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The Dynamics of Returns to Education in Kenyan and Tanzanian Manufacturing*

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Abstract

The returns to education remain a central concern for development policy. In developed countries there is evidence that the returns to education have been rising. Evidence for changes over this period for developing countries is limited. In this paper we use data from Kenya and Tanzania to estimate returns to education for manufacturing workers and examine how these returns have changed from 1980 to the late 1990s. We find strong evidence that the earnings function is convex for both countries and document significant differences in the earnings profiles across cohorts, typically with stronger convexity amongst the young. We also find evidence of increasing convexity over the 1990s in Tanzania, but remarkable stability in Kenya. We test for the importance of ability bias and find convexity robust to endogeneity. Treating education as an endogenous explanatory variable generally results in higher estimated returns to education than what is obtained by OLS. Potential reasons for this result are discussed.

Keywords: Returns to education, Africa, Kenya, Tanzania, manufacturing.

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1. Introduction

Education is often seen as the main policy instrument for reducing poverty in developing countries. Two broad empirical generalisations are central to the argument that expanding education will help the poor. The first is that in developing countries the returns to education are relatively high, the second is that the returns are concave with respect to education. One common policy recommendation based on concavity is that, because of higher returns to primary relative to higher levels of education, expanding primary education should be the priority (Psacharopoulos, 1994). However, the notion that earnings functions are concave in education has been challenged for both developed and developing countries.[1] If in fact the earnings function is convex then marginal returns to education will be lowest for the individuals with the least education, with obvious implications for the demand for education, the distribution of income and the effectiveness with which education can serve to reduce poverty.

In this paper we investigate the shape and the dynamics of the earnings function for two African countries - Kenya and Tanzania.[2] We have comparable data on workers in manufacturing firms over the 1990s so we can trace changes in the shape of the earnings function in detail over this period. We can put these changes in a longer term context as excellent data exist for the returns on education in the 1980s (Knight and Sabot, 1990). We can also ask if the earnings profile differs across cohorts, another dimension of our dynamic analysis.

[1] Kingon and Unni (2001) report that, for urban India, returns increase with the level of education; Duraisamy (2002) finds a similar result. Belzil and Hansen (2002) report increasing marginal returns to education in the U.S., up to grade 14. Bennell (1996) argues that the results reported by Psacharopoulos (1994) are not credible due to methodological shortcomings.

[2] Available empirical evidence shows mixed results concerning changes in returns to education in the 1990s in sub-Saharan Africa. Krishnan, Sellassie and Dercon (1998) show that educational returns did not change in urban Ethiopia despite labor market reforms instituted in early 1990s. In contrast in Uganda, from 1992 to 1999, returns to education increased markedly, Appleton (2002) and in Ghana from 1987 to 1991 there is evidence of rising returns, Canagarajah and Thomas (1997). These studies have been confined to relatively short time periods. Where longer run comparisons have been made there is evidence of falls. In South Africa, Moll (1996) reports that returns to primary education declined from 1960 to 1975. In urban labour markets in Kenya between 1978 and 1995 Appleton, Bigsten and Manda, (1999) report declines in returns to education for workers with secondary education and below.

Kenya and Tanzania offer an interesting opportunity to analyse the connections between earnings and education, because the different educational policies pursued by the two countries in the 1980s constituted close to a natural experiment (Knight and Sabot, 1990). While Kenya allowed a rapid expansion of secondary education, much of it privately financed, Tanzania severely restricted access to secondary education and introduced wage polices to reduce differentials. By comparing Kenya and Tanzania we can therefore find out the long run consequences in the 1990s of these very different policies adopted in the 1980s. Further, in the 1990s educational and other policies in Tanzania became much more similar to those in Kenya. Have returns to education in Tanzania become more like those in Kenya as a result?

The rest of the paper is organised as follows: Section 2 outlines our empirical framework, Section 3 discusses the data and shows summary statistics, Section 4 shows OLS estimates of the earnings functions, Section 5 provides a comparative analysis over time and across cohorts, Section 6 shows additional results in which education is treated as an endogenous variable, Section 7 provides a summary and conclusions.

2. The Earnings Model

We write our baseline model of earnings as

$$\ln w_m = \alpha \cdot x_m + f_{ct}(s_m) + \upsilon_m \qquad (1)$$

where w_m is real earnings, x_m is a vector of worker characteristics excluding education, α is a parameter vector to be estimated, s_m is the years of education, $f_{ct}(\cdot)$ is the education-earnings profile, υ_m is a residual, and $\{m, c, t\}$ are indices for observation, cohort and time, respectively.[3] Variables included in x_m are years of tenure, age and age squared, a dummy variable for whether the individual is a male or not and a dummy variable for whether the individual lives in the capital city. Our data begin in 1993 and span seven years for Kenya and

[3] We do not have panel data on individuals (see Section 3), hence there is no need for $\{i,t\}$ subscripts on the variables.

eight years for Tanzania, and central to our concerns is whether the returns to education have changed over this period and whether there are differences across cohorts. Therefore we estimate period-cohort specific profiles, reflected in (1) by the *ct* subscripts.

Most empirical studies in this area assume log earnings to be linear or quadratic in years of education. We seek to document the shape of the entire earnings-education profile, and therefore adopt a more flexible approach specifying $f_{ct}(\cdot)$ as a piecewise linear spline function with *J* nodes at selected levels of education:

$$f_{ct}(s_m) = \mu_t + \iota_c + \beta_{0ct} \cdot s_m + \sum_{j=1}^{J} \beta_{jct} \cdot \max\{s_m - \theta_j, 0\},$$

where θ_j denote the position of the *j*th node, μ_t and ι_c are time and cohort effects (intercept shifters). The slope of the earnings-education profile, often referred to as the marginal or local return to education, may vary across the different segments depending on the coefficients $\beta_{0ct},...,\beta_{jct}$. The coefficient β_{0ct} is interpretable as the slope of the profile in the first education interval (i.e. for the lowest levels of education), while β_{jct} for $j > 0$ is interpretable as the change in the slope of the profile that results from moving from the education interval $\{\theta_{j-1}, \theta_j\}$ to $\{\theta_j, \theta_{j+1}\}$, where $\theta_0 = 0$. The slope of the earnings function in the interval $\{\theta_{j-1}, \theta_j\}$, $j > 0$, is thus given by $\beta_{0ct} + \sum_{i=1}^{j} \beta_{ict}$. Hence, if $\beta_{1ct} = \beta_{2ct} =,...,= \beta_{Jct} = 0$, the earnings function is linear.

In the empirical analysis we begin by taking education to be exogenous, i.e. uncorrelated with the residual in the earnings regression. We then consider the effects of treating education as an endogenous variable, using a control function approach. Throughout the analysis we put in nodes of the earnings-education profile $f_{ct}(\cdot)$ at 7, 10 and 12 years of education. Using four segments of the earnings-education profile ensures that there is a reasonable number of observations in each category. We divide the data into two cohorts only, where an individual is considered 'young' if his/her age is less than 30 years and 'old' otherwise. This way of dividing up the sample is driven by the data.

