Determinants of Earnings in Eritrea: A First Attempt to Estimate the Mincerian Earnings Function

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Economics (Labour economics and Labour market Policy specialization)

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Abstract

This paper attempts to estimate the Mincerian earnings function for Eritrea by employing Eritrean Household Income and Expenditure Survey (EHIES) 96/97 data. The Mincerian earnings function is estimated by using OLS and Heckman two-stage econometric techniques. The latter was found to be plausible because it avoids selectivity bias. The list of potential determinants of earnings is broadened to include education, potential experience, occupation, gender, the pre-independence history of workers and region. On average, the rate of return to education increases with increased years of schooling. The highest rate of return is found for a technical school or university diploma, followed respectively by a university degree, secondary, middle and elementary schooling. Females enjoy a higher rate of return to education than males. The rate of return to education differs substantially between private and public sector employment. Ex-fighters enjoy some form of special wage premium in view of the importance of their pre-independence history and this party premium is substantially higher in the public sector than in the private sector. There is also a peak level of experience that positively affects earnings. The effect of experience on earnings is greater in the private sector than in the public sector. Occupational choice is one of the determinants of earnings in Eritrea; however, not all occupational groups affect earnings significantly. There is also a regional earnings differential in Eritrea.

1. Introduction[1]

Eritrea is situated in the horn of Africa, with the Red Sea on its east coast, the Sudan to the west and north, Ethiopia to the south and Djibouti at its extreme southern tip. Its geographic area covers approximately 125, 000 square kilometres (about the size of the Western Cape, South Africa). Although there is no exact estimate of Eritrea's population size, it is reported to be between 3- 3.5 million with hundreds of thousands residing in exile mainly in the Sudan (World Bank, 2002). Eritrea used to have a relatively advanced and competitive industrial sector in the 1950s. The 30-year war of independence with Ethiopia, destructive policies of the colonial Ethiopian regimes, successive droughts and the recent war with Ethiopia have however severely damaged the economy.

Eritrea was liberated in May 1991 after 30 years of war. After a democratic referendum under United Nations (UN) supervision in May 1993, Eritrea became an independent state and joined the UN. In 1991, the liberated Eritrea was characterized by a ruined infrastructure, feeble institutions, and non-dynamic and technologically backward sectors (IMF, 1998: 4). These decades of lost opportunities for growth and development have made Eritrea's post-liberation endeavour for development very difficult. In 2001 the per capita income was reported to be USD 200 with a GDP of USD 690 million (World Bank, 2002).

To realise their ambition of nationalism, Eritreans commenced re-building their nation in 1991 with the limited resources available to them. The philosophy of the government was self-reliance, which mainly entailed a high dependence on the mobilization of domestic resources. As the private sector was non-existent and market forces were inadequate to allocate resources efficiently, the government had to play a key role in the economy. The Provisional Government of Eritrea (PGE) accordingly articulated in its intent of policy that the macroeconomic objectives were, among others, to promote an outward oriented, private sector led market economy (Macro Policy, 1994). Foremost among these objectives was the development of the country's human capital in a market-based system. The labour market was however supply

[1] I would like to thank Jeremy Wakeford for his insightful guidance in preparing the research paper. I would like to thank also DPRU, University of Cape Town, for their financial assistance.

constrained, i.e. there was insufficient manpower (skilled and unskilled) for the work that needed to be done, and the economy had to produce the essential manpower. Wage determination was and is an integral part of this process. Even though the ex-liberation fighters were working virtually for free[2] until 1994, other civil servants were being paid according to the Ethiopian salary scale. In the private sector, wages were set according to the forces of demand and supply. Up until 1997 the economy was highly influenced by market forces with very little government regulation of the labour market.

Understanding the determinants of earnings in general and the rate of return for different levels of education in particular is vital for the efficient gearing of investment. In 2002 the Cabinet of Ministers evaluated the educational system of Eritrea during the preceding decade and identified as considerable wastage.[3] Eritrea remains one of the few African countries for which there has so far been no academic study on the returns from investment in education. This paper attempts to fill this gap by employing the standard earnings function approach and thereby presenting a policy guide for investment in education[4].

The paper is organized as follows. Section 2 presents the human capital earnings function mainly due to Jacob Mincer (1974), examines the issue of self-selection bias and draws attention to the quality versus quantity of schooling debate. This section also mentions other sources of bias in the analytical technique that has been employed. Section 3 discusses the model specification and motivation for the included variables. Section 4 presents the empirical results and discusses the main issues surrounding the conventional findings *vis-à-vis* the Eritrean evidence. Section 5 concludes the paper by making several policy recommendations.

[2] Ex-liberation fighters were provided with food and accommodation and very minimal pocket money.
[3] www.Shaebia.org
[4] It is to be noted that our methodology provides private rates of return to education, whereas government policy should be based on social rates of return to education. The private rate of return could however be used as rough guide for policy.

2. Theoretical Background

2.1 Human Capital Theory

The most common economic theory informing wage determination is the human capital theory, which was pioneered by Becker (1964) and Mincer (1974). The conventional theory of human capital views education and training as the major sources of human capital accumulation. Schooling[5] can be seen as a form of investment in an individual's productive capacity and therefore earning potential. This is not, of course, to deny that some pleasure can be derived to schooling at the same time; people can and do after all enjoy student life. Yet, schooling is not, however, without opportunity costs. Additional schooling necessitates both sacrifices, such as earnings forgone, and direct costs, such as tuition, accommodation and other expenses.

