0.52)	0.245 (0.44)
Post schooling years of experience	−0.863 (1.97)	−16.3 (1.63)	0.203 (1.00)	1.91 (0.52)
Experience squared ($\times 10^{-2}$)	0.242 (2.89)	4.76 (2.50)	−0.0135 (0.34)	0.0924 (0.13)
Household assets ($\times 10^{-6}$):				
Business	0.0255 (1.77)	0.165 (0.50)	−0.107 (0.07)	−0.956 (0.03)
Value of land	−0.0068 (0.31)	−0.151 (0.31)	−0.0159 (0.12)	−1.10 (0.42)
Savings	−0.151 (1.48)	−2.43 (1.05)	−2.02 (1.15)	−15.9 (0.50)
Unearned income	0.523 (2.37)	7.12 (1.42)	6.05 (1.82)	80.2 (1.32)
Tontines/Susu	−1.68 (0.67)	−19.7 (0.35)	2.85 (0.35)	51.3 (0.34)
Dowry	−0.179 (1.57)	−1.77 (0.69)	−0.548 (0.49)	−5.45 (0.27)
Region, rain / dry seasons and malaria interactions				
North – rainy	−0.708 (1.09)	−1.37 (0.93)	−0.643 (0.78)	−11.7 (0.77)
North-dry	−0.580 (0.84)	−19.1 (1.21)	−0.162 (0.19)	3.53 (0.23)
South-rainy	−0.0050 (0.02)	−0.386 (0.06)	0.198 (0.97)	3.68 (0.99)
Malaria · North-rainy	6.50 (1.33)	203. (1.81)	0.013 (0.01)	6.12 (0.27)
Malaria · North-dry[c]			1.13 (.93)	3.33 (.15)
Malaria · South-rainy	4.51 (1.10)	74.6 (0.80)	0.664 (1.54)	10.3 (1.31)
Distance to market in km	−0.0827 (1.04)	−3.20 (1.77)	−0.00967 (0.59)	0.0315 (0.11)
Rainfall (in cm/year)	−2.51 (2.03)	−77.7 (2.76)	−0.386 (0.82)	−1.74 (0.20)

Local market prices				
Beef/eggs	−0.295 (0.13)	21.9 (0.42)	2.43 (0.66)	24.4 (0.36)
Fish	−0.137 (0.11)	−17.4 (0.60)	0.0331 (0.30)	1.51 (0.75)
Rice/maize	−0.501 (0.75)	−13.4 (0.89)	0.102 (0.08)	−15.3 (0.64)
Onions	−0.837 (0.48)	−13.2 (0.33)	−0.0611 (0.72)	−1.26 (0.81)
Peanut butter	2.78 (2.07)	45.4 (1.49)	0.0500 (0.08)	6.71 (0.62)
Palm oil	−0.249 (0.66)	−6.00 (0.70)	−0.285 (1.05)	−6.57 (1.33)
Manioc/Cassava	6.84 (1.66)	201. (2.15)	3.36 (1.39)	79.2 (1.79)
Bananas	−6.93 (1.76)	−123. (1.38)	0.628 (0.77)	11.6 (0.78)
Tomatoes			0.108 (.55)	2.45 (.68)
Sugar			−0.948 (1.48)	−7.89 (.67)
Antibiotic			0.258 (1.50)	1.53 (.49)
Health infrastructure				
Distance to the closest hospital/clinic (km)	−0.0614 (2.42)	−1.53 (2.65)	−0.0126 (0.56)	−0.483 (1.16)
Distance to the closest doctor/nurse (km)	0.0739 (2.11)	2.47 (3.11)	−0.0034 (0.16)	−0.195 (0.49)
Community health problems				
Malaria	−0.918 (0.22)	−34.1 (0.36)	0.242 (0.44)	−2.00 (0.20)
Diarrhea	0.146 (0.10)	19.4 (0.59)	−0.341 (0.86)	−6.66 (0.92)
Measles and chicken pox	−0.736 (0.69)	−25.2 (1.03)	−0.155 (0.45)	−7.91 (1.26)
Water sanitation and transportation	−0.278 (0.20)	−3.83 (0.12)	0.0618 (0.17)	−1.23 (0.18)
Anti-malaria campaign in the last five years			−0.422 (1.09)	−11.2 (1.09)
Immunization campaign in the last five years			0.330 (.65)	16.5 (1.79)
State level public health expenditures appropriated per person in 1987				
Preventative services			2.10 (1.51)	42.0 (1.65)
Curative services			0.0421 (.11)	−1.05 (.15)

Table 4 (*continued*)

Disabled days and disabled days squared estimated by ordinary least squares for the male wage earners samples: Côte d'Ivoire, 1985–1987 and Ghana, 1987–1989[a]

