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The returns to vocational training and academic education: Evidence from Tanzania

Godius Kahyarara
Economics Department, University of Dar-es-Salaam, Tanzania

Francis Teal
Centre for the Study of African Economies
Department of Economics
University of Oxford, UK.

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Abstract

In this paper we ask what can account for the continuing strong preference for academic education in Africa where the level of development is so low and there are few wage jobs and which form of educational investment, the academic or vocational, is most profitable. We argue that the answers to these questions are linked through the shape of the earnings function and the importance of firm effects. High levels of academic education have far higher returns than those available either from vocational or lower levels of academic. However at lower levels the vocational return can exceed the academic.

Keywords: *Vocational and General education in Tanzania, manufacturing, training*.

This study uses data from the fourth and fifth rounds of survey work on Tanzania's manufacturing sector. Round five was conducted between January-February 2002 and round four between November 1999 and January 2000. These rounds were undertaken by combined teams from the Centre for Study of African Economies (CSAE) in Oxford and the Economic and Social Research Foundation (ESRF) in Dar es Salaam. The original three surveys in the early 1990s, upon which this later work builds, were undertaken as part of the Regional Program on Enterprise Development (RPED) organised by the Africa Technical Department of the World Bank. This dataset forms part of an ongoing CSAE research project into manufacturing sector performance in Tanzania and Ghana funded by the ESRC under the Global Poverty Research Group and the Department for International Development (DFID). We are greatly indebted to Måns Söderbom for preventing errors and making many valuable suggestions. John Knight and Adrian Wood raised many insightful queries with respect to an earlier version of this paper which led us to revise several of our interpretations of the results. Three referees made very constructive suggestions that led to major improvements in the paper. Remaining errors are ours. The data used in this paper and a STATA do file to recreate the main results can be found at: http://www.csae.ox.ac.uk/datasets/main.html.

1 Introduction

The conflict between the wish of educators in Africa to supply vocational education while students and their parents demand an academic one has been a continuing theme in discussions of educational policy in Africa since the now classic works of Foster (1965a,b). Tanzania is a country which has been through a cycle of policy making which began in the 1960s with an attempt to shift the educational system towards a more vocational focus and a restriction on the supply of secondary education (see Psacharopoulos and Loxley (1985) and Knight and Sabot (1990)) and ended in the 1990s with a reversal of many of its key educational policies. While Tanzania's shifts have been more dramatic than most a general trend away from vocational schooling to more general academic education was apparent in the 1990s. This process had powerful backing from those investing in education. The Education Sector Review of the World Bank (1995) argued that there was a general case that the rate of return was much higher to investments in academic than in vocational secondary education.

This 'new' view - that it is academic not vocational training that should underlie educational policy - has not gone unchallenged. Bennell (1996 a, b) reports some higher rates of returns to vocational education than the rates of return to general education and argues strongly against any underlying presumption that academic education has a higher return than vocational. A similar argument can be found in Bennell and Sergerstrom (1998). Two papers which report higher returns from vocational than academic education are a study by Neuman and Ziderman (1989, 1991) for Israel and one by Moenjak and Worswick (2003) for Thailand.

Indeed research findings do appear to be inconclusive. Zymelman (1976) in a review of school-based vocational training concluded that there was no clear evidence either for or against this type of educational provision. Chung (1995) in a review of the literature undertaken from the 1970s to the early 1990s found that twelve studies on returns to vocational education in developing countries reported higher returns to vocational training, ten studies reported lower returns to vocational education or not different from other forms of learning, and five studies concluded that there is no basis to compare the returns to vocational education with the returns from other forms of learning. Other studies have stressed that the returns to vocational education depend substantially on the general level of economic development, the availability of private sector jobs, and whether or not people are employed in a field related to their training (Bennell and Segerstrom (1998) and Middleton et al. (1993)).

In parallel with the concern to promote skills within schools by means of vocational schooling has been the perceived need to promote training within firms to address problems of poor productivity. A large literature has developed arguing that limited skills is the key to understanding poor performance in African countries, particularly in their manufacturing firms,

Pack (2002). The central premise of much of this discussion has been that markets for skills will not operate and that there is a need to subsidise firms to ensure that the training occurs.

In this paper we ask three questions flowing from these concerns. First, what can account for the continuing strong preference for academic education in Africa where the level of development is so low and wage jobs are expanding so slowly (see Kingdon, Sandefur and Teal (2006) for a review of the empirical evidence for this assertion)? Secondly, what can account for the diversity of the findings in the literature regarding the returns from vocational and academic education and is any general answer possible as to which has the higher returns? Thirdly, and most specifically, which forms of educational investment have been most profitable in terms of increasing incomes - vocational school, technical college, academic education or on-the-job training - in Tanzania? We will argue that the answers to all these questions are linked through the shape of the earnings function and the role of firm effects in determining earnings.

In the next section we set out the background as to how enrolment has changed in Tanzanian schools over the period from the 1960s to 2000. In section 3 we set out the earnings function we will use. An extensive literature has been concerned with two econometric problems that arise in estimating such functions in developing countries. The first is the possibility of a selectivity bias as wage earners are not a random sample of the population, Moenjak and Worswick (2003) find a much higher return on vocational education for Thailand when they allow for selectivity. Tansel (1994), who also allows for selection, finds high returns to vocational education in Turkey for the young. The second problem is that the return on education may be biased up if ability is omitted from the equation. Both these issues are extensively discussed in Söderbom et al (2006*)* for the data that will be used in this paper. They can find no evidence from instrumenting that the returns from education go down, which is in line with virtually all research in this area (see Card (2001) for a review). In this paper we follow their control function approach of using the residuals from an auxiliary for education to test if the results are biased due to the endogeneity of education. In section 4 we set out how we propose to use the data to address the issue of how returns from vocational and academic schools can be compared. Sections 5 reports results for the sample as a whole, section 6 sets out the returns by the size class of firms. In section 7 we consider the returns to on-the-job training. Finally we return to the most general issue under review - the returns to vocational relative to academic education.

2 Education and training in Tanzania

Since independence the education and training system of Tanzania has gone through distinct regimes, primarily influenced by changing political objectives and economic constraints. In 1961, there were only 3,115 primary schools available with a total capacity of 431,056 pupils

Maliyamkono and Kahama (1986), 95 secondary schools with a total capacity of 11,832 pupils, and a few crafts and technical schools with the total capacity of 1,500 pupils, Ministry of Education (1968). At the university level there was the University of East Africa that admitted students from Kenya, Uganda and Tanzania. The annual intake of Tanzanian students to the University of East Africa was about 200, United Republic of Tanzania (1964).

Tanzania adopted 'Education for Self-Reliance' in 1967 and after 1968 "formal education comprised seven years of primary, four years of 'ordinary' secondary and two years of 'advanced' secondary education", Buchert (1994). This change replaced the system which had operated since the Second World War of 4 years of primary and 4 years of middle school which were then the prelude to secondary schooling. Other changes made at this time included the introduction of Swahili as the sole teaching language in primary schools and the setting of a target to achieve Universal Primary Education (U.P.E.) by November 1977. The objective was a transformation into a mass educational system, whereby formal study could end for most after seven years, Ministry of Education (1968).

Reforms which began in the mid 1980s represented, in many respects, a reversal of the policies introduced in 1967. The free education system was replaced by a cost-sharing scheme, and private sector participation in educational provision was enhanced. These reforms of the education system were introduced after severe budget problems and a general economic crisis in the 1970s and 1980s and were part of the social, political and economic reforms introduced in the mid 1980s, Galabawa (2000).

The changes in enrolment rates for the various education levels over the period 1962-2000, shown in Table 1, reflect these changing political priorities. From 1967 to 1981 primary enrolment rose from 37 to 93 per cent of the 7-14 age cohort. This enrolment rate then declined until the early 1990s after which a modest recovery was effected to 84 per cent by 2000. In contrast enrolment rates for secondary and post-secondary level expanded modestly until 1981 and then accelerated rapidly to 2000 such that between 1981 and 2001 enrolment rates at the secondary level more than doubled from 5 to 13 per cent of the relevant age cohorts (see Table 1). The work of Knight and Sabot (1990) used this limited expansion of secondary education until 1980 as the basis for a comparison between Tanzania and Kenya as to the differential effects of investment in education in the two countries**.** Söderbom (et al) (2006) provide a comparison of how the returns to education in Kenya and Tanzania have changed over the period since 1990 using the same data for Tanzania as will be used in this paper.

