# Human Capital Externalities and Returns to Education in Kenya

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*KIPPRA Discussion Paper No. 13*
*April 2002*

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Published 2002

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ISBN 9966 949 18 6

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KIPPRA acknowledges generous support by the European Union (EU), the African Capacity Building Foundation (ACBF), the United States Agency for International Development (USAID), the Department for International Development of the United Kingdom (DfID) and the Government of Kenya (GoK).

# Abstract

*This study has used micro data to analyse the effect of human capital externality on earnings and returns to education. The parameters of the earnings function are estimated using the ordinary least squares method. The results show that human capital has a positive effect on earnings, indicating that a general increase in the level of education benefits all workers. The general increase in female education benefits both men and women, but men benefit more from it than do women. Private returns to education generally increase with the level of education. Taking into account human capital externality reduces returns to primary education but increases returns to university education. However, the effect of human capital externalities on private returns to secondary education is negligible.*

# Contents

# 1 Introduction

At the time of independence, the shortage of skilled labour was a major constraint to the Government of Kenya in working towards achieving its development goals. To improve on this situation, the government has devoted the largest share of its budget to expanding education. For instance, the education sector share was 29% of the total budget in 1998. In the early decades after independence, most of the expansion took place in primary and secondary education. But since the late 1980s, the number of institutions of higher learning, both public and private, has expanded rapidly. Student enrolment in primary and secondary schools increased from 0.9 and 0.03 million in 1963 to 5.9 and 0.7 million in 1999, respectively. The number of primary and secondary schools also increased from 6,058 and 150 in 1963 to about 17,600 and 3,100 in 1998, respectively. The number of schools, however, understates the extent of expansion in the educational system because the existing schools also expanded by increasing the number of streams (classes) they offered.

Expansion in primary school enrolment was partly fostered by free primary education introduced in 1974 while the increase in secondary school enrolment was due to the large number of schools that were built through self-help initiatives in response to high demand for education. Given the large amount of resources devoted to education by government and parents, it is fitting to investigate whether the educational system yields returns to the individual and the society to justify the investment in it.

A large number of studies from all parts of the world show that educational returns for an additional year of schooling are positive and range anywhere from 5% in developed countries to as high as 29% in developing countries (see Psacharopoulos

1994). In a 1994 survey, Psacharopoulos shows that returns to education in Africa are higher than for other world regions. This finding has generated debate about whether the estimated rates of return prevail for some African countries, given the existing labour market conditions. For instance, Bennell (1996) suggests that the findings by Psacharopoulos (1994) for Africa are heavily influenced by a few dated studies, some of which were based on poor data. Furthermore, estimates of returns to schooling in Africa since the 1980s have been moderate (Appleton 1999). Given the inconclusiveness of these studies, policy-makers are unclear as to where to invest their limited resources. Consequently, more accurate estimates of returns to education can usefully inform them. Refined estimates of returns to education are therefore needed, based on elaborate and more recent data. This is important because, as rates of return to education in Kenya vary over time (see Appleton et al. 1999; Manda 1997), estimates based on dated data may be of little relevance to policy formulation.

Returns to education are useful for policy-making in a number of ways. For instance, social returns to education give an indication of which sector of the educational system the government should invest in most. If the returns to primary and secondary education are significantly different, policy-makers are able to make more efficient allocation choices by spending more resources on the level of education that yields higher returns.

An analysis of returns to education can also help evaluate broad education policies. It is, for example, well established that developing human capital is crucial to economic development. Government should therefore seek to adopt policies that are consistent with human capital development. To the extent that returns to education in a particular country show a declining trend, it is necessary to evaluate the causes of the decline.

Declining returns may influence private choices on education as evidenced by high dropout rates and low enrolments. Or it could be that government policies themselves are responsible for the decline in enrolment. For example, it is often stated that the policy of cost sharing in the educational system has had a negative impact on enrolment.

Further, households evaluate schooling decisions in terms of future income benefits. If these benefits turn out to be too low, then policies advocating the use of educational services as part of the plan for poverty alleviation may be ill conceived. Alternatively, if these rates of return are very high, it could be evidence that individuals are not able to obtain the optimal amount of education. Thus, a study on returns to education has several policy implications.

When private returns to education are estimated, it is normally assumed that returns to an individual are independent of the human capital endowments of others. This assumption, which dominates most previous studies, ignores a major aspect of human capital theory—human capital externalities.[1] Human capital externality suggests that increasing the human capital of one person will have some impact not only on returns to education for that person but also on returns to education for others.

In a competitive economy where workers are paid their marginal product, increasing the average human capital induces an increase in the demand for skilled labour—the demand effect. Similarly, a direct consequence of having a large educated share of the population is that it increases the supply of skilled labour. The net effect on earnings is positive when human capital externalities are such that the demand effect

[1] Externalities are simply defined as the effect of the action of one economic agent upon another agent (Mas-Colell et al. 1995). An externality benefit occurs when one agent creates a benefit for another agent but is not paid for it (Koutsoyiannis 1979).

dominates the supply effect (see Michaud and Vencatachellum 2000). Failure to control for human capital externalities in the earnings equation can therefore lead to biased estimates of private returns to education.

An interesting extension of the idea of human capital externalities concerns the impact of male education on female earnings, or vice versa. If in fact there are significant positive female human capital externalities on, for example, male earnings, then the limited emphasis on women's education in Africa could actually have the effect of lowering the earnings of men, all else being equal. And providing educational opportunities to both men and women may have an overall salutary effect on earnings.

A number of studies have analysed earnings and returns to education in Kenya (for example, Appleton et al. 1999; Bigsten 1984; Knight and Sabot 1981; Knight et al. 1992; Manda 1997), but they suffer from a number of limitations. For instance, most of the studies do not take into account the effect of human capital externalities on earnings and returns to education. If human capital externalities have a significant impact on earnings and returns to education then the results from these studies may be of limited use to policy.