Explanatory variables[b] in Côte d'Iviore/Ghana	Côte d'Iviore		Ghana	
	Disabled days	Disabled days squared	Disabled days	Disabled days squared
Parental background				
Mother's years of schooling	0.204 (1.43)	4.38 (1.36)	−0.0136 (0.44)	−0.190 (0.34)
Father's years of schooling	0.0297 (0.51)	0.229 (0.17)	0.0146 (0.72)	0.217 (0.58)
Father's years of schooling unknown	0.978 (0.90)	10.1 (0.41)	−0.140 (0.18)	−2.60 (0.18)
Mother's work agricultural	0.182 (0.64)	−1.09 (0.17)	0.321 (1.71)	5.75 (1.67)
Father's work agricultural	0.472 (1.40)	5.39 (0.71)	−0.178 (0.86)	−1.79 (0.47)
Intercept	4.06 (1.79)	97.7 (1.89)	−2.98 (1.10)	−65.5 (1.32)
F (df)	1.861 (41.1005)	1.791 (41.1005)	1.620 (51.1408)	1.500 (51.1408)
R^2	0.0705	0.0681	0.0554	0.0515
Sample size	1047	1047	1460	1460
Mean of the dependent variable (S.D.)	1.17 (3.85)	16.2 (87.4)	1.09 (2.98)	10.1 (54.3)

[a] Absolute value of the t-ratios are in parentheses.

[b] For the definitions and units of measurement of variables see Table 3.

[c] Small population cell was empty in wage earner and worker samples in Côte d'Ivoire, and these variables were suppressed in regressions.

of days disabled in the reference period was estimated. This specification produced essentially the same results at sample means as the linear model. Third, because disabled days is constrained to be nonnegative and the majority of adults report zero, a left censored Tobit model was estimated for disabled days. Because there was little evidence from prior analysis that sample selection bias was serious, sample selection correction was not done. Instrumental variable estimates of the wage, hours, and earnings equations were obtained using the prediction of disabled days from the Tobit of disabled days. These estimates based on the wage earner sample were similar whether the linear model or the Tobit specification is assumed. Details of these estimations, based on a prior model specification, are in Schultz and Tansel (1992). We appreciate the suggestions of referees to further evaluate this potential nonlinearity in our model that led to the quadratic specification reported here.

5.2. *Empirical findings*

Table 4 reports the ordinary least squares (OLS) estimates of disabled days and disabled days squared. They are estimated from only the sample of wage earners, to mitigate problems of self-reporting of health status among the self-employed and family workers. Disabled days are also estimated with the wage-earner sample selection corrected (not shown). The coefficient on λ in Heckman (1979) two-stage estimation procedure was insignificant. Although the joint significance test of the community health variables imply that the selection model is empirically identified, the sample selection bias is unimportant for predicting disabled days from the wage-earner sample. Nonetheless, the selection-corrected estimates are retained and used to assess the robustness of the productivity equation estimates to variations in model specification.

The productivity estimates summarized in Table 5 (linear) and Table 6 (quadratic) are based on the expanded sample of male workers aged 15–65 for whom hourly earnings could be calculated and corrected for potential sample selection bias. Only the coefficients on disabled days are reported. In panel 1 the maximum likelihood estimates are based on the actual reported values of disabled days and corrected for the potential unrepresentativeness of the sample of workers. In all three panel, estimates for three measures of productivity in the two countries the Wald test is highly significant, implying empirical identification of the selection model. The statistical significance of the estimate of ρ suggests that sample selection bias is serious for Ghana but not for Côte d'Ivoire. To maintain comparability for the two countries, only the maximum likelihood estimates of the productivity equations are reported, correcting sample selection.

Estimates in Table 5, panel 1, suggest small wage effects, but modest hours and earnings effects which are significant only in Côte d'Ivoire. These estimates may be biased due to measurement error and simultaneity, and may be particularly unreliable for the self-employed. The exogeneity of disabled days is therefore

Table 5
Alternative estimates of linearized productivity effects per disabled day in the last four weeks

Specification tests	Côte d'Ivoire			Ghana		
	Log wage	Log hours	Log earnings	Log wage	Log hours	Log earnings
1. Actual reported disabled days (t)	0.004 (0.91)	−0.014 (5.95)	−0.011 (2.60)	−0.0005 (0.09)	−0.0037 (0.81)	−0.0036 (0.62)
ρ^{a}	−0.074 (0.60)	0.063 (0.44)	−0.126 (0.95)	−0.249 (2.05)	0.938 (126.)	0.392 (4.23)
Wald test of selection instruments[b] (df)	227 (15)	198 (9)	198 (9)	55.64 (17)	39.03 (11)	39.03 (11)
2. Predicted disabled days IV (t)	−0.105 (5.72)	−0.033 (1.52)	−0.084 (2.05)	−0.117 (3.07)	−0.0305 (0.97)	−0.0742 (1.78)
ρ^{a}	−0.072 (0.61)	0.032 (0.22)	−0.131 (1.01)	−0.254 (2.12)	−0.940 (128.)	−0.394 (4.26)
Wald test of selection instruments[b] (df)	239 (15)	210 (9)	210 (9)	55.57 (17)	38.95 (11)	38.95 (11)
Hausman test of exogeneity of disabled[c]	5.74	1.58	1.90	3.06	1.82	1.77
3. Predicted disabled days selection corrected, ML-IV (t)	−0.097 (5.35)	−0.047 (1.70)	−0.068 (1.47)	0.0078 (1.42)	−0.0570 (4.40)	−0.151 (7.03)
ρ^{a}	−0.062 (0.50)	0.058 (0.41)	−0.127 (0.95)	−0.198 (3.44)	−0.035 (0.41)	−0.0127 (0.14)
Wald test of selection instruments[b] (df)	596 (15)	571 (9)	571 (9)	581 (17)	80.9 (9)	80.9 (9)
Hausman test of exogeneity of disabled[c]	4.91	2.34	1.03	1.87	9.15	11.7

[a] Correlation between the errors of the probit sample selection equation for workers and the productivity equation, estimated jointly by maximum likelihood methods.

