Economic Issues, Vol. 18, Part 2, 2013

Schooling, BMI, Height and Wages: Panel Evidence on Men and Women

Abbi Mamo Kedir[1]

ABSTRACT

While the link among wage, BMI, height and schooling has often been estimated based on US data, this study investigates this relationship using panel data for a developing country — Ethiopia. Controlling for endogeneity of schooling and BMI, our findings indicate that wage is significantly affected by education, height and BMI for the overall sample. Disaggregation by gender shows the absence of wage penalties due to higher BMI. Height is found to be a significant factor affecting men's wage but not of women. Returns to schooling are significant, but more beneficial for women than men. We provide policy implications of our findings.

1. INTRODUCTION

While the link among wage, BMI, height and schooling has often been estimated based on US data, the present study makes a contribution by analysing this relationship based on panel data, for 1994-2000, of urban residents aged 15 and above in Ethiopia. BMI and height can be indicative of nutrition and socio-economic conditions in developing countries, while in the US and other rich economies, the focus has been on the effect of obesity and other physical attributes on wages and consequent social costs. Thus, we argue given the labour intensive nature of the economic structure in poor economies, there would be different implications of the relationship among wages, schooling and physical attributes (i.e. BMI and height). For developing countries, the relationship has potential policy implications such as the effectiveness of nutrition policy interventions in raising income and subsequently GDP growth.

This paper seeks to estimate the effects of different dimensions of human capital investments on wages in a poor economy context, from a microeconomic perspective using a panel of household survey data. We address the potential endogeneity of schooling and BMI and attempt to shed light on policy relevant questions such as; i) Do returns to human capital (schooling, height and BMI) vary by gender?; ii) Do physical attributes (as captured by height and BMI) attract a wage penalty or premium for men and women in the Ethiopian urban labour market?; and iii) What are the nutrition and education policy implications of the findings? We attempt to give answers to these and related questions using an instrumental variables (IV) estimator.

There is a huge literature that estimates and demonstrates the substantial labour market returns associated with schooling, using data from developing countries. Often, the impact of other dimensions of human capital, such as BMI and health, are ignored in the Mincerian regression models fitted to data from these countries. We argue this is a surprising weakness of the existing empirical literature on poor economies, given their labour intensive economic structure where the rewards for BMI and height are expected to be important. Most studies that attempt to link wages with height and BMI are based on data from developed countries. These studies focus on the labour market discrimination experienced by individuals due to their physical attributes as captured by BMI and height (Baum II and Ford, 2004). Case and Paxson (2008) argue that taller people earn more not only because they hold higher status jobs but also because they are smarter, while Cawley (2004) reported the wage penalties faced by white females due to weight.

In developing countries, the literature focuses on the impact of past and current nutritional investments (i.e. height and BMI respectively) on productivity mainly in the context of household data sets collected from rural areas. There is work on urban data sets from Brazil (Thomas and Strauss, 1997), but none for Ethiopia. Therefore, we shall contribute to the existing literature by estimating the wage equations for Ethiopia, controlling for schooling, height, BMI and other relevant covariates. We revisit existing schooling returns measured for Ethiopia (e.g. Girma and Kedir, 2005) by considering other dimensions of human capital investment (i.e. height and BMI). We adopt an IV (GMM) regression model using a panel data collected in 4 waves from urban centres of Ethiopia in 1994, 1995, 1997 and 2000.

We find that productivity is positively and significantly affected by education, height and BMI, for all individuals. Neither men nor women suffer a wage penalty due to BMI. Height has been a significant factor affecting men's productivity but not women's. The results for men in general support the 'high-nutrition and high-productivity equilibrium' story. Schooling is more beneficial for women as the returns to schooling of women are higher than men. The remainder of the paper is organised as follows. Section 2 discusses briefly the link between health and productivity. This is followed by a review of the empirical literature in section 3. Section 4 gives a theoretical motivation for the estimating equation. Sections 5 and 6 describe the data and the estimation results respectively. The paper concludes with potential nutrition and education policy implications of the results.

2. Health/nutrition and productivity

The specific way in which the poor participate in growth tends to be through a productive use of 'their most abundant asset', labour (Kanbur and Squire, 1999). The link between human development and economic growth can be ascertained if one finds a robust and significant relationship using data on nutrition, health and wages. Therefore, identifying factors that affect productivity significantly is crucial to assist the intellectual effort that attempts to understand the mechanism through which human capital investment at the household level contributes to overall economic growth.

The link between productivity and consumption and its impact on productivity (wages) has been explored, among others, by Leibenstein (1957), Stiglitz (1976), Mirrlees (1976), Bliss and Stern (1978) and Svedberg (1988) and is now commonly referred to as the 'efficiency wage theory'. In a recent survey, Deaton (2003) pointed out that the nutritional wage model provides an account of how inequality affects both health and earnings, while recognising explicitly that health and earnings are determined simultaneously. Dasgupta (1993) argued that nutritional wage models can account for persistent poverty and destitution in poor countries.