# 2 Data and Analytical Methods

This study focuses on estimating private returns to education in Kenya using comprehensive micro data from the welfare monitoring survey (WMS) of 1994 undertaken by the Government of Kenya (Central Bureau of Statistics, Ministry of Finance and Planning). It also focuses on human capital externalities.

We use WMS data to analyse returns to education and the effect of human capital externality on earnings. The survey

aimed at collecting data that would help the government assess the welfare of the population. It covered all eight provinces in Kenya and gathered information from each district on employment status, health, fertility, household size, crops and livestock, household incomes and expenditure on various items, children's nutrition, and social amenities. The data set also has information on individual characteristics such as educational level, age and marital status. We supplement this information in the survey with district-level measure of education for males and females (measure of the stock human capital that helps capture human capital externalities). The WMS of 1994 provides information on individual earnings, education and age, which is useful in estimating returns to education. The sample used in our study includes only persons in the working-age group of 15 to 65 years who are not attending school. The sample size consists of 20,806 observations covering persons in both rural (17,912) and urban (2,894 observations) areas.

A worker's specific human capital is approximated by level of education and years of experience. We define a worker's experience as age minus six years and the number of years of schooling. Dummy variables are used to capture the effect of education on earnings and district-level average education (in years) for both males and females as a measure of human capital externality. Other control variables include regional dummies. The variables used in the analysis are defined in the appendix in table A1 and descriptive statistics are presented in table A2.

## 2.1 The model

We follow Mincer (1974) in estimating a semi-logarithmic equation for the determinants of earnings:

$$\ln(Wi) = \alpha + \Sigma\beta_k S_{ik} + \lambda A + \delta Z_i + U_i \qquad [1]$$

where $W$ is the monthly earnings for worker $i$, $S_k$ is a dummy variable for being educated at least up to level $k$, $A$ represents

experience variables, $Z$ is a vector of control variables such as sex and region, $\alpha$, $\beta$,$\lambda$, $\delta$ are parameters to be estimated, and $U$ is an error term. It would have been useful to use hourly earnings, but information on hours of work was not available in the data set. The monthly earnings used in the analysis are derived from the sum of earnings from primary and secondary activities.

Our main interest in estimating equation 1 is to calculate the rates of return to education. Estimates conventionally measure the benefits of education in the form of higher wages. Private rates of return to education include only private benefits and costs, and the social rate of return differs from the private only by including the direct cost of education to the government as well as benefits in terms of higher taxes. Where direct costs are low, a useful approximation is the Mincerian returns to education, which is the increment in earnings expressed as a proportion of wages forgone. From equation 1, if the level of education $k$ comprises $E_k$ years of education, the rate of return to education is derived as shown in equation 2.

$$\textit{Rate of return to a year of education} = [\exp(\beta_k) - 1]/E_k \qquad [2]$$

Such conventional estimates of rates of return to education have been widely criticized. One criticism concerns the correlation between education and unobservables—such as school quality, pre-existing worker ability, health, family background—which may bias estimates of $\beta$. This study cannot fully address this issue, since in common with many conventional studies, our data do not include measures of such variables. However, several studies (for example, Ashenfelter and Krueger 1994; Ashenfelter and Rouse 1998**;** Behrman et al. 1994) show that standard rates of return to education estimates may not be wholly misleading.

## 2.2 Estimation issues

As mentioned earlier, estimates of returns to education are an important input in policy-making, but they suffer from several drawbacks. These include omission of relevant variables such as student ability, school quality and sample selection issues, and they ignore the endogenous nature of schooling. Several approaches have been developed to tackle these problems.

The problem of unobserved characteristics such as ability may bias conventional ordinary least squares (OLS) estimates and can be controlled by including proxies for ability in earnings equations (see Blackburn and Neumark 1995). Including ability proxies tends to lower the estimated returns to schooling, an indication that OLS estimates are biased upwards. Other studies (for example, Ashenfelter and Krueger 1994; Ashenfelter and Zimmerman 1993; Taubman 1976) have used panel data for twins to estimate returns to schooling. The idea behind this approach is that differencing eliminates the effects of common ability and family background so that the estimates are purged of these time-invariant effects. Results from studies using this approach vary, with some reporting slightly lower and others slightly higher educational return estimates as compared with conventional OLS estimates.

The problem of endogeneity of schooling is dealt with by constructing a selectivity correction term from a schooling attainment equation and then including the correction term in the earnings equation. Studies using this method typically report higher returns as compared with OLS estimates (for example, Gaston and Tenjo 1992; Hansen 1997). An alternative way of solving schooling endogeneity relies on using exogenous (or 'natural') variation in educational attainment to provide instrumental variable estimates of the returns to education (see Angrist and Krueger 1991; Bedi and Gaston 1999; Card 1993; Harmon and Walker 1995). The estimates of most of these studies are high.

The OLS estimates of the effect of education on earnings are consistent only if, for example, unobserved variables are not correlated with both education and schooling. If, however, an unobserved characteristic, say 'ability', has a positive effect on earnings and schooling, then OLS estimates of the returns to schooling will be biased upward. Another source of bias is measurement error in schooling. This may generate a negative correlation between the earnings and schooling equation error terms, thus inducing a negative bias in OLS estimates (see Blackburn and Neumark 1995; Griliches 1977).

A negative bias may also arise if persons with little schooling have a high earning capacity (and high returns to schooling) or can curtail their education because of higher discount rates. Such a negative correlation is implied in the Becker model of human capital investment in which schooling is acquired until the marginal return to schooling equates the discount rate (see Card 1995). Thus, while unobserved ability may bias the OLS estimates upwards, controlling for schooling endogeneity may reveal a downward bias on the conventional OLS rate of return estimates.

# 3 Results

The estimated results for national, rural and urban areas, and for males and females, are presented in appendix tables A3 to A8. A test for endogeneity of schooling showed that it is not a serious problem. The results presented here, therefore, are based on OLS estimation of equation 1.