[b] Wald test of the restriction of the coefficients on the assets and prices to zero in the worker probit that is estimated jointly by maximum likelihood with the wage equation. In the hours and earnings equation, the Wald test is reported only for prices which identify the worker probit. The Wald test is distributed as a χ^2 statistic with the degrees of freedom reported in parentheses.

[c] The Hausman test is based on absolute value of t statistic on the coefficient for the residual of disabled days, when the actual value is included, in the relevant equation, based on either the OLS or Heckman sample selection-corrected estimates of disability days, as reported in Table 4. The Heckman first stage estimates are available from the authors.

The estimation method in all three panels is maximum likelihood selection corrected based on worker sample.

Table 6
Alternative estimates of the quadratic productivity effects per disabled day

Specification tests	Côte d'Ivoire			Ghana		
	Log wage	Log hours	Log earnings	Log wage	Log hours	Log earnings
1. Actual reported disabled days (t)	−0.0316 (2.16)	0.0055 (0.60)	−0.0276 (1.87)	−0.0032 (0.28)	−0.0233 (2.51)	−0.0100 (0.82)
Disabled days squared (t)	0.00148 (2.75)	−0.00081 (2.44)	0.00070 (1.27)	0.00014 (0.24)	0.00106 (2.35)	0.00034 (0.57)
Derivative[c]	−0.0549	0.0076	−0.0503	−0.0043	−0.0305	−0.0134
ρ^a	0.0737 (0.59)	0.057 (0.40)	−0.129 (0.97)	−0.270 (2.35)	−0.937 (124.)	−0.407 (4.58)
2. Predicted disabled days IV (t)	−0.182 (3.39)	−0.179 (2.89)	−0.362 (3.92)	−0.195 (3.35)	−0.158 (2.64)	−0.238 (2.68)
Disabled days squared (t)	0.00390 (1.44)	0.00596 (2.63)	0.0115 (3.41)	0.00634 (1.94)	0.00678 (2.30)	0.00871 (2.07)
Derivative[c]	−0.334	−0.321	−0.651	−0.260	−0.208	−0.316
ρ^a	−0.003 (0.03)	0.036 (0.26)	−0.091 (0.69)	−0.260 (2.22)	−0.939 (126.)	−0.398 (4.40)
Hausman test of exogeneity of disabled[b] ($\chi^2(2df)$)	1% (35.5)	1% (10.7)	1% (16.6)	1% (12.3)	14% (3.93)	6% (5.64)
3. Predicted disabled days selection corrected ML-IV (t)	−0.159 (3.15)	−0.122 (2.16)	−0.321 (3.71)	−0.156 (2.60)	−0.0877 (2.05)	−0.239 (3.63)
Disabled days squared (t)	0.00221 (1.00)	0.00352 (1.41)	0.00987 (2.73)	0.00979 (2.74)	0.00191 (0.73)	0.00576 (1.47)
Derivative[c]	−0.297	−0.221	−0.578	−0.199	−0.119	−0.323
ρ^a	−0.219 (3.16)	0.0832 (0.81)	−0.145 (1.58)	−0.190 (3.26)	−0.036 (0.41)	−0.046 (0.50)
Hausman test of exogeneity of idisabled[b] ($\chi^2(2df)$)	1% (39.9)	4% (6.68)	1% (27.8)	1% (12.5)	1% (84.1)	1% (138.)

[a] Correlation between the errors of the probit sample selection equation for workers and the productivity equation, estimated jointly by maximum likelihood methods.
[b] The Hausman test is based on the Wald test statistic on the coefficients for the residuals of disabled days and disabled days squared, when the actual values are included in the relevant equation, based on either the OLS or Heckman sample selection-corrected estimates of disability days and disability days squared.
[c] Derivative evaluated at the mean of OLS predicted disabled days for worker sample (Table 3).
Estimation method in all three panels is maximum likelihood selection corrected based on worker sample.

tested and generally rejected in panels 2 and 3, based on the Hausman (1978) test. Consequently, the second and third panels report the instrumental variable (IV) estimates of the coefficients on disabled days in the productivity equations which are free of bias due to random measurement error, simultaneity and heterogeneity. In panel 2, the predicted disabled days are obtained from the auxiliary equations in Table 4 [18]. In panel 3 the predicted disabled days is obtained from an auxiliary equation (not shown) corrected for wage earner sample selection. Panels 1, 2, and 3 of Table 5 are otherwise similarly estimated.