In the area of training there have also been major changes in policy over the period. Until the end of the 1980s Tanzania had a centralised labour market with a government set pay structure and centrally planned labour supply (including job training) and utilization. Most firms were state owned and some large firms had their own training centres. In the 1990s policies of state control were reversed as part of a move to a market economy. Specific reform measures

included privatisation of state owned firm, abolition of centralized labour allocation and gradual elimination of government set wages and the introduction of wage bargaining at an enterprise

TABLE 1
TOTAL ENROLMENT AND PERCENTAGE OF ENROLMENT TO RELEVANT POPULATION COHORTS FOR DIFFERENT LEVELS OF LEARNING INSTITUTIONS IN TANZANIA 1960-2000

Year	Primary	% Age 7-14yrs	Secondary (O-Level)	%Age 14-17yrs	Secondary (A-level)	% Age 17-19yrs	Higher Education	% Age 20-24yrs	Technical College
1962	518,663	33.10	13,690	2.25	485	0.10	203	0.03	299
1963	592,104	33.52	16,604	2.33	572	0.12	305	0.04	327
1964	633,678	35.28	18,830	2.51	1,067	0.21	407	0.05	360
1965	710,200	36.19	20,529	2.69	1,386	0.27	642	0.08	335
1966	740,991	36.33	22,240	2.76	1,596	0.29	740	0.08	350
1967	753,114	37.42	23,842	2.92	1,709	0.31	1,313	0.15	318
1968	765,169	37.95	26,829	3.14	1,214	0.21	1,498	0.17	320
1969	776,109	37.99	27,322	3.19	2,636	0.44	1,975	0.21	305
1970	827,974	38.02	28,322	3.23	2,895	0.47	2,086	0.22	343
1971	902,609	38.67	29,559	3.25	3,044	0.49	2,099	0.21	368
1972	1,003,396	39.72	30,185	3.27	3,228	0.50	2,230	0.22	380
1973	1,106,387	40.23	31,021	3.26	3,481	0.53	2,345	0.22	375
1974	1,288,886	42.26	32,246	3.25	3,680	0.54	2,337	0.20	351
1975	1,532,953	50.22	34,560	3.20	3,767	0.53	2,402	0.20	395
1976	1,954,442	59.32	36,218	3.28	3,729	0.51	2,828	0.23	400
1977	2,020,883	59.83	37,878	3.62	4,082	0.54	3,075	0.24	418
1978	2,751,931	78.66	39,527	3.84	3,842	0.50	3,038	0.23	420
1979	3,076,210	85.52	46,353	3.92	3,884	0.50	3,002	0.22	413
1980	3,359,966	90.56	63,607	4.25	3,685	0.49	3,051	0.22	469
1981	3,538,183	92.79	63,826	4.68	3,776	0.47	3,006	0.21	478
1982	3,512,799	89.93	64,834	4.92	4,310	0.47	3,018	0.21	510
1983	3,561,410	88.05	66,564	4.96	4,655	0.51	3,049	0.20	525
1984	3,483,944	84.76	69,083	5.10	5,127	0.55	3,069	0.19	484
1985	3,169,759	75.10	77,400	5.37	5,697	0.59	3,025	0.18	506
1986	3,158,839	72.73	85,706	5.53	5,936	0.61	3,085	0.18	604
1987	3,159,726	70.85	97,854	6.23	6,192	0.63	3,042	0.17	634
1988	3,165,113	69.27	112,619	7.19	6,221	0.62	3,065	0.16	610
1989	3,258,601	70.23	125,397	7.87	7,012	0.68	3,087	0.15	680
1990	3,373,000	71.47	136,729	8.35	8,513	0.81	3100	0.15	850
1991	3,507,000	77.3	156,250	9.32	10,562	0.97	3221	0.14	1,824
1992	3,600,000	71.1	164,117	9.51	11,786	1.05	3543	0.16	1,698
1993	3,733,000	77.3	168,302	9.52	12,597	1.10	4594	0.19	1,760
1994	3,793,000	76.8	173,620	9.52	12,672	1.07	5407	0.21	1,669
1995	3,878,000	76.5	183,659	9.81	12,716	1.05	7897	0.31	1,896
1996	3,943,000	75.5	185,449	9.71	13,974	1.12	9370	0.35	1,827
1997	4,052,000	77.9	205,562	10.32	18045	1.40	10,781	0.39	1,859
1998	4,032,000	79.2	208,738	10.29	18,165	1.37	12,069	0.43	1,833
1999	4,183,000	82.0	225,866	10.77	21,713	1.59	12,555	0.43	2,049
2000	4,136,000	83.7	238,254	10.97	23,702	1.69	13,442	0.45	2,178

Source: Tanzania Statistical Abstract (1995), Tanzania Economic Surveys (1964, 1968, 1977, 1982, 2001), Tanganyika Five-Year Plan (1964) and Official Statistical from National Bureau of Statistics. The gross enrolment figures from 1991-2000 for primary school are from official source in the Ministry of Education. The gross enrolment figures for other years are author's computation. The information of total population, and population categorised by age groups reported in the census reports summarised in statistical abstracts along with total enrolments information for each education level are used to compute the gross enrolment rates. Figures for technical education from 1990 are from Basic Statistics on higher education prepared by the Ministry of Science, Technology and Higher Education.

level. Due to privatisation, restructuring and closure of some state owned firms, training centres that used to operate under specific companies closed down, VETA (1997). The new Training Act (of 1994) established an autonomous training authority. Employers are now integrated within the training system as they have a say on the matters related to the type of training provided and also contribute to the cost of training through a 2% levy paid annually. While these reforms to the training system were motivated by a wish to enhance the value of training to employers they also

clearly show the continuing belief among policy makers that central direction, and subsidisation, of training remains necessary.

3 The specification of the earnings function

Our empirical strategy is to estimate an earnings function of the standard form (Becker (1964), Mincer (1974)) in which we have controls for experience, imputed from age less years at school less six, and tenure and then introduce education and training allowing for the fact that when the student enters vocational school or technical college may be important for the return to that level of education. As will be discussed in more detail below our data was collected in a way that enables us to identify the path taken by the student through the education system. In particular we know the highest level they completed before entering vocational school or technical college. We also know whether they went on to obtain professional qualifications or received higher education in the form of a bachelor degree or a post-graduate qualification. Our specification is as follows:

$$\begin{aligned} LnE_{ijt} = {} & \beta_1 Exp_{ijt} + \beta_2 Exp_{ijt}^2 + \beta_3 Tenure_{ijt} \\ & + \theta_p Primary_i + \theta_m Middle_i + \theta_o OLevel_i + \theta_a ALevel_i \\ & + \theta_v Vocational_i + \theta_t TechCol_i + \theta_{pr} Professional_i + \theta_{he} Higher_i \\ & + \theta_{pv} Primary\_vocational_i + \theta_{ov} OLevel\_vocational_i + \theta_{av} ALevel\_vocational_i \\ & + \theta_{ot} OLevel\_techCol_i + \theta_{at} ALevel\_TechCol_i \\ & + \omega_c CJT_{ij} + \omega_p PJT_{ij} + \omega_{sc} STC_{ij} \\ & + \mu_j + T_t + \varepsilon_{ijt} \end{aligned} \qquad [1]$$

where *i*, *j* and *t* are subscripts of individual, firm and time respectively.

Ln E is log of real earnings, *Exp* the potential experience of the worker, measured as age-years of education-6, *Tenure* the length of time spent in their current firm, *CJT* is a dummy if the worker is receiving current on-the-job training, *PJT* a dummy for whether a worker received on-the-job training in the past and *STC* is a dummy for whether they went on a short training course in the last six months. *T* are time dummies, μ are firm fixed effects and ε is the error term.

We identify the highest level of education achieved where the dummy variables are for those who completed the following levels of education: Primary School, Middle School, O and A-Level Secondary, Professional and Higher Education, which is those with a degree. The omitted category is those with no education. We then identify two categories of non-academic education that undertaken at vocational schools and that undertaken at technical colleges. In the case of vocational schools we identify if the student enters vocational school after primary (primary_vocational), after middle school (middle_vocational), after O-level (OLevel_vocational) or after A-Level (ALevel_vocational). Similarly for those using technical college we identify if they enter after O-Level (OLevel-techCol) or after A-level (ALevel_techCol). We will report the returns to middle school but as this was discontinued in the

mid 1970s we will focus on the return to other levels as these are of current concern for policy purposes.

