Is education more beneficial to the less able?
Econometric evidence from Ethiopia

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Abstract

The paper investigates whether returns to schooling in Ethiopia vary according to the ability of individuals. To do so it adopts an instrumental variables quantile regression framework that allows for both endogeneity of schooling resulting from unmeasured ability, and possible heterogeneity in the impact of schooling. The empirical estimates indicate that education contributes more to the earnings of the less able individuals, consistent with the notion that education and ability are substitutes. By contrast, the relatively low (but still economically significant) returns to education at the higher end of the conditional earnings distribution suggest the importance of inherent ability or personal connections in securing high paying jobs.

Key Words: returns to schooling; quantile regression
JEL Classification: I2; J3

The empirical literature on the returns to education focuses mainly on developed countries[1], and much of the literature in developing countries compares the returns to vocational and academic education (Psacharopoulos, 1994; Bennell, 1996), or seeks to identify the impact of completing a given schooling cycle on earnings (Appleton, 2001). Few studies consider the returns to an additional year of education and still fewer attempt to investigate the pattern of returns along the earnings distribution. The aim of this study, therefore, is to contribute to the literature by conducting a systematic investigation on the returns to education in Ethiopia. Two key questions are addressed. First, we ask to what extent returns to education vary across the ability distribution. Here ability is shorthand for " those marketable factors that make up an individuals initial endowment of human capital that translate into higher earnings" (Arias et al., 2001, p.8). Secondly, we examine the empirical implications of allowing for the endogeneity of schooling in the process that governs the wage profiles of individuals.

The answer to the first question would clarify our understanding of where in the income/ability distribution the impact of education is more pronounced, providing a basis for informed policy analysis. For example, if the marginal returns to education are higher for the less able, the expansion of educational opportunities for this section of society will maximise the (private) returns to schooling. The importance of examining the endogeneity issue stems from the observation that the estimation of the schooling effect on earnings is often contaminated by the endogeneity of the schooling level. It is not always clear in the literature whether individuals with higher schooling earned more as a result of their additional education, or because of some

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[1] For an excellent summary of the literature see Card (1999).

other unobserved factors like ability or family background, which are correlated with education. Controlling for endogeneity will thus allow for a more accurate description of the *causal* impact of education, thereby providing useful information for education policy makers.

To simultaneously address the two issues of heterogeneity in returns and endogeneity of schooling, we adopt an instrumental variable quantile regression framework. Our empirical estimates indicate that education contributes more to the earnings of the less able individuals, consistent with the notion that education and ability are substitutes. By contrast, the relatively low (but still economically significant) returns to education at the higher end of the conditional earnings distribution suggest the importance of inherent ability or personal connections in securing high paying jobs. We also find that neglected endogeneity imparts serious biases to the returns to education estimates in Ethiopia.

The rest of the paper is organised as follows. Section II presents a selected review the literature. Section III outlines the econometric methodology, and this is followed by the data description in Section IV. Section V discusses the empirical results, and Section VI concludes.

II. Literature review

It is widely argued that any investment in human capital has a pure productivity element. But there are criticisms levelled against this argument. The main criticism centres on the idea that the effect of education is simply to enhance the productivity of the individual undertaking the specific education. This is the pure human capital hypothesis. The alternative hypothesis suggests that education is not productivity enhancing but simply acts as a screen to identify highly productive

individuals. The signalling/screening hypothesis states that individuals have an inherent ability and education raises their earnings. It is the attainment of specific levels of education that is used to command higher earnings, and as such highly intelligent individuals will choose to make human capital investments. However, the primary role of education is to signal to employers as to the inherent ability of individuals and not to enhance the productivity of an individual. The evidence for and against the screening hypothesis has been sought by providing the presence/absence of a diploma/sheepskin effect which is tested empirically by introducing dummy variables for various levels of completed schooling (Bauer et al 2002; Antelius, 2000).

Rosenzweig (1995) developed a framework for investigating the circumstances under which schooling improves productivity in the market and in the household, based on the notion that schooling enhances information acquisition. He focuses on two channels through which schooling may enhance productivity: i) by improving access to information sources such as newspapers or instruction manuals, which are found to be a major route in Thomas et al (1991) and ii) by improving the ability to decipher new information, whether from external sources or from own experience, as suggested by Schultz (1975).