Dummy variables for education, potential experience, sex and location explain about 40% of the log monthly earnings for all workers and males but only about 30% for females at the national level. In both rural and urban areas, the variables explain about between 20 and 35% of the variations in earnings. Most of the independent variables are statistically significant

and have the expected impact on earnings. The cohort variable shows that those who joined the labour force after 1984 receive lower earnings than those who joined before 1985.

## 3.1 Effect of human capital externality on earnings

Our first contribution in this paper is to use district-level average education attainment of workers to capture the direct effect of human capital externality on earnings. The effect is positive and statistically significant for all workers, both sexes, and various subgroups. Since male and female average human capital variables are highly correlated, we investigated their effects by including them in separate equations. Our estimates show that the human capital externality for males and females has a positive impact on earnings for all workers in a pooled regression. An increase in average human capital for females has a positive impact on earnings of male workers relative to female workers. Men also benefit more from increase of their own human capital than do women.

Both male and female aggregate human capital has a positive effect on an individual person's own earnings. This probably means that the supply effect on the labour market never dominates the demand effect for services. For instance, an increase in the supply of skilled males and females is accompanied by an increase in the demand for their labour services such that the demand effect for their improved skills exceeds their supply effect, leading to a net increase in earnings. Consequently, increasing the proportion of females who are educated has two effects on returns to education. First, as explained in Mwabu and Schultz (2000), a fall in marginal returns to education as more people are educated shows that the new education function can be represented by a flatter line than before. Second, the function of returns to education shifts upwards, so that for a given level of education, a worker's earnings increase. We consider in greater detail the effect of

human capital externalities on returns to education in the next subsection. Our results find support in Griliches (1977) as well as in the literature on endogenous growth.

Next we consider the cross effect of male human capital on female earnings and vice versa. When the model is estimated on the sample of male workers, an increase in the average education of female labour force has a positive effect on male earnings. Also, when the model is estimated on a sample of females, an increase in the education of males has a positive effect on female earnings. These results are consistent at both national and regional levels, with differences emerging only in relative impact (see tables A4 to A6 in the appendix). One explanation of this result seems to be that, other things being equal, if the education of male workers increases, the demand for female workers increases, and vice versa. The increase in the demand effect may be because when female human capital increases, male productivity increases, leading to an increase in demand for male workers. Also, an increase in female earnings must be due to the demand effect originating from male human capital externalities, which increases female productivity. Thus, it appears that education levels of males and females reinforce each other in the labour market, thereby raising the productivity of both sexes.

Another interesting result is that at national and regional levels, the earnings effect of female human capital externality is higher for males than for females. This is consistent in both urban and rural areas and shows that female education is more beneficial for males than it is for females. Male education also benefits men more than it does women. This result suggests that constraining the average education for females through low female access to education may in fact reduce male productivity and earnings. Equitable public and private investment, including household investment, in both male and female education is thus justified on Pareto efficiency grounds and can lead to a superior position in productivity. This result is

particularly important for policy-makers in Africa, where many societies discriminate against girls in the provision of education. In such cases, active government policy to encourage the education of girls should be given priority.

## 3.2 Returns to education

Table 1 shows national returns to education, both urban and rural and by gender, before taking into account the effect of human capital externality. The private returns to education generally increase with the level of education. Nationally, the rate of return is 7.9% for primary education, 17.2% for secondary education and 32.5% for university education. Returns to education in the urban areas compare well with those of previous studies (for example, Appleton et al. 1999; Manda 1997) using urban micro data. Generally, returns to primary education in the rural areas are higher than those for urban areas, while returns to university education in the urban areas are much higher than those in the rural areas. Thus, it is more beneficial for those with primary education to work in rural areas than in urban areas, and it is more beneficial for those with university education to work in urban areas than in rural areas. Those with secondary education do not lose as much as those with university education when employed in rural areas.

Table 1. Private returns to education (percentage)

| Category | Primary | Secondary | University |
|---|---|---|---|
| National | 7.9 | 17.2 | 32.5 |
| Urban | 4.4 | 21.3 | 48.5 |
| Rural | 8.3 | 16.3 | 23.0 |
| All males | 11.0 | 17.8 | 35.2 |
| Urban males | 7.4 | 21.8 | 43.7 |
| Rural males | 11.1 | 16.7 | 29.7 |
| All females | 5.7 | 15.8 | 32.2 |
| Urban females | 2.1 | 21.1 | 70.2 |
| Rural females | 6.9 | 15.1 | 15.9 |

The returns to education for males are relatively higher than those for females. Nationally and in urban and rural areas, the return to primary education for males is about double that for females, but for secondary education there is not much difference between the sexes. The returns to male university education are higher than those for females, both nationally and in the rural areas. However, the returns to female university education in the urban areas are about double those for males.

Tables 2 and 3 show returns to education after taking into account the human capital externality for males and females. As shown in the tables, returns to education still increase with the level of education. The tables indicate that male and female human capital externality generally reduces the rate of returns to primary education by about 35% but has a negligible effect on returns to secondary education. Returns to university education generally increase when human capital externality is taken into account.

Table 2. Returns to education taking into account male human capital externality (percentage)

| Category | Primary | Secondary | University |
|---|---|---|---|
| National | 4.6 | 16.0 | 35.4 |
| Urban | 2.4 | 21.0 | 50.0 |
| Rural | 4.8 | 14.8 | 25.6 |
| All males | 6.3 | 16.4 | 39.8 |
| Urban males | 4.3 | 21.0 | 46.7 |
| Rural males | 6.1 | 15.1 | 34.6 |
| All females | 3.0 | 14.9 | 33.3 |
| Urban females | 0.7 | 21.1 | 69.6 |
| Rural females | 3.2 | 13.9 | 15.7 |

These results have several implications. First is that previous studies on private returns to education, which did not take into account human capital externalities, tend to overestimate private returns to primary education and underestimate private returns to university education. Human capital externality can be interpreted as capturing the non-market external benefits

Table 3. Returns to education taking into account female human capital externality (percentage)

| Category | Primary | Secondary | University |
|---|---|---|---|
| National | 5.0 | 16.1 | 35.2 |
| Urban | 2.9 | 21.0 | 49.8 |
| Rural | 5.0 | 15.0 | 25.3 |
| All males | 7.0 | 16.7 | 39.4 |
| Urban males | 5.2 | 21.3 | 45.8 |
| Rural males | 6.6 | 15.3 | 34.3 |
| All females | 3.3 | 15.0 | 33.3 |
| Urban females | 1.0 | 21.1 | 70.2 |
| Rural females | 3.7 | 13.9 | 15.3 |

taken as potential social benefits and costs to one person derived from the schooling of another person. Controlling for human capital externality therefore isolates these social benefits and costs from the usual measure of returns to education to give pure private returns to education.