This way of classifying students means that the return on vocational school or technical college can differ depending on at which stage the student enters the school or college. The returns to vocational schooling may well differ depending on the stage of the educational cycle at which it occurs. Söderbom (et al) (2006) document, using this data, that the returns from education are strongly non-linear and convex. In their paper they model education by means of a spline function which allows the returns to education to differ across levels. We wish to measure the increment in earnings which accrue to attending vocational school so this dummy variable approach is the most general specification we can adopt. So can identify the returns to vocational education after primary (ROR_{pv}), after O-Level (ROR_{ov}) and after A-Level (ROR_{av}). A similar argument applies to progress through technical college so we have the returns to technical education after O-Level (ROR_{ot}) and after A-Level (ROR_{at}). The rates of return which we will be reporting are defined as follows[1]:

$$ROR_{pv} = \exp((\theta_v + \theta_{pv} - \theta_p)/2) - 1 \qquad ROR_{ot} = \exp((\theta_t + \theta_{ot} - \theta_t)/3) - 1$$

$$ROR_{ov} = \exp((\theta_v + \theta_{ov} - \theta_o)/2) - 1 \qquad ROR_{at} = \exp((\theta_t + \theta_{at} - \theta_a)/3) - 1$$

$$ROR_{av} = \exp((\theta_v + \theta_{av} - \theta_a)/2) - 1$$

These rates of return need then to be compared with those available to those who follow an exclusively academic stream which we define as follows:

$$ROR_p = \exp(\theta_p/7) - 1 \qquad ROR_a = \exp((\theta_a - \theta_o)/2) - 1$$

$$ROR_m = \exp(\theta_m/8) - 1 \qquad ROR_{pr} = \exp((\theta_{pr} - \theta_0)/2) - 1$$

$$ROR_o = \exp((\theta_o - \theta_p)/4) - 1 \qquad ROR_{he} = \exp((\theta_{he} - \theta_a)/3) - 1$$

These are the Mincerian rates of return from following alternative paths through the education system where it is assumed growth between the highest completed levels of education and the level before is exponential. We need to make an assumption as to how long it takes to complete any level of education and we present those assumptions in Table 2 where we have reported the median years of education which will be used in this Mincerian calculation.

One of our contributions in this paper is to show that rates of return differ depending on how students proceed through the education system. A second contribution follows from our ability to match firm characteristics with the education of the workers. There is work, using the labour force data from these firms, showing that part of the return to education results from a process of sorting so that workers in larger firms receive a higher return on education than those in smaller firms, Fafchamps, Söderbom and Benhassine (2006). There is also work showing that firm size is an important correlate of wages paid in these firms, Fafchamps and Söderbom (2006). To address that issue we will interact all the educational dummies with the log of employment as

our measure of firm size. If the effect of size is to increase the return, for example, on A-Level more than it increase the return on vocational after A-Level then it is perfectly possible (as we will see) for the returns to vocational education to be negative. The implications of any such negative returns will be taken up after the results are presented.

We turn now to consider measuring the returns to training in the firm. We have three measures of training; the first (*CJT*) is whether the worker is currently receiving on-the-job training; the second (*PJT*) is whether such training occurred in the past and the third whether the worker has attended a short training course, (*STC*). These are simply dummy variables and thus a very crude measure of training. In their defence it can be argued that training within the firm is actually very difficult to measure and a simple measure of any or none (which is the form our variables takes) at least avoids the problems posed by comparing the range of activities which is the typical pattern of within firm training. The more basic problem with the variable is that it is endogenous in that individuals may be selected for training on the grounds, unobservable to the econometrician, that they are more able. Thus any return to training may capture not the effect of the training but the effects of the selection. While we have not sought to model the selection process we do have firm-level panel data so we can allow for a range of factors which may be correlated with the training and thus cause potential bias in the estimated returns on training. As we will show these are important factors in understanding what determines the return on training.

4 Data and variables

The data used in this study is from the fourth and fifth rounds of the Tanzanian Manufacturing Enterprise surveys. The fifth round was conducted between January-February 2002 and covered a total of 192 manufacturing enterprises in 6 main industrial locations in Tanzania. The fourth round was conducted between November 1999 and January 2000. These surveys were the follow-up to the three Regional Program of Enterprise Development (RPED) surveys carried out in the early 1990s. We confine ourselves to the fourth and fifth rounds as the education questions were then asked in a way that allows us to make the distinction we require as to when a workers left the main academic stream and entered a vocational school or technical college. As in both the fourth and fifth waves of the survey recall questions were asked we have four years of data spanning the period 1997 to 2000. Table 2 shows summary statistics for education and earnings across these four years.

We have a sample of 2527. Column (1) of Table 2 shows how this sample is distributed across the educational categories we can identify. The two categories on which we wish to focus are those who went to technical college, which was 5 per cent of the sample, and those who attended vocational school, which is 20 per cent of the sample. Clearly vocational school is far more important than technical college and attending vocational school was reasonably common. Column (2) shows the monthly earnings in 1994 US$. Those who have been to technical college

earn far more than those who attended vocational school, US$ 75 as compared with US$ 44 per month. Also it is apparent from the Table that the earnings of those with O-Level qualification are very similar to those with vocational training. It will matter when students entered vocational school or technical college. In Column (3) we show when students entered vocational school. While most enter after primary school, 66 per cent, a substantial number, 27 per cent enter after O-Level and a relatively small number, 3 per cent, after A-Level. By far the most common path into technical school is after O-Level, 79 per cent of the sample. This data confirms what we know from how academic and vocational education is structured. Entry levels differ and there is a hierarchy by which entry into technical colleges is limited, in the main, to those with O-Level qualifications.

TABLE 2
Education and Earnings

Highest Level completed	Percentage of Sample	Monthly Earnings in 1994 US$	Percentage of Sample in Vocational School after highest level of general school completed	Percentage of Sample in Technical College after highest level of general school completed	Median Years of Education
	(1)	(2)	(3)	(4)	(5)
Higher Education	2.5	272			16
Professional	5.5	83			13
Technical College	5.4	75			14
Vocational	19.7	44			9
A-Level	1.7	87	2.6	11.0	13
O-Level	10.3	47	27.4	79.4	11
Middle	2.5	50	4.0	9.6	8
Primary	48.3	33	65.6	0	7
None	4.2	27	0.4	0	0
Average		39			
N	2527				

At the same time as the workers were interviewed information was also collected about the firms in which they were employed. This data referred to the year before the earnings data. We have matched the firm level data with the earnings data such that, for example, firm data for 1992 is matched to the earning for 1993. A similar procedure is used throughout the period. The earnings variable was obtained by taking the total monthly earnings, plus any allowances received which include food, clothing and housing. In addition any annual and/or Christmas bonuses were also included.

5 Rates of Return on Vocational and Academic Education in the Sample

In this section we present our empirical results assessing the effects of vocational and general education and job training on earnings. Table 3 shows the first four regressions that will the basis for our initial analysis. All the regressions control for gender, tenure and potential experience and whether or not the worker is employed in the capital city. The means and the full definitions of the variables are given in Appendix 1. In Column (1) we report our basic regression where the returns to vocational education and technical college are allowed to vary depending on the entry level of the student and in Column (2) we allow for the potential endogeneity of education by means of an auxiliary regression reported in Appendix 3.[2] In Column (3) we allow for the process of sorting, documented by Fafchamps, Söderbom and Benhassine (2006), by which workers in certain kind of firms may receive a higher return on education than those in other types of firm. We do this here by allowing for firm fixed effects. Finally in Column (4) of the Table we control for the endogeneity of education in addition to the controls for firm fixed effects.

Before presenting the results it is useful to set out how these differing sets of controls will affect the results. We will discuss the returns to vocational education but exactly the same issues apply in assessing the returns to going to technical college. The ROR will depend on two aspects of the educational path followed by the worker. The first is when entry to vocational school occurred and the second is the type of firms in which the worker is employed. In the case of entry into vocational school after primary the ROR is given by: $\exp((\theta_v + \theta_{pv} - \theta_p)/2) - 1$. So the ROR will be a function of the size of θ_{pv} and how all the elements of the ROR are affected by firm fixed effects.