Two important implications stand out of Rosenzweig's framework. The first implication of the model is that the returns to schooling should be higher in regimes or economies in which there is greater scope for misusing an input, or when tasks are sufficiently complex that substantial learning is required to execute them efficiently. Conversely, where tasks are simple and easy to master, schooling should have little influence on productivity. His model also implies that schooling returns are not necessarily augmented by the introduction of new technologies, if the new technology is relatively simple to use. This is corroborated by estimates from a reproduction

function in relation to the contraceptive revolution (Rosenzweig and Schultz, 1989). Foster and Rosenzweig (1993) report that high-tech and high-schooling returns are correlated based on the Green Revolution data of India

Psacharopoulos' (1994) finds that returns to schooling (particularly for primary schooling) in least developed countries (LDCs) are high, but Bennell (1996) begs to differ. He argues that with chronically low internal and external efficiencies at all educational levels in most Sub-Saharan Africa SSA countries, it seems highly implausible that rates of return to education are higher than in the advanced countries. Looking at returns country by country, it is certainly not the case that returns to primary education is consistently higher than either secondary or higher education (e.g., Appleton, et al, 1999)

When it comes to the analysis of returns to schooling in Ethiopia, there is very little empirical evidence. Using Youth Employment Survey of 1990 from Ethiopia, Krishnan (1996) investigates the impact of family background on both entry into employment in the private and public sector and its effect on returns to education. She finds that family networks to be a key determinant of entry into public sector work. However, education seems to serve as a screening mechanism in finding productive employees in the private sector. In another study (Krishnan et al, 1998) asks whether returns to education have changed over time following recent economic reforms. The study shows that returns to education, as measured by the total percentage returns from completing a particular level of education, have remained largely unaffected by the structural reforms.

III.   Econometric methodology

It is now well-understood that OLS fails to account for the heterogeneity in the effect of education on earnings as well as the bias introduced due to the endogeneity of schooling (Buchinsky, 1998; Card, 1999). It is therefore important to adopt an empirical strategy that fits the earnings model across different ability levels, while at the same time allows for endogeneity of schooling. To this end, we deploy quantile regression techniques due to Koenker and Bassett (1978) in the estimation of standard Mincerian earning functions. As is customary in the literature (cf. Buchinsky, 1998; Arias et al, 2001), we assume that the unobserved ability distribution can be approximated by the conditional earnings distribution.

Let y_i denote the log of hourly wage of worker i and let X be the vector of covariates which consists of year of schooling, experience, experience squared, and a set of binary dummies for gender and location of residence. The θth quantile of the conditional distribution of y_i given X is specified as:

$$Q_\theta(y_i \mid X) = \alpha(\theta) + X_i'\beta(\theta), \quad \theta \in (0,1). \tag{1}$$

where $Q_\theta(y_i \mid X)$ denotes the quantile θ of log earnings conditional on the vector of covariates. Following Koenker and Basset (1978), the θth quantile estimator can be defined as the solution to the problem:

$$\min_\beta \frac{1}{n}[\sum_{i:y_i \geq x'\beta} \theta|y_i - X_i'\beta_\theta| + \sum_{i:y_i \prec x_i'\beta}(1-\theta)|y_i - X_i'\beta_\theta|] = \min_\beta \frac{1}{n}\sum_{i=1}^{n}\rho_\theta(u_{\theta i}) \tag{2}$$

where $\rho_\theta(.)$ is known as the 'check function' and is defined as $\rho_\theta(u_{\theta i}) = \theta u_{\theta i}$ if $u_{\theta i} \geq 0$ and $\rho_\theta(u_{\theta i}) = (1-\theta)u_{\theta i}$ if $u_{\theta i} < 0$. The minimisation problem can be solved by using linear programming methods (Buchinsky, 1998). Like

standard OLS estimates, a quantile regression estimate can be interpreted as the partial derivative with respect to a particular regressor at the relevant quantile.

To allow for the potential endogeneity of schooling alluded to earlier, we follow a two-stage quantile regression approach in which the schooling variable is instrumented with the years of schooling completed by the parents of the individuals under investigation[2]. Since this is a non-standard instrumental variables estimation, the variance-covariance matrices of the estimates are obtained using bootstrapping techniques[3].

IV. Data

The paper uses data drawn from the 1994 Ethiopian Urban Household Survey, conducted in seven urban areas. Members of each household are asked to report their wages (monthly, weekly and hourly), years of schooling completed, age, gender, ethnic origin, marital status, work experience in years. Information on the number of years of schooling completed by the parents of individuals covered in the survey is also available. For our study, we selected individuals from this survey based on the following three criteria: i) individuals who are currently wage employed either in the public or private sector; ii) individuals who are not attending full time schooling during the survey period; and iii) individuals who are between the ages of 15 and 59.