Among economists, there is a consensus that recent periods of sustained growth in total factor productivity (TFP) are dependent on improvements in a population's nutrition, health, education and mobility (Shultz, 1997). Investigation of the link between nutrition and productivity is useful to the study of poverty and inequality. Dasgupta (1997) shows the mechanism by which inequality determines malnutrition, through the nutrition-productivity link. Therefore, a careful estimation of this link, addressing some of the key empirical issues, contributes towards a deeper understanding of the link and provides insights for policy making.

A non-convex relationship between labour supply and consumption underlies the argument about the link between nutrition and productivity, on the one hand, and the persistence of poverty on the other. Because of this non-convexity, multiple equilibria are possible. At the lower end of this spectrum of equilibria lies a low nutrition-low productivity point. At the other extreme lies a high nutrition-high productivity equilibrium, where people enjoy high levels of productivity and better nutrition. Because of the fixed requirements, individuals could be trapped in the low equilibrium point where they stay poor.

Those who have access to non-labour income can secure some level of consumption, while the poor require employment to finance the same level of consumption. The quality of labour that is supplied depends upon the level of caloric consumption. From the employers' point of view, hiring the poor is therefore expensive, because the poor require a wage high enough to be able to consume what is required for basic metabolism rate-BMR (Dasgupta, 1993), plus additional amounts needed to undertake external work.

3. Literature review

It is theoretically conceivable and empirically supported to state that investments in nutrition and health increase the lifetime productivity of individuals and thereby contribute to economic growth and hence lower poverty (Shultz, 1997). If a worker is healthier, less susceptible to disease and more alert and more energetic, then he or she will probably be more productive and command higher earnings (Thomas and Frankenberg, 2002). Macro and micro level nutrition-health-productivity links have been investigated extensively over the years, using data from developing countries. One of the established links between investment in human capital and its impact on increases in productivity is based on examining farm level data (Strauss, 1986; Deolalikar, 1988; Haddad and Bouis, 1991).

There have been similar attempts using household survey data from rural Ethiopia (Kim *et al*, 1997; Croppenstedt and Muller, 2000; Ayalew, 2003). Croppenstedt and Muller (2000) estimated the impact of health and nutritional status on the efficiency and productivity of cereal growing Ethiopian farmers. They reported that indicators of both health (measured in travel time to the daily source of water) and nutrition (measured in terms of weight for height of the household head) have significant effects on farm production. Since they used cross-sectional data, all the limitations identified by Strauss (1986) apply to their study. Ayalew (2003) went one step further, by using a panel data set collected from the same rural localities investigated by Croppenstedt and Muller (2000).

Except for few applications in developing countries, most studies have ignored the impact of nutrition and health on the productivity of urban residents (Thomas and Strauss, 1997). To the best of our knowledge, no study has shown how investments in nutrition (health) affect wages for urban households in Ethiopia. There is a recent effort to estimate earnings functions, with a focus on uncovering heterogeneous private returns to schooling without controlling for health indicator variables (Girma and Kedir, 2005). In this study, we augment our analysis by considering not only the role of education but also other key human capital variables such as nutrition indicators.

Most studies that attempt to establish the relationship between labour productivity and nutrition are contaminated by simultaneity between calorie intake and labour productivity. The causation of the relationship could go in either direction. Variables that affect earnings or production affect nutrition consumption, via the associated effect on income, in which case consumption is rendered endogenous (Ayalew, 2003). Body mass index (BMI) affects the current productivity of the individual, particularly at low levels of calories and for energy-demanding tasks. This indicator of nutritional status among adults, as argued by Shultz (1997), should be treated as simultaneously determined with increased current expenditures on nutrition and the performance of more demanding jobs. Finding unbiased estimates of the uni-directional effect of improved adult nutrition on wage productivity requires instruments that predict current BMI. Because of potential ability bias, we also consider schooling to be endogenous, and instrumented it with parental schooling.

4. Theoretical motivation and methodology

Most studies find that growth, as captured by the growth rate of per capita GDP across countries, is positively correlated with schooling (Bils and Klenow, 2000; Benhabib and Spiegel, 1994). To show the link from schooling to growth, ignoring other dimensions of human capital, it is possible to start with production technologies without assumptions about preferences or capital markets. Suppose we have an economy with the following production technology (Bils and Klenow, 2000):

$$Y(t) = K(t)^{\alpha}[A(t)H(t)]^{1-\alpha} \tag{1}$$

Where Y is the flow of output, K is the stock of physical capital, A is a technology index, and H is the stock of human capital. The aggregate stock of human capital is the sum of the human capital stocks of working individuals in the economy. Often, the only human capital variable considered is schooling, which is responsible for producing knowledge, ideas and skills. Other dimensions of human capital, such as observable nutrition measures, are important factors that impact on labour productivity. If individuals in cohort a go to school from age 0 to s and work from s to T, the human capital stock in the economy can be written as:

$$H(t) = \int_{s}^{T} h(a,t)L(a,t)da \tag{2}$$

Based on extensive the labour literature and the empirical work on earnings equations, suppose the human capital function of cohort a is given by:

$$h(a,t) = e^{f(s)+g(a-s)} \tag{3}$$

The exponential portion shows the role of years of schooling (s) and labour market experience (a-s) in human capital formation. Often, experience is proxied indirectly by *a*-*s*-6. However, we observe it directly in our data. It is postulated that $f'(s)>0$ and $g'(a-s)>0$. A parameterisation of eq(3) is required to arrive at an estimating equation in the Mincerian tradition by taking logs. Thus, we have:

$$\ln h(a,t) = f(s) + g(a-s) \tag{4}$$

Let:

$$f(s) = \theta(s)$$
$$g(a-s) = \gamma_1(E) + \gamma_2(E)^2$$

Then, equation (4) will be:

$$\ln h(a,t) = \theta(s) + \gamma_1(E) + \gamma_2(E)^2 \tag{5}$$

Since the human capital stock of each individual is expected to bring a wage premium, the parameters θ, γ_1 and γ_2 can be obtained from a Mincerian wage equation of the form (including time and person subscripts):

$$\ln y_{it} = \alpha + \theta s_{it} + \gamma_1(E_{it}) + \gamma_2(E_{it})^2 + u_{it} \tag{6}$$

Because of the panel nature of our data, we can control for unobserved individual heterogeneity (say v_i) in eq(6) as:

$$\ln y_{it} = \alpha + \theta s_{it} + \gamma_1(E_{it}) + \gamma_2(E_{it})^2 + v_i + \varepsilon_{it} \tag{7}$$

Equation (7) is restrictive because it omits other important dimensions of human capital, mainly indicators of past and current nutrition investments such as height and BMI. BMI is defined as weight divided by the square of height measured in meters. Most applications using data from developed economies have focused on BMI and examined the impact of obesity on wages (Baum II and Ford, 2004). Height and BMI are important anthropometric indicators of health of individuals. To motivate our empirical work, in the remaining part of this section we show formally the importance of accounting for this omission. First, we start with a simple linear function of the form where the only control variable affecting the wage of individual i is schooling, s:

$$y_i = \theta s_i + \mu_i \tag{8}$$

All other relevant regressions are grouped in the unobservable, μ. The parameter estimate of θ will be biased if we have another determinant of wage, which is correlated with schooling, s. Suppose we have height (h) as an omitted variable. We argue that height is correlated with schooling, i.e. $\mathrm{cov}(s_i, h_i) \neq 0$. This is reasonable in light of existing literature linking height with cognitive ability. In fact, the precise link between height and cognition (and hence schooling) is not well understood yet, but studies on the determinants of cognition suggest an important role for nutrition, which is the mechanism for the connection (Kretchmer *et al*, 1996). Ignoring other regressors, we have:

$$\mu_i = bh_i + e_i \tag{9}$$

where e_i is the idiosyncratic error uncorrelated with height. Dropping the subscript *i*, the probability limit of the OLS estimate of the returns to schooling is given by:

$$p\lim \hat{\theta} = \theta + p\lim(s's)^{-1}s'\mu = \theta + b\sigma_{hs} / \sigma_s^2 \tag{10}$$

where $\sigma_{hs} = \mathrm{cov}(h_i, s_i)$ and $\sigma_s^2 = \mathrm{var}(s_i)$. Height is observed and if omitted our estimate, $\hat{\theta}$, will be overestimated and the bias $(\hat{\theta} - \theta)$ is $b\sigma_{hs} / \sigma_s^2$. However, there is also another complication we would like to consider carefully here: the potential correlation of height with other productive attributes of individuals in the labour market of a developing economy such as Ethiopia. For instance, physical strength is an attribute with important labour market outcomes in poor societies and it is often captured by BMI. It is reasonable to say that the height premium in wages might reflect the reward for physical health and productivity. Thus, eq (9) can take the form:

$$\mu_i = b_h h_i + b_w w_i + e_i \tag{11}$$

Thus the vector μ_i should include both of our nutritional investment indicators height (*h*) and weight (*w*) (as captured by BMI). If both of these variables are omitted the probability limit of the estimate of the returns to schooling in eq(8) will be:

$$p\lim \hat{\theta} = \theta + [\frac{b_h \sigma_{hs} + b_w \sigma_{wh}}{\sigma_s^2}] \tag{12}$$

Because taller individuals are more likely to be heavier, it is possible that $\sigma_{wh} \neq 0$. Therefore, the illustration from eq(8) to (12) indicates that eq(7) should look like:

$$\ln y_{it} = \alpha + \theta s_{it} + \gamma_1(E_{it}) + \gamma_2(E_{it})^2 + \delta(h_{it}) + \phi(w_{it}) + v_i + \varepsilon_{it} \tag{13}$$

with $\delta > 0$ and $\phi > 0$. Equation (13) includes other determinants of wages, such as sector of employment, age, age squared and location. We estimate (13) using IV (GMM) estimator with time effects included. We do not use the ordinary least squares (OLS) estimator, as this leads to biased estimates and ignores the endogeneity of schooling and BMI. Because of the endogeneity of BMI, we adopt an estimator that allows for a heteroscedasticity-robust GMM estimator, with parental schooling used as an instrument for schooling and Fisher's price index and household size instrumenting BMI (Thomas and Strauss, 1997).