The implications for these alternative approaches for the calculation of the ROR are most readily seen by presenting the point estimates as we do in Figure 1.[3] The top left part of Figure 1 reports the implied estimates for the Mincerian rates of return from Table 3 Column (1). It is these rates of return that are usually cited in comparisons between vocational and academic education. Two points stand out from this Figure. The first is that in assessing the returns to vocational and technical college the level of entry does matter. For those who enter vocational school after primary, which is 66 per cent of our sample, the Mincerian return is higher than for those that enter after O-Level, 9.6 as compared with 8.8 per sent. For those who enter after A-Level the returns are much lower, 3.2 per cent. A similar pattern holds for those going to technical college, for those who enter after O-Level the returns are 10.5 per cant compared with 7.3 for those who enter after A-level. There is a pattern by which the higher is the level of exit

Table 3: Dependent Variable: Ln (Earnings in 1994 US$)

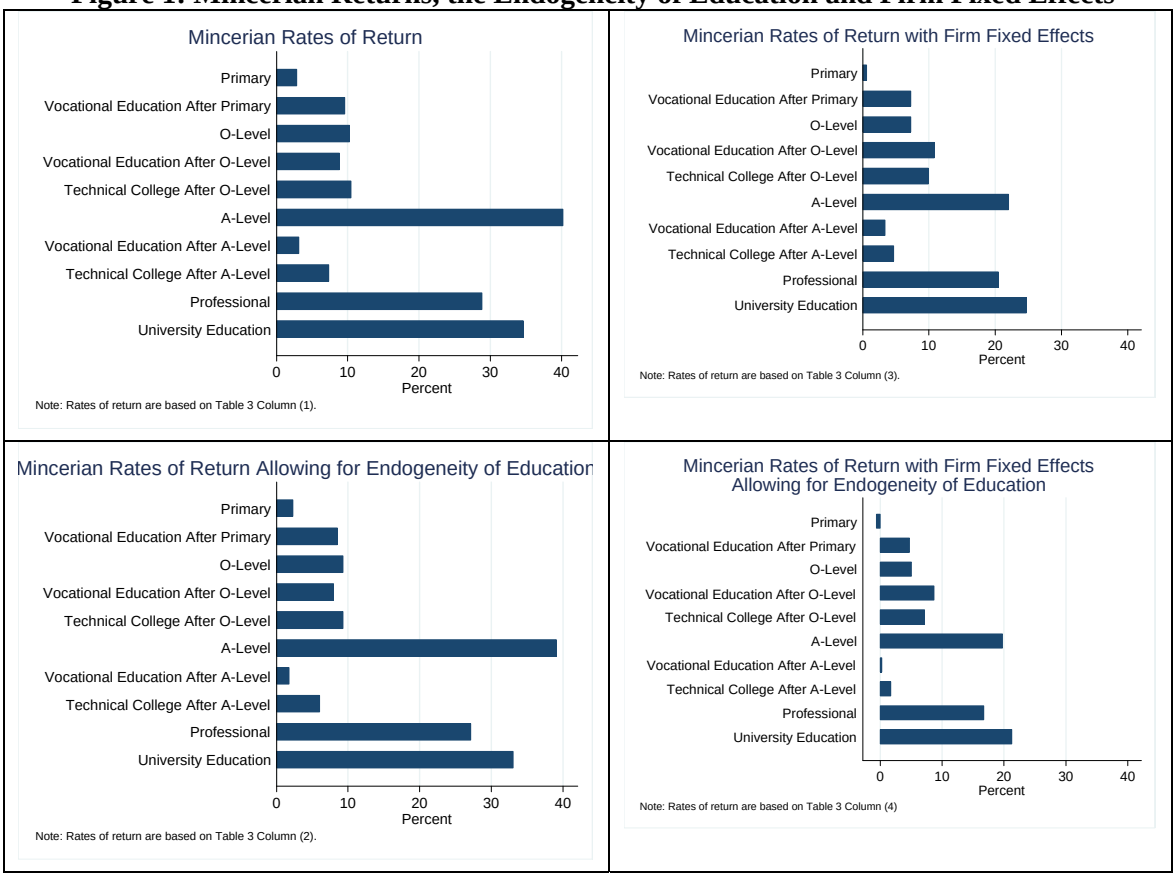
	(1) OLS	(2) Education Endogenous	(3) FE	(4) FE, Endogenous Education
Male	0.117	0.108	0.121	0.097
	(2.30)*	(1.93)	(4.24)**	(3.28)**
Capcity	0.132	0.132		
	(2.38)*	(2.37)*		
Exp	0.047	0.047	0.038	0.038
	(7.14)**	(7.13)**	(10.29)**	(10.26)**
Expsq	-0.073	-0.074	-0.054	-0.056
	(6.20)**	(6.26)**	(8.01)**	(8.23)**
Tenure	0.000	0.000	0.007	0.006
	(0.03)	(0.00)	(3.54)**	(3.40)**
Primary	0.196	0.159	0.042	-0.045
	(3.18)**	(2.05)*	(0.80)	(0.76)
Middle	0.481	0.422	0.237	0.094
	(4.29)**	(3.00)**	(3.05)**	(1.05)
O-level	0.588	0.515	0.322	0.152
	(7.94)**	(4.10)**	(5.36)**	(1.90)
A-level	1.263	1.174	0.721	0.514
	(7.23)**	(5.20)**	(7.81)**	(4.55)**
Vocation	0.855	0.768	0.808	0.596
	(7.28)**	(4.47)**	(2.43)*	(1.76)
Techcol	0.947	0.858	0.714	0.495
	(4.12)**	(3.43)**	(5.17)**	(3.21)**
Profes	1.094	0.995	0.694	0.462
	(6.89)**	(5.30)**	(10.17)**	(4.62)**
Highered	2.156	2.032	1.382	1.092
	(13.53)**	(9.12)**	(16.38)**	(8.77)**
Train_current	0.218	0.217	0.003	0.001
	(2.97)**	(2.96)**	(0.08)	(0.04)
Train_past	0.059	0.059	-0.011	-0.010
	(1.38)	(1.38)	(0.43)	(0.41)
Train_sc	0.170	0.169	0.112	0.110
	(2.47)*	(2.45)*	(3.09)**	(3.03)**
Voc_primary	-0.476	-0.446	-0.626	-0.548
	(4.24)**	(3.85)**	(1.90)	(1.66)
Voc_middle	-0.247	-0.238	-0.323	-0.292
	(1.31)	(1.30)	(0.93)	(0.84)
Voc_olevel	-0.098	-0.100	-0.281	-0.277
	(0.76)	(0.84)	(0.85)	(0.84)
Voc_alevel	0.471	0.441	-0.020	-0.077
	(1.59)	(1.50)	(0.06)	(0.22)
Techcol_olevel	-0.061	-0.076	-0.108	-0.134
	(0.24)	(0.30)	(0.78)	(0.97)
Techcol_alevel	0.529	0.493	0.144	0.070
	(1.81)	(1.63)	(0.79)	(0.38)

Table 3 Continued

Res_educ		0.010		0.024
		(0.70)		(3.16)**
Constant	2.651	2.722	2.827	2.990
	(26.21)**	(19.11)**	(41.37)**	(34.96)**
Observations	2527	2527	2527	2527
R-squared	0.41	0.41	0.29	0.29
Number of firms			235	235

Robust t statistics in parentheses * significant at 5%; ** significant at 1%

Figure 1: Mincerian Returns, the Endogeneity of Education and Firm Fixed Effects



from the academic to the vocational stream the lower are the returns. The second point that is clear from the top left part of Figure 1 is that the ROR for the upper levels of the academic stream are massively higher than for those following a vocational one A-Level (40.2 per cent) and university (34.6 per cent).[4]

This last pattern is the one which arises from the convexity of the earnings function, a result which has been found elsewhere in poor countries, Kingdon and Unni (2001) and Duraisamy (2002) for India and Aslam (2007) for Pakistan. One possible source of such convexity is the potential bias which arises from the endogeneity of education in the specification, a subject which has been the focus of a very large volume of research, Card (2001). The results reported in Table 3 Column (2), and shown in the bottom left part of Figure 1, allow

for endogeneity by means of a control function approach, the basis for which is set out in Appendix 3. The result is to reduce the returns to education, but by very modest amounts, and not to alter at all the patterns shown in the top left of Figure 1. This finding that allowing for the endogeneity of education has little, if any impact, in reducing the returns to education is one common in the literature, Card (2001).