3. Data

We use survey data on employees in the manufacturing sectors in Kenya and Tanzania.[4] For both countries we have four years of data: the Kenyan data cover 1993, 1994, 1995 and 2000; the Tanzanian data cover 1993, 1994, 1999 and 2001.[5] Four broadly defined manufacturing sub-sectors were surveyed: food processing, textiles and garments, wood and furniture, and metal-working including machinery. These sub-sectors comprise the bulk of manufacturing employment in both countries. Large as well as small firms, including informal ones, were included in the sample, and each wave of the data contains information on 150-220 firms. In each firm up to 10 workers were interviewed to provide information on personal characteristics, characteristics of their jobs and information on earnings and allowances. The aim was to sample employees representing all types of jobs in the firms, e.g. casual workers, production workers, supervisors, office clerks and managers. There is a panel dimension at the firm level, but not at the individual level.[6]

Table 1 shows summary statistics of the key variables in the analysis. To facilitate comparison across the two countries, earnings are recorded on a monthly basis and expressed in constant 1993 US Dollars. The average of monthly earnings in Kenya is USD 75 while in

[4] There are advantages and disadvantages to focussing solely on individuals in the manufacturing sector and not the whole population. Because of significant private ownership the manufacturing sector provides a relatively good basis for interpreting returns to education as returns to productive skills. In contrast, in the public sector earnings are determined by a number of factors orthogonal to productive ability, and so the returns to education would have a different interpretation in this sector. Further, focusing on one sector only ensures that changes over time are not driven by changes in the relative sizes of different sectors, across which there may be radical technological differences. A related point is that, for both Tanzania and Kenya, there is no evidence of significant technological progress over the 1990s. We can thus reasonably argue that for our sample technology is held constant. The main disadvantage of focussing only on individuals in the manufacturing sector, is that the results may be biased by sample selectivity. We discuss this, and how we deal with this problem, in Section 5.

[5] The first three waves of the Kenyan data, and the first two waves of the Tanzanian data, were collected as part of the World Bank's Regional Program on Enterprise Development (RPED), while the remaining waves of the data were collected by teams from the Centre for the Study of African Economies, University of Oxford. The survey instruments and the sampling design were very similar both over time and across the two countries, thus providing an excellent basis for comparative analysis. For general information on the surveys, see Söderbom (2001) and Bigsten and Kimuyu (eds.) (2002) for Kenya; and Harding, Kaharaya and Rankin (2002), Harding, Söderbom and Teal (2002), for Tanzania.

[6] See Bigsten et al. (2000) for a study of the returns to physical and human capital in five African countries. For a panel data analysis based on the firm level data, see Söderbom and Teal (2004).

Tanzania the average is USD 55, indicating a substantial differential across the two countries. The average years of education is 9.1 in Kenya and 8.8 in Tanzania. Figure 1 illustrates the sample distributions of earnings (in natural logarithms) and education. It is clear that there is considerable variation in both variables within each sample. While there is an obvious differential across the countries in average earnings, the distributions have similar shapes. For education, however, the sample distributions differ markedly across the countries. In Tanzania, there is a spike in the data at 7 years of education, while in the Kenyan sample the distribution features spikes at 7 and 11 years of education. This pattern of similar earnings distributions and different education distributions is interesting. If the aggregate supply of education impacts strongly on the returns to education, we would expect the earnings-education profiles to differ significantly across the countries. We now turn to regression analysis to investigate the returns to education in detail.

4. Earnings Function Estimates

Table 2a shows OLS estimates of the parameters of the earnings function, by year and cohort, for Kenya. Table 2b shows results for Tanzania. We focus on the role of education and, for ease of interpretation, show the predicted earnings education profiles in Figures 2a-b. Three main results emerge.[7]

First, for both countries there is strong evidence that earnings are non-linear in education. For 15 of the 16 regressions reported in Tables 2a-b we can reject the linear model, and by implication constant marginal returns to education, at the 10 per cent level of significance or lower. Most of the coefficients on the max(.) terms are positive, suggesting that earnings are convex in education. Many of the coefficients on max(0,EDUC-12) are quite large, indicating sharp increases in the marginal returns to education after 12 years of education. This is also apparent in the graphs.

[7] In addition to these three main results we also note the following: earnings, conditional on human capital, are much higher in Kenya than in Tanzania (Figures 1a-b); the age-earnings profile is, in most cases, inverse u-shaped; the tenure coefficient is small, typically less than 0.01 and insignificant; the

Second, for both countries the results suggest the earnings profiles differ across cohorts. In the range (0,12) years of education the profiles seem steeper for the old than for the young cohort, especially for Tanzania. In the case of Tanzania it also looks as though the earnings profile is much less convex for the old cohort than for the young. In both countries the returns to education for the young cohort are typically very low before the tertiary level.

Third, for both countries it appears the earnings functions have changed over time. In Kenya there is a clear upward intercept shift referring to 1995, which was sustained in 2000 for the old cohort but not for the young. The shape of the Kenyan profile, however, looks quite stable over time, except for 1994. In Tanzania the earnings profiles of 1994, 1999 and 2001 exhibit more pronounced non-linearities than those of 1993. Comparing the last time period to the first it seems clear that earnings have become more convex over time for both cohorts. In contrast to Kenya there is little evidence for intercept shifts over time in Tanzania.

We now investigate whether the data pool over time and/or across cohorts. We start from a model where the explanatory variables are interacted with time and cohort in such a way as to make the specification equivalent to separate earnings functions as in Tables 2a-b, and then test for the joint significance of the relevant interaction terms. Results are reported in Table 3. For both countries we can reject at the one per cent level the hypothesis that all the time and cohort effects are jointly zero (row 1), hence the earnings equations in Tables 2a-b do not pool. We accept the null hypothesis that the coefficients on the control variables (i.e. age and its square, tenure, male and capital city) do not vary across cohorts and over time (row 2), and firmly reject the hypothesis that the earnings education profile is constant across cohorts and over time (row 3). Thus, the control variable effects appear stable over time and across cohorts; the education effects do not.

We drop the interaction terms associated with the control variables, and the cross terms between time and cohort, yielding specification 2. The remaining time and cohort effects are highly significant (row 1), and there is strong evidence that the shape of the

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male coefficient is usually positive but only significant in two out of the 16 regressions; and there is a wage premium to working in the capital city.

earnings education profile varies across cohorts for both countries (row 8). The interaction terms between time and cohort crossed and education are redundant, and so we drop these next. Table 4 shows the resulting specifications, our preferred models, and Figures 3a-b show the predicted earnings education profiles. For both countries the earnings profile for the young cohort is virtually flat for less than twelve years of education, indicating small or no marginal returns to education before the tertiary level. For Tanzania there is evidence of a gradual and systematic change in the shape of the earnings profile for more than twelve years of education, with increased convexity as a result. The interaction terms between education and time, and education and cohort, are significant at the five per cent level or lower, indicating significant differences in the earnings-education profiles both over time and across the cohorts. Looking specifically at the first and last wave of the data, we accept the hypothesis that the earnings profiles exhibit the same shape for Kenya, and reject it for Tanzania.