Human capital externality benefits those with primary education by raising their returns to education as shown in table 1, but it has the effect of lowering returns to education for those with university education. The results suggest that when persons with primary education work in an environment where human capital is generally improved, their productivity increases and thereby their earnings. Conversely, the productivity of persons with university education tends to decline when they work in an environment where the educational level of most of the employees is low.

Table 4 shows the returns to education for different cohorts of workers. The returns to primary education for the young cohort are lower than those of the older cohort. Thus, primary education is more beneficial to the older cohort than to the younger cohort. The returns to secondary education seem to be slightly higher for the young cohort than for the older cohort. This means that the young cohort benefits more from secondary education than does the older cohort.

Table 4. Returns to education by cohort (percentage)

| Cohorts | Primary | Secondary | University |
|---|---|---|---|
| *Young cohort (joined labour force 1985 or later)* | | | |
| All workers (without human capital externality) | 5.5 | 19.7 | 32.2 |
| All workers (with male human capital externality) | 2.2 | 18.9 | 35.0 |
| All workers (with female human capital externality) | 3.5 | 19.2 | 34.1 |
| *Older cohort (in labour force before 1985)* | | | |
| All workers (without human capital externality) | 9.5 | 16.6 | 39.6 |
| All workers (with male human capital externality) | 5.5 | 15.3 | 47.2 |
| All workers (with female human capital externality) | 5.7 | 15.5 | 46.6 |

The returns to university education seem to be higher for the older cohort than for the younger one, and human capital externalities increase private returns to university education for the older cohort by a larger percentage than for the younger cohort.

# 4 Conclusion

This study analyses returns to education and the effect of human capital externality on earnings and returns to education. We tested for schooling endogeneity, and it was found not to be a serious problem in our data set. The earnings parameters are therefore estimated using the ordinary least squares method. Several regressions for the entire sample are estimated—urban and rural and by gender. The results show that human capital externality has a positive effect on earnings. This means that a general increase in the level of education benefits all workers in terms of higher earnings. Human capital externality can be interpreted as capturing the non-market external benefits from education. The general increase in the female level of education benefits both men and women, but men benefit more than do the women themselves.

The private returns to education generally increase with the level of education. Human capital externality reduces returns to primary education but increases returns to university education. However, its effect on private returns to secondary education is negligible. The decline in returns to primary education when human capital externality is taken into account could be reflecting the actual decline in productivity of individuals with primary level of education when the impact of the education of other individuals is taken into account. The increase in private returns to university education could reflect improved productivity after isolating the impact of those with a low level of education on their productivity.

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# Appendix

Table A1. Definition of variables

| Variable | Definition |
|---|---|
| Dependent variable | Natural logarithm of monthly wages |
| Primary education dummy | 1 if a person joined but did not complete primary education, 0 otherwise |
| Secondary education dummy | 1 if a person joined but did not complete secondary education, 0 otherwise |
| University education dummy | 1 if a person has university education, 0 otherwise |
| Potential experience | Number of years a person has been working |
| Potential experience squared | Square of the number of years a person has been working |
| Urban | 1 if a person lives in an urban area, 0 otherwise |
| Nairobi | 1 if a person lives in Nairobi Province, 0 otherwise |
| Central | 1 if a person lives in Central Province, 0 otherwise |
| Coast | 1 if a person lives in Coast Province, 0 otherwise |
| Eastern | 1 if a person lives in Eastern Province, 0 otherwise |
| North Eastern | 1 if a person lives in North Eastern Province, 0 otherwise |
| Nyanza | 1 if a person lives in Nyanza Province, 0 otherwise |
| Rift Valley | 1 if a person lives in Rift Valley Province, 0 otherwise |
| Western | 1 if a person lives in Western Province, 0 otherwise |
| Male | 1 if a person is male, 0 otherwise |

Table A2. Descriptive statistics by region and gender

| Variable | National | Urban | Rural | Males | Females |
|---|---|---|---|---|---|
| Mean monthly earnings (Ksh) | 1864.40 | 4671.96 | 1410.75 | 2840.48 | 1013.70 |
| Primary education dummy | 0.47 | 0.40 | 0.43 | 0.44 | 0.41 |
| Secondary education dummy | 0.22 | 0.46 | 0.18 | 0.28 | 0.17 |
| University education dummy | 0.01 | 0.02 | 0.004 | 0.01 | 0.004 |
| Potential experience | 18.45 | 14.45 | 19.09 | 19.28 | 17.72 |
| Potential experience squared | 498.76 | 312.16 | 528.91 | 530.05 | 471.49 |
| Urban | 0.14 | – | – | 0.15 | 0.13 |
| Nairobi | 0.02 | 0.14 | – | 0.02 | 0.01 |
| Central | 0.16 | 0.12 | 0.16 | 0.16 | 0.15 |
| Coast | 0.09 | 0.16 | 0.08 | 0.09 | 0.09 |
| Eastern | 0.18 | 0.17 | 0.18 | 0.17 | 0.18 |
| North Eastern | 0.07 | 0.03 | 0.07 | 0.07 | 0.06 |
| Nyanza | 0.14 | 0.12 | 0.14 | 0.12 | 0.15 |
| Rift Valley | 0.26 | 0.21 | 0.27 | 0.27 | 0.26 |
| Western | 0.08 | 0.05 | 0.09 | 0.08 | 0.09 |
| Joined labour force after 1985 | 0.22 | 0.31 | 0.20 | 0.34 | 0.24 |
| District average education for males | 6.07 | 7.02 | 5.89 | 6.07 | 6.07 |
| District average education for females | 4.52 | 5.62 | 4.34 | 4.54 | 4.45 |
| Male | 0.46 | 0.52 | 0.46 | | |