In contrast to the limited impact that allowing for endogeneity has on the returns is the much larger impact of allowing for firm fixed effects which we show in the top right of Figure 1. There are substantial falls in the return to education at nearly all levels. These falls are particularly large for those in the academic stream, indeed the return on A-level is roughly halved while the return to university education is reduced from 35 to 25 per cent. Finally in the bottom right of Figure 1 we report the results of allowing for both firm fixed effect and endogeneity. It is clear from the right hand side of Figure 1 that allowing for both firm fixed effects and the potential endogeneity of education results in a remarkable similarity in the return to education from post primary to below A-Level of 5-7 per cent, a rate of return less than half that available from higher levels of the academic stream.

6 Rates of Returns on Vocational and Academic Education by Firm Size

How should these results be interpreted? In particular should we control for fixed effect when assessing the returns to education? It is possible to argue that such controls are inappropriate. As Fafchamps, Söderbom and Benhassine (2006) argue education may well be more productive in certain types of firms and thus part of the return to education accrues in the form of a better "match" between the firm and the worker. However certain controls may be crucial for understanding how vocational and other technical training impacts on earnings and one is that the effect may differ by the size of the firm. There are two reasons why firm size may matter. The first is that large firms are over-represented in our sample. The second follows from our concern to identify the path through the educational system that the worker has taken. To see the implications of firm size we can write the ROR allowing for the effects of size as: $ROR^{s}_{pv} = \exp((\theta_v + \theta_v \cdot ll + \theta_{pv} - \theta_p - \theta_p \cdot ll)/2) - 1$ where ll is the log of firm size. Size may increase both the returns to attending vocational school and the return from attending primary in a way that reduces the *ROR* on vocational school if the effect on primary is larger than the effect on having attended vocational school.

In Table 4 Column (1) we report the results for extending the specification of Table 3 by allowing for the effects of size on the returns to education, Table 4 Column (2) allows for firm fixed effects in this more general specification, Table 4 Column (3) allows both firm fixed effects and the potential endogeneity of education. The implied rate of return, which can be obtained

Table 4: Dependent Variable: Ln (Earnings in 1994 US$)

	(1) OLS	(2) FE	(3) FE, Endogenous Education
Male	0.149	0.109	0.091
	(3.10)**	(3.86)**	(3.11)**
Capcity	0.124	0.000	0.000
	(2.55)*	(.)	(.)
Exp	0.035	0.037	0.037
	(5.87)**	(10.21)**	(10.17)**
Expsq	-0.053	-0.053	-0.054
	(5.01)**	(7.86)**	(8.03)**
Tenure	-0.001	0.008	0.007
	(0.33)	(3.97)**	(3.85)**
Primary	0.185	0.134	0.062
	(1.12)	(1.21)	(0.54)
Middle	0.190	0.326	0.207
	(0.69)	(1.68)	(1.04)
O-level	0.439	0.370	0.233
	(2.28)*	(3.20)**	(1.82)
A-Level	0.760	0.509	0.360
	(3.07)**	(3.60)**	(2.36)*
Vocation	0.678	0.825	0.651
	(4.30)**	(2.46)*	(1.90)
Techcol	0.422	0.625	0.443
	(0.98)	(2.40)*	(1.64)
Profes	-0.116	0.162	-0.016
	(0.38)	(0.94)	(0.09)
Highered	1.201	1.335	1.132
	(2.71)**	(4.63)**	(3.79)**
Train_current	0.007	-0.175	-0.174
	(0.05)	(2.05)*	(2.04)*
Train_past	-0.080	-0.074	-0.076
	(0.95)	(1.21)	(1.23)
Train_sc	0.121	0.035	0.017
	(0.83)	(0.33)	(0.16)
Voc_primary	-0.421	-0.548	-0.487
	(1.90)	(1.60)	(1.42)
Voc_middle	-0.445	-0.252	-0.231
	(1.32)	(0.66)	(0.60)
Voc_olevel	-0.233	-0.236	-0.234
	(0.95)	(0.69)	(0.68)
Voc_alevel	0.043	-0.206	-0.235
	(0.15)	(0.56)	(0.63)
Techcol_olevel	0.066	-0.160	-0.180
	(0.17)	(0.75)	(0.85)
Techcol_alevel	0.236	-0.229	-0.269
	(0.57)	(0.90)	(1.06)
Primary_ll	0.002	-0.027	-0.026

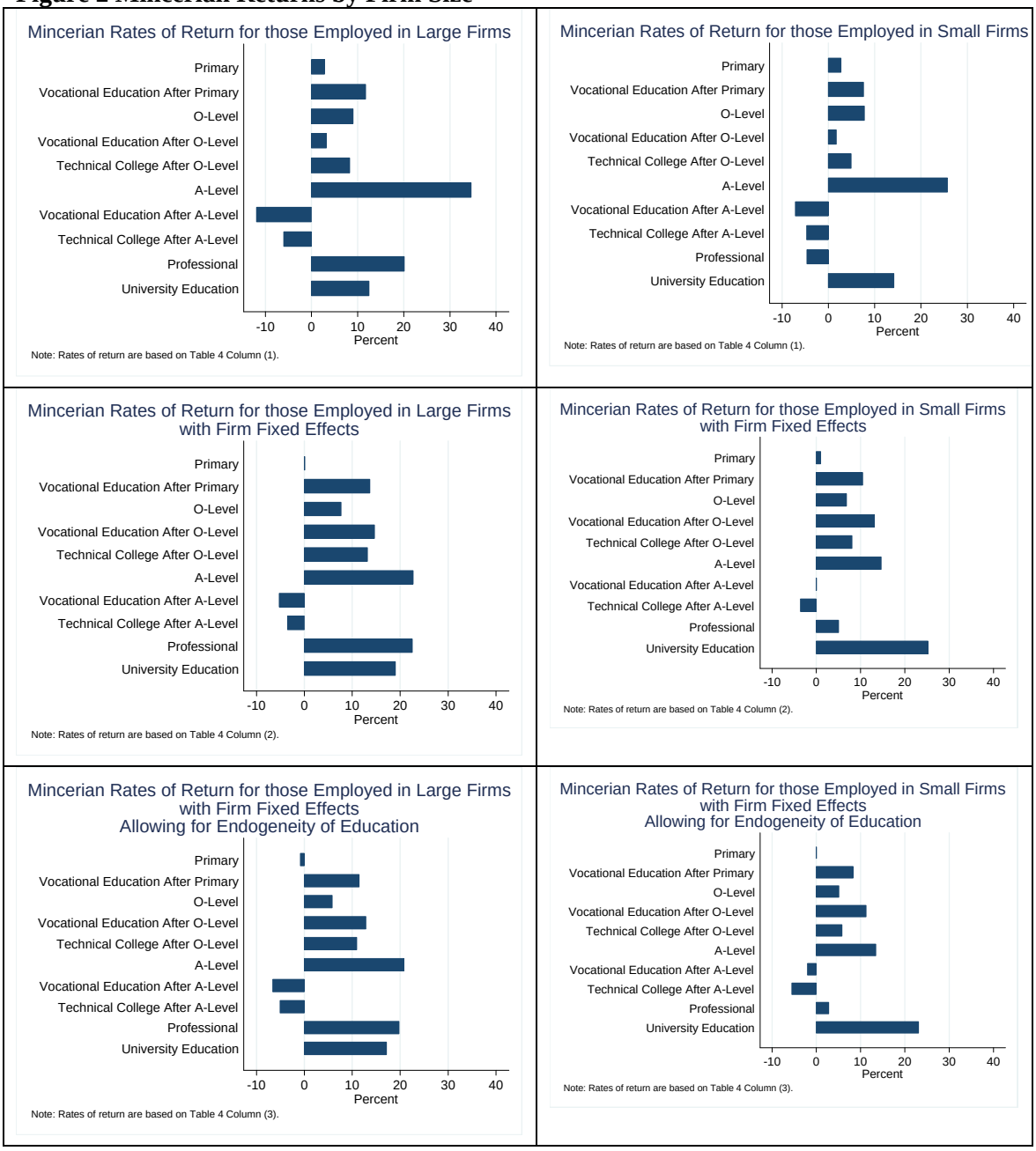
Table 4 Continued			
	(0.04)	(0.85)	(0.83)
Middle_ll	0.073	-0.028	-0.027
	(0.88)	(0.53)	(0.52)
O-Level_ll	0.022	-0.014	-0.014
	(0.38)	(0.45)	(0.45)
A-Level_ll	0.081	0.045	0.040
	(1.51)	(1.40)	(1.26)
Voc_ll	0.034	-0.002	-0.001
	(1.20)	(0.12)	(0.07)
Techcol_ll	0.063	0.046	0.047
	(1.17)	(1.29)	(1.32)
Profes_ll	0.222	0.119	0.118
	(3.50)**	(3.60)**	(3.58)**
Highered_ll	0.062	-0.021	-0.024
	(0.89)	(0.42)	(0.48)
Train_current_ll	0.033	0.045	0.044
	(0.95)	(2.13)*	(2.11)*
Train_past_ll	0.031	0.016	0.017
	(1.38)	(1.00)	(1.04)
Train_sc_ll	0.001	0.016	0.021
	(0.04)	(0.68)	(0.85)
ll	0.065	0.029	0.030
	(1.18)	(0.56)	(0.57)
Res_educ			0.020
			(2.55)*
Constant	2.605	2.736	2.866
	(13.51)**	(14.86)**	(15.02)**
Observations	2527	2527	2527
R-squared	0.48	0.30	0.31
Number of firms		235	235
F Test that education interacted with ll=0 (P value)	4.28 (0.00)	5.55 (0.00)	5.22 (0.00)
Robust t statistics in parentheses: * significant at 5%; ** significant at 1%			