5. Comparative Analysis

Based on our preferred specifications we now analyse more in detail how returns to education have changed during the sampling period and how they differ across cohorts. We focus on the first and the last wave of the data, thus spanning a period of 7-8 years. We can also put some of the results in a longer term context by drawing on the study by Knight and Sabot (1990). Panel A in Table 5 summarises the estimated marginal returns to education. Because our model is non-linear marginal returns vary with the level of education, and so we report sample averages of the individual marginal effects. The average marginal effect in the Kenyan sample was 12-13 per cent in 1993 and two percentage points higher in 2000. In the Tanzanian sample, the average marginal effect for the young cohort increased from 4 per cent in 1993 to 8 per cent in 2001. For the old there was an increase from 8 per cent to 13 per cent. If we consider only the sub-samples of individuals with more than 7 years of education, the average marginal returns are higher, reflecting the convexity of the earnings functions.

These average marginal effects are large, compared to estimates reported in other studies. Because the underlying earnings profiles are highly non-linear, they mask substantial variation in marginal returns across individuals with different levels of education. In panels B and C we show predicted earnings premiums (in logarithmic form) attributable to education, using two different baselines: no education (panel B) and primary 5-7 (panel C).

For Kenya we find that the differentials have shrunk over time at all levels of education irrespective of which benchmark is used. In 1980 average log earnings of a Kenyan individual with 5-7 years of primary education were about 0.38 higher than that of someone without education, representing an earnings differential of 46 per cent. In 1992 the equivalent differential was 0.37 for the old cohort and 0.22 for the young, and in 2000 the differentials were lower still (we can reject at the five per cent level unchanged differentials between 1992 and 2000). The trend is similar for higher levels of education. We also find that the differentials are smaller in the young cohort.

For Tanzania the differentials fell between 1980 and 1992 but subsequently increased, reflecting the increase in the convexity over the latter period. In 1980 the average earnings of a Tanzanian individual with post-secondary education were 183 per cent higher than those of someone with no education. In 2000 this difference is bracketed by that of the old (278 per cent) and the young (123 per cent) cohort. For Tanzania, the earnings differentials differ significantly (at least at the ten per cent level) across the cohorts at all levels of education. Comparing across the two countries in the last time period the earnings differentials are strikingly similar.

6. Endogenous Education

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 ability, and that the estimates of the returns to education would be upward biased as a result. The conventional way of correcting for ability bias is by means of instrumental

variable (IV) techniques. We use a closely related alternative to IV estimation, well suited for estimating models that are non-linear in the endogenous variable, known as a control function approach.[8] This involves regressing education on a set of instruments, and using the estimated residual to control for endogeneity in the earnings regression. We use a partial linear model of the form $y = \lambda \cdot x + \eta(u)$, where u is the residual from the education regression and $\eta(\cdot)$ is an unknown, smooth function. To estimate the parameter vector λ, we use the semiparametric approach proposed by Robinson (1988), which this involves estimating $\eta(\cdot)$ using a kernel estimator, thus imposing very few restrictions on the shape of $\eta(\cdot)$. In the special case where the endogenous variable enters linearly and $\eta(\cdot)$ is linear, the control function approach is equivalent to two-stage least squares (2SLS).

We require valid exclusion restrictions, i.e. variables that are correlated with education and uncorrelated with the earnings residual. In the last wave of the data there is information on the distance to primary school at the age of six and to secondary school at the age of twelve, as well as on parents' education and main occupations. These are our potential instruments for education. Distance to school is a supply side measure of education and it could therefore be reasonably argued that this variable is correlated with education and not with ability (Card, 2001). Several recent studies, mostly based on U.S. data, have used similar information to form instruments for education. Family background variables have been used as instruments for education in many previous studies, on the grounds that such variables should have no direct causal effects on earnings.[9]

[8] As discussed by Amemiya (1974), the standard 'fitted value' method will not work for non-linear models. For a recent discussion of the control function approach in the context of estimating semiparametric models, see Blundell and Powell (2001). For an early application of the control function approach in the context of estimating earnings functions, see Garen (1984).

[9] While these variables may have no direct causal effect on earnings it is still possible that they are invalid instruments, e.g. if the ability of parents is correlated with that of their children or if parents with a lot of education (or with certain jobs) can help their children develop skills that are subsequently rewarded in the labour market. Similarly, if parents with highly able children may choose to live close to a school, the distance variable will not be a valid instrument. A dose of caution in interpreting the instrumental variable results therefore is recommended.

Table 3 reports control function results using the last wave of data for both countries.[10] We begin by checking that parental characteristics and distance to school indeed have explanatory power for education, a necessary condition for consistency of the estimates. Based on the first stage regressions, where education is regressed on all exogenous variables, we test for the joint significance of the coefficients on parental characteristics and distance to school and find that we can safely reject the hypothesis that these coefficients are jointly zero (EXCRES).

Columns 1 and 2 in Table 3 show control function estimates for the Kenyan sample. Individuals in the young cohort with 0-7 years of education receive local returns of about one per cent, which is lower than the OLS estimate (Table 2a, col. 7). At higher levels of education, however, the estimated returns increase substantially as a result of controlling for the endogeneity of education, thus providing even stronger support for convexity than obtained by OLS. The picture is similar for the old cohort, column 2, in that that estimated returns increase as a result of the instrumenting. For both cohorts linearity of the earnings function is firmly rejected. We can reject exogeneity at the ten per cent level for the old cohort and at the five per cent level for the young. For the Tanzanian samples the effects of controlling for endogeneity of education are smaller. The results reported in column 3 imply that in the young cohort the estimated returns are 4-5 percentage points higher than the OLS estimates over the entire range of education (Table 2a, col. 7).[11] For the old cohort the control function results are almost identical to the OLS results. Consistent with convexity, returns to education are highest for individuals with more than 12 years of education. For both cohorts we accept exogeneity and reject the linear specification at the ten per cent level or lower.