Table A3. Estimated earnings coefficients for all workers and male workers

| | All workers | | | Male workers | | |
|---|---|---|---|---|---|---|
| | Coefficients | Coefficients | Coefficients | Coefficients | Coefficients | Coefficients |
| Constant | 4.7956** | 3.7251** | 3.9926** | 4.9936** | 3.8089** | 4.0987** |
| | (0.083) | (0.099) | (0.094) | (0.115) | (0.139) | (0.132) |
| Experience | 0.0850** | 0.0814** | 0.0822** | 0.1041** | 0.1022** | 0.1028** |
| | (0.004) | (0.004) | (0.004) | (0.006) | (0.006) | (0.006) |
| Experience squared | –0.0013** | –0.001** | –0.0013** | –0.0016** | –0.0016** | –0.0016** |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| Primary dummy | 0.4930** | 0.3154** | 0.3371** | 0.6311** | 0.4074** | 0.4436** |
| | (0.023) | (0.026) | (0.026) | (0.039) | (0.041) | (0.041) |
| Secondary dummy | 1.0157** | 0.8090** | 0.8347** | 1.1697** | 0.9124** | 0.9551** |
| | (0.031) | (0.033) | (0.033) | (0.047) | (0.049) | (0.049) |
| University dummy | 1.8490** | 1.6912** | 1.7141** | 2.0477** | 1.8646** | 1.9010** |
| | (0.111) | (0.110) | (0.110) | (0.135) | (0.134) | (0.134) |
| Central Province | –0.2683** | –0.1108 | –0.1837** | –0.0437 | 0.1372 | 0.0511 |
| | (0.073) | (0.073) | (0.073) | (0.096) | (0.096) | (0.096) |
| Coast Province | –0.6564** | –0.1910** | –0.1506* | –0.3711** | 0.1570 | 0.2039* |
| | (0.074) | (0.077) | (0.079) | (0.097) | (0.103) | (0.106) |
| Eastern Province | –0.8645** | –0.4661** | –0.5227** | –0.7469** | –0.2937** | –0.3574** |
| | (0.072) | (0.074) | (0.074) | (0.095) | (0.099) | (0.098) |
| North Eastern Province | –0.8844** | 0.1484 | –0.0641 | –0.7152** | 0.4292** | 0.1975 |
| | (0.080) | (0.094) | (0.092) | (0.107) | (0.130) | (0.126) |
| Nyanza Province | –0.3784** | –0.0543 | –0.0366 | –0.4480** | –0.0783 | 0.0245 |
| | (0.073) | (0.075) | (0.076) | (0.096) | (0.099) | (0.102) |
| Rift Valley Province | –0.5620** | –0.0403 | –0.1083 | –0.3832** | 0.1991* | 0.1248 |
| | (0.072) | (0.076) | (0.076) | (0.093) | (0.100) | (0.100) |
| Western Province | –0.6461** | –0.3510** | –0.3006** | –0.6617** | –0.3217** | –0.2656** |
| | (0.076) | (0.077) | (0.078) | (0.102) | (0.104) | (0.106) |
| Male dummy | 0.5649** | 0.5992** | 0.5929** | | | |
| | (0.019) | (0.019) | (0.019) | | | |
| Urban dummy | 0.6091** | 0.5661** | 0.5461** | | 0.5571** | 0.5448** |
| | (0.030) | (0.029) | (0.030) | | (0.043) | (0.043) |
| Formal sector | 1.0923** | 1.0727** | 1.0808** | 0.9219** | 0.8957** | 0.9048** |
| | (0.025) | (0.025) | (0.025) | (0.032) | (0.032) | (0.032) |
| Joined labour force from 1985 | –0.1635** | –0.1940** | –0.1880** | –0.1942** | –0.2126** | –0.2068** |
| | (0.040) | (0.036) | (0.036) | (0.056 | (0.055) | (0.056) |
| District average education for males | | 0.1382** | | | 0.1564** | |
| | | (0.007) | | | (0.010) | |
| District average education for females | | | 0.1282** | | | 0.1448** |
| | | | (0.007) | | | (0.011) |
| Adj. $R^2$ | 0.38 | 0.39 | 0.38 | 0.37 | 0.39 | 0.39 |
| Observations | 20806 | 20806 | 20806 | 9689 | 9689 | 9689 |