The linear estimates in Table 5 panel 2 indicate that wages are 10.5% lower for each disabled day in Côte d'Ivoire and 11.7% lower in Ghana. The effect of disabled days on hours, although not estimated precisely, suggest a 3% reduction in hours for each disabled day. The linear effects of disabled days on earnings are significant and lie between the estimates on wages and hours [19]. In Table 5 panel 3, the estimated effects of disabled days are generally similar to those obtained from the IV estimates in panel 2 for Côte d'Ivoire, but in Ghana the effect on wages decreases and the effects on hours and earnings increase.

In all estimates of the productivity equations in Table 6, the squared term in disabled days were statistically significant. The derivative of the estimated quadratic function is evaluated at the sample mean of the predicted values of disabled days for the worker sample (Cf. Table 3). The Wald tests confirm the power of the identifying instruments in the sample selection model for disabled days and disabled days squared. Estimates based on the actual disabled days variable (Table 6, panel 1) suggest more significant (joint) quadratic than linear effects for wages, hours, and earnings, but the magnitude of the estimated effects of adult health remain modest, from 1 to 5% per disabled day. The Hausman (1978) tests for the exogeneity of the quadratic form of disabled days reported in panels 2 and 3 show that the exogeneity of disabled days can be generally rejected.

The preferred IV estimates in panel 2 Table 6 imply that a disabled day is associated with 33 and 26% reductions in wages in Côte d'Ivoire and Ghana, respectively. Hours are similarly reduced by 32% in Côte d'Ivoire and 21% in Ghana. The analogous estimated impact on annual earnings is a 65% reduction in Côte d'Ivoire and a 32% reduction in Ghana for one additional disabled day. These large productivity effects of adult health at sample means diminish, as expected, as the number of predicted days disabled increases. The third panel

[18] Nelson and Startz (1990), Bound et al. (1995) and Staiger and Stock (1994) show that weakly correlated instruments can lead to biased and inconsistent coefficient estimates and misleading inferences. In the estimates presented in this paper, finite sample bias and inconsistency are unlikely to be problems since the instruments explain a significant portion of the variation in disabled days in both countries.

[19] Because the selection-corrected model is nonlinear in parameters, the log wage and log hours parameters on a specific variable do not need to add up to that variable's parameter in the log earnings equation.

reports the estimates when sample-selection corrected predictions of disability days are used. These estimates imply derivative effects that are somewhat smaller than the panel 2 estimates, but of the same rough magnitude in both countries.

5.3. *Evidence of systematic measurement error*

If the measurement error in self-reported health status, proxied by disabled days, is not random but correlated with determinants of productivity, the IV estimates of the productive returns to adult health could be biased. According to the 'cultural conditioning' hypothesis (Johansson, 1991) discussed in Section 2, education is one characteristic of the worker that leads to a systematic overstatement of his bad health. If this were a problem, we would expect a positive coefficient in the productivity functions on an interaction variable between the years of schooling and disability days. This interaction variable predicted by an auxiliary equation parallel to those reported in Table 4 was therefore added to the panel 2 model in Tables 5 and 6. In Côte d'Ivoire the interaction variable (not reported) is not statistically significant, whereas in Ghana it is significant at the 5% level, but only in the wage equation with an unexpected negative sign. More educated workers experience a greater loss in wage-productivity from their predicted disabled days than less educated workers. This limited test of the cultural conditioning hypothesis does not support the view that the productivity enhancing effect of good health is systematically understated by better educated workers, providing us more confidence in assuming that the measurement error is random among wage earners, and our estimates are unbiased.

6. Conclusions

Life expectancy at birth is lower in Africa than on any other continent, and the burden of disabling acute and chronic health conditions is undoubtedly as heavy in Africa as it is anywhere. This study has proposed an empirical approach for evaluating the disabling burden of poor health as it reduces the productivity of labor per hour worked and erodes the capacity of workers to labor longer hours. Two measurement issues have been addressed. The first is that health may affect the productivity of the worker, but productivity provides the resources to invest in better nutrition and health care, and hence to produce better health (Strauss, 1986). The production of health and the effect of health on productivity must, therefore, be viewed in a simultaneous-equation framework.

In addition, measurement error due to self-reporting of health status may be a serious source of parameter bias. Ashenfelter and Krueger (1994), Behrman et al. (1994) and many others (e.g., Griliches, 1977) have found measurement error to be an important source of downward bias in estimating returns to human capital from wage relations. Recent investigations of self-reported and clinically-performed health evaluations show that persistent differences occur between these two kinds of health status measures for the same individuals (Idler and Angel, 1990). Some studies have found that self-reported health status predicts subsequent mortality better than do clinical examinations (Idler, 1991; Idler and Kasl, 1991). Regardless of whether self-reports or clinical measures of health status are better predictors of worker productivity, both are likely to be subject to measurement error and require special forms of analysis. The distinctly lower cost of self-reported survey data than clinical data should predispose health economists to examine carefully the strengths and shortcomings of health status questions in surveys in low-income countries. The information content of responses to such questions as ''How many days were you sick and unable to perform your usual activity?'' may be enhanced by selecting for analysis a sample of wage earners for whom the reporting of acute health disabilities may reflect a balancing of costs and benefits.