By and large the implications of modern human capital theory for education can be summarized in three premises. Firstly, net present values of life-long earnings should be positive in order to induce an individual to invest in schooling. This is a supply side proposition. Secondly, the marginal productivity of workers should increase with an increase in years of schooling. More educated workers earn higher wages because they are expected to be more productive than their less educated fellow workers. Thirdly, as stated by Berndt (1996: 154), "in the long run competitive equilibrium the relationship between schooling and life time earnings must be such that the supply of and demand for workers of each schooling level are equated, and no worker wishes to alter his or her level of schooling." This third proposition is a statement about market equilibrium in the labour market. Of course, the presumption underlying these hypotheses is the existence of a perfectly competitive labour market. Even though the absence of perfectly competitive markets is omnipresent in economics, we can make the fair assumption that the labour market in Eritrea during the time of data collection was liberal and competitive. Market forces mainly determined the operation of labour markets. Employers were free to employ workers

[5] Schooling means formal education.

at the agreed-upon wages, and there was no government intervention in wage determination in the private sector (Berndt, 1996).

2.2 The Earnings Function

Based on the human capital theory Mincer (1974) devised the so-called Mincerian earnings function, in which the logarithm of earnings per week (or month or year) is expressed as a linear function of the number of years of schooling completed and as a linear and quadratic function of potential experience[6]. This functional notation, which is known as the semi-log quadratic earnings function, has been employed mainly for three applications. Its first role is to explain earnings variation across individuals and through time and across groups of individuals or classes of a society at a point in time. This is effectively what this paper does. Secondly, it has in many applications been used to measure or estimate the effect of such characteristics as race, region, gender, training and other factors. Thirdly, it has been employed to explore the effect of non-competitive or non-market determined factors on wage determination. However, for the standard earnings function to provide such information it must offer a sound approximation to actual earnings profiles (Kjellstrom and Bjorklund, 2002).

The 'human capital earnings function' (HCEF) has become an essential tool in research on wage earnings in developed and developing economies. Even though it has many uses, it is most frequently used to make educational policy decisions based on estimates of the rate of return to investment in schooling (see, for example, Psacharopoulos and Mattson, 1996). The focus of this present study is to explore the determinants of earnings in Eritrea. The emphasis will be on years of schooling, potential experience, gender, sector of employment, pre-independence history of workers, and occupational category. The Mincerian earnings function[7], which is employed in this paper, can be mathematically expressed as:

$$\ln y = \alpha + b_1 S + bX + U_i \qquad (1)$$

[6] Mincer defined potential work experience as age – years of education - 6, to proxy the number of years an individual spends in the labour market, assuming they are continuously employed. The quadratic specification of the experience variable reflects the commonly observed concave pattern of age-earnings profile.

[7] The original Mincerian function is $\ln y_i = \ln y_0 + bS + c_1 X - c_2 X^2 + U_i$ where x = potential years of experience and s = years of schooling.

where S_i = Years of schooling

X_i = Vector of factors other than years of schooling

U_i = Error term

The basic feature of the HCEF is that it relates the natural logarithm of earnings to investments in human capital measured over time, such as years of schooling and years of post-school work experience. It has several desirable features: (1) It is not an ad hoc specification, but is derived from an identity.[8] As a result, the coefficients of the equation have economic interpretations. (2) By using the natural logarithm of earnings rather than earnings themselves as the dependent variable, because of the positive skewness of earnings and the rise in earnings inequality as schooling level increases, the residual variance in the HCEF is less heteroskedastic and the distribution of the residuals is closer to normal. (3) It is an efficient user of data. Although data on earnings, years of schooling and years since leaving school are readily available, data on individual schooling costs are not readily available. The HCEF procedure involves converting a relationship between earnings and monetary investments in human capital to one between the natural logarithm of earnings and years of investment in schooling and training. (4) The HCEF is flexible, allowing for easy incorporation of additional variables appropriate for the particular purpose of the study. This characteristic is very important to the present study, as it enables the inclusion of other variables that are expected to influence earnings in Eritrea. (5) Finally, the coefficients of the HCEF are devoid of units, facilitating comparisons across space (e.g., countries) or across time periods (e.g., decades).

As mentioned above, one feature of the HCEF is its frequent use for estimating the rate of return to education, experience and other relevant variables. Particularly, the coefficient of the schooling variable is often interpreted as the rate of return to schooling (Willis, 1986). However it is important to distinguish between the internal rate of return derived from cost benefit analysis and the coefficient of the schooling term from the Mincerian earnings equation. Whereas the internal rate of

[8]If we assume that the rate of return to education is uniform for all levels of education. $Y_s = Y_0(1+r_1)(1+r_2)...(1+r_s)$ (1) where r = rate of return for education, s = years of schooling. If we approximate $(1+r)$ by e^r, then (1) can be written as $Y_s = Y_0 e^{rs}$ (2). Also (1) can be appended with a disturbance term e^u. Then (2) can be rewritten as $\ln Y_s = \ln Y_0 + rs + u$ (3), which is the basic earnings function.

return takes into account both costs and benefits of any project, the schooling coefficient from the earnings function is a rough estimate of the rate of return to education because it only takes into account the stream of earnings (benefits). Furthermore, the latter approach makes a number of simplifying assumptions. It assumes that the only costs of schooling are forgone earnings. It does not take into account tuition, accommodation and other direct costs. Moreover, it does not incorporate earnings (gained or lost) while attending school[9]. Clearly, the Mincerian earnings function is not without flaws. The following section thus mentions the major sources of bias within the conventional approach.

2.2.1. Self-selection Problem

The main assumption fundamental to the use of statistical earnings functions to estimate the rate of return to schooling is that schooling precisely represents the set of opportunities faced by a representative individual (after controlling for observed exogenous characteristics in our model such as race, age or sex). If it does, it is suitable for answering questions of the sort: "What would a given individual's expected life cycle earnings path be if he/she chooses S_1 rather than S_2 years of schooling?"(Wills, 1986).

A large literature addresses the issue of the extent to which the estimated rate of return to education is upward biased. The main reason for this is because ability is unobserved and "high ability" individuals, on average, have higher schooling attainment than "low ability" individuals. If so, the error term U_i in (1) will be positively correlated with S_i and the estimated earnings function will be subject to an "*ability bias*" which overstates the earnings gain a person of given ability would achieve through increased schooling. In other words, the level of schooling might be determined by the ability of individuals, and hence higher earnings may be attributed partly to the ability of individuals and not to the level of education per se.