from Table 4, now varies by firm size and we will report results for small firms (those with 10 employees) and large firms (defined as those with 100 employees). The p value decisively rejects the hypothesis that these interaction terms are not significantly different from zero. We appear to have convincing evidence from Table 4 that we must allow not only for the entry point into any level of vocational education but the fact that the returns to this will differ depending on the size of the firm.

We show in Figure 2 the Mincerian returns to the vocational and academic streams by firm size using the estimates available from Table 4. As we would anticipate from the results of Fafchamps, Söderbom and Benhassine (2006) the returns on education vary by firm size. However the impact of firm size is not uniform across the educational levels. The impact on the

rates of return at O-level and below is modest while the rates of return on both A-Levels and professional qualifications are much higher in large than small firms. Because the impact of firm size on the intermediate level qualification of A-Level is much larger than its impact on

Figure 2 Mincerian Returns by Firm Size



Note: A large firm is defined as one with 100 employees, a small firm as one with 10 employees.

university education the effect of firm size is to reduce the return on university education in large firms. Indeed once we allow for firm size the returns to dimensions of vocational and technical education are now negative, sometimes substantially as in entering vocational education after A-Level if employed in a large firm.

Such results present us with a problem. Why if the returns are negative go at all? The effect cannot be causal. A possible source of the problem lies in the unobservables in the regressions which underlie Figure 2. We can use the results reported in Table 4 Column (2) to ask if allowing for firm fixed effects does allow us to identify a possibly positive effect of vocational and technical college on earnings at all educational entry levels. The results are reported in the second row of Figure 2 which presents a similar calculation to that in the top row but with controls for fixed effects.

It is clear that that firm fixed effects are an important factor in explaining the net negative return from vocational training. It is now the case that for vocational school after O-Level the returns among both small and large firms are positive and as large, or larger, than the returns from O-Level. It remains true that the returns from vocational or technical college after A-Level remain negative in large firms although it is far lower than in the case where there are no controls for firm fixed effects.

The implication of these results is clear. Low wage firms tend to employ those with some form of vocational or technical education - there is a negative correlation between the unobservables determining wages and those with vocational or technical qualifications. While this result follows from the firm-fixed effect, it may well reflect, in part, the unobserved quality of the workers. If firms which employ those with technical qualifications end up with a low-quality workforce then the firm fixed effect is simply picking up this quality dimension of the worker. If this interpretation is correct then in assessing the return from vocational or technical schooling it is necessary to control for the firm fixed effect. Conditional on the worker quality we see that for the large majority of those attending vocational or technical school the returns are positive and higher than O-level. For those who attend vocational school after primary, 67 per cent of our sample, the return is 10 per cent for those in small firms and 14 per cent for those in large firms. For those who attend technical college after O-level, 79 per cent of our sample, the Mincerian return is 8 per cent in small firms and 13 per cent in large ones.

Finally in Figure 2 we show, in the bottom row, the effect of controlling for the endogeneity of education in addition to the fixed effects. As in Figure 1 we find that this makes little difference to the results. It is the firm fixed effect which is of far greater importance in affecting the pattern of the returns to education.

7 The Return to On-the-job Training

We turn now to consider the returns to on-the-job training. The results reported in Tables 3 and 4 allow for the possibility that the three forms of training we can identify - currently being trained in the firm, having been given training in the past in the firm and attending a short training course - may shift earnings. As we have already noted the interpretation of these point estimates is

problematic as endogeneity is an even more acute problem than it is in the case for education. It seems very likely that the relatively able will be chosen for training so any increment from earnings from such training will confound the training with the ability. However if this form of endogeneity is of importance it is easy to sign so we can regard any estimate of the effect of past training on earnings as an upper estimate. In Figure 3 we present the implied returns from the three forms of training which are reported in Tables 3 and 4.

Figure 3 Rates of Return on Training

Among small firms there is a substantial return to current training and attending a short training course and nothing for past training. Firm size is clearly of importance for these returns as return

for all forms of training are higher in larger firms. As with our earlier discussion the effects of fixed effects are very important while allowing for endogeneity is much less so.

Our results strongly suggest that the positive correlation between earnings and current and past training is due to the fact that firms which train pay more. It is only for those attending a short training course that there is any evidence that attending this course is associated with a rise in earnings. The results for past training are particularly striking in that, allowing for fixed effects there is no positive return in either small or large firms. If it had been the case that earnings rose with training, within the firm, there would have been the issue as to whether this was due to some unobservable of the worker. However we cannot find such an effect.[5]

It is possible to advance an interpretation that the firm fixed effect has captured the quality of the workforce from the training. If that is so the training benefits all the workers in the firm not simply the person trained who sees no return from the training except through the firm effect. Given that firms do train some mechanism along these lines seems the most likely explanation for our inability to find an effect from training within the firm.

8 The Returns from Academic and Vocational Education

In the introduction we posed three questions. First, what can account for the continuing strong preference for academic education in Africa where the level of development is so low and wage jobs are expanding so slowly? Secondly, what can account for the diversity of the findings in the literature regarding the returns from vocational and academic education and is any general answer possible as to which has the higher returns? Thirdly, and most specifically, which forms of educational investment have been most profitable in terms of increasing incomes - vocational school, technical college, academic education or on-the-job training - in Tanzania?

The first of these questions is linked to the shape of the earnings function and the second and third to the role of firm effects in determining earnings. While there are two routes through the education system, one academic and the second vocational, they are not separate. The academic stream - from primary to O-level, to A-level, to professional or university - is the preferred route as the returns to education are far higher at the A-level stage and above than below that level. This pattern holds for the OLS earnings function and when we allow for the potential endogeneity of education and for firm fixed effects[6]. It is this pattern of returns that can explain the continuing strong preference for academic education. The vocational stream is one entered at various levels from the academic. While the return from vocational schooling can exceed that for the academic, *at the level at which entry occurs,* at no level does the return from vocational schooling remotely match that at the higher academic levels.

In addressing our second general question - what can account for the diversity of the findings - we have shown the importance of three factors relevant to the return to vocational

training or technical school. The first is the necessity of identifying the point at which the student enters the vocational stream, given the structure of the Tanzanian education system where entry can occur at different points along the educational ladder; the second is the importance of the size of the firm in which the worker is employed and the third is the importance of unobserved firm fixed effects.