It is anticipated that simultaneous equation bias would lead to an overestimation by OLS of the effect of morbidity in a wage function, whereas classical errors-in-variables would introduce bias in the opposite direction. Because the two sources of bias in OLS estimates are offsetting to some degree, the direction of the net bias of an OLS estimate of the coefficient on the morbidity variable in a wage function cannot be deduced a priori (Cf. Griliches, 1977).

From Table 6 the derivative of log wages with respect to actual (OLS) disabled days (panel 1) are much lower than the corresponding IV estimates (panel 2) in both countries. This is also noted in the labor supply equations. In both cases the OLS estimates appear to be biased toward zero, presumably due to the greater importance of measurement error compared with the hypothesized simultaneous equation bias. Past OLS studies of adult health effects on worker productivity may therefore have underestimated the impact of adult health.

To study the empirical consequences of health for labor productivity requires appropriate instruments that account for a sufficient fraction of the variation in morbidity but are independent of individual's preferences and exogenous to (unobserved) health endowments or regional constraints. Variation across communities in the time and money prices of food and health care, and local health and transportation infrastructure are the instruments used in this study to help explain health status and identify the model.

The framework provides an empirical check on the endogeneity of disabled days in the relationship between health and productivity. Conditional on the identification of our health and wage/hours/earnings model, the disability variables are tested for their exogeneity and rejected in both linear and quadratic forms. But the results provide little guidance on how public health or social welfare interventions might cost-effectively reduce morbidity and thereby increase labor productivity. Finding policy instruments that are effective in improving health status is always difficult, and in low-income settings, such as West Africa, where the effectiveness of the existing health care systems is sometimes in doubt, the empirical challenge is daunting.

Another issue explored in this paper is how meaningful responses about adult health status are elicited (e.g., Butler et al., 1987). Self-reported health status is subjective and may well be modified by modernization and the respondent's education and, therefore, may not always be a satisfactory metric of morbidity across a society or over time (Johansson, 1991). In response to this concern, days of activity limitation were examined from parallel LSMS household surveys collected in Côte d'Ivoire and Ghana in the late 1980s. About a fifth of all persons report an activity limitation in the last four weeks. On average, one day in those four weeks is lost to work because of their illness. It was argued that wage earners would be more disciplined by labor market institutions into accurately reporting 'disabled days' than would self-employed or family unpaid workers, because of the wage-employment contract, and the cost of information and monitoring output. To improve the estimation of the relationship between labor productivity and reported activity limitation, the number of disabled days are instrumentally predicted only for wage earners.

The size of the working sample is sharply reduced when the sample is restricted to those who hold a wage job or are self-employed for whom wages and hours could be determined, by 66% in Côte d'Ivoire and 33% in Ghana [20]. Consequently, a probit function is specified to explain who is in the 'worker' sample, which is estimated jointly by maximum likelihood methods with the wage, labor supply, or earnings equations (Heckman, 1979; Greene, 1981). Although the sample selection correction equations appear to be reasonably identified by exclusion restrictions, where wealth variables have the expected effect of significantly reducing the likelihood that a man is a worker, this correction procedure does not systematically change the estimated effect of morbidity on worker productivity or labor supply, as can be seen by comparing the estimates in panels 2 and 3 in Tables 5 and 6.

Larger samples of wage and self-employed workers, longitudinal data, and more focused questionnaires [21] might yield more precise estimates of the effects of adult morbidity on wage rates than reported here. It would then be appropriate to explore intrafamily labor supply relationships in which health indicators could be endogenized (Pitt and Rosenzweig, 1986).

Identifying the effects of adult health on adult productivity is a difficult dynamic problem, and our results depend empirically on contestable identifying restrictions. We have greater confidence in our estimates of adult disability effects

[20] The estimates for women wage earners in both countries are unrevealing, with some small signs of reduced wages and hours among women in Côte d'Ivoire who are more likely to experience morbidity (Schultz and Tansel, 1992).

[21] The LSMS questionnaires could also be used to clarify what economic penalty people incur to be 'inactive' because of their illness, how individual daily wage rates compare to community standards, how the qualities and quantities of health care vary across communities, and how the government's objectives and regulations affect the placement of community health care facilities.

on wages than those on labor supply. This is because our instruments for adult disability — local health infrastructure and relative food prices — could influence hours worked through other unobserved mechanisms than those associated with observed adult disability. However, our linear (and quadratic) estimates of the wage effects are substantial, 10% (or more) per predicted day of disability, and relatively precisely estimated. Our estimates of labor supply effects of adult health are less stable and often smaller, and because of the relative weaknesses of our instruments in this case, they may be conservatively discounted.