[9] The estimated rate of return is the private rate of return to education. It does not take into account public subsidisation of schooling, or any positive and negative externalities associated with schooling. Thus it is not the same as the social rate of return (Berndt, 1996).

There are two fundamental problems associated with ability. Firstly, it is impossible to observe the life cycle earnings path of the same individual who has made alternative schooling investments. Secondly, it is impossible to observe all the factors, which affect his/her earning opportunities. We can only observe the earning levels of a given individual who has selected a given level of schooling.

Unfortunately, since there is no information about the ability of individuals in our data set, there may be certain shortcomings in our analysis.[10] However, as the aim is to determine the factors which may affect earnings in Eritrea, it is not unjustifiable to employ the years of educational attainment to estimate the rate of return to schooling, with the proviso that it may incorporate the effect of ability on earnings.

The fundamental behavioral hypothesis of economics is the presumption that economic agents select the most preferred alternative from their set of opportunities. As the complete opportunity set cannot be observed and as opportunities vary across parents, the operation of optimal choice implies that market data may be systematically censored. Consequently, there is no guarantee that estimates based on interpersonal differences in earnings and schooling will accurately estimate the opportunity set of any individual in the population. Hence there is a need to employ appropriate econometric techniques to tackle these issues (Maddala, 1977).

In the milieu of the literature on investment in schooling this has come to be known as the *self-selection problem* (Rosen, 1987). This issue is an omnipresent problem in economics and will present thorny econometric problems in any situation in which the full opportunity set of each agent is not observed. Since many of the empirical issues, including the question of ability, that have arisen in the earnings function literature can be interpreted in terms of the self-selection problem, caution is needed in any attempt to interpret the econometrics results in this paper. Thus the first issue in any empirical findings regarding the relationship between earnings and schooling is the methodology of estimation, which takes into account the nature of the data.

[10] The effect of ability bias in schooling is not a settled issue though (Moll 1998).

2.2.2. Quality versus Quantity of Schooling

Another issue to consider in the discussion of rates of return to schooling is the quantity versus quality debate. In most cases the quantity of schooling is represented by years or grades of schooling attained. But a failure to control for significant differences in the quality of schooling in earnings function estimates may cause biases in the estimated returns to schooling.

Excluding the quality aspect of schooling renders the estimates of the coefficients most probably not BLUE.[11] The possible biases may be downward or upward, but the bias is more likely to be positive because of the positive correlation between quality and quantity of schooling. The bias may also be considerable if quality plays an important role in the actual relationship.

Even though it is theoretically sound to include quality of schooling in the rate of return estimation, there are certain problems with the practical application of this suggestion. It is very difficult to obtain a consistent and standard measure of schooling quality in practice. There is no generally agreed upon quality index, which can be employed for such studies. An attempt to compile an index for quality would also be very costly and often may not be very rewarding (Behrman and Birdsall, 1983). Thus the choice of a proxy for quality remains highly normative. Among the variables used as a proxy for quality measures are the teacher-pupil ratio, schooling expenditure per pupil and the teacher's level of education.

Fortunately, there seem to be no noticeable differences in quality of schooling in Eritrea. Almost all schools in Eritrea are state-owned. There is only one international school, which is privately owned, and two Italian schools. In these private schools most of the students are non-Eritrean nationals and they all go to Italy after completing high school. There is one Teachers Training Institute (TTI) in Eritrea. There is also only one university, the University of Asmara (UOA), in the whole country. The teachers in the elementary school are recruited in TTI and the secondary school teachers are graduates of the University of

[11] BLUE is an abbreviation for best linear unbiased estimate.

Asmara. Teachers are assigned by the Head Office of the Ministry of Education. Moreover, since our data set is from the urban areas of Eritrea, we can assume that there are no major quality differences in school quality and thus our estimates may not suffer from the aforementioned bias.

In addition to the above, our model may suffer from variable omission bias and measurement error. The latter is especially important to consider, given the fact that this was the very first survey in Eritrea and that questionnaires about income or earnings are very sensitive. The measurement of wage or earnings in a society such as Eritrea is not an easy task. Moreover, it has been very common for the majority of Eritrean households not to report income honestly for political and economic reasons. We can thus expect some measurement error bias to be present in our data. To minimize the problem of variable omission bias, this study attempts to include the major variables which are supposed to affect earnings in Eritrea.

3. Data

The data are drawn from the Eritrean Household Income and Expenditure Survey (EHIES), an urban survey that was conducted in the large towns of Eritrea in 1996. It was designed to be able to report separately from five main geographical reporting domains corresponding to the three large towns, the Highlands and the Western Lowlands. The National Statistics Office selected a sample size of 5,061 households. The absence of any operational sampling framework in the country necessitated complete mapping and listing of all households in all towns except in one town, Keren. The sampling method employed was one-stage stratified sampling in all towns. Simple random sampling was used to choose households from the selected clusters.

The survey was conducted from July to September 1996 in four rounds. The main reason for this was to incorporate seasonal variations in data collection. Of the selected total 5,061 households, the surveyors were able to include 4,644 households in the data. The non-response rate was very low. However, the data do not include all the variables needed for the analysis, and the data set also has many missing observations and some outliers. These problems are omnipresent in most developing countries. As a result, the data had to be cleaned by excluding all the missing

information and anomalies. No income and expenditure survey[12] except for the survey conducted during the Ethiopian colonisation, which treats Eritrea as a province of Ethiopia. EHIES 96 is the only available data set relevant for our analysis. By and large it contains the basic variables included in the standard Mincerian earnings function.

The unavailability of individual level data has discouraged researchers from examining the nature of the labour market in post-independence Eritrea. Consequently, so far no research known to the author has estimated wage or earnings equations for Eritrea. By using individual level data, this paper attempts to fill this gap by estimating the return to human capital characteristics and the variations of earnings by sector, gender, region and occupation. It also controls for the endogeneity of employment choice.