**significant at 1% level; * significant at 5% level; standard errors in parentheses

Table A4. Estimated earnings coefficients for females workers and urban workers

| | Female workers | | | Urban workers | | |
|---|---|---|---|---|---|---|
| | Coefficients | Coefficients | Coefficients | Coefficients | Coefficients | Coefficients |
| Constant | 5.2327** | 4.2682** | 4.5170** | 5.6012** | 4.6473** | 4.9863** |
| | (0.127) | (0.144) | (0.139) | (0.163) | (0.244) | (0.220) |
| Experience | 0.0694** | 0.0652** | 0.0660** | 0.1871** | 0.0880** | 0.0878** |
| | (0.005) | (0.005) | (0.005) | (0.012) | (0.012) | (0.012) |
| Experience squared | –0.0010** | –0.0010** | –0.0010** | –0.0013** | –0.0014** | –0.0014** |
| | (0.0001) | (0.0001) | (0.0001) | 0.0002) | (0.0002) | (0.0003) |
| Primary dummy | 0.3736** | 0.2182** | 0.2329** | 0.3036** | 0.1763** | 0.2081 |
| | (0.031) | (0.033) | (0.033) | (0.093) | (0.096) | (0.096) |
| Secondary dummy | 0.8641** | 0.6864** | 0.7019** | 0.9200** | 0.7856** | 0.8189** |
| | (0.043) | (0.045) | (0.045) | (0.098) | (0.101) | (0.102) |
| University dummy | 1.6962** | 1.5324** | 1.5483** | 1.9978** | 1.8858** | 1.9154** |
| | (0.203) | (0.202) | (0.202) | (0.181) | (0.181) | (0.182) |
| Coast Province | –1.0383** | –0.6164** | –0.5831** | –0.6315** | –0.3770** | –0.4078** |
| | (0.117) | (0.120) | (0.122) | (0.091) | (0.103) | (0.106) |
| Rift valley Province | –0.8406** | –0.3623** | –0.4271** | –0.6202** | –0.1872** | –0.3010** |
| | (0.114) | (0.118) | (0.118) | (0.086) | (0.119) | (0.115) |
| Western Province | –0.7719** | –0.5073** | –0.4624** | –0.7543** | –0.4524** | –0.4695** |
| | (0.119) | (0.119) | (0.121) | (0.130) | (0.141) | (0.146) |
| Eastern Province | –1.0961** | –0.7371** | –0.7898** | –0.6675** | –0.3000** | –0.3929** |
| | (0.114) | (0.116) | (0.117) | (0.091) | (0.115) | (0.112) |
| North Eastern Province | –1.1377** | –0.1864 | –0.3870** | –1.2136** | –1.2763 | –0.5815** |
| | (0.123) | (0.140) | (0.137) | (0.174) | (0.249) | (0.231) |
| Nyanza Province | –0.4653** | –0.1710 | –0.0899 | –0.5160** | –0.2596** | –0.2375** |
| | (0.116) | (0.117) | (0.119) | (0.098) | (0.108) | (0.118) |
| Central Province | –0.6008** | –0.4609** | 0.5250** | –0.3936** | –0.2679** | –0.3404** |
| | (0.115) | (0.115) | (0.115) | (0.098) | (0.101) | (0.099) |
| Male dummy | | | | 0.6335** | 0.6499** | 0.6473** |
| | | | | (0.054) | (0.054) | (0.054) |
| Urban dummy | 0.5793** | 0.5281** | 0.5200** | | | |
| | (0.040) | (0.040) | (0.040) | | | |
| Formal sector | 1.3641** | 1.3560** | 1.3621** | 0.7602** | 0.7547** | 0.7586** |
| | (0.043) | (0.043) | (0.046) | (0.055) | (0.054) | (0.054) |
| Joined labour force from 1985 | –0.1275** | –0.1643** | –0.1578** | 0.0524 | 0.0646 | 0.0657 |
| | (0.046) | (0.046) | (0.046) | (0.098) | (0.098) | (0.098) |
| District average education for males | | 0.1262** | | | 0.1089** | |
| | | (0.009) | | | (0.021) | |
| District average education for females | | | 0.1168** | | | 0.0839** |
| | | | (0.010) | | | (0.020) |
| Adj. $R^2$ | 0.26 | 0.27 | 0.27 | 0.33 | 0.34 | 0.34 |
| Observations | 11117 | 11117 | 11117 | 2894 | 2894 | 2894 |

**significant at 1% level; * significant at 5% level; standard errors in parentheses

Table A5. Estimated earnings coefficients for urban male workers and urban female workers

| | Urban male | | | Urban female | | |
|---|---|---|---|---|---|---|
| | Coefficients | Coefficients | Coefficients | Coefficients | Coefficients | Coefficients |
| Constant | 6.0338** | 4.9435** | 5.3196** | 5.8192** | 5.0580** | 5.3233** |
| | (0.234) | (0.328) | (0.297) | (0.240) | (0.360) | (0.326) |
| Experience | 0.1051** | 0.1070** | 0.1065** | 0.0843** | 0.0848** | 0.0849** |
| | (0.015) | (0.016) | (0.016) | (0.018) | (0.018) | (0.018) |
| Experience squared | –0.0017** | –0.0018** | –0.0017** | –0.0013** | –0.0013** | –0.0013** |
| | (0.0003) | (0.0003) | (0.0003) | (0.0003) | (0.0004) | (0.0004) |
| Primary dummy | 0.4696** | 0.2949* | 0.3491** | 0.1582 | 0.0581 | –0.0770 |
| | (0.146) | (0.150) | (0.148) | (0.125) | (0.130) | (0.130) |
| Secondary dummy | 1.0957** | 0.9069** | 0.9648** | 0.7705** | 0.6704** | 0.6886** |
| | (0.150) | (0.154) | (0.153) | (0.136) | (0.140) | (0.140) |
| University dummy | 2.1071** | 1.9600** | 2.0083** | 2.1076** | 2.0014** | 2.0260** |
| | (0.216) | (0.216) | (0.216) | (0.361) | (0.362) | (0.362) |
| Central Province | –0.0361 | 0.1074 | –0.0226 | –0.7944** | –0.6936** | –0.7502** |
| | (0.122) | (0.125) | (0.123) | (0.158) | (0.084) | (0.159) |
| Coast Province | –0.4385** | –0.1260 | –0.1601 | –0.9054** | –0.7119** | –0.7334** |
| | (0.108) | (0.126) | (0.130) | (0.154) | (0.168) | (0.171) |
| Eastern Province | –0.6772** | –0.2316 | –0.3397** | –0.8135** | –0.5266** | –0.5966** |
| | (0.113) | (0.147) | (0.143) | (0.148) | (0.179) | (0.176) |
| North Eastern Province | –0.7103** | 0.3990 | 0.0492 | –1.7948** | –1.0517** | –1.2885** |
| | (0.218) | (0.320) | (0.294) | (0.272) | (0.378) | (0.353) |
| Nyanza Province | –0.4909** | –0.1895 | –0.1606 | –0.5790** | –0.3748** | –0.3524* |
| | (0.115) | (0.131) | (0.144) | (0.164) | (0.178) | (0.192) |
| Rift Valley Province | –0.3487** | 0.1479 | –0.0210 | –0.9726** | –0.6178** | –0.7064** |
| | (0.102) | (0.146) | (0.140) | (0.146) | (0.192) | (0.188) |
| Western Province | –0.7972** | –0.4480** | –0.4588** | –0.8142** | –0.5723** | –0.5842** |
| | (0.162) | (0.177) | (0.184) | (0.204) | (0.221) | (0.228) |
| Formal sector | 0.3405** | 0.3348** | 0.3359** | 1.1727** | 1.1671** | 1.1731** |
| | (0.070) | (0.069) | (0.069) | (0.084) | (0.084) | (0.084) |
| Joined labour force from 1985 | 0.1016 | 0.1210 | 0.1211 | –0.0674 | –0.0727 | 0.0753 |
| | (0.131) | (0.130) | (0.130) | (0.142) | (0.142) | (0.142) |
| District average education for males | | 0.1281** | | | 0.0874** | |
| | | (0.027) | | | (0.031) | |
| District average education for females | | | 0.0996** | | | 0.0685** |
| | | | (0.026) | | | (0.030) |
| Adj. $R^2$ | 0.22 | 0.23 | 0.22 | 0.28 | 0.28 | 0.28 |
| Observations | 1499 | 1499 | 1499 | 1395 | 1395 | 1395 |