Table 1 reports some basic descriptive statistics. The average hourly wage for 1994 was 1.515 Ethiopian *Birr*. This is equivalent to an average monthly earnings of about 317 *Birr,* which is more than 2.5 times the minimum wage.[4] The wage data

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[2] See Arias et al. (2001) for a recent application of instrumental variables quantile regression .
[3] The estimations for this study have been conducted using the Stata Release 7, and further details are available from the authors.
[4] There is no minimum wage legislation in Ethiopia but a wage of 120 Birr (US $15) per month is currently acceptable as minimum rate payable for unskilled workers.

exhibit quite a high variation, which suggests the prevalence of substantial wage inequality.

[Table 1 here]

V.   Empirical estimate

We first estimate the Mincerian earning functions by assuming that the schooling variable is exogenous, in order to indicate the bias that might be introduced by neglecting the endogeneity issue. Table 2 reports the OLS and the quantile regression estimates for five values of θ.

According to the OLS estimate the average return to one extra year education is 15%. This rather high figure is consistent with findings elsewhere in the developing world. But it is obvious that OLS masks important heterogeneity in the impacts of education. For example, the quantile regressions show that at the lower end of the earnings distribution (the 10th quantile) the marginal effect of schooling is nearly 21%, whereas at the upper end it is just above 10%.

[Table 2 here]

As suggested by theory there is an inverted U-shaped relationship between earnings and experience. Furthermore, females appear to be discriminated against in the Ethiopian labour market, especially at the higher end of the income distribution.

Our main empirical findings from the instrumental variables quantile regressions are reported in Table 3. The standard (conditional mean) IV estimate shows that the endogeneity-corrected schooling effect is on average 18%. Thus it would appear that OLS underestimates the average effect of schooling by 20%. This is consistent with the direction and magnitude of OLS biases reported elsewhere in the literature (Card, 1999, 2001; Griliches, 1977).

In our analysis we were careful to check for the appropriateness of parents' years of schooling as instruments for our schooling variable. Firstly, we apply a Sargan test for the over-identifying restrictions implied by the instruments. We find that parents' schooling and the disturbance term of the conditional earnings function are uncorrelated, suggesting that the instruments we employed are valid. Second, we also examine whether the instruments and the potentially endogenous schooling variable exhibit sufficiently high correlation. It has been noted in the econometric literature (see, for example, Staiger and Stock, 1997) that when the partial correlation between the instrument and the instrumented variables is low, instrumental variables regression is biased in the direction of the OLS estimator. Staiger and Stock (1997) recommend that the F-statistics (or equivalently the p-values) from the first-stage regression be routinely reported in applied work. The F-statistic tests the hypothesis that the instruments should be excluded from the first-stage regressions (i.e. they are irrelevant instruments). If we this hypothesis cannot be rejected (the F-statistic is too small or the corresponding p-value is large), the instrumental variable estimates and the associated confidence interval would be unreliable. Reassuringly, we find that the parents' schooling variables are relevant instruments.

The endogeneity-corrected quantile regression estimates show that the impact of an additional year of education to low ability individuals (as proxied by their low position in the income distribution) is an increase in wages of 28%. This is 40% higher compared with the equivalent coefficient in Table 2, emphasising that the bias introduced by endogenous schooling could be serious. It is also remarkable that the impact of schooling at the 10th quantile is three times higher than the 9% returns for schooling found at the higher end of the wages spectrum, and more than 10 percentage points higher than the returns to education at the 75th quantile.

Interestingly, endogeneity-corrected returns for high ability individuals are lower than the returns suggested by the standard quantile estimates. It seems that neglected endogeneity leads to the overestimation of the contribution of education to the earnings of the more able individuals.

Our finding of a negative relationship between ability and returns to schooling is in line with the results reported by Ashenfelter and Rouse (1998) based on a sample of genetically identical twins in the U.S, but in contrast to the finding by Bauer et al (2002) that returns are higher for the more able in Japan. For South Africa, Mwabu and Schultz (1996) report that ability and returns are positively related among white South African who received higher education, whereas returns are homogenous amongst blacks with high education. But at the primary education level, they find that returns to education and ability are negatively related.

Following Mwabu and Schultz (1996), we interpret a negative ability-returns relationship as evidence that education is a substitute for ability. This means that maximising (private) returns to schooling requires the expansion of educational opportunities for the less able or the more disadvantaged. By contrast, the relatively low (but still economically significant) returns at the higher end of the earning spectrum is consistent with the notion that there are important factors leading to high-paying employment, which act independently of education-generated human capital. This can take the form of inherent ability, or family connections as argued by Krishnan (1996) using a Youth Employment Survey in Ethiopia (see also Krueger, 2000 for a similar argument).

