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WAGE GAINS ASSOCIATED WITH HEIGHT AS A FORM OF HEALTH HUMAN CAPITAL

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Abstract

Height is consulted as a latent indicator of early nutrition and lifetime health status. Height is observed to increase in recent decades in populations where per capita national income has increased and public health activities have grown. Height is determined by genetic make up and realized in part through satisfactory nutrition and health related care and conditions. Alternative instrumental variables (IV) are explored which proxy price and income constraints which are expected to influence the latter reproducible human capital investments in height. I report OLS and IV estimates of the partial effect of height on log hourly wages in recent national surveys from three countries: Ghana, Brazil and the United States. I conclude that the human capital productivity effect of height estimated by parent education IVs in the US and Ghana are many times larger than the OLS estimates, and in Ghana and Brazil the regional price IVs estimates also imply a substantially larger human capital wage effects of height compared with the OLS estimates. The OLS estimates of height effects on wages are dominated by the genetic variation in height, and appear to understate substantially the human capital returns to health and nutrition inputs which increase adult height.

Keywords: Health, Height, Wages, Human Capital

JEL Classification: I10, I12, J24

1. Introduction

In studies of the effect of health on labor productivity, adult height, a latent measure of health status, has been assumed homogeneous, measured without error, and exogenous with respect to the individual's wage. These assumptions are reconsidered in this paper and empirically evaluated by considering wages of workers and their height in Ghana, Brazil, and the United States. Other survey indicators of health and nutrition, such as weight-for-height, current food intakes, or recent illness, are increasingly treated as endogenous and measured with error in models accounting for labor productivity (Strauss and Thomas, 1995; Schultz and Tansel, 1997). A nutrition-motivated efficiency-wage model describes rural Indian labor markets as a combination of a relationship linking nutrition to labor productivity, and one relating income to food purchases (Bliss and Stern, 1978). To correct for this possible source of simultaneous equation bias, Strauss (1986) uses the local food price as an instrument for the family intake of calories and estimates a family farm production function from which he infers the effect of calorie availability on farm labor productivity. Subsequent studies in a variety of low-income countries have used local food prices, and health and sanitation services, as instruments for current measures of nutrition and health status, which then enter into a second stage wage function (e.g. Deolalikar, 1988; Foster and Rosenzweig, 1995; Thomas and Strauss, 1997).

Adult height is formed by genetic, hormonal, and biochemical factors, as well as a child's early nutrition and health conditions (Martorell and Habicht, 1986; Coutant, et al., 2001). Some of the latter conditions are affected by family and community resources and behavior and are viewed as investments in health human capital. These investments are likely to be most important during three critical stages of human development: (1) foetal development including the mother's pregnancy (e.g., Barker, 1998); (2) the first four years of childhood (e.g., Fogel, 1986; Glewwe and King, 2001); and

(3) the adolescent physical growth spurt, which tends to occur at an earlier age in a better nourished, healthier population (e.g. Eveleth and Tanner, 1976).

Adult height between the ages of 25 and 54 is thus affected some 10 to 50 years before adult wages are observed, and this fact appears to justify treating this form of health human capital as predetermined when modeling wage determinants. In contrast, many other indicators of health and nutrition, such as weight-for-height or morbidity, could respond to current food intakes, family time allocation, and health care, all of which are potentially determined simultaneously with current wages (Pitt and Rosenzweig, 1986). However, unobserved variations in the endowments, prices, and preferences of an individual's parents might affect an individual's height inputs as a child and enhance adult health status and lifetime productivity. Height would thus be correlated with the error in the wage function or endogenous.

Variation in height arises from at least two components: one described above as a long-gestating form of health human capital, and another related to genetic, hormonal, and physiological differences which have not been amenable to human control until recently (Coutant, et al., 2001). It is not clear why these two sources of variation in height should be associated with identical changes in productivity, survival, or illness. Errors in the survey measurement of height might also lead to an attenuation bias in the estimation by ordinary least squares (OLS) of height's effect on wages or health outcomes, which instrumental variable estimation methods (IV) should correct. My empirical strategy in this paper is to specify several sets of instruments (IVs) related to height, which are hypothesized to capture different combinations of behavioral and biological mechanisms associated with the human capital and genetic variation in height. Unfortunately, the variation in height associated across groups defined by each set of instruments will not discriminate neatly between the genetic and the human capital variation in height, because these two sources of variation are likely to be correlated, unless it were possible to observe a random experiment that removed this covariation.

2. Hypotheses Related to the Choice of Instrumental Variables Associated with Height

The first set of instrumental variables (IV-1) are selected to represent the community supply of health related services and infrastructure, as well as environmental conditions which might affect exposure to disease, such as climate and ecology. These community residential conditions affect the cost and ability of parents to enhance their child's health human capital, and could be viewed as a local price of health which is exogenous to the household, assuming parents do not migrate in response to these health input prices or to their preferences between child health and other commodities (Rosenzweig and Schultz, 1983).