The result, obtained for three of the four regressions just discussed, that the estimated returns to education increase as a result of treating education as endogenous is not uncommon

[10] The reported standard errors have been bootstrapped to take the two-step procedure into account.
[11] The earnings profile is quite wiggly, and in the interval 10-12 years of education the slope is actually negative. This seems to be driven by noise in the data, as at the ten per cent level we cannot reject linearity of the profile between 7 and 12 years of education. If we impose linearity over this range, the estimated returns are between 8 and 10 per cent up to 12 years of education, while beyond 12 years the estimated return is 27 per cent.

in the literature. Three possible reasons why this may happen, discussed by Card (2001), are measurement errors in reported years of education, invalid instruments and heterogeneity in the returns to education.[12] While there are almost certainly some reporting errors in the education data in our samples, it is our impression (having been present at many of the interviews ourselves) that respondents were able to recall years of schooling both with ease and with a relatively high degree of accuracy. We would therefore be wary of attributing too large a role to reporting errors in this context. A variant on the theme of measurement errors is that the true explanatory variable in the earnings function is not years of education, but 'knowledge'. If, for instance, the quality of education differs markedly across schools then observed years of education may in practice be a noisy proxy for the true explanatory variable. This could explain why the OLS results are quite low. Card's second potential explanation, invalid instruments, cannot be ruled out, as it is possible that our instruments are in fact correlated with the residual of the earnings equation (see footnote 9). We cannot establish whether or not this is so, however compared to most other studies of returns to education in Africa we would argue that our data contain what would seem, *a priori*, relatively good instruments. The third explanation offered by Card, heterogeneity in the returns, should not be relevant in our case since we allow explicitly for non-linearities in the earnings profile.

An alternative possible reason why controlling for endogeneity leads to higher estimates is that, in our application, the OLS estimates may be downward biased due to sample selectivity, even if education is positively correlated with unobserved ability in the population. This can happen if individuals self-select into the manufacturing sector based on unobserved ability, and the residual in the selectivity equation is positively correlated with the residual in the earnings equation. In this case individuals with low levels of ability, and therefore little education, do not get a job in the manufacturing sector unless the residual in the selectivity equation is atypically high, hence in the sample (unlike the population)

[12] Card discusses a fourth reason why controlling for endogeneity tends to increase the estimated returns, namely specification searching by the econometrician.

education and the selectivity residual are negatively correlated. Because the selectivity residual is positively correlated with the earnings residual, the latter may well be negatively correlated with education in the sample, in which case the OLS estimator would be downward biased. The control function estimator, however, would be consistent, provided that the instruments are uncorrelated with ability and the residual in the selectivity equation.

7. Conclusions

Three main findings have emerged in this study. First, there is strong evidence that the earnings function is convex for both Kenya and Tanzania, a result robust to endogeneity. The control function estimates are generally larger than their OLS counterparts and in one case out of four (the young cohort in Kenya) we can reject exogeneity at the five per cent level. A reasonable interpretation of the results is that there is some downward bias in the OLS results, but probably not as much as some of the control function results imply. Second, there are significant differences in the earnings profiles across the cohorts, typically with stronger convexity in the young cohort. Third, for Tanzania there is increasing convexity over the 1990s, for Kenya remarkable stability.

There is limited empirical evidence on changes in the returns to education in developing countries over long periods of time. Our data have enabled us to document changes in the returns to education in Kenya and Tanzania during the 1990s and also allowed a direct comparison with earlier work by Knight and Sabot (1990). It is clear that in both countries the returns to education have been variable since 1980. One of the primary hypotheses advanced to explain the increased returns to education observed in the U.S. is the possibility of skill biased technical change. This is unlikely to be the reason for the dynamics of returns to education in Kenya and Tanzania, as the rate of technological progress in manufacturing has been at best modest in these countries over the last decades (Bigsten, 2002; Pack, 2002). An alternative hypothesis for changing returns to education, advanced by Adrian Wood, is that increases in trade exert downward pressure on unskilled wages in developed countries, thus raising returns to education by a quite different route to that suggested by skill

biased technical change. Investigating the role of openness to trade in this context appears an interesting area for future research.

As noted in the introduction, the policy recommendation that primary education should be the priority in poor countries is often based on the idea that earnings are concave in education. With convexity and low returns at low levels, the premise of this recommendation is undermined. The implication is *not* that poor countries should invest less in primary education. Only with sound primary education will individuals be able to proceed to the levels of education associated with higher returns. Convexity, however, does imply that the effect of education policies designed to stimulate individuals who otherwise would have no or little education to obtain only a modestly higher amount will have a small aggregate effect on income and poverty. Finally, one of the micro-macro puzzles in the development literature is why at the macro level the expansion of education in Africa during the last two decades has generated so little growth, while at the micro level the average returns to education appear high. With convexity, these two results can be reconciled if, as probably is the case, the expansion of education has primarily occurred on relatively flat segments of the earnings function.

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TABLE 1

SUMMARY STATISTICS

	Kenya		Tanzania	
	Mean	Standard Dev.	Mean	Standard Dev.
Earnings	74.6	117.4	54.7	71.2
Years of Education	9.1	2.9	8.8	3.5
Age	33.9	9.1	35.5	10.0
Years of Tenure	7.9	7.2	8.1	7.3
Male Dummy	0.85		0.80	
Works in Capital City	0.64		0.44	
Old Cohort[(1)]	0.57		0.63	
Observations	4039		2738	

[(1)] An individual is belongs to the old cohort if he or she is more than 30 years old.

TABLE 2A

RETURNS TO EDUCATION IN KENYAN MANUFACTURING: 1993-2000

	1993		1994		1995		2000	
	[1] Young	[2] Old	[3 Young	[4] Old	[5] Young	[6] Old	[7] Young	[8] Old
Age	0.035	0.052	-0.021	0.026	0.243	0.074	0.040	0.047
	(0.117)	(0.031)	(0.119)	(0.034)	(0.099)*	(0.037)*	(0.111)	(0.037)
Age squared/100	-0.024	-0.032	0.075	-0.019	-0.429	-0.075	-0.024	-0.035
	(0.234)	(0.036)	(0.235)	(0.040)	(0.199)*	(0.044)	(0.223)	(0.042)
Tenure	-0.002	0.001	0.021	0.012	0.023	0.006	0.003	0.008
	(0.010)	(0.003)	(0.010)*	(0.004)**	(0.010)*	(0.004)	(0.012)	(0.004)*
Male	-0.001	0.135	-0.021	0.088	0.049	0.121	0.106	-0.031
	(0.074)	(0.080)	(0.063)	(0.082)	(0.063)	(0.074)	(0.066)	(0.078)
Capital city	0.367	0.320	0.287	0.368	0.342	0.319	0.251	0.201
	(0.056)**	(0.047)**	(0.052)**	(0.053)**	(0.052)**	(0.050)**	(0.055)**	(0.055)**
Education	0.027	0.061	0.023	0.038	0.007	0.009	0.027	0.014
	(0.035)	(0.017)**	(0.028)	(0.019)*	(0.043)	(0.023)	(0.143)	(0.026)
max(0,EDUC-7)	-0.041	0.027	0.003	0.006	0.042	0.065	0.018	0.124
	(0.056)	(0.037)	(0.051)	(0.043)	(0.065)	(0.044)	(0.164)	(0.051)*
max(0,EDUC-10)	0.247	0.136	0.060	0.220	-0.021	0.008	0.103	-0.034
	(0.089)**	(0.075)	(0.100)	(0.098)*	(0.102)	(0.089)	(0.107)	(0.093)
max(0,EDUC-12)	-0.009	0.064	0.083	-0.194	0.240	0.166	0.116	0.277
	(0.107)	(0.091)	(0.120)	(0.121)	(0.095)*	(0.095)	(0.091)	(0.104)**
Test: Education earnings profile linear (p-value)	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.00
R-squared	0.288	0.374	0.182	0.261	0.363	0.265	0.377	0.317
Observations	429	675	460	488	467	570	371	579

Note: The dependent variable the log of monthly earnings. Standard errors robust to heteroskedasticity and intra-firm correlation are reported in parenthesis. Significance at the 1%, 5% and 10% level is indicated by * , ** and $^{+}$ respectively.