4. Model Specification

As discussed in Section 2 above, the Mincerian earnings function has been widely used to estimate the returns to education and other investment in human capital. These estimates have very important effects on policy debates. Fashionably, following Mincer (1974), almost all studies include in their specification years of schooling, work experience and work experience squared. As previously explained in Section 2, the popularity of this specification stems partly from simplicity and convenience in interpretation. However, it should be noted that this specification makes the following bold assumptions:

i) The appropriate definition of the dependent variable is the logarithm of earnings as opposed to earnings as such or any other functional form.
ii) There is no interaction between the contributions of the schooling and work experience variables to earnings.
iii) A single model can be employed to model life-time earnings, making no distinction between early and mature labour market experience. [Dougherty and Jimenez, 1991: 85]

After a thorough test of the validity of the specifications, Dougherty and Jimenez (1991) found that the semi-logarithmic earnings function is superior to its linear counterpart. They further argue that the semi-logarithmic transformation is supported by the Box-Cox transformation, by relative heteroskedasticity in both

[12] To date no census has been conducted in Eritrea.

schooling and work experience dimensions, and by relative normal distribution of the residuals (Dougherty and Jimenez, 1991). Among simple transformations the natural logarithm of earnings is a more appropriate dependent variable in earnings functions (Heckman and Polachek, 1974). On other hand, Assadzadeh and Paul (2001) argue that the semi-log quadratic specification fits the actual earnings profiles very poorly. Kjellstrom and Bjokrkurnd (2002) also warn that the semi-log Mincerian earnings function can be misleading in some cases. Although the debate is not settled, the majority of earnings function studies use the semi-log Mincerian specification.

With this in mind, this study uses the Mincerian earnings function to examine the determination of personal earnings in Eritrea. The list of potential determinants of earnings is however broadened to include occupation, gender, pre-independence history of individuals and region. The model is specified as follows:

$$LNWAGE = \beta_0 + \beta_1 EDULEV + \beta_2 EXPER - \beta_3 EXPER^2 + U \qquad (2.1)$$

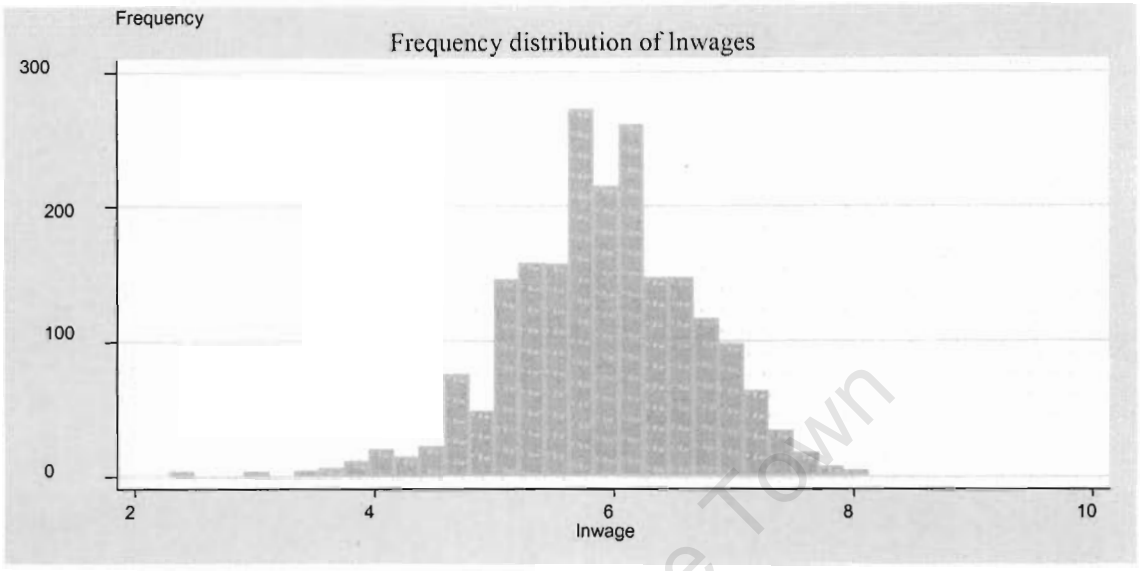
$$LNWAGE = \beta_0 + \beta_1 EDULEV + \beta_2 EXPER - \beta_3 EXPER^2 + \beta_4 GENDER + \beta_5 PFDJ + \beta_6 ETHNIC + \beta_7 ASMARINO + \beta_8 OTHERS + U \qquad (2.2)$$

Equations 2.1 and 2.2 are the standard and expanded earnings functions respectively. The variables are defined as follows: ln *wage* is the natural logarithm of gross average monthly income; *edulev* is years of schooling completed; exp*er* is years of potential experience; $gender = 1$ if male and $gender = 0$ if female; $EPLF = 1$ if the individual is an ex-fighter and $EPLF = 0$ if the individual was not a fighter; $Ethnic = 1$ if ethnicity is Tigrigna and $Ethnicity = 0$ otherwise, if ethnicity is not Tigrigna; $Asmarino = 1$ if town is Asmara and $Asmarino = 0$ otherwise. *Others* is any other variable of interest to be included in the wage equation, such as a set of occupational or sectoral dummy variables. U is the error term. Each variable will now be described and motivated in greater detail.

Gross Average Monthly Income

The average monthly wage ascertained from each individual is defined to include regular wages, bonus, allowances, subsidies, welfare payments, and income from other work. The average monthly income is transformed into logarithmic figures. The

distribution of the selected sub-sample is reported in Figure 1. The figure also shows that ln *wage* is nearly normally distributed with mean 5.914652 and standard deviation 0.7911551. The average monthly income of our sample is ERN[13] 492.3701.