In the remainder of this section, we discuss further the need for the instrumenting of BMI. In the model developed by Becker (1964) and extended by Grossman (1972), it is suggested that health must be treated as an endogenous choice. In principle, the stock of education is also determined by endogenous choices. For health, however, it is different because workers typically start with a large health endowment that must be continuously replenished as it depreciates, with many investments in health occurring later in life. Thus, the endogeneity of health (proxied by BMI) may be a greater potential source of bias or measurement error than the endogeneity of education (Currie and Madrian, 1999).

There are convincing arguments why we should instrumentalise health (i.e. BMI) in our case. First, exogenous changes in wages can influence health, by affecting the probability of stress and risk-taking behaviour, by changing the opportunity costs of investments in health capital, or by changing the returns to health. In this case, the health measure may be correlated with the error in the structural (i.e. wage) equation, suggesting that health needs to be treated as an endogenous choice. Second, wages can affect investments in BMI, just as they affect other human capital investment decisions (Willis and Rosen, 1979). Hence, our estimation framework allows for the endogeneity of BMI.

5. DATA

The present paper examines the returns to human capital investments for a sample of wage employed individuals aged 15 and above in Ethiopia. Our reported regression results are based on the final set of individuals, after losing 15 per cent of the original sample through panel attrition. This study is based on urban household panel data for 1994, 1995, 1997 and 2000, collected by the Department of Economics of Addis Ababa University (Ethiopia), in collaboration with the Departments of Economics of Gothenburg University (Sweden) and Michigan State University (USA). The survey covers 1500 households in each round, with the intention to resurveying the same households and individuals in subsequent rounds.

In each round, household and individual level information were collected over a period of four successive weeks covering seven major cities in Ethiopia — Addis Ababa (the capital), Awassa, Bahar Dar, Dessie, Diredawa, Jimma and Mekele. The sample of households surveyed is intended to be representative of the main socio-economic characteristics of the cities. The total sample was distributed over the selected urban centres proportional to their populations, based on the CSA's (Central Statistical Authority) 1992 population projections.

Accordingly, the sample included 900 households in Addis Ababa, 125 in Diredawa, 75 in Awassa, and 100 in each of the remaining four towns. Once the sample size for each town was set, the allocated sample-size was distributed over all weredas (districts) in the town, in proportion to the wereda population. In the next stage, however, 50 per cent of the kebeles[3] in each wereda[4] were selected randomly. A group of kebeles form weredas and a city is sub-divided into different weredas or districts. For instance, in Awassa there are two weredas and 12 kebeles. Therefore, according to the sampling rule, both weredas and 6 of the kebeles are covered by the survey.

The sample size allocated to each wereda was then further distributed over the selected kebeles, again in proportion to population. In order to select the sampled households in each selected kebele, information that serves as a sampling frame was collected, by consulting officials and records of the selected kebeles. This information included the list of house numbers registered with the kebele, non-residential (business, office…etc.) house numbers, and houses demolished or abandoned after the registration by the kebele. A list of house numbers with potential respondents was then prepared. Households were chosen from this list using a systematic sampling procedure: households were selected from the list at a fixed interval from a random start. The interval used depended on the range of house numbers available and the sample-size allocated to each kebele.

The data were collected by interviewing the most informed member of the household (usually the household head). The date of the interview was deliberately fixed after the holiday season.[5] This is to protect our data from picking untypical consumption patterns by households, because the main purpose of the surveys is to study household consumption behaviour and welfare. The data we use in this study are believed to be of good quality for at least two reasons.

First, data collection has been based on a questionnaire which is modified on the basis of results from a pilot survey conducted in the capital city. This has helped in the rewording of vague questions in the original draft questionnaire, and to give crucial training for survey enumerators, verifiers and supervisors. Second, the enumerators were individuals with at least a first degree, or students finishing their degree studies in economics, accounting and management. In cities outside Addis Ababa, interviewers also included employees of Statistical and Regional Planning offices. This facilitated the collection of clear and good quality data as opposed to the data in statistical offices collected often by high school dropouts. Other benefits of the data include a very high response rate. Almost all households collaborated with the interviewer, to supply the required information for the expenditure module.