The second set of instruments would capture variation in endowments and lifetime income constraints (IV-2) which should expand the opportunity choice set for parents and allow them to invest in and consume more health care and health related inputs which could benefit their children. Measuring this exogenous lifetime income constraints is difficult because market or monetized income is endogenous, involving family labor supply decisions and possibly other human capital investments in the child. Consequently, the variable examined here is the educational attainment of the mother and father. There is finally the possibility that poor households are credit constrained, by which I mean poor households will invest less in their children's health human capital than do rich households, because they lack collateral against which to borrow at the market interest rate.

The third set of instruments (IV-3) combines both the regional price and parent education instruments.

It is desirable for both the price instruments (IV-1) and the endowment instruments (IV-2) to be measured in the residential location and time period during which the child is of the age when child health inputs have their strongest effect on height and adult health status. In the case of the Ghanian survey it is possible to assess the community characteristics of the current residence if the individual is born there, and if not a native then to attribute to the individual the averaged community characteristics of the region in which they were born. But these characteristics of local health services, infrastructure, and relative food prices are measured at the time of the survey and not measured years or decades earlier when the respondent was a child. In Brazil the municipality health infrastructure, education and income variables are also measured contemporaneously, and birthplace is not available to attribute to migrants the more appropriate conditions at origin. In the US survey a limited set of questions relate to the location and family structure at the time the individual was age 14. This information is used to form the regional instrumental variables (IV-1) for the U.S. sample.

A fourth set of instruments (IV-4) use information available in the survey to distinguish ethnic groups according to language in Ghana, and by race in Brazil, and by race and ethnic group in the United States. Height is expected to differ between these ethnic/race groups, and some part of these differences might be due to biological or genetic differences, whereas much of these height differences across groups would reflect distinctions of socioeconomic status. Consequently, IV-4 estimates are based on a combination of health human capital variations and biological variations accumulated over generations within these groups which tend to lived in, and intermarry in, a specific region.

3. Empirical Findings

The ordinary least squares (OLS) coefficients on height measured in meters are estimated in a log hourly wage equation, in which controls are included for a schooling (spline), a quadratic in post-schooling experience, rural residence (See Table 1). Height is significantly positively associated with the log hourly wage for men and women age 25 to 54 in Ghana in 1987-89 as recorded in the Living Standard Survey, age 25-54 in Brazil in 1989 in the Health and Nutrition Survey, and among youth age 20-28 in the United States from 1989-93 in the National Labor Survey of Youth. Controls for ethnic-language or race groups are included as Galton (1869) would have preferred, measuring such traits as height as deviations from ethnic group means. An additional centimeter in adult height is associated with wages being 1.5 percent higher for men and 1.7 percent higher for women in Ghana, 1.4 and 1.7 percent higher in Brazil, respectively, and .45 and .31 percent higher in the United States, respectively. The percentage increase in wages with respect to height in the United States is roughly one third of that in the two lower income countries. This may be due to diminishing returns to nutrition/health, where health conditions in the United States allow most of the expression of the genetic potential, compared with Ghana and Brazil. Alternatively, the larger share of white collar jobs in the U.S. economy may warrant less of a wage premium for the extra physical work capacity that is associated with larger stature.

The second row in Table 1 reports the instrumental variable estimates for height in the log wage equation, where the instruments are from the region's prices (IV-1) explain from 5 to 9 percent of the variation in height, and the identifying instruments are jointly significant at the 5 percent level or better, with the exception of women in the United States where the price instruments have no power and should not be regarded as providing a satisfactory IV estimate (Bound, et al., 1995). The regional price IV-1 estimates for height's effect on the log wage are roughly five to seven times larger than the OLS estimates in Ghana and Brazil for both men and women, and the IV estimates are nearly as precise as the OLS estimates, and thus differ substantially in their implications for the wage payoff to this indicator of health human capital. The male estimates in the United States are more than twice as large as the OLS, but they are insignificantly different from zero, as they are for women. The regional price instruments used from the U.S. survey do not provide a satisfactory basis for estimating the effect of height on wages.

The third row in Table 1 uses as instruments the education of the mother and father and whether their occupation was in agriculture in Ghana, and only the parent education in the United States. Parent education is not reported in the Brazilian Health and Nutrition Survey. The Parent IV-2 estimate for height is only slightly smaller for Ghanian men compared with the price IV-1 estimates, whereas the parent IV-2 estimates are three times larger than the price IV-1 estimates for women in Ghana and more precisely determined. Also in the United States the parent education instruments determine a more steeply sloped relationship between height and log wages, with the IV-2 coefficient on height 8 times larger than the OLS coefficient for men, and 20 times larger for the women, and the t ratios are also larger and statistically significant. Combining both the regional price and parent education as identifying instruments yields intermediate magnitudes for the IV estimates between those estimates based on the region or parent instruments separately.