Source: HIES Eritrea, 1996/97

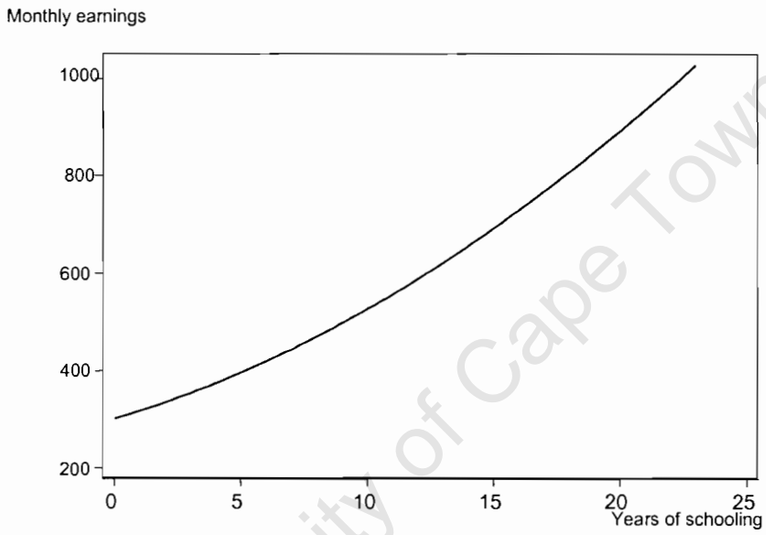
Figure 1. Frequency distribution of lnwages

Years of Schooling

It is well known that schooling and income are positively correlated. The magnitude and degree of the effect of different schooling levels on earnings have been however contestable. It has been argued in the literature that different school years impart different skills and productivity. Hence it is naïve to assume a uniform rate of return for all educational levels. In order to study the effect of school years at different levels of education, Van der Gaag and Vijverberg (1989), for instance, divided the years of schooling according to the school systems of Cote d'Ivoire. Similarly, Khandker (1990) also used the years of primary, secondary and post-secondary schooling in a wage function for Peru. Both studies found significant differences in returns to education at different levels of education. Following Van der Gaag and Vijverberg (1989), we similarly divided the school years into eight categories according to the education system of Eritrea. In Eritrea, the primary education consists of 6 years of schooling; middle requires 2 more years; and by completing 4 more years of

[13] ERN is an abbreviation to Eritrean Nacfa, legal tender in Eritrea.

schooling after middle, an individual obtains a secondary school certificate *i.e.,* Matric. In secondary school after grade 10 students have a choice between technical (vocational) and formal education. A technical education diploma can be obtained from technical institutions which award a diploma after 3 years of education, while those who go the normal education route receive a high school certificate after 2 years (grade 12). After the completion of secondary school or technical school, students can join the University of Asmara, the only university in Eritrea. Thus in the latter estimation schooling was entered as linear splines. The splines were defined for zero education, elementary education (1-6) middle school, (6-7), senior secondary (9-12) certificate from university, vocational training, university incomplete (13-16), bachelors degree holders, and postgraduates.



Source: EHIES 1996/97

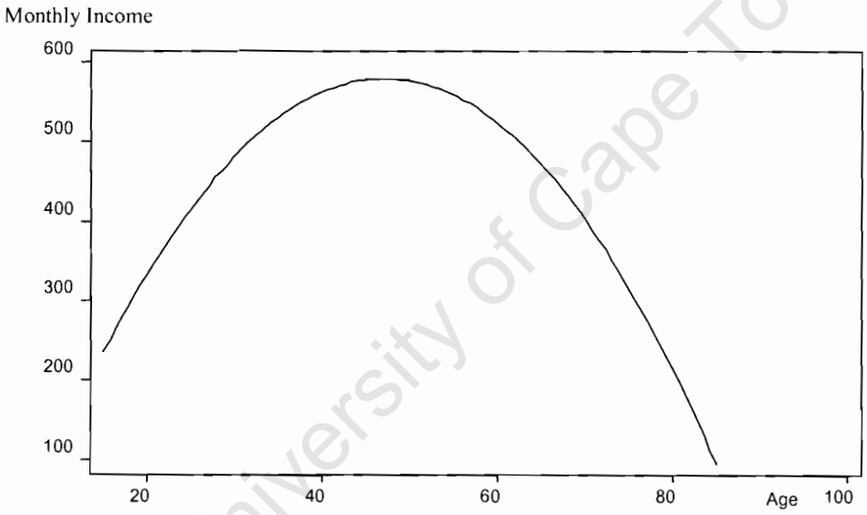
Figure 2. Schooling-earnings profile

The splines allow the effects on earnings of each of the schooling levels to vary, while constraining annual effects within each of the schooling levels to be identical. The coefficients on the splines are interpreted in the same way as is a coefficient on a continuous school variable. It is interpreted as the percentage change in earnings due to a unitary change in years of education (Gujarati, 1996). Figure 2 above illustrates the relationship between earnings and years of education. The Figure

was created by imposing a second order polynomial relation using the estimated coefficients for education and education squared instead of a simple scatter plot.[14] This was done to investigate whether the relationship is not linear and uniform for all levels of education. Figure 2 shows that the relationship between education and wages is positive and increasing. The rate of return to education increases as years of education rise. The earnings-schooling profile is thus convex to the origin. In order to examine the returns to education at different levels of education, this paper employs education splines, which provide a more detailed picture of the pattern of returns.