What would constitute improved instruments for our problem? Longitudinal data on persons and their local environment might permit the estimation of adult health effects on wages using, as instruments for individual health changes, the changes over time in the relative prices and availability of local food and medical care. Although migrants might experience more marked changes in these health input prices, migration could itself be affected by changes in adult health status; thus migration would not be a valid instrument. Because the correlation between local health input price changes and new bouts of disabling adult illness is probably attenuated, a large sample might be needed, and even then the marginal explanatory power of the instruments to explain changes in adult health could be sufficiently low to yield misleading inferences (Bound et al., 1995). Only in the case of the Côte d'Ivoire are segments of our survey samples reinterviewed in the following year, and many of those individually 'matched' do not report consistently their age or sex, suggesting matches are imperfect. We did not think it would be productive to reestimate our model on less than a third of the Côte d'Ivoire sample for which we have two years of data. Côte d'Ivoire is already the smaller of our two survey populations. Further research is clearly needed to confidently identify and estimate the value of adult disabilities on the labor productivity and the welfare of poor people. The challenge may be no less important than studies of height and weight as proxies of adult health capital (Fogel, 1991; Strauss and Thomas, 1995).

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References

Ainsworth, M., Munoz, J., 1986. The Côte d'Ivoire Living Standards Survey, Living Standards Measurement Study Working Paper No. 26. The World Bank, Washington, DC.

Alters, G., Riley, J.C., 1989. Frailty, Sickness and Death: Models of Morbidity and Mortality in Historical Populations. Population Studies 43, 25–46.

Ashenfelter, O., Krueger, A., 1994. Estimates of the Economic Returns to Schooling from a New Sample of Turns. American Economic Review 84 (5), 1157–1173.

Bartel, A., Taubman, P., 1986. Some Economic and Demographic Consequences of Mental Illness. Journal of Labor Economics 4 (2), 243–256.

Behrman, J.R., Birdsall, N., 1983. The Quality of Schooling: Quantity Alone is Misleading. American Economic Review 73 (5), 928–946.

Behrman, J.R., Deolalikar, A.B., 1989. Wages and Labor Supply in Rural India: The Role of Health, Nutrition and Seasonality, in Causes and Implications of Seasonal Variability in Household Food Security. In: Sahn, D.E. (Ed.). Johns Hopkins Univ. Press, Baltimore, MD, 107–118.

Behrman, J.R., Rosenzweig, M.R., Taubman, P., 1994. Endowments and the Allocation of Schooling in the Family and in the Marriage Market: The Twins Experiment. Journal of Political Economy 2 (6), 1131–1174.

Behrman, J.R., Wolfe, B.L., 1987. How Does Mother's Schooling Affect Family Health, Nutrition, Medical Care Usage, and Household Sanitation. Journal of Econometrics 36, 185–204.

Bound, J., Jaeger, D.A., Baker, R.M., 1995. Problems with Instrumental Variables Estimation When the Correlation between the Instruments and Endogenous Explanatory Variables is Weak. Journal of the American Statistical Association 90 (430), 443–450.

Brundage, D.K., 1930. The Influence of Illness Among Wage-Earning Adults. Journal of Industrial Hygiene 12 (1930), 339–350.

Butler, J.S., Burkhauser, R.V., Mitchell, J.M., Pincus, T.P., 1987. Measurement Error in Self Reported Health Variables. Review of Economics and Statistics 69 (4), 644–650.

Caldwell, J.C., et al., 1990. Cultural, Social and Behavioral Determinants of Health and Their Mechanisms, in What Do We Know about Health Transition. In: Caldwell, J.C., et al. (Eds.). Health Transition Center, The Australian National University, Canberra, 534–541.

Clemens, J.D., Stanton, B.F., Chakraborty, J., Chowdhury, S., Rao, M.R., Ali, M., Zimicki, S., Wojtyniak, B., 1988. Measles Vaccination and Childhood Mortality in Rural Bangladesh. Am. J. Epidemiol. 128 (6), 1330–1339.

Crimmins, E.M., Saito, Y., Ingegneri, D., 1989. Changes in Life Expectancy and Disability-Free Life Expectancy in the United States. Population and Development Review 15 (2), 235–267.

Deolalikar, A.B., 1988. Nutrition and Labor Productivity in Agriculture. Review of Economics and Statistics 70 (3), 406–413.

Fogel, R.W., 1991. New Sources and New Techniques for the Study of Secular Trends in Nutritional Status, Health Mortality, and the Process of Aging. NBER Working Paper No. 26, May, Cambridge, MA.

Foster, A., Rosenzweig, M.R., 1993. Information, Learning, and Wage Rates in Low Income Rural Areas. Journal of Human Resources 28 (4), 759–790.

Foster, A., Rosenzweig, M.R., 1994. A Test of Moral Hazard in the Labor Market. Review of Economics and Statistics 76 (2), 213–227.

Ghana Health Assessment Project Team (GHAPT), 1981. A Quantitative Method of Assessing the Health Impact of Different Diseases in Less Developed Countries. Int. J. Epidemiol. 10 (1), 73–80.

Glewwe, P., 1987. The Distribution of Welfare in the Republic of Côte d'Ivoire, Living Standards Measurement Study Working Paper No. 29. The World Bank, Washington, DC.

Greene, W.H., 1981. Sample Selection Bias as a Specification Error: Comment. Econometrica 49 (3), 795–798.

Griliches, Z., 1977. Estimating the Returns to Schooling: Some Econometric Problems. Econometrica 45, 1–22.