**significant at 1% level; *significant at 5% level; standard errors in parenthesis

Table A6. Estimated earnings coefficients for rural male workers and rural female workers

| | Rural male | | | Rural female | | |
|---|---|---|---|---|---|---|
| | Coefficients | Coefficients | Coefficients | Coefficients | Coefficients | Coefficients |
| Constant | 4.9271** | 3.8644** | 4.0254** | 4.6673** | 3.8018** | 3.9696** |
| | (0.088) | (0.112) | (0.108) | (0.068) | (0.092) | (0.089) |
| Experience | 0.1033** | 0.1005** | 0.1010** | 0.0674** | 0.0623** | 0.0630** |
| | (0.006) | (0.006) | (0.006) | (0.005) | (0.005) | (0.005) |
| Experience squared | –0.0016** | –0.0016** | –0.0016** | –0.0010** | –0.0010** | –0.0010** |
| | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) | (0.0001) |
| Primary dummy | 0.6348** | 0.3966** | 0.4224** | 0.3923** | 0.2308** | 0.2417** |
| | (0.041) | (0.043) | (0.043) | (0.032) | (0.033) | (0.034) |
| Secondary dummy | 1.1473** | 0.8689** | 0.9008** | 0.8653** | 0.6718** | 0.6832** |
| | (0.050) | (0.053) | (0.053) | (0.047) | (0.049) | (0.049) |
| University dummy | 1.9304** | 1.7377** | 1.7651** | 1.3377** | 1.1603** | 1.1613** |
| | (0.094) | (0.192) | (0.192) | (0.265) | (0.263) | (0.264) |
| Coast Province | 0.2898** | 0.1386** | 0.3283** | –0.4956** | –0.1535** | –0.0272** |
| | (0.064) | (0.069) | (0.078) | (0.056) | (0.060) | (0.067) |
| Eastern Province | –0.7124** | –0.4351** | –0.3933** | –0.5620** | –0.3779** | –0.3187** |
| | (0.051) | (0.054) | (0.056) | (0.044) | (0.046) | (0.048) |
| North Eastern Province | 0.6431** | 0.3753** | 0.2777** | –0.5195** | 0.3327** | –0.2168** |
| | (0.072) | (0.100) | (0.098) | (0.063) | (0.088) | (0.086) |
| Nyanza Province | 0.3742** | 0.1723** | 0.0548** | –0.1261** | 0.2901** | 0.4546** |
| | (0.067) | (0.057) | (0.064) | (0.046) | (0.047) | (0.053) |
| Rift Valley Province | 0.3330** | 0.0929** | 0.1335** | –0.2469** | 0.1079** | –0.1198** |
| | (0.047) | (0.055) | (0.058) | (0.041) | (0.048) | (0.051) |
| Western Province | 0.5754** | 0.4163** | 0.2446** | –0.1869** | 0.0617 | 0.0630** |
| | (0.064) | (0.063) | (0.067) | (0.052) | (0.052) | (0.056) |
| Formal sector | 1.0606** | 1.0282** | 1.0390** | 1.4519** | 1.4414** | 1.4463** |
| | (0.036) | (0.035) | (0.035) | (0.052) | (0.051) | (0.051) |
| Joined labour force from 1985 | –0.2784** | –0.3081** | –0.3038** | –0.1656** | –0.2100** | –0.2046** |
| | (0.062) | (0.061) | (0.061) | (0.049) | (0.049) | (0.049) |
| District average education for males | | 0.1677** | | | 0.1335** | |
| | | (0.012) | | | (0.010) | |
| District average education for females | | | 0.1655** | | | 0.1285** |
| | | | (0.107) | | | (0.010) |
| Adj. $R^2$ | 0.33 | 0.35 | 0.34 | 0.20 | 0.22 | 0.21 |
| Observations | 8190 | 8190 | 8185 | 9722 | 9722 | 9722 |