Potential Work Experience

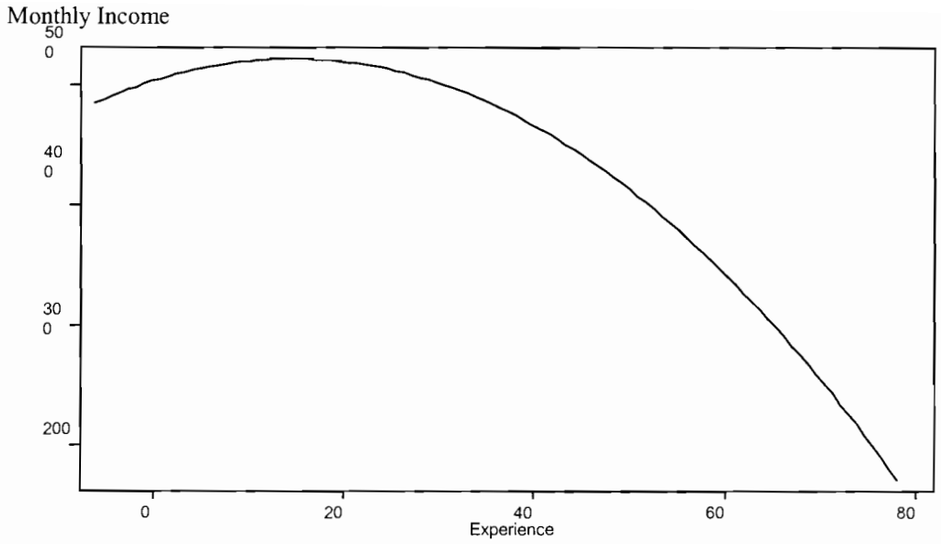
Actual experience is not obtainable from the HIES 96/97. For this reason potential experience is employed as a proxy. Following Mincer (1993) approximate potential experience is defined as a worker's age minus years of schooling and age of entrance to school. That is, years of experience = age – years of schooling – 7, because the age of school entrance in Eritrea is 7 years.



Source: EHIES 1996/1997

Figure 3. Age-Earnings Profile

[14] This quadratic prediction plot was generated by the STATA package.



Source: EIEHS 1996/97

Figure 4. Experience-earnings profile

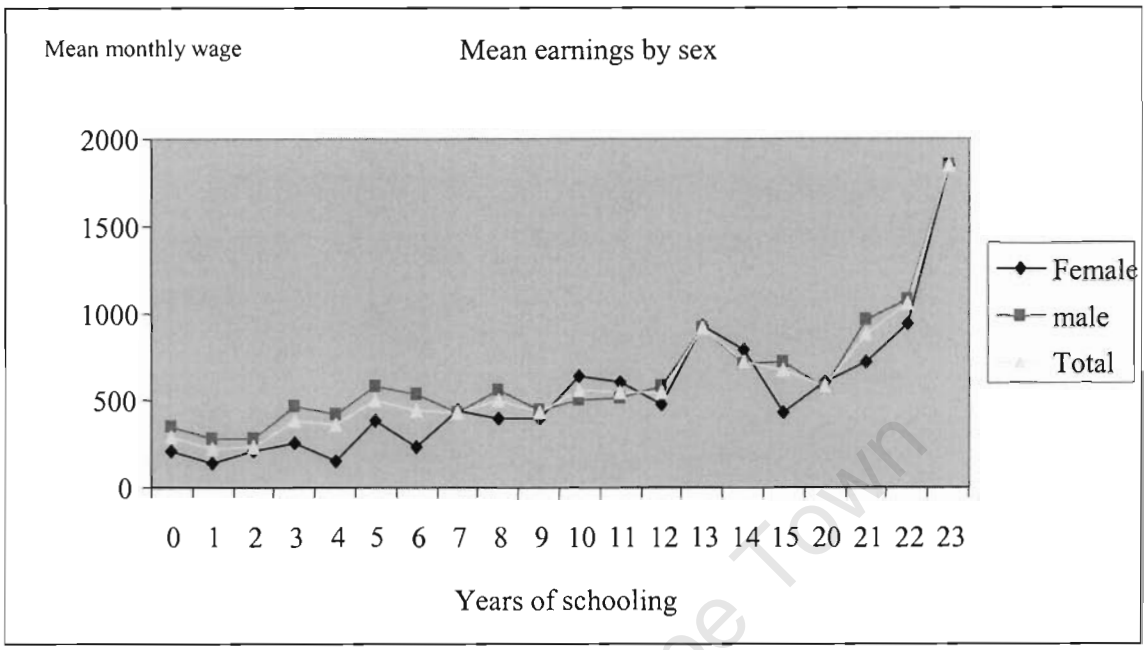
Employing potential experience as a proxy for actual work experience is not without flaws though. It will overstate the actual amount of experience because it assumes that a worker is continuously employed throughout his/her life after school. However, a worker can be unemployed for a number of years after school. Workers also can be frictionally unemployed to change between jobs.

Experience squared is included to test whether the effect of experience on earnings is concave. Figures 3 and 4 clearly show the rate of return for experience increases until 20-25 years of experience. However, after more than 25 years experience, at about the age 50-55, the rate of return from experience becomes negative. In most earnings function estimations the implied earnings-experience profile is concave (Willis, 1986).

Gender

Figure 5 below shows the schooling earnings profile by sex. Average earnings increase with an increase in the level of education. The Figure shows that mean earnings for all levels of education are higher for male workers than for their female counterparts, except for the senior secondary level. This may be explained by the small sample size of females who have senior secondary qualification. A gender dummy is introduced in the earnings function to capture differences between females

and males, all other things remaining constant. In addition, separate earnings functions are estimated for males and females to examine the relationship of the human capital characteristics with earnings in male and female sub samples.



Source: EHIES Eritrea, 1996/97

Figure 5. Mean earnings and years of schooling

Ethnicity

An ethnicity variable is included in the study because it is hypothesized that the Tigrigna people, the majority, are expected to be more exposed to education and other public services, which makes their opportunity to invest in schooling significantly

Table 1. Distribution of the sample by ethnic group

	Frequency	Percent
Afar	1423	1.9
Billen	2850	3.7
Hedareb	84	0.1
Kunama	1779	2.3
Nara	2137	2.8
Rashaida	71	0.1
Saho	2406	3.2
Tigre	13914	18.3
Tigrigna	41552	54.6
Other	237	0.3
not asked	9630	12.7
Information missing	41	0.10
Total	76124	100.0