TABLE 2B

RETURNS TO EDUCATION IN TANZANIAN MANUFACTURING: 1993-2001

	1993		1994		1999		2001	
	[1] Young	[2] Old	[3 Young	[4] Old	[5] Young	[6] Old	[7] Young	[8] Old
Age	0.035	-0.006	-0.068	0.043	0.220	0.060	0.265	0.014
	(0.108)	(0.027)	(0.164)	(0.051)	(0.133)	(0.038)	(0.151)	(0.037)
Age squared/100	-0.016	0.020	0.179	-0.036	-0.374	-0.052	-0.460	-0.011
	(0.219)	(0.030)	(0.332)	(0.057)	(0.265)	(0.042)	(0.304)	(0.042)
Tenure	0.004	-0.001	0.008	0.005	-0.018	-0.000	0.004	0.004
	(0.011)	(0.003)	(0.018)	(0.006)	(0.011)	(0.004)	(0.013)	(0.004)
Male	0.044	0.186	0.083	0.160	0.063	-0.098	0.270	0.058
	(0.065)	(0.066)**	(0.102)	(0.107)	(0.073)	(0.096)	(0.082)**	(0.081)
Capital city	0.068	0.194	0.279	0.371	0.171	0.119	0.271	0.184
	(0.056)	(0.045)**	(0.091)**	(0.084)**	(0.060)**	(0.059)*	(0.070)**	(0.057)**
Education	0.055	0.034	0.019	0.042	-0.010	0.061	0.053	0.030
	(0.041)	(0.015)*	(0.056)	(0.027)	(0.025)	(0.018)**	(0.042)	(0.025)
max(0,EDUC-7)	-0.012	0.048	0.058	-0.024	0.047	0.031	0.068	0.087
	(0.059)	(0.041)	(0.086)	(0.071)	(0.049)	(0.048)	(0.065)	(0.050)
max(0,EDUC-10)	0.005	0.076	-0.209	0.216	-0.043	-0.016	-0.297	-0.083
	(0.125)	(0.089)	(0.177)	(0.155)	(0.118)	(0.116)	(0.141)*	(0.107)
max(0,EDUC-12)	0.085	-0.076	0.561	-0.122	0.216	0.231	0.469	0.269
	(0.156)	(0.086)	(0.205)**	(0.148)	(0.139)	(0.124)	(0.157)**	(0.114)*
Test: Education earnings profile linear (p-value)	0.65	0.00	0.00	0.03	0.00	0.00	0.01	0.00
R-squared	0.140	0.318	0.250	0.318	0.207	0.417	0.304	0.389
Observations	304	601	176	268	297	433	227	432

See Table 1A for notes.

TABLE 3

POOLING TESTS

Null hypothesis	Specification 1		Specification 2	
	Kenya	Tanzania	Kenya	Tanzania
1. All time & cohort effects = 0	0.00 (70)	0.00 (70)	0.00 (32)	0.00 (32)
2. Controls x [time, old, (time x old)] = 0	0.42 (35)	0.43 (35)		
3. Education x [time, old, (time x old)] = 0	0.00 (28)	0.00 (28)	0.00 (28)	0.00 (28)
4. Time = 0	0.51 (3)	0.42 (3)	0.00 (3)	0.60 (3)
5. Old = 0	0.72 (1)	0.57 (1)	0.01 (1)	0.02 (1)
6. Time x old = 0	0.69 (3)	0.40 (3)		
7. Education x time = 0	0.37 (12)	0.12 (12)	0.12 (12)	0.75 (12)
8. Education x old = 0	0.00 (4)	0.22 (4)	0.00 (4)	0.01 (4)
9. Education x time x old = 0	0.79 (12)	0.11 (12)	0.42 (12)	0.52 (12)
Restrictions imposed	None	None	2, 6	2, 6

Note: The table shows p-values associated with Wald tests of the various null hypotheses. The underlying covariance matrices are robust to heteroskedasticity and intra-firm correlation.

TABLE 4

PREFERRED SPECIFICATIONS

	Kenya		Tanzania	
	Coef.	Std.Error	Coef.	Std.Error
Age	0.044	0.011**	0.041	0.011**
Age squared/100	-0.033	0.014*	-0.034	0.013*
Tenure	0.006	0.002**	0.001	0.003
Male	0.053	0.036	0.099	0.034**
Capital city	0.306	0.040**	0.188	0.049**
Wave 2	0.067	0.116	0.032	0.184
Wave 3	0.433	0.123**	-0.177	0.138
Wave 4	0.433	0.115**	-0.059	0.131
Education	0.033	0.020+	-0.003	0.019
max(0,EDUC-7)	-0.021	0.037	0.064	0.040
max(0,EDUC-10)	0.184	0.069**	-0.049	0.106
max(0,EDUC-12)	0.068	0.086	0.106	0.142
Wave 2 x Education	-0.014	0.022	0.009	0.027
Wave 2 x max(0,EDUC-7)	0.008	0.047	-0.040	0.058
Wave 2 x max(0,EDUC-10)	-0.029	0.098	0.025	0.136
Wave 2 x max(0,EDUC-12)	-0.136	0.146	0.091	0.150
Wave 3 x Education	-0.034	0.020+	0.028	0.020
Wave 3 x max(0,EDUC-7)	0.050	0.040	-0.019	0.045
Wave 3 x max(0,EDUC-10)	-0.157	0.088+	-0.078	0.129
Wave 3 x max(0,EDUC-12)	0.117	0.104	0.248	0.157
Wave 4 x Education	-0.043	0.019*	0.023	0.020
Wave 4 x max(0,EDUC-7)	0.095	0.047*	0.011	0.046
Wave 4 x max(0,EDUC-10)	-0.144	0.095	-0.192	0.124
Wave 4 x max(0,EDUC-12)	0.129	0.097	0.368	0.146*
Old	-0.302	0.109**	-0.270	0.121*
Old x Education	0.022	0.017	0.030	0.016+
Old x max(0,EDUC-7)	0.038	0.032	-0.010	0.036
Old x max(0,EDUC-10)	-0.021	0.061	0.148	0.105
Old x max(0,EDUC-12)	-0.018	0.074	-0.209	0.145
Education x time (p-value)	0.01		0.04	
Education x old (p-value)	0.00		0.00	
Wave 4 interactions (p-value)	0.17		0.02	

Note: The dependent variable the log of monthly earnings. Standard errors are robust to heteroskedasticity and intra-firm correlation. Significance at the 1%, 5% and 10% level is indicated by * , ** and + respectively.