For our application, we use individual data on monthly wage/salary, age, experience, location, years of schooling completed, height, BMI and other relevant explanatory variables such as the sector of employment. Unlike the experience variable, the years of schooling variable is not directly observed but is constructed by converting the reported schooling cycles completed. As is common in many anthropometric surveys, data on height and weight are subject to reporting error. We cleaned the data by removing prohibitively high values of height (e.g. 4.78 meters) and weight.

Table 1 reports some basic descriptive statistics. The median monthly wage is 262.5 Ethiopian birr. There is prevalent wage inequality in the Ethiopian urban labour market, as shown by the high variation in the wage data. On the other hand, the nutrition indicators BMI and height give conventionally normal median values, with less volatile variation across the population. The state sector is still the major employer in Ethiopia with only about 19 per cent of the work force employed in the private sector, with an average of 9 years of schooling completed.

Table 1: Descriptive statistics

Variable	
Median Monthly wage	262.5 (3553.1)
Gender (per cent male)	60.5
Median BMI	22.5 (3.92)
Median Height	1.65 (0.15)
Private sector (per cent)	18.9
Mean Years of Schooling	8.9 (4.77)
Mean Age	35.1 (11.9)

N.B. Standard deviations in parentheses.

6. Results

Estimates of wage equations that neglect the endogeneity issue in schooling and BMI will be biased. Therefore, to avoid the bias we do not use any linear panel data models that assume exogeneity of the BMI and schooling variables. Table 2 presents the estimation results for all individuals aged 15 and above, accounting for endogeneity. The results are for the full sample, without disaggregation by gender, which we do in Tables 3 and 4.

The first two columns report the returns to human capital investment with and without height, respectively. Height, which is treated as predetermined, is positive and significant, as also are schooling and the log of BMI. The inclusion of height does not lead to changes in the significance and sign of schooling and BMI. This indicates that BMI is not picking the non-linear effects of height, given the fact that BMI is constructed using weight and height of individuals. The result suggests also that height is not correlated with schooling and BMI, even if it captures long-term health/nutritional status and previous non-human capital investments. According to the data in column 2, both taller and heavier individuals earn more, indicating the positive welfare effects of greater physical strength, physical capacity, and good nutrition.

The effect of BMI and height on wages depends on the type of activities individuals do. It is more likely that those with low levels of schooling engage in manual and physically demanding jobs than those with a higher level of schooling. This shows that choice of economic activity and nutritional/health status indicators (i.e. BMI and height) can be determined simultaneously. However, in our data we do not have enough observations to estimate the relationship among BMI, height and wages for a particular economic activity or occupation. Therefore, we investigate the relationship after separating individuals who have completed schooling at the primary level or less, from those with schooling above a primary level (i.e. 6 years of completed schooling).

Table 2: IV-GMM estimates: Full sample for 15 and above

Dep. Variable: Log of wage	*All individuals*		*Individuals with primary level schooling or less*	*Individuals with above primary schooling*
Years of schooling	0.126***	0.123***	0.193	0.241***
	(0.019)	(0.019)	(0.147)	(0.063)
Ln(BMI)	3.731**	3.673**	3.683*	-2.475
	(1.825)	(1.788)	(2.045)	(2.496)
Ln(Height)		1.586***	1.954***	0.619
		(0.368)	(0.554)	(0.600)
Ln(age)	2.956	2.610	3.401	11.959***
	(2.626)	(2.578)	(3.459)	(3.337)
Ln(age) squared	-0.278	-0.242	-0.390	-1.482***
	(0.364)	(0.357)	(0.502)	(0.442)
Private sector	0.105*	0.096**	0.108	0.100
	(0.059)	(0.055)	(0.131)	(0.070)
Time Effects	Yes	Yes	Yes	Yes
Hansen's J $\chi^2_{(1)}$, (p-value)	6.00 (0.01)	4.17 (0.04)	3.00 (0.08)	2.49 (0.10)
Observations	2256		869	1387

Notes: (i) Robust standard errors in parentheses; (ii)* significant at 10 per cent; **significant at 5 per cent; *** significant at 1 per cent. (iii) The above results are robust to different specifications. No qualitative changes were found when we used experience and experience squared instead of age and age squared. We avoided including them simultaneously because of collinearity.

The results for both education levels are reported in the last two columns of Table 2, which indicate clearly that returns to BMI and higher vary over the education distribution (implicitly over jobs/occupation too). The returns to investments in nutrition/health are large for those who have at most a primary level of schooling - those who are more likely to be in manual occupations. A higher BMI for males reflect musculature (as opposed to excess bodyweight) which can impart a positive return for low-skilled manual workers.

In our data, most of the male waged workers are employed in the industrial sector as factory workers, transportation workers, construction workers, technicians and equipment maintenance. We believe this occupation pattern might be the underlying factor driving the results of males. For males with higher schooling levels beyond primary, the returns to their schooling are larger and significantly positive, while BMI and height have no wage premium. This indicates that BMI and height represent strength and are likely to be having less of an effect on wages with education.