Source: EHIES Eritrea, 1996/97

higher than any other group. In addition, since the majority of the Tigrigna ethnic group are located in relatively metropolitan areas, their probability of wage employment is higher. The above differences will be captured by the education and regional variables. The ethnicity dummy is introduced for Tigrigna and non-Tigrigna to capture any effect of ethnicity on earnings, keeping all other things constant. This is used to explore the possibility of racial discrimination in a crude way, i.e. by speculating whether certain rewards are not related to education, experience etc. As shown in Table 2 above, the Tigrigna population comprises about 55% of the sample.[15]

EPLF dummy for party membership

A party member identifier is specifically included, as we expect ex-fighters to enjoy some special premium considering the importance of their participation in the armed struggle. In other words, the role of the pre-independence history of individuals in the determination of earnings in Eritrea is expected to be significant. Generally, party members are better educated than non-ex-fighters. The mean educational level for ex-fighters is 8.81 years, whereas for non-ex-fighters it is 7.5, years which is not much different, though. The average age for ex- fighters is 35 years, whereas for non-ex-fighters it is 38 years, again this is not that different. When we look at work experience, we find that non-ex-fighters are more experienced than ex-fighters. This seemingly real difference in experience is because the number of years the ex-fighters spent in the armed struggle, as soldiers, were considered as work experience in post-independence Eritrea as civil servants. By and large, in all aspects the differences between the mean characteristics of these two groups are small. What is striking is the earnings differential. The average salary for an ex-fighter is 804 ERN per month, whereas it is a mere 436 ERN for non-ex-fighters. The ratio of the mean salary of ex-fighters to that of non-ex-fighters is 1.84. That is, the mean earnings of ex-fighters are 84% higher than the average earnings of non-ex-fighters. There is therefore, a noticeable earnings gap between ex-fighters and non-ex-fighters in post-independence

[15] The ethnicity dummy was found to be insignificant in all specifications and hence it is not reported in the models estimated.

Eritrea. Thus the EPLF dummy is employed as a proxy for the pre-independence history of workers as one of the determinants of earnings in Eritrea.

Regional Dummy "ASMARINO[16]"

It is expected – and true – that earnings in Eritrea are not the same in the capital Asmara and other towns. There are substantial regional income level differences in Eritrea. Average income in the capital Asmara is more than twice as high as the average income in the other towns of the Highlands and Lowlands. It should be noted, however, that the composition of income in the Highlands and Lowlands is not same (EHIES, 1998). The 'ASMARINO' regional dummy is included in our model to capture regional variation. That is ASMARINO=1 if the town is Asmara and ASMARINO=0 otherwise.

5. Empirical Results

In this section the estimated Mincerian earnings functions are reported. The methodology employed will range from the simple standard specification to the extended earnings function. That is to say the Mincerian earnings function will be built up to test the different hypotheses. The specification will be broadened in such a way that it includes other relevant determinants of earnings in subsequent stages.

5.1. The Standard Mincerian Earnings Function[17]

In this section the standard earnings function is fitted, in which the logarithm of earnings per month is expressed as a linear function of the number of years completed and as a quadratic function of years since leaving school or work experience. Results are reported in Table 2. This estimation is done so as to compare the rate of return estimates for schooling and experience with the corresponding education literature of developing countries. Earnings functions similar to those reported in Table 2 have been estimated many times using cross-sectional data for many countries (Willis, 1986). Table 2 reports the ordinary least-square estimates (OLS) of the standard

[16] Asmarino is an Italian term applied to individuals who are born and brought up in Asmara, the capital city.

[17] All models were tested for hetroskedasticity using White's test for hetroskedasticity; null hypothesis, Ho: homoskedasticity against alternative hypothesis Ha: unrestricted heteroskedasticity. The null hypothesis was not rejected in all cases.

earnings equation by using HIES data for Eritrea[18]. Table 1 reports results for males and females separately. In both cases, in column 1 and 2, all the coefficients are significant at 1% level and have the expected signs. The overall model, column 3, explains about 38% of the variation in earnings. The explanatory power of the model as a whole is quite robust and comparable with and in some cases even higher than the basic earnings functions estimated for developing countries (for example, see Psacharopolous , 1973, Psacharopolous and Woodhall, 1985, Psacharopolous and Robert, 1996 and Siphambe, 2000). The education coefficient, which is a crude measure of rate of return to schooling, is 9.65%. Psacharopolous and Patrinos (2002), report the average rate of return for schooling to be 11.7% for sub-Saharan Africa countries and 9.7% for the world average. The lower rate of return to education in Eritrea *vis-à-vis* the other Sub-Saharan African countries may be explained by the lower earnings forgone. For instance, in Eritrea, a professor's salary would not be enough to own a car. The government, which employs 80% of post-high school graduates, pays little attention to school and more to other factors such as the pre-

Table 2. Standard Earnings function. Dependent variable is lnwage

	OLS (1) Male	OLS (2) Female	OLS (3) All
Constant	4.70896***	4.48392***	4.541036***
	(0.0677)	(0.0891)	(0.5378)
Years of schooling	0.08375***	0.10399***	0.0965125***
	(0.0036)	(0.005)	(0.002913)
Experience	0.047098***	0.02931***	0.0416627***
	(0.0035)	(0.0048)	-0.002862
Experience squared	-0.0005***	-0.0002***	-0.0004017***
	(0.00006)	(0.00007)	(0.0000449)
R^2	0.3118	0.4129	0.376
N	1327	716	2043

Source: EHIES 1996/97. The values in parentheses are standard errors.
***Significant at 1% level.

[18] A tobit model was estimated and there seems to be no significant change in the sign and size of coefficients. This is explained by the fact that the number of censored observations is very small *vis-à-vis* the non-censored observations. According to our computer output there were only two left-censored observations.

independence history of the worker and party affiliation in setting the salary scale. Briefly, the benefits accruing to additional years of schooling are low in Eritrea. The result of this study overlaps exactly with the world average.

It is to be noted that in the above estimations the influence of years of schooling on earnings is treated as linear and constant throughout the different levels of education. Its effect is, as expected, positive and significant. This model is naïve in a sense, though, because it assumes the rate of return for all education levels to be uniform throughout. In Section 5.2, this assumption will be relaxed and splines will be employed.