Students enter vocational and technical college at different points along the educational path. In Tanzania the two most common paths are to enter vocational school after primary (66% of those attending vocational school in the sample) and to enter technical college after O-level (80% of those attending technical college in the sample). In assessing the return to going to either vocational or technical school it is necessary to know the return from completing primary or O-level. We have shown that these returns depend on the size of the firm in which the worker is employed. There are two general patterns in the data. The first is that the return to vocation or technical education is lower the higher the level at which it is entered. The second is that returns to all levels of academic education are higher in large than small firms but this is not true for some levels of the vocational/technical stream.

The finding that firm size has a much bigger impact on academic educational levels, particularly those at O and A-level than on vocational education can be regarded as a confirmation of the argument that Foster (1965a,b) makes against vocational training. By teaching narrowly defined skills rather than the ability to solve problems such training fails to develop general skills which firms with any degree of technical sophistication find most useful. The fact that the returns to academic education rise much faster with firm size than those for vocational education is consistent with this view. However it does not follow that the return to vocational school or technical college is lower than that for those with primary school or O-levels.

Once we allow for the effects of firm size we find that the returns to vocational education after primary are much higher than the returns to primary school and higher even than that for O-level. As we have already stressed these are much lower than the academic returns from A-level and above. We also find, once we allow for the effects of firm size, the return to vocational/technical after A-Level can be negative. This effect is mitigated, although not entirely eliminated, by allowing for firm fixed effects. One possible interpretation of this result is that the firm fixed effect can be interpreted as capturing an element of unobserved quality of the worker or of the firm. If this interpretation is accepted then the negative return to vocational education after A-level reflects, in part, not the effects of the training but a combination of the quality of the worker and of the work place in which they are employed.

We have also shown the importance of firm effects for assessing the impact of training on earnings. The returns are very different across small and large firms. Rather strikingly we can find no evidence that being trained in the past increases earnings once we allow for size and fixed

effects. One interpretation of this result is that the training effect gets incorporated in the firm fixed effect which captures an increase in the quality of the workforce. This benefits all those working in the firm but not differentially those being trained.

While we have shown that firm effects, including size, matter for the returns to vocational relative to academic education there are other factors which the literature has also shown to matter but for which we do not have relevant data. The returns to vocational school may depend on the matching of the skills with employment outcomes. It may differ if the paths through education allow switches between a vocational and an academic stream rather then the pattern which prevails in Tanzania where entry into vocational, it seems clear, is a result of being unable to proceed though the academic and which ends the possibility of entering higher education.

Finally turning to our third question: which forms of educational investment are most profitable? Do these results imply that vocational education should be encouraged relative to academic? Clearly that inference cannot be dawn from these results for, at least, three reasons. The first, to which we have already referred, is that the costs of supplying vocational and academic education differ and we have abstracted from those costs in this discussion. The second, and more fundamental, reason is that the pattern of rising returns with the level of education suggests that the issue is not primarily between the academic and vocational paths but the appropriate rate of investment at different levels for either path. The third, and one that is of particular importance for Tanzania at present, is the potential importance of the workplace in which those being trained will be employed. The returns to both academic and vocational training can differ greatly between firms of different size.

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Appendix 1 The Data

Variable		Mean	Std. Dev.	Min	Max
earn94	Monthly earnings in 1994 Tanzanian Shillings	30,868.3	45,344.8	413.3	1,002,278.0
lern94us	ln(Monthly earnings) in 1994	3.8	0.7	-0.3	7.6
earn94us	Monthly earnings in US$	60.6	89.0	0.8	1966.7
male	Dummy=1 if male	0.83	0.37	0	1
capcity	Dummy=1 if in capital city	0.48	0.50	0	1
age	Age of the worker	34.96	10.22	15	65
exp	Experience of the worker	20.34	11.00	1	59
tenure	Length of time in job	8.20	7.70	0	42
educ	Education in years of worker	8.62	3.35	0	16
none	No education	0.04	0.20	0	1
primary	Primary completed	0.48	0.50	0	1
middle	Middle School completed	0.02	0.16	0	1
olevel	O-Level Completed	0.10	0.30	0	1
alevel	A-Level Completed	0.02	0.13	0	1
vocation	Attended vocational school	0.20	0.40	0	1
techcol	Attended Technical College	0.05	0.23	0	1
profes	Post A-level Professional	0.06	0.23	0	1
highered	University completed	0.02	0.16	0	1
train_curent	Currently receiving training	0.09	0.29	0	1
train_past	Received training in the past in this firm	0.23	0.42	0	1
train_sc	Attended a short training course	0.09	0.29	0	1
voc_primary	Vocation after primary	0.13	0.34	0	1
voc_middle	Vocation after middle	0.01	0.09	0	1
voc_olevel	Vocation after O-level	0.05	0.23	0	1
voc_alevel	Vocation after A-level	0.01	0.07	0	1
techcol_olevel	Technical after O-level	0.04	0.20	0	1
techcol_alevel	Technical after A-level	0.01	0.08	0	1
mgmt	Dummy=1 if Manager	0.03	0.16	0	1
admin	Dummy =1 if Administrator	0.06	0.24	0	1
cleric	Dummy=1 if Clerical	0.08	0.26	0	1
sales	Dummy=1 if sales	0.04	0.19	0	1
super	Dummy =1 if supervisor	0.07	0.26	0	1
tech	Dummy =1 if technician	0.13	0.33	0	1
prod	Dummy=1 if production worker	0.60	0.49	0	1
emp	Number of Employees in firm	105.35	278.51	1	2100
ll		3.32	1.48	0	7.65
educdad	Father's education in years	5.97	4.43	0	20
educmum	Mother's education in years	4.46	4.13	0	20
farmdad	Dummy =1 if father a farmer	0.45	0.50	0	1
farmmum	Dummy=1 if mother a farmer	0.64	0.48	0	1
profdad	Dummy= if father professional	0.10	0.30	0	1
profmum	Dummy=1 if mother professional	0.04	0.18	0	1

Number of observations =2527.
The sample is confined to African workers aged between 15 and 65, apprentices are excluded. The data is annual covering the period 1997 to 2000.

Appendix 2 The Mincerian Rates of Return

Whole Sample	ROR	ROR_ee	ROR_fe	ROR_fe_ee
Primary	2.8	2.3	0.6	-0.6
Vocational Education After Primary	9.6	8.5	7.3	4.8
O-Level	10.3	9.3	7.3	5.1
Vocational Education After O-Level	8.8	8.0	10.8	8.7
Technical College After O-Level	10.5	9.3	9.9	7.2
A-Level	40.2	39.1	22.0	19.8
Vocational Education After A-Level	3.2	1.8	3.4	0.3
Technical College After A-Level	7.3	6.1	4.7	1.7
Professional	28.8	27.1	20.5	16.8
University Education	34.6	33.1	24.7	21.3

Men Only	ROR	ROR_ee	ROR_fe	ROR_fe_ee
Primary	2.6	1.8	0.5	-0.5
Vocational Education After Primary	11.1	9.5	6.8	5.0
O-Level	10.2	8.7	7.7	6.0
Vocational Education After O-Level	7.5	6.1	6.4	4.7
Technical College After O-Level	13.9	12.1	8.9	6.9
A-Level	37.0	35.3	20.4	18.4
Vocational Education After A-Level	3.3	1.6	-1.0	-2.6
Technical College After A-Level	6.5	4.6	3.8	1.6
Professional	25.1	22.6	20.8	17.9
University Education	35.7	33.6	24.9	22.8

Whole Sample	ROR_10	ROR_100	ROR_10 _fe	ROR_100 _fe	ROR_10 _fe_ee	ROR_100 _fe_ee
Primary	2.7	2.8	1.0	0.1	0.0	-0.8
Vocational Education After Primary	7.6	11.7	10.5	13.7	8.3	11.5
O-Level	7.8	9.0	6.9	7.7	5.1	5.9
Vocational Education After O-Level	1.8	3.2	13.1	14.7	11.3	12.9
Technical College After O-Level	4.9	8.3	8.1	13.2	5.8	10.9
A-Level	25.7	34.6	14.7	22.7	13.4	20.8
Vocational Education After A-Level	-7.1	-12.0	0.1	-5.2	-2.0	-6.6
Technical College After A-Level	-4.7	-6.0	-3.6	-3.5	-5.5	-5.0
Professional	-4.6	20.1	5.1	22.5	2.8	19.8
University Education	14.1	12.5	25.2	19.0	23.1	17.2