Table 3 provides results as in Table 2 but only for males aged 15 and above. Looking at the first two columns shows once again that the inclusion of height has not resulted in qualitative changes to the statistical significance and sign of key variables such as schooling and BMI, as well as other covariates. It is worth mentioning that the magnitude of the returns to schooling for males will be overestimated if one disregards disaggregating the sample by gender, and controlling for other dimensions of human capital (Girma and Kedir, 2005). But the results on the gender-disaggregated sub-samples should be treated with caution because of a limited number of observations, which limits the power of the inferences that can be made, particularly for women. Active participation in wage employment is still predominantly the preserve of men in Ethiopia. Height and schooling have positive and significant returns for men, the former having the larger effect on wage income. For men, height is an important determinant of wage, regardless of the level of schooling completed, while there are no significant wage returns associated with BMI.

Table 4 is similar to Table 3 but is based on a sample of females. The most striking result is the importance of education in the wage equations. Except for those who have at most a primary level of schooling, returns to schooling for women are much larger than for men. None of the indicators of physical attributes (height and BMI) matter for the productivity of women. However, do human capital returns in general vary over the education distribution for women? According to the results shown in the last two columns of Table 4, we can see that returns to schooling are significant only for females with schooling above the primary level. The absence of any significant impact of BMI and height at higher schooling levels is not surprising given their implied declining important with education. The results for females should be treated with caution, given the small sample size. The 1st stage results, the identifying instruments and further robustness checks are discussed further below.

Table 3: IV-GMM estimates: Males 15 and above

Dep. Variable: Log of wage	*All individuals*		*Individuals with primary level schooling or less*	*Individuals with above primary schooling*
Years of schooling	0.078**	0.079 **	0.032	0.156
	(0.033)	(0.032)	(0.141)	(0.112)
Ln(BMI)	2.520	2.650	0.835	5.388
	(4.158)	(4.031)	(4.698)	(4.836)
Ln(Height)		1.194*	0.990**	1.966*
		(0.655)	(0.520)	(1.240)
Ln(age)	8.000	7.161	12.173	1.865
	(9.661)	(9.665)	(8.915)	(9.350)
Ln(age) squared	-1.007	-0.867	-1.585	0.242
	(1.307)	(1.307)	(1.234)	(1.195)
Private sector	0.113	0.113	0.367**	-0.010
	(0.080)	(0.079)	(0.148)	(0.104)
Time Effects	Yes	Yes	Yes	Yes
Hansen's J $\chi^2_{(1)}$, (p-value)	5.39	5.11	4.36	1.645
	(0.06)	(0.07)	(0.10)	(0.43)
Observations	1183		408	775

Table 4: IV-GMM estimates: Females 15 and above

Dep. Variable: Log of wage	*All individuals*		*Individuals with primary level schooling or less*	*Individuals with above primary schooling*
Years of schooling	0.172***	0.170***	0.546	0.289***
	(0.027)	(0.028)	(0.423)	(0.078)
Ln(BMI)	0.199	0.242	3.365	-0.961
	(2.173)	(2.163)	(3.880)	(1.624)
Ln(Height)		0.288	0.519	0.453
		(0.567)	(1.021)	(0.527)
Ln(age)	-0.742	-0.763	-8.373	13.365***
	(3.565)	(3.561)	(11.031)	(4.81)
Ln(age) squared	0.251	0.252	1.309	-1.778**
	(0.527)	(0.526)	(1.598)	(0.695)
Private sector	-0.086	-0.078	-0.135	-0.003
	(0.108)	(0.107)	(0.245)	(0.131)
Time Effects	Yes	Yes	Yes	Yes
Hansen's J $\chi^2_{(1)}$, (p-value)	0.32	0.37	1.68	2.20
	(0.85)	(0.83)	(0.43)	(0.33)
Observations	691		276	415

Notes to tables 3 and 4: (i) Robust standard errors in parentheses; (ii)* significant at 10 per cent; **significant at 5 per cent; *** significant at 1 per cent. (iii) The above results are robust to different specifications. No qualitative changes were found when we used experience and experience squared instead of age and age squared. We avoided including them simultaneously because of collinearity.

We instrument BMI using the Fisher ideal food price index and household size. This is because both prices and household size are key determinants of availability of food, or the capability of having access to it, both at the market and household level. The price index is superior in the sense that it is less biased than Laspeyres and Paasche indices, which either underestimate or overestimate price difference across households. Food prices vary across location and crucially affect food availability in Ethiopia, thus the index can serve as an important identifying instrument. However, relying on prices alone as instruments, might not be sufficient.