The effect of experience is found to be positive and significant in linear terms. When experience squared was introduced, it was found to be significant and negative. There is a peak level of experience, at which experience affects earnings positively. Experience adds positively to earnings until the age of 52[19]. Thereafter, though, there are diminishing returns from experience. This agrees with the age-earnings profile reported in Section 4 and is also in line with Becker's hypothesis (1974).

In Table 2, the model has a larger explanatory power for females, OLS (2) with an R^2 of 41.29% as compared with 31.18% for males, OLS (1). All coefficients are significant at the 1% level of significance and have the expected signs for both sexes. Females have higher rate of return to education, viz. 10.4% compared with 8.3% for males. These results are in line with many findings and may be attributed to the lower forgone earnings of females compared with their male counterparts (see Figure 5). The higher private rate of return for females also explains their relative scarcity in the labour market. This analysis is replicated for the extended earnings function in later sections.

The results in Table 2, columns 1, 2 and 3 may potentially be subject to selection bias. The results are estimated for only those individuals who were working for wages, resulting in a censored sample of the population. The problem is that

[19] The point at which experience stops adding positively to earnings is defined by $\frac{\partial \ln wage}{\partial \exp er} = 0$ from the earnings function.

unobserved wage offers for those not working are probably lower than for those persons who are in the sample[20]. The wage information of the employed is hereafter extrapolated to the unemployed. To check for these effects, the Maximum Likelihood Heckman two-stage model is utilised. The results for this Heckman two-step method are summarised in Table 3.

Censored data and Sample selection[21]

The two-stage estimation procedure suggested by Heckman mainly captures the common structure of models of censoring, sample selection and truncation. In all cases we have a dependent variable $\ln wage_i$, which is completely observed only for a sub-sample (the employed wage earners) of our total sample. Whether $\ln wage_i$ is completely observed or not can depend on the value of $\ln wage_i$ itself (in which case we have simple censoring) or upon the value of another variable z_i, say the variable $employed_i$[22] in our case, (in which case we have a sample selection issue). The difference between censoring and sample selection is that in the former we have information on both selected and non-selected samples. The difference between censoring and truncation is that in the latter we only have data of the selected sub-sample. Therefore, whereas for censored and sample selected data we can model both the selection stage (the probability that a given worker is employed) and the outcome stage (the expected value of $\ln wage_i$, conditional upon a worker being employed), for truncated data we can only model the latter (Breen, 1996).

The basic model for censored data is the so-called tobit[23] model, following Tobin (1958). One very common interpretation of the tobit and other similar models, is in terms of underlying latent variables, $\ln wage^*$, whereas $\ln wage$ is the actual observation. In our case $\ln wage^*$ will be the true wage and the observed wage rate (monthly) would be denoted by $\ln wage$. That is, $\ln wage^*$ will be the capacity of individuals to earn a certain wage rate, but this is only realised if the actual monthly

[20] The nature of unemployment in Eritrea is mostly of voluntary in nature as a result of negative attitudes to some jobs(unpublished report, Labour Office, Asmara, 1997).
[21] This section is mainly taken from Breen (1996).
[22] $employed = 0$ if the worker is unemployed and $employed = 1$ if the worker is employed. The EHIES 96/97 uses a narrow definition for unemployment.
[23] Tobit is short cut for Tobin's probit.

salary exceeds zero. Therefore, even though many observations (about 41 in our sample) may have an identical value zero on the realized variable, they can be considered to vary on the latent variable. The model in terms of the underlying variable can be written as:

$$\ln wage_i = x_i^{'}\beta + u_i \quad [24] \tag{3}$$

and the relationship between the latent and actual $\ln wage$ can be written as

$$\begin{aligned} &\ln wage_i = \ln wage^{*} \; if \; \ln wage^{*} > c; \\ &\ln wage_i = cif \; \ln wage^{*} \le c \end{aligned} \tag{4}$$

where c is the threshold for censoring ($c = 0$ in our sample). Our model, if written in terms of observed monthly salary, $\ln wage$ and allowing the censoring threshold to be zero, is then:

$$\ln wage_i = x_i^{'}\beta + u_i \qquad \text{if } \ln wage_i > 0 \tag{5}$$

$$\ln wage_i = 0 \text{ Otherwise.}$$

The formula for an expected value of a variable, which is censored at $c = 0$ can be stated as:

$$\mathrm{E}(\ln wage_i \mid x_i) = pr(\ln wage > 0 \mid x_i)\mathrm{E}(\ln wage_i \mid \ln wage_i > 0, x_i). \tag{6}$$

This can also be estimated by the two-stage Heckman model. Lets us present both stages of Heckman's procedure.

Selection stage

Note that $\ln wage > 0$ implies $x_i\beta + u_i > 0$ and hence $u_i > -x_i\beta$. That is, the probability of $\ln wage > 0$ means the probability that $u_i > -x_i\beta$. Since u_i is normally distributed, we are looking for the probability of u exceeding z_i, where in this case $z_i = -x_i^{'}\beta$. After a certain mathematical derivation[25] the selection stage can be denoted by

$$\Phi_i \equiv \Phi\left(\frac{x_i^{'}\beta}{\sigma}\right)' = \int_{-\infty}^{x_i'\beta/\sigma} \frac{1}{\sqrt{2\pi}} \exp(-t^2/2)dt \tag{7}$$

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[24] Assumptions: (1) u_i are independent and normally distributed errors with a zero mean and constant variance σ^2; (2) correct functional form of the model: (3) no measurement error (4) no omitted variable from the model specification. It is worth noting that these models are less robust to the violation of underlying assumptions.

[25] But because the normal distribution is symmetric, the probability that a normally distributed variable exceeds z is equal to the probability that it is less than $-z$. Then in this case $pr(u_i > -x_i^{'}\beta) = pr(u \le x_i^{'}\beta)$.

where Φ_i is the normal distribution function evaluated at a probability of $