Row 5 of Table 1 reports the mapping of height from seven ethnic/language groups for Ghana, from four racial (color) groups in Brazil, and four race/ethnic groups from the United States survey. The ethnic groups in Ghana explain a significant share of the variation in height, but these group height differences imply that the shorter groups are more productive, holding constant for their education, experience, sex and residential region. In Brazil the race groups define a positive instrumental variable estimate for height of a similar magnitude to that identified from municipal socioeconomic characteristics, positive and highly significant. In the United States the ethnic/race groups are also significant explanatory variables for height, but the IV-4 estimates of height's effect on log wages is not significantly different from zero, and these estimates vacillate in sign between men and women. Variations in height associated with ethnicity and race are not uniformly related to wages across these three countries, suggesting the genotypic variation in height is weakly associated with wages.

4. Conclusion

This study of three countries examines the productive returns to health human capital which is associated with adult height, when its effect is identified from regional price (IV-1) and parent education (IV-2) instruments. These instrumental variable estimates of height's effect on wages imply several fold larger effects of height on wages than does the OLS association between the overall variation in height and wages, perhaps becasue the OLS estimates is predominantly determined by the apparently random genetic factors underlying this polymorphic physical trait of stature.

Adult height is an curious measure of the relative risk of mortality (inverse), general health status, and labor productivity or wage of an individual (Fogel, 1986; Steckel, 1995). But it appears to encompass many sources of variation which do not exhibit the same proportional connection to wages. The economic interpretation of height variation across populations, and within a relatively closed population over time, as emphasized by development economists and economic historians, respectively, warrants a reappraisal in light of these findings.

A one centimeter increase in height instrumented by local prices and access of private and public inputs to nutrition and health care are associated with an eight to ten percent increase in wages in Ghana and Brazil for both men and women. But this one centimeter increase in stature appears to have been achieved in Brazil in each decade from 1940 to 1970 (Schultz,2000). This "return" on health human capital cannot yet be attributed to a particular intervention for which the costs could be calculated and weighed against the productive wage gains, as Mincer (1974) implicitly does in motivating the specification of his earnings function. If the costs of enhanced childhood nutrition and health care could be identified as the cause for the inter-cohort increase in Brazilian height, would the internal rate of return which balanced these input costs and wage gains be the appropriate rate of return to this form of health human capital? Or are these costs of food and health care also demanded as current consumption by parents to raise the utility of their children and themselves? It is common practice to treat all of the input costs of schooling as an investment in this form of human capital and neglect the consumer benefits enjoyed by students and parents, but it may be less satisfactory to ignore these consumer benefits in future accounting exercises which seek to assess the returns from health human capital.

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Table 1: Alternative Estimates of the Effect of Adult Height in Meters on Log Hourly Wage in Ghana, Brazil and the United States

		Ghana 1987-89		Brazil 1989		United States 1989-93	
		Age 25-54		Age 25-54		Age 20-28	
		Male	Female	Male	Female	Male	Female
1.	Ordinary Least Squares (* t *)	1.54 (a) (4.78)	1.67 (a) (4.04)	1.40 (e) (10.3)	1.66 (e) (8.13)	.451 (h) (4.90)	.306 (h) (3.06)
2.	Instrumental Variables: Regional Conditions, Prices (* t *) [Joint F prob.; df] First Stage Height R^2	 9.42 (b) (3.71) [.0272; 29] .048	 10.9 (b) (4.14) [.0001; 29] .058	 7.75 (f) (9.34) [.0001; 7] .094	 10.9 (f) (8.12) [.0001; 7] .075	 1.24 (i) (1.24) [.0022; 8] .088	 3.44 (i) (1.57) [.410; 8] .056
3.	Parent Education, etc. (* t *) [Joint F prob.; df] First Stage Height R^2	8.71 (c) (3.94) [.0009; 4] .039	34.7 (c) (7.02) [.0005; 4] .042	na	na	3.62 (j) (5.31) [.0000; 4] .106	6.24 (j) (5.39) [.0000; 4] .063
4.	Region and Parent (* t *) [Joint F prob.; df] First Stage Height R^2	9.33 (2.19) [.0017; 33] .054	15.2 (5.60) [.0001; 33] .064	na	na	3.01 (4.82) [.0000; 12] .106	4.63 (4.57) [.0000; 12] .065
5.	Ethnic/Language/Race (* t *) [Joint F prob.; df] First Stage Height R^2	-10.2 (d) (3.66) [.0001; 6] .033	-7.65 (d) (2.37) [.0001; 6] .035	7.01 (g) (12.4) [.0001; 3] .070	8.62 (g) (8.11) [.0001; 3] .054	.520 (k) (1.38) [.0000; 3] .082	-.599 (k) (1.22) [.0000; 3] .054
6.	Residual from IV Based on Region and Parent Education (4) (* t *)	1.37 (4.19)	1.24 (2.96)	1.21 (8.82)	1.43 (6.95)	.385 (4.16)	.261 (2.59)
7.	Sample Survey	GLSS	GLSS	PNSN	PNSN	NLSY	NLSY
8.	Sample Size (Individuals in Panel)	2,876	2,754	7,808	4,047	18,189 (4,708)	16,302 (4,549)
9.	Sample Means (Standard Deviation) Height in meters	 1.69 (.0649)	 1.58 (.0616)	 1.68 (.0720)	 1.56 (.0663)	 1.78 (.0764)	 1.63 (.0697)
	Years of Schooling	7.33 (5.56)	4.18 (5.05)	4.80 (4.33)	6.21 (4.87)	12.8 (2.44)	13.3 (2.24)
	Years of Post School Experience	23.7 (10.8)	26.3 (11.2)	26.4 (10.2)	24.5 (10.7)	10.9 (3.49)	10.6 (3.40)