Because of its important effect on intra-household food distribution, and to reinforce our instrument set, we also use household size as an additional identifying instrument. Some may argue that state dependence justifies the use of lagged BMI as an instrument, and location can be used to instrumentalise BMI. However, this is not convincing because current and past wages are likely to be correlated, and using lagged BMI does not solve the correlation between unobservables in the current wage equation and unobservables in the lagged BMI. Likewise, location captures environmental factors which affect not only BMI but also wages. Hence, we do not use lagged BMI and location as instruments. We also consider schooling to be endogenous and an individuals' schooling is instrumentalised using the years of schooling completed by both parents. The schooling of parents has been found to be a strong predictor of the endogenous schooling variables in a variety of empirical estimates based on data across the globe.

Table 5 reports a summary of the overidentification Hansen J-statistic and the first stage results (i.e. Shea's Partial R-squared), which are important to judge the validity of our instruments. The summary below corresponds to the results in the second columns of Tables 2, 3 and 4. The first stage results for the other columns have a similar pattern to the summary provided in Table 5.

Table 5: Instrument validity statistics and first stage estimates

Sample	*Hansen's J, chi-square(1); p-value*	*Shea's Partial R-Squared*	
		Schooling	*BMI*
Full sample	4.17(0.04)	0.05	0.01
Male sample	5.11(0.07)	0.03	0.01
Female sample	0.37(0.83)	0.07	0.01

N.B. p-values are given in parentheses.

According to our results, there are clear correlations between endogenous regressors (BMI and schooling) and excluded instruments (Fisher's ideal food price index and household size), but Shea's R-squared values are small. The Hansen J-statistics show the validity of our instruments for the full and male samples, but not for the female sample. Hence, the results for the female sample should be treated with caution, as emphasised earlier. Further work on a larger sample, or an analysis on a cross-section which limits the impact of attrition with a relative guarantee to get large observations, is worth pursuing.

The instruments are weaker in the female than in the male sample mainly because of the smaller sample size. However, potentially weak instruments arise even in the presence of large samples and stronger correlations, as showed by Staiger and Stock (1997). We thus use a stringent IV estimator which is relatively robust to the presence of weak instruments. Our inferences are therefore mostly valid and reliable, given the care taken to avoid the endogeneity bias that could have contaminated the estimates. It should also be noted that the results are conditional on people who have jobs and stay employed throughout the study period, which often leads to loss of observations the longer the panel period (i.e. 1994-2000). We address the potential empirical issues given the sample at our disposal, and most of the results pass the overidentifying restriction tests.

We argue that the results above are robust to the age range on which we base our analysis. It is clear that individuals under the age of 18 included in the analysis may still be growing, making it difficult to defend the assumption that height is predetermined. Therefore, we re-estimate the second column results restricting the sample to working age adults (18 and above). The findings do not lead to any changes in significance and sign reversal in the estimated parameters.[6] As opposed to applications in developed countries (e.g. the US where there are large numbers of overweight and obese individuals), we do not model the non-linear effects (e.g. quadratic) of BMI on wages. This point of departure is justified in the Ethiopian context, given the fact that our sample of individuals does not include many overweight or obese individuals (see Table 1).

7. Conclusions

This study has posed policy-relevant questions and we observe the following key results from our analysis: i) returns to human capital investments (schooling, height and BMI) vary by gender; ii) physical attributes and wages for women are not significantly associated with wages; iii) the wage/productivity effects of schooling are more important for women than men; iv) the returns to height for men are significant; and; v) returns to all variables of interest vary by the level of education of the individual. After controlling for the potential endogeneity of BMI and schooling, we provide evidence for the presence of a significant ‘high-nutrition and high-productivity equilibrium’ particularly for men in the Ethiopia urban labour market.

In agreement with evidence elsewhere in the developing world, we find significant returns to schooling investment, pointing to its well-established importance in the welfare of individuals and the overall growth of economies. The schooling returns for women are found to be higher than for men, which has an important policy implication. Provision of education for all should be promoted but especially so for women. Schultz (2002b) argues that the marginal returns of schooling for women exceed those for men, particularly in countries such as Ethiopia where women are much less educated. On the basis of this argument and three other conditions, he justifies the disproportionate allocation of public expenditures towards the education of women. Our results are consistent with his policy suggestions.

In line with the social psychology literature, we find that height is more significant for men than women. Height is a cumulative measure reflecting both investment in nutrition during one's life (mostly as a child) and also, possibly, non-health related human capital investment (Schultz, 2002a). Hence, our findings can be used to highlight the importance of improving children's nutrition from a policy point of view, as it has productivity implications in their adult lives. In terms of potential policy implications, improving access to food (e.g. through food price subsidies) in the current climate of high global food prices seems an urgent priority.

Accepted for publication: 10th May 2013

ENDNOTES

1. Freelance Economic Consultant and Associate Staff, School of Management, University of Leicester, LE1 7RH, UK; E-mail: ak493@le.ac.uk. I gratefully acknowledge the valuable comments on earlier versions of the paper from two anonymous referees.

2. We used the ivregress command (with GMM) which is supported by STATA 10.0.

3. Kebeles are urban dwellers' associations and represent the lowest administrative units, which consist of a number of households ranging from 500 to 1500.

4. A group of kebeles form weredas, and a city is sub-divided into different weredas or districts.

5. There are two holidays in early and late September every year. For instance, the Ethiopian New Year is observed on the 11th of September except in a leap year.

6. These results are available upon request.

REFERENCES

Ayalew T (2003) The Nutrition-Productivity Link and the Persistence of Poverty', Discussion paper, 2003-02, Institute of Development Policy and Management, University of Antwerp, Belgium.

Baum II C and Ford W (2004) 'The wage effects of obesity: a longitudinal study', *Health Economics*, 9, 885-899.

Becker G (1964) *Human Capital*, New York: Columbia U P.

Benhabib J and Spiegel M (1994) 'The role of human capital in economic development: evidence from aggregate cross-country data', *Journal of Monetary Economics*, 34, 143-174.

Bils M and Klenow P J (2000) 'Does Schooling Cause Growth?', *The American Economic Review*, 90, 1160-1183.

Bliss C and Stern N (1978) 'Productivity, Wages, Nutrition: Some Observations', *Journal of Development Economics*, 5, 331-398.

Case A and Paxson C (2008) 'Stature and Status: Height, Ability and Labour Market Outcomes', *Journal of Political Economy*, 116, 499-532.

Cawley J (2004) 'The Impact of Obesity on Wages', *The Journal of Human Resources*, 39, 451-474.

Croppenstedt A and Muller C (2000) 'The Impact of Farmers' Health and Nutritional Status on their Productivity and Efficiency: Evidence from Ethiopia', *Economic Development and Cultural Change*, 48, 475-502.

Currie J and Madrian B (1999) 'Health, Health Insurance and the Labour Market' in Ashenfelter O and Card D (eds.) *Handbook of Labour Economics,* 3c, Amsterdam: North-Holland.

Dasgupta P (1993) *An Inquiry into Well-Being and Destitution*, Oxford: Oxford U P.

Dasgupta P (1997) 'Nutritional Status, the Capacity for Work and Poverty Traps', *Journal of Econometrics*, 77, 3-37.

Deaton A (2003) 'Health, Inequality and Economic Development', *Journal of Economic Literature*, 41, 113-158.

Deolalikar A B (1988) 'Nutrition and Labour Productivity in Agriculture', *Review of Economics and Statistics***,** 70, 406-413.

Girma S and Kedir A (2005) 'Heterogeneity in returns to schooling: Econometric evidence from Ethiopia', *Journal of Development Studies*, 41, 1405-1416.

Grossman M (1972) 'On the Concept of Health Capital and the Demand for Health', *Journal of Political Economy*, 80, 223-255.

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

Kanbur R and Squire L (1999) 'The Evolution of Thinking About Poverty: Exploring the Interactions', mimeo.

Kim A, Tandon A and Hailu A (1997) 'Health and Labour Productivity: Economic impact of Onchocercal Skin Disease', World Bank Policy Research Working Paper no. 1836.

Kretchmer N, Beard J and Carlson S (1996) 'The Role of Nutrition in the Development of Normal Cognition', *American Journal of Clinical Nutrition* 63, 997S-1001S.

Leibenstein H A (1957) *Economic Backwardness and Economic Growth*, New York: Wiley.

Mirrlees J A (1976) 'A pure theory of underdeveloped economies' in Reynolds L (ed.) *Agriculture in Development Theory*, New Haven CT: Yale U P.

Shultz T P (1997) 'Assessing the Productive Benefits of Nutrition and Health: An Integrated Human Capital Approach', *Journal of Econometrics*, 77, 141-158.

Schultz T P (2002a) 'Wage gains associated with height as a form of health human capital', *American Economic Review*, 92, 349-353.

Schultz T P (2002b) 'Why Governments Should Invest More to Educate Girls', *World Development*, 30, 207-225.

Staiger D and Stock J H (1997) 'Instrumental variables regression with weak instruments', *Econometrica*, 65, 557–586.

Stiglitz J E (1976) 'The Efficiency Wage Hypothesis, Surplus Labour and the Distribution of Income in LDCs', *Oxford Economic Papers*, 28, 185-207.

Strauss J (1986) 'Does better nutrition raise farm productivity?', *Journal of Political Economy*, 94, 297-320.

Svedberg P (1988) 'A model of Nutrition, Health and Economic Productivity, UNU-WIDER Working paper no. 46.

Thomas D and Strauss J (1997) 'Health and Wages: Evidence on men and women in urban Brazil', *Journal of Econometrics*, 77, 159-185.

Thomas D and Frankenberg E (2002) 'Health, Nutrition and Prosperity: a microeconomic perspective', *Bulletin of the World Health Organisation*, 80, 106-113.

Willis R and Rosen S (1979) 'Education and Self-selection', *Journal of Political Economy*, 87, S7-S36.