Haddad, L., Bouis, H., 1991. The Impact of Nutritional Status on Agricultural Productivity: Wage Evidence from the Philippines. Oxford Bulletin of Economics and Statistics 53 (1), 45–68.

Hausman, J.A., 1978. Specification Tests in Econometrics. Econometrica 46 (6), 1251–1271.

Heckman, J.J., 1979. Sample Bias as a Specification Error. Econometrics 47 (1), 153–162.

Idler, E.L., 1991. Self-Assessed Health and Mortality: A Review of Studies. International Review of Health Psychology.
Idler, E.L., Angel, R.J., 1990. Self Rated Health and Mortality in the NHANES-1 Epidemiologic Follow-up Study. Am. J. Public Health 80 (4), 446–452.
Idler, E.L., Kasl, S., 1991. Health Perception and Survival: Do Global Evaluations of Health Status Really Predict Mortality?. J. Gerontol. 46 (2), S55–65.
Jamison, D.T., Mosley, W.H., 1991. Disease Control Priorities in Developing Countries. Am. J. Public Health 81 (1), 15–22.
Johansson, S.R., 1991. The Health Transition: The Cultural Inflation of Morbidity During the Decline of Mortality. Health Transition Review 1 (1), 39–68.
Kroeger, A., 1985. Response Errors and Other Problems of Health Interview Surveys in Developing Countries. World Health Stat. Q. 38, 15–33.
Lee, L.F., 1982. Health and Wages. International Economic Review 23 (1), 199–221.
Martorell, R., Habicht, J.P., 1986. Growth in Early Childhood in Developing Countries. In: Falkner, F., Tanner, J.M. (Eds.), Human Growth, Vol. 3. Plenum, New York.
Mincer, J., 1974, Schooling, Experience and Earnings, Columbia University Press, New York.
Mitchell, J.M., Butler, J.S., 1986. Arthritis and the Earnings of Men: An Analysis Incorporating Selection Bias. J. Health Econ. 5 (1), 81–98.
Morrow, R.H., 1984. The Application of a Quantitative Approach to the Assessment of the Relative Importance of Vector and Soil Transmitted Diseases in Ghana. Soc. Sci. Med. 19 (10), 1039–1049.
Morrow, R.H., Smith, P.G., Nimo, K.P., 1982. Assessing the Impact of Disease. World Health Forum 3 (3), 331–335.
Nelson, C.R., Startz, R., 1990. The Distribution of the Instrumental Variables Estimator and the *t*-Ratios When the Instrument is a Poor One. Journal of Business 63 (1:2), S125–140.
Newmann, A.K., Sai, F.T., Ofosu-Amaah, S., 1991. The Danfa Comprehensive Rural Health Project, Ghana, 1969–1979. In Feachem: R.G., Jamison, D.T. (Eds.), Disease and Mortality in Sub-Saharan Africa. Oxford Univ. Press, New York.
Omran, A.R., 1971. The Epidemiological Transition. Milbank Memorial Fund Quarterly 49 (4), 509–538.
Palloni, A., 1990. Methodological Problems in the Study of the Health Transition. Health Transition 2 (2), 896–899.
Patterson, K.D., 1981. Health in Colonial Ghana: Disease, Medicine, and Socio-Economic Change, 1900–1955. Cross-Roads Press, Waltham, MA.
Pearson, K., 1887. The Chances of Death and other Studies of Evolution. Edwards Arnold, London.
Pencavel, J., 1986. Labor Supply of Men. In: Ashenfelter, O., Layard, R., (Eds.), Handbook of Labor Economics, Vol. I. North-Holland, Amsterdam.
Pitt, M., Rosenzweig, M., 1986. Agricultural Prices, Food Consumption, and the Health and Productivity of Indonesian Farmers. In: Singh, I., Squire, L., Strauss, J., (Eds.), Agricultural Household Models: Extensions, Applications and Policy. The World Bank. Johns Hopkins Univ. Press, Washington, DC, 153–182.
Pitt, M., Rosenzweig, M., Hassan, M.D.N., 1990. Productivity, Health, and Inequality in the Intrahousehold Distribution of Food in Low Income Countries. American Economic Review 80 (5), 1139–1156.
Preston, S.H., 1980. Causes and Consequences of Mortality Declines in LDCs during the 20th Century. In: Easterlin, R.A., (Ed.), Population and Economic Change in Developing Countries. University of Chicago, NBER, Chicago.
Remy, G., 1988. Paysages et mîlieux épidémiologiques dans l'espace Ivoiro-Burkinapé. Editions du Centre National de la Recherche Scientifique, Paris.
Riley, J.C., 1990. The Risk of Being Sick: Morbidity Trends in Four Countries. Population and Development Review 16 (3), 403–432.
Rogers, W.H., Williams, K.N., Brook, R.H., 1979. Conceptualization and Measurement of Health for

Adults in the Health Insurance Study, Vol. VII. Power Analysis of Health Status Measures, R-1987. The Rand Corp, Santa Monica, CA.