TABLE 5

EDUCATION AND EARNINGS: COMPARATIVE ANALYSIS

	1980	1993, young	1993, old	2000/01, young	2000/01, old	Constant returns across cohorts (*p*-value)	Same returns in 1993 & 2000/01 (*p*-value)
A. Average marginal returns							
Kenya		0.12	0.13	0.14	0.15		
Kenya, >7 years		0.15	0.18	0.15	0.19		
Tanzania		0.04	0.08	0.08	0.12		
Tanzania, > 7 years		0.05	0.10	0.12	0.17		
B. Earnings differentials, baseline: No education							
Kenya							
Primary 1 to 4 (E2)	0.18	0.11	0.18	-0.03	0.04	0.18	0.03
Primary 5 to 7 (E3)	0.38	0.22	0.37	-0.07	0.08	0.18	0.03
Secondary (E4)	0.86	0.26	0.59	0.10	0.43	0.00	0.25
Post-secondary (E5)	1.62	0.97	1.42	0.68	1.13	0.00	0.04
Tanzania							
Primary 1 to 4 (E2)	0.06	-0.01	0.10	0.08	0.19	0.06	0.24
Primary 5 to 7 (E3)	0.28	-0.02	0.19	0.14	0.35	0.06	0.24
Secondary (E4)	0.64	0.15	0.41	0.40	0.67	0.04	0.10
Post-secondary (E5)	1.04	0.43	0.96	0.80	1.33	0.00	0.02
C. Earnings differentials, baseline: Primary 5-7							
Kenya							
Secondary (E4)	0.48	0.04	0.22	0.17	0.35	0.00	0.20
Post-secondary (E5)	1.24	0.75	1.05	0.75	1.05	0.00	0.97
Tanzania							
Secondary (E4)	0.36	0.17	0.22	0.26	0.32	0.47	0.36
Post-secondary (E5)	0.76	0.45	0.77	0.66	0.98	0.00	0.04

Note: The estimates for 1980 are based on Knight and Sabot (1990), Table 6-2, column 3. The estimates for 1993 and 2000/01 are based on the regressions reported in Table 4.

TABLE 6

SEMIPARAMETRIC INSTRUMENTAL VARIABLE ESTIMATES:

KENYA 2000 AND TANZANIA 2001

	Kenya		Tanzania	
	[1] Young	[2] Old	[3] Young	[4] Old
Age	-0.032	0.029	0.291	0.007
	(0.126)	(0.047)	(0.144)*	(0.038)
Age squared/100	0.063	-0.004	-0.539	-0.003
	(0.249)	(0.053)	(0.285)$^{+}$	(0.043)
Tenure	0.026	0.013	0.013	0.005
	(0.014)$^{+}$	(0.005)**	(0.017)	(0.004)
Male	0.268	0.002	0.365	0.066
	(0.094)**	(0.081)	(0.085)**	(0.081)
Capital city	0.235	0.206	0.241	0.182
	(0.060)**	(0.093)*	(0.089)**	(0.091)*
Education	0.011	0.111	0.090	0.028
	(0.168)	(0.048)*	(0.098)	(0.038)
max(0,EDUC-7)	0.132	0.116	0.072	0.106
	(0.185)	(0.057)*	(0.108)	(0.049)*
max(0,EDUC-10)	0.148	-0.046	-0.296	-0.083
	(0.099)	(0.086)	(0.189)	(0.122)
max(0,EDUC-12)	0.103	0.313	0.478	0.268
	(0.098)	(0.097)*	(0.199)*	(0.174)
Education earnings profile linear (p-val.)	0.00	0.00	0.05	0.00
EXCRES (p-value)[(1)]	0.00	0.00	0.00	0.00
EXOGEN (p-value)[(2)]	0.02	0.09	0.95	0.99
Observations	371	579	227	432

Note: The dependent variable the log of monthly earnings. All regressions control for endogeneity of education by means of a semiparametric control function as described in the text. Bootstrapped standard errors, robust to heteroskedasticity and intra-firm correlation are reported in parenthesis. Significance at the 1%, 5% and 10% level is indicated by * , ** and $^{+}$ respectively. The explanatory variables in the regression modelling education (step 1) are: dummy variables for mother's and father's education (none; primary; middle (pre 1964) or training college; O level; A level; vocational/technical; university; don't know) and occupation (farming, fishing, forestry; trading, self-employed; clerical; employed in construction, tailoring, or worked as foreman; professional; watchman, soldier; don't know); dummy variables for distance to primary school at the age of six and to secondary school at the age of twelve (less than 1 km; 1-3 km; 3-6 km; 6-10 km; more than 10 km; don't know); and age, age squared, tenure, male, capital city.

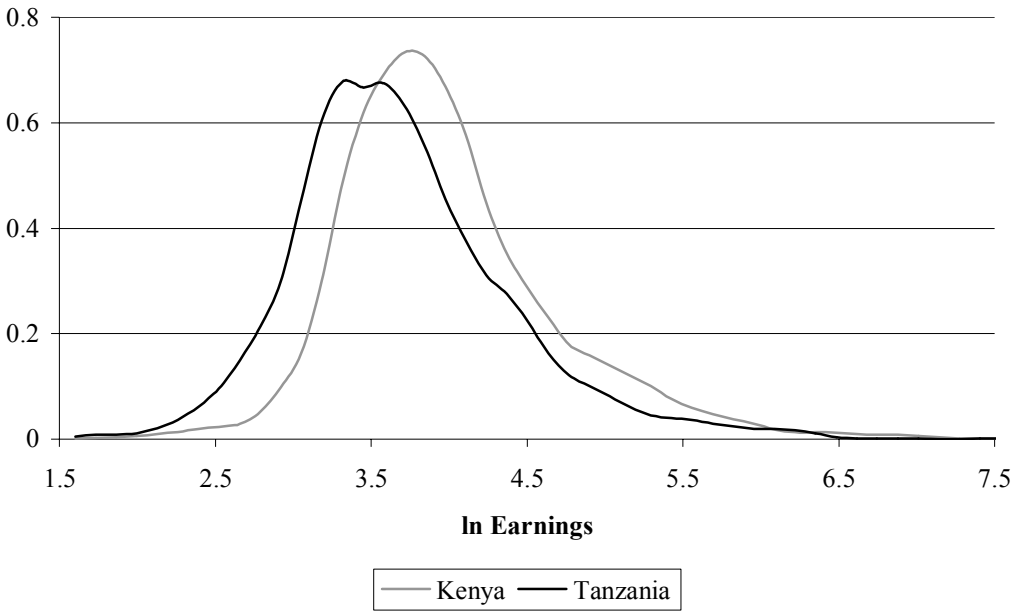
(1) Wald test for joint significance of the identifying instruments in step 1 (the exclusion restrictions).