**significant at 1% level; *significant at 5% level; standard errors in parenthesis

Table A7. Estimated earnings coefficients for rural male workers

| | Rural | | |
|---|---|---|---|
| | Coefficients | Coefficients | Coefficients |
| Constant | 4.5343** | 3.5740** | 3.7394** |
| | (0.054) | (0.072) | (0.069) |
| Experience | 0.0842** | 0.0797** | 0.0804** |
| | (0.004) | (0.004) | (0.004) |
| Experience squared | –0.0012** | –0.0012** | –0.0013** |
| | (0.0001) | (0.0001) | (0.0001) |
| Primary dummy | 0.5096** | 0.3233** | 0.3386** |
| | (0.025) | (0.027) | (0.027) |
| Secondary dummy | 1.0125** | 0.7894** | 0.8082** |
| | (0.034) | (0.035) | (0.035) |
| University dummy | 1.6639** | 1.4951** | 1.5082** |
| | (0.154) | (0.153) | (0.153) |
| Coast Province | –0.4070** | 0.0312** | 0.1220** |
| | (0.042) | (0.046) | (0.051) |
| Eastern Province | –0.6387** | –0.3935** | –0.3645** |
| | (0.033) | (0.035) | (0.037) |
| North Eastern Province | –0.5940** | 0.3250** | 0.3645** |
| | (0.047) | (0.066) | (0.037) |
| Nyanza Province | 0.0965** | 0.0803** | 0.2710** |
| | (0.036) | (0.036) | (0.041) |
| Rift Valley Province | 0.2963** | 0.0865** | 0.1111** |
| | (0.031) | (0.037) | (0.038) |
| Western Province | –0.3688** | 0.2317** | 0.0874** |
| | (0.041) | (0.041) | (0.043) |
| Male dummy | 0.5549** | 0.5942** | 0.5880** |
| | (0.021) | (0.020) | (0.020) |
| Formal sector | 1.1991** | 1.1742** | 1.1831** |
| | (0.029) | (0.028) | (0.029) |
| Joined labour force from 1985 | –0.2224** | –0.2626** | –0.2578** |
| | (0.039) | (0.038) | (0.039) |
| District average education for males | | 0.1468** | |
| | | (0.008) | |
| District average education for females | | | 0.1433** |
| | | | (0.008) |
| Adj. $R^2$ | 0.33 | 0.35 | 0.34 |
| Observations | 17912 | 17912 | 17912 |

** significant at 1% level; * significant at 5% level; standard errors in parenthesis

Table A8. Estimated earnings coefficients by cohorts

| | Joined labour force from 1985 | | | Joined labour force before 1985 | | |
|---|---|---|---|---|---|---|
| | Coefficients | Coefficients | Coefficients | Coefficients | Coefficients | Coefficients |
| Constant | 4.4568** | 3.6853** | 4.0698** | 4.8849** | 3.7240** | 3.9608** |
| | (0.156) | (0.198) | (0.184) | (0.098) | (0.113) | (0.109) |
| Experience | 0.1989** | 0.1931** | 0.1965** | 0.0738** | 0.0703** | 0.0709** |
| | (0.129) | (0.029) | (0.028) | (0.004) | (0.004) | (0.004) |
| Experience squared | 0.0091** | 0.0087 | 0.0089 | –0.0011** | –0.0011** | –0.0010 |
| | (0.003) | (0.003) | (0.003) | (0.0001) | (0.0001) | (0.0001) |
| Primary dummy | 0.3668** | –0.1642 | 0.2506** | 0.5084** | 0.3239** | 0.3560** |
| | (0.102) | (0.106) | (0.106) | (0.025) | (0.027) | (0.027) |
| Secondary dummy | 0.9474** | 0.7269** | 0.8195** | 1.0178** | 0.8008** | 0.8172** |
| | (0.052) | (0.107) | (0.106) | (0.036) | (0.037) | (0.037) |
| University dummy | 1.7751** | 1.6030** | 1.6806** | 1.8599** | 1.6825** | 1.6920** |
| | (0.180) | (0.145) | (0.181) | (0.153) | (0.151) | (0.151) |
| Central Province | –0.337** | –0.1946 | –0.2744* | –0.2262** | –0.0899 | –0.1624 |
| | (0.121) | (0.131) | (0.130) | (0.088) | (0.088) | (0.087) |
| Coast Province | –0.7469** | –0.3879** | –0.4900** | –0.5909** | –0.0906 | –0.0128 |
| | (0.134) | (0.144) | (0.149) | (0.089) | (0.092) | (0.094) |
| Eastern Province | –0.8738** | –0.5716** | –0.6988** | –0.8416** | –0.4118** | –0.4519** |
| | (0.128) | (0.137) | (0.136) | (0.087) | (0.089) | (0.089) |
| North Eastern Province | –0.4770** | 0.2599 | –0.0843 | –0.9254** | 0.1892 | 0.0127 |
| | (0.170) | (0.206) | (0.197) | (0.094) | (0.109) | (0.105) |
| Nyanza Province | –0.2907** | 0.0143 | 0.0621 | –0.3619** | –0.0211 | 0.1041 |
| | (0.136) | (0.142) | (0.148) | (0.088) | (0.088) | (0.090) |
| Rift Valley Province | –0.6573** | –0.2715* | –0.4287** | –0.5101** | –0.0555 | 0.0090 |
| | (0.127) | (0.141) | (0.140) | (0.086) | (0.090) | (0.090) |
| Western Province | –0.7718** | –0.5220** | –0.5811** | –0.5759** | –0.2667** | –0.1899** |
| | (0.141) | (0.046) | (0.149) | (0.091) | (0.091) | (0.093) |
| Male dummy | 0.3058** | 0.3185** | 0.3137** | 0.6589** | 0.7003** | 0.6940** |
| | (0.040) | (0.040) | (0.040) | (0.022) | (0.022) | (0.022) |
| Urban dummy | 0.6831** | 0.6514** | 0.3137** | 0.5649** | 0.5038** | 0.4874** |
| | (0.055) | (0.054) | (0.040) | (0.035) | (0.035) | (0.035) |
| Formal sector | 1.5228** | 1.5162** | 1.5219** | 0.9346** | 0.9093** | 0.9173** |
| | (0.050) | (0.017) | (0.050) | (0.029) | (0.029) | (0.029) |
| District average education for males | | 0.1048** | | | 0.1489** | |
| | | (0.017) | | | (0.008) | |
| District average education for females | | | 0.0649** | | | 0.1466** |
| | | | (0.017) | | | (0.008) |
| Adj. $R^2$ | 0.42 | 0.42 | 0.42 | 0.36 | 0.37 | 0.37 |
| Observations | 4525 | 4525 | 4525 | 16281 | 16281 | 16281 |

** significant at 1% level; * significant at 5% level; standard errors in parenthesis

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