Notes: Beneath the estimated coefficient on height in the log wage equation are reported in parentheses the absolute value of the t ratio. In addition to height in the wage function, the standard specification includes a spline in years of schooling completed by levels, post-schooling years of experience (age-schooling-6), experience squared, and rural residence. In brackets is the probability that the coefficients on the identifying instrumental variables in the first-stage height regression (but excluded from the wage equation) are zero, according to a joint F test, followed by the number of instrumental variables used in the estimation. The final figure is the R squared for the first-stage height regression used in the second-stage estimate of the wage equation.

(a) The standard variables in the wage function in Ghana include primary school years (max 6) and beyond, and a dummy for resident in a semiurban cluster, the annual average rainfall as reported in the nearest weather station, and six ethnic dummy variables for language of household head, specifically, Akan, Ewe, Ga-Adangbe, Gagbani, Hausa, Nzema (with others being the omitted group).

(b) The height equation also includes the following instrumental variables which identify the estimated effect of height in the wage equation: characteristics of the current residential cluster if the respondent has not migrated since birth, and of his or her birthplace state if a migrant : distance to the nearest market, health clinic, middle school, and secondary school, community health problems of malaria, measles and chicken pox, diarrhea, equipment/transport or water, whether there has been an immunization campaign in the last five years, or anti-malaria campaign, state-level expenditures budgeted per capita on preventive and on curative health services in 1987, protected water supply (1,2,6,7 and 8), flush or latrine toilet, community prices for ten staple foods, and price of antibiotics as described in Schultz and Tansel (1997).

(c) The years of schooling of the mother and the father and whether the mother or father worked in agriculture are the list of identifying instruments.

(d) The seven ethnic language groups are excluded from the wage equation, but included in the height equation and thereby serve to identify this instrumental variable estimate of height in the wage equation.

(e) The standard variables in the wage function in Brazil includes a spline in the years of primary (max 8), and secondary or higher education, post-schooling years of experience and experience squared, and current rural residence, and three dummy variables for ethnic/racial groups for "color" as black, brown (mixed or indigenous), yellow (Asian) (with white being the omitted group).

(f) The height equation includes the following county (municipio) characteristics measured in the 1991 Census:population density, density squared, average family per capita income in minimum wage units, hospital beds per capita, percent households with adequate sanitation, and of clean running water, and average years of schooling of adults over 25 years of age.

(g) The three ethnic/race variables are excluded from wage equation and used as instruments to identify the effect of height in the wage equation.

(h) The standard variables in the wage equation includes a spline for years of education to the completion of high school (max 12), and for years of higher education, a dummy if the individual is born in the South, or in a rural area of the United States, or in a high income country of Western Europe, Israel, Japan or Oceania, or in another (lower income) country, and three dummies for ethnic/racial groups of black, hispanic-nonblack, Asian (with white non-hispanic being the omitted group).

(i) The height equation includes the following instrumental variables which identify the effect of height in the wage equation : resident at age 14 in the South, in a rural area of the United States, in a high income country, or in a lower income country (as defined above), whether the respondent lived at age 14 with his/her father and not mother, with his mother and another man, with neither his mother or father, living with mother as head of household (omitted category is living with his mother and father).

(j) In addition, the height equation includes the years of education of the mother and father as well as dummies if either are not reported.

(k) The three ethnic/race variables are excluded from the wage equation and used as instrument to identify the effect of height in the wage equation.

na = parent education variables not available in the Brazilian survey to obtain this analogous estimate.