(2) Hausman test for exogeneity.

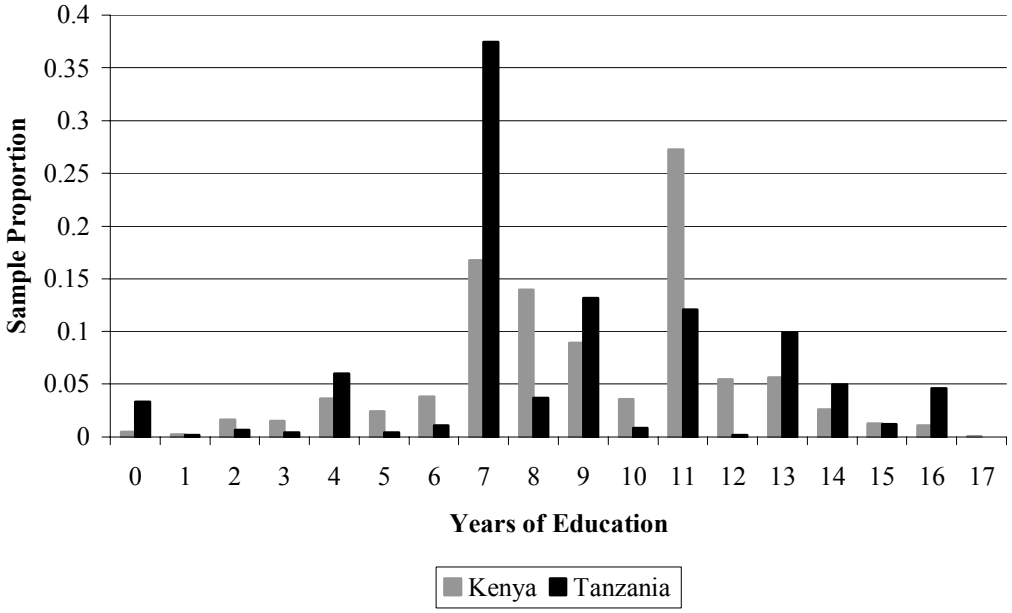
FIGURE 1

SAMPLE DISTRIBUTIONS OF LOG EARNINGS AND EDUCATION

i) Sample Distribution of Log Earnings (Kernel Density Estimates)



ii) Sample Distribution of Education



Note: Figure (i) was estimated using the Stata 8.0 command 'kdensity' (StataCorp, 2003).