Male only	ROR_10	ROR_100	ROR_10 _fe	ROR_100 _fe	ROR_10 fe_ee	ROR_100 _fe_ee
Primary	2.1	3.5	1.1	-0.3	0.3	-1.0
Vocational Education After Primary	4.2	2.3	11.4	17.2	9.4	14.8
O-Level	7.5	8.7	6.9	8.2	5.4	6.8
Vocational Education After O-Level	-4.4	-8.3	8.6	11.4	6.8	9.2
Technical College After O-Level	8.1	3.1	8.4	12.6	6.5	10.5
A-Level	25.2	32.6	15.0	20.6	13.7	18.9
Vocational Education After A-Level	-14.1	-22.1	-3.1	-5.3	-4.3	-6.4
Technical College After A-Level	-1.5	-9.4	0.2	0.8	-1.7	-1.0
Professional	-12.0	7.4	4.5	24.9	2.3	22.0
University Education	7.1	5.8	26.3	22.7	24.6	21.0

Whole Sample	ROR_10	ROR_100	ROR_10 _fe	ROR_100 _fe	ROR_10 fe_ee	ROR_100 _fe_ee
Current Training in the Firm	8.7	17.3	-7.0	3.0	-7.0	2.9
Past Firm-Level Training	-0.9	6.4	-3.6	0.0	-3.6	0.2
Short Course Training Attended	13.3	13.7	7.6	11.7	6.6	11.8

Male only	ROR_10	ROR_100	ROR_10 _fe	ROR_100 _fe	ROR_10 fe_ee	ROR_100 _fe_ee
Current Training in the Firm	5.1	13.0	-12.2	-0.6	-12.1	-0.7
Past Firm-Level Training	-2.7	7.7	-5.3	1.2	-5.4	1.3
Short Course Training Attended	16.4	10.5	7.3	6.2	6.5	6.1

Definitions:
ROR is the Mincerian rate of return with no controls.
ROR_ee is the Mincerian rate of return allowing for endogenous education.
ROR_fe is the Mincerian rate of return allowing for fixed effects.
ROR_fe_ee is the Mincerian rate of return allowing for fixed effects and endogenous education.
ROR_10 is the Mincerian rate of return in a small firm (one employing 10).
ROR_100 is the Mincerian rate of return in a large firm (one employing 100).
ROR_10_fe is the Mincerian rate of return in a small firm with fixed effects.
ROR_100_fe is the Mincerian rate of return in a large firm with fixed effects.
ROR_10_fe_ee is the Mincerian rate of return in a small firm allowing for firms fixed effects and endogenous education.
ROR_100_fe_ee is the Mincerian rate of return in a large firm allowing for firms fixed effects and endogenous education.

Appendix 3 Endogenous Education

	(1)	(2)	(3)	(4)
	educ	train_current	train_past	train_sc
male	-0.684	0.055	0.054	-0.007
	(2.65)**	(2.16)*	(1.36)	(0.31)
capcity	-0.341	0.049	-0.035	0.016
	(1.22)	(1.97)*	(1.08)	(0.94)
exp	0.099	-0.012	-0.015	0.004
	(2.92)**	(3.67)**	(3.58)**	(1.41)
expsq	-0.363	0.013	0.010	-0.006
	(6.13)**	(2.58)*	(1.34)	(1.32)
tenure	0.003	0.001	0.012	0.002
	(0.18)	(0.87)	(5.79)**	(1.44)
educdad	0.094			
	(2.93)**			
educmum	0.013			
	(0.46)			
farmdad	0.047			
	(0.19)			
farmmum	-0.406			
	(1.66)			
profdad	1.317			
	(3.92)**			
profmum	0.274			
	(0.57)			
educ		-0.001	-0.009	0.020
		(0.15)	(1.56)	(5.94)**
mgmt		-0.009	0.099	0.146
		(0.20)	(1.11)	(2.09)*
admin		-0.020	0.062	0.157
		(0.57)	(0.98)	(3.61)**
cleric		-0.033	-0.038	0.181
		(1.07)	(0.80)	(3.96)**
sales		-0.043	-0.098	0.061
		(0.74)	(1.76)	(1.18)
super		-0.049	-0.020	0.046
		(2.09)*	(0.36)	(1.19)
tech		-0.015	-0.032	-0.010
		(0.54)	(0.82)	(0.70)
ll		0.025	0.022	0.010
		(2.31)*	(1.82)	(1.22)
Constant	8.853	0.127	0.323	-0.223
	(15.93)**	(1.85)	(3.53)**	(5.13)**
Observations	2527	2527	2527	2527
R-squared	0.22	0.06	0.07	0.17

Robust t statistics in parentheses
* significant at 5%; ** significant at 1%

In this appendix we present the auxiliary regression for education which underlies the regression results in Tables 3 and 4 which control for endogeneity. As is well-known, the OLS estimator will give biased estimates of the returns to education if education is 'endogenous', i.e. correlated with the residual in the earnings equation. A common concern in the literature is that education may be positively correlated with unobserved labour market ability, and that the estimates of the returns to education would be upward biased as a result. To allow for a general earnings-education profile whilst controlling for effects of unobserved ability on earnings and returns to

earnings, we adopt a two-stage control function approach, Garen (1984). In the first stage we run a regression of education on a set of instruments. Based on this regression we estimate the residual, denoted res_educ. In the second stage we estimate an earnings function in which res_educ is used as a 'control variable' for ability. Provided standard conditions for identification hold, and provided the instruments are independent of ability and uncorrelated with the equation residual, this procedure will give consistent estimates of the parameters of interest. We have data on parents' education and main occupations. These are our potential instruments for education. As discussed in Söderbom et al (2006) it is possible that the control function also addresses the sample selectivity problem. The requirement is that the instruments are independent of the error term in the selected sample.

In this appendix we also include regressions, which are the linear probability model, for our three dimensions of training - past current and attending a short training course. The determinants of training depend on the type. It is only for those attending a short training course that education appears to increase the probability of attending. Firm size is most important for those currently receiving training. We experimented with finding instruments for training but were unsuccessful. As we acknowledge in the text our results cannot allow for the possible endogeneity bias induced by the selection process for training.

[1] This definition of the Mincerian return converts the dummy variable to an annualised equivalent increment in earnings by assuming that the growth in earnings between education levels is exponential. For small differences in earnings across education levels there is little difference between this definition and one which assumes growth is linear, $ROR_{pv} = (\exp(\theta_v - \theta_p) - 1)/2$. However the differences are substantial when the earnings differentials are as large as they become beyond O-level.

[2] As the summary statistics in Appendix 1 show only 17 per cent of the sample is female. We have checked if the education and training parameters differ by gender and at the 1 per cent significance level we can reject the null they are the same across men and women. We report in Appendix 2 the rates of return for a sample confined to men only. However given the small representation of women in the sample the conclusions drawn should be viewed as applying most clearly to men.

[3] The data which is summarised in the Figure can be found in Appendix 2.

[4] Psacharopoulos (1994, page 1326) objects to the Mincerian assumptions when it comes to assessing the return to primary school on the grounds that the forgone earnings of those aged from 7 to 14 are not earnings of adults with no education which the ROR calculations implicitly assume. However there is evidence that child labour is substantial in Tanzania particularly in rural areas. Burke and Beegle (2004) have data for rural Tanzania which shows that for 47 per cent of the sample a child wage is reported in the community and 62 per cent of children are engaged in farming. Imputing wages to child labour is clearly problematic. Our data implies that a primary education increases annual earnings by some US$85. The internal rate of return on an income stream of US$ 85 per year for 50 years with an annual cost of US$360 per year for seven years is 2 per cent. If we assume that the actual cost is half this then the internal rate of return becomes 5 per cent. Such an assumption imputes an income of US$15 per month which does not seem unreasonable. It is clear that the private Mincerian rate of return at the primary level is far below that at A-level and beyond.

[5] In previous work on training in Tanzanian firms, Beyer (1990) also finds no effect from past training in the firm onto earnings. She does however find that the earnings profile is steeper for those undergoing training. We have investigated whether this is true for our data and find it is not.

[6] That the Mincerian return to education rises with the level of that education is consistent with Bennell's (1996c) argument that the pattern of returns presented by Psacharopoulos (1994) does not apply in Africa.