Rosenzweig, M.R., Schultz, T.P., 1983. Estimating a Household Production Function: Heterogeneity and the Demand for Health Inputs. Journal of Political Economy 91 (5), 723–746.

Rosenzweig, M.R., Wolpin, K., 1986. Evaluating the Effects of Optimally Distributed Public Programs. American Economic Review 76, 470–482.

Sahn, D.E., Alderman, H., 1988. The Effect of Human Capital on Wages, and the Determinants of Labor Supply in a Developing Country. Journal of Development Economics 29 (2), 157–184.

Sarris, A., Shams, H. 1991. Ghana Under Structural Adjustment: The Impact on Agriculture and the Rural Poor, IFAD Studies in Rural Property No. 2. International Fund for Agricultural Development. New York University Press, New York.

Schultz, T.P., 1981. Economics of Population, Addison-Wesley, Reading, MA.

Schultz, T.P., 1988. Heterogeneous Preferences and Migration. In: Schultz, T.P. (Ed.), Research in Population Economics, Vol. VI. JAI Press, Greenwich, CT.

Schultz, T.P., 1994. Returns to Human Capital and Economic Development. 22nd International Conference of Agricultural Economists, August 22–29. Harare, Zimbabwe.

Schultz, T.P., 1995. Investments in the Schooling and Health of Women and Men. In: Schultz, T.P. (Ed.), Investment in Women's Human Capital. University of Chicago Press, Chicago.

Schultz, T.P., Tansel, A., 1992. Measurement of Returns to Adult Health: Morbidity Effects on Wage Rates in Côte d'Ivoire and Ghana. Discussion Paper No. 663 (April). Economic Growth Center, Yale University, New Haven, CT.

Sindelar, J., Thomas, D., 1991. Measurement of Child Health: Maternal Response Bias, Discussion Paper No. 633 (June). Economic Growth Center, Yale University, New Haven, CT.

Sokal, D.C., Imbova-Bogui, G., Soga, G., Emmou, C., Jones, T.S., 1988. Mortality from Neonatal Tetanus in Rural Côte d'Ivoire. Bull. WHO 66 (1), 69–76.

Staiger, D., Stock, J.H., 1994. Instrumental Variables with Weak Instruments. NBER Technical Paper No. 151, Cambridge, MA.

Stewart, A.L., Ware, J.E., Brook, R.H., Davies-Avery, A., 1987. Conceptualization and Measurement of Health for Adults in the Health Insurance Study: Vol II, Physical Health in Terms of Functioning, R-1987 (July). The Rand Corp, Santa Monica, CA.

Strauss, J., 1986. Does Better Nutrition Raise Farm Productivity?. Journal of Political Economy 94 (2), 297–320.

Strauss, J., Gertler, P.J., Rahman, O., Fox, K., 1995. Gender and Life-Cycle Differentials in the Patterns and Determinants of Adult Health. In: Schultz, T.P. (Ed.), Investment in Women's Human Capital. University of Chicago Press, Chicago.

Strauss, J., Thomas, D., 1995. Health, Nutrition and Economic Development. Working Paper. Rand Corp, Santa Monica, CA.

Tanner, J.M., 1981. A History of the Study of Human Growth. Cambridge Univ. Press, London.

Thomas, D., Lavy, V., Strauss, J., 1991. Public Policy and Anthropometric Outcomes in Côte d'Ivoire, Discussion Paper No. 643 (August). Economic Growth Center, Yale University.

Thomas, D., Strauss, J., 1996. Health and Wages: Evidence on Men and Women in Urban Brazil. Journal of Econometrics, forthcoming.

Timaeus, I.M., 1993. Adult Mortality. In: Foote, K.A., Hill, K.H., Martin, L.G. (Eds.), Demographic Change in Sub-Saharan Africa. National Academy Press, Washington, DC.

United Nations, 1982. Levels and Trends of Mortality Since 1950. Dept. of International Economic and Social Affairs, ST/ESA/SER.A/74, New York.

United Nations, 1991. World Population Prospects 1990. United Nations, New York.

van der Gaag, J., Vijverberg, W.P.M., 1987. Wage Determinants in Côte d'Ivoire. Living Standards Measurement Study Working Paper No. 33. The World Bank, Washington, DC.

van Wieringen, J.C., 1986–1988. Secular Growth Changes. In: Falkner, F., Tanner, J.M. (Eds.), Human Growth, Vol. 3. Plenum, New York.

Vijverberg, W.P.M., 1988. Profits from Self-Employment. Living Standards Measurement Study Working Paper No. 43. The World Bank, Washington, DC.
Waaler, H.Th., 1984. Height, Weight, and Mortality: The Norwegian Experience. Acta Medica Scandinava 77, 279–303.
Waldron, I., 1983. Sex Differences in Illness Incidence, Prognosis and Mortality. Soc. Sci. Med. 17 (16), 1107–1123.
Waldron, I., Harold, J., Dunn, D., 1982. How Valid are Self Reported Measures for Evaluating the Relationship Between Women's Health and Labor Force Participation. Women Health 7, 53–66.
World Bank, 1993. World Development Report, 1993. Investing in Health, New York. World Bank. Oxford Univ. Press.