FIGURE 2A

PREDICTED EARNINGS BASED ON RESULTS IN TABLE 2A: KENYA

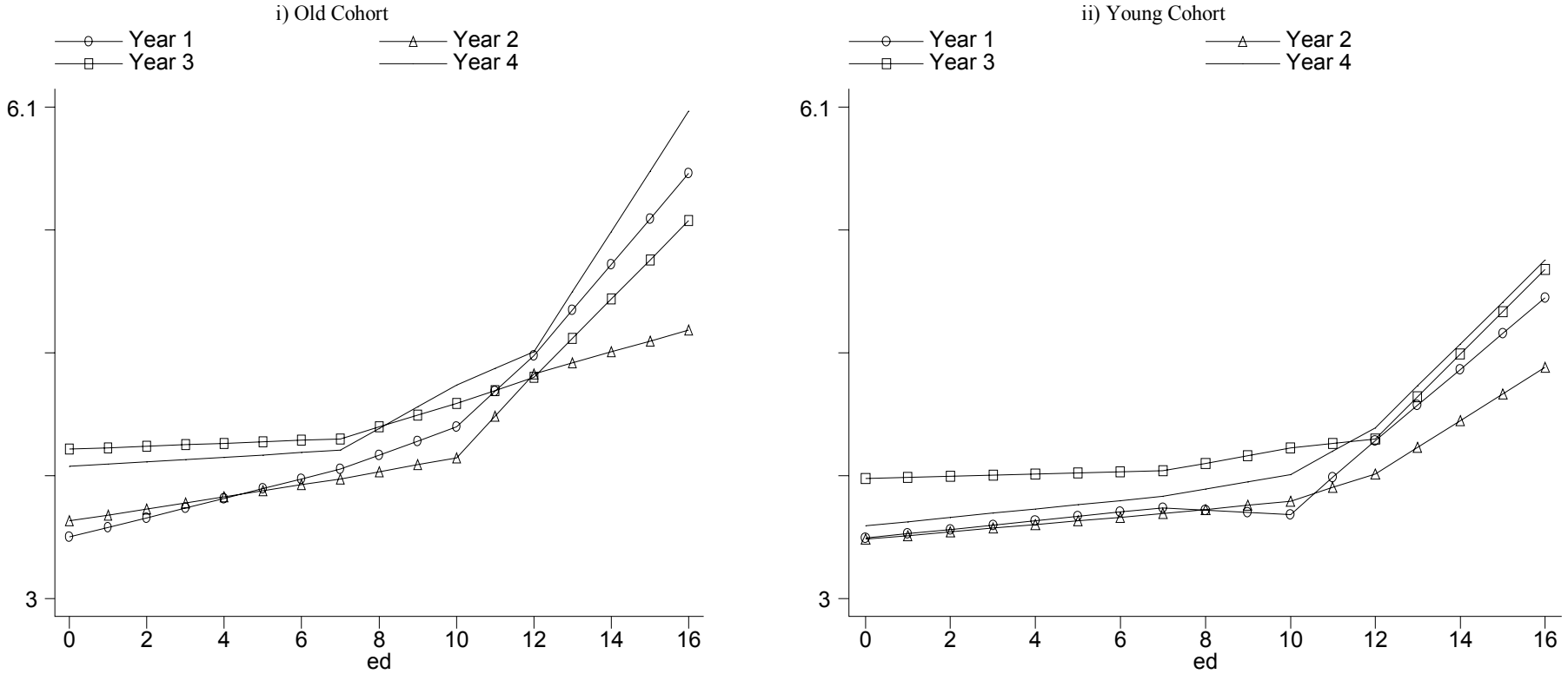


FIGURE 2B

PREDICTED EARNINGS BASED ON RESULTS IN TABLE 2B: TANZANIA

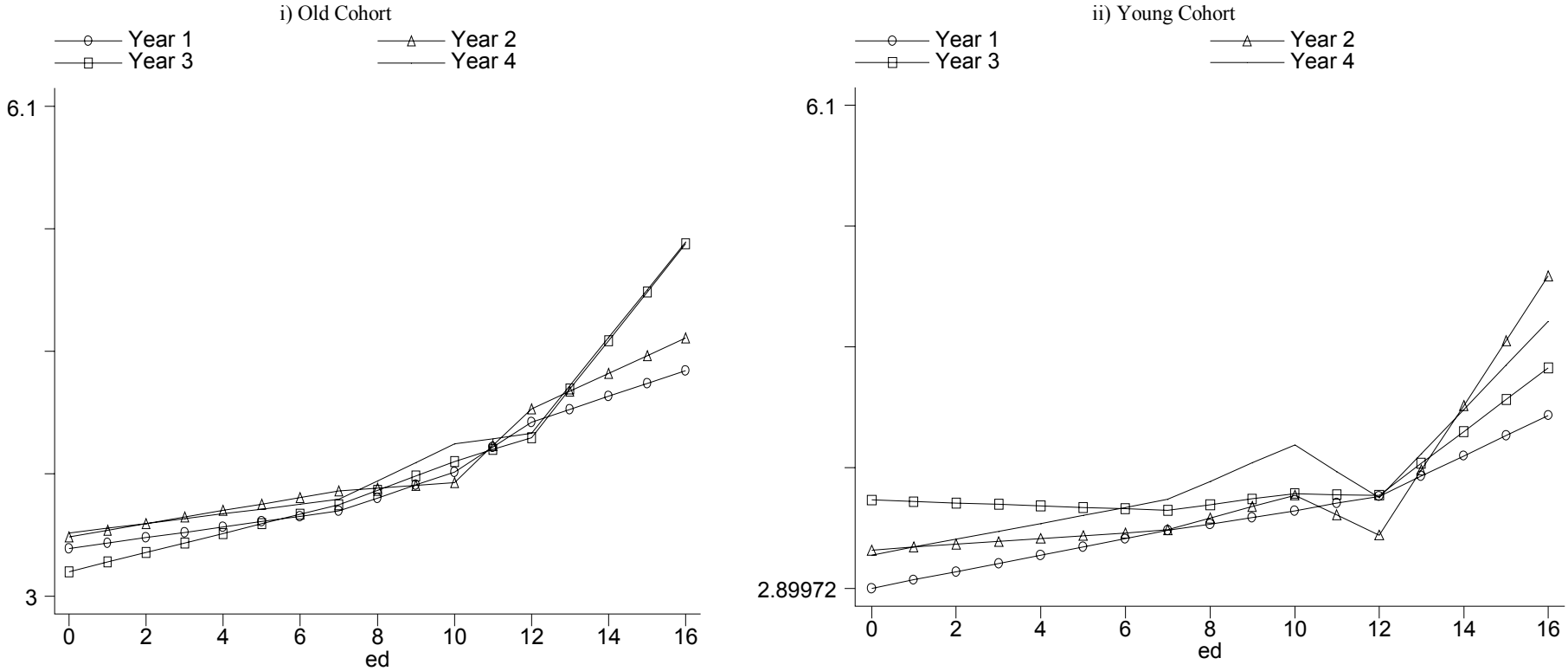


FIGURE 3A

PREDICTED EARNINGS BASED ON PREFERRED SPECIFICATION: KENYA

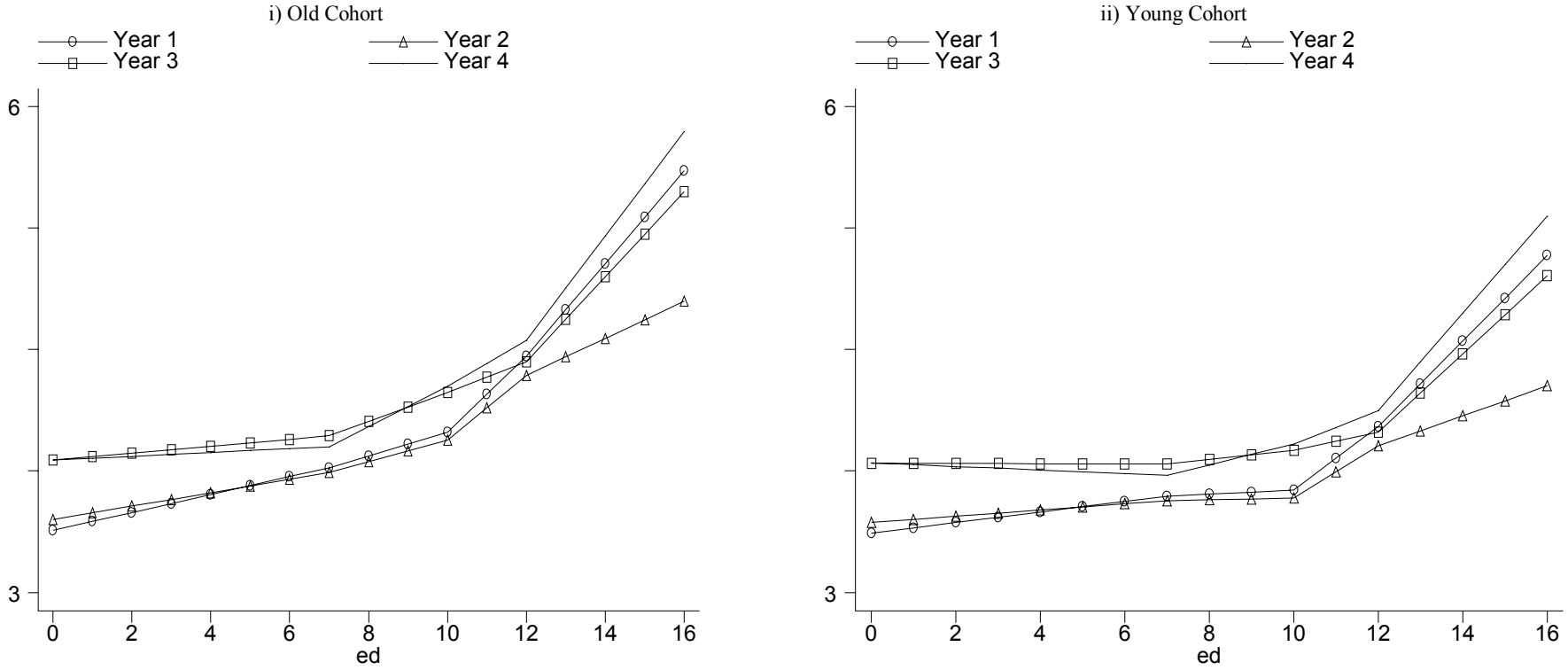


FIGURE 3B

PREDICTED EARNINGS BASED ON PREFERRED SPECIFICATION: TANZANIA