But the reader should be aware of a caveat in our analysis. After an automatic graduate placement is abolished in Ethiopia in the early 1990's, firms in Ethiopia are having a considerable degree of labour market power, which allows them to pay

wages below skilled workers marginal products. In such a scenario, estimates of the estimated returns might not fully reflect the extent to which education augments productivity.

VI.   CONCLUSION

The paper investigates whether returns to schooling in urban Ethiopia vary according to the ability of individuals. It shows that controlling for the endogeneity of schooling that results from its association with unmeasured ability is important for the accurate identification of the causal impacts of education. The empirical estimates indicate that education is more beneficial to the less able, implying that the expansion of educational opportunities to the more disadvantaged members of society might contribute to the maximisation of the private rate of returns. This suggests an interesting question: can education be used as a policy instrument for reducing income inequality? A detailed analysis of this interesting issue is high on our research agenda.

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Table 1: Descriptive statistics

Variable	1994
Hourly wage in	
Mean	1.515
St. deviation	2.445
Quantiles	
Q10	0.104
Q25	0.417
Q50	1.042
Q75	2.083
Q90	6.161
Gender (% of females)	37.7
Mean years of Schooling	8.72
(St. deviation)	4.518
Mean years of experience	9.39
(St. deviation)	(9.135)

N.B. Wages are expressed in Ethiopian currency- Birr.

Table 2
Returns to education in Urban Ethiopia:
Quantile regression estimates

Variable	Mean	10th quantile	25th quantile	50th quantile	75th quantile	90th quantile
Years of schooling	0.150***	0.209***	0.193***	0.157***	0.123***	0.104***
	(15.73)	(10.20)	(17.11)	(21.67)	(14.84)	(7.25)
Female	-0.217***	0.026	-0.176	-0.298***	-0.215***	-0.302***
	(2.63)	(0.12)	(1.61)	(4.43)	(2.98)	(2.71)
Experience	0.084***	0.167***	0.107***	0.077***	0.051***	0.046***
	(10.90)	(8.90)	(10.95)	(12.27)	(9.08)	(5.60)
Experience ^{2}	-0.001***	-0.003***	-0.002***	-0.001***	-0.001***	-0.001***
	(5.58)	(12.16)	(10.62)	(6.66)	(7.44)	(4.73)
Constant	-2.09***	-4.366***	-3.038***	-1.903***	-0.953***	-0.284*
	(15.54)	(16.15)	(20.03)	(20.09)	(9.47)	(1.69)
R - squared	0.39	-	-	-	-	-
No of observations	636	636	636	636	636	636

Notes:

(i)   t-statistics are reported in parentheses;

(ii)   * significant at 10%; **significant at 5%; *** significant at 1%;

(iii)   Location dummies are included in the regressions

Table 3
Returns to education in Urban Ethiopia:
Instrumental variable quantile regression estimates

Variable	Standard IV	10th quantile	25th quantile	50th quantile	75th quantile	90th quantile
Years of schooling	0.180***	0.281*	0.166*	0.201***	0.107	0.090*
	(5.51)	(1.76)	(1.90)	3.32)	(1.51)	(1.69)
Female	-0.303***	-0.413	-0.427**	-0.575***	-0.476***	-0.349***
	(2.91)	(1.23)	(2.28)	(4.40)	(2.96)	(2.72)
Experience	0.110***	0.117**	0.190***	0.200***	0.120***	0.070***
	(6.38)	(2.30)	(6.47)	(9.65)	(4.59)	(3.33)
Experience ^{2}	-0.002***	-0.002	-0.004***	-0.005***	-0.003***	-0.002*
	(3.60)	(0.99)	(4.70)	(7.12)	(2.96)	(1.91)
Constant	-2.326***	-5.212***	-3.314***	-2.752***	-0.791	0.042
	(7.67)	(3.69)	(4.19)	(5.05)	(1.24)	(0.09)
R-squared	0.46					
No of observations	451	451	451	451	451	451

Notes:

(i)   t-statistics are reported in parentheses;
(ii)   * significant at 10%; **significant at 5%; *** significant at 1%;
(iii)   Location dummies are included in the regressions
(iv)   The Sargan test for the validity of instruments conducted within the GMM framework gives a p-value of 0.302, validating the use of parents education as instruments
(v)   We also checked the quality (relevance) of instruments by examining the F-statistics from the first stage regressions. The results (p-values =0) indicate a strong correlation between parents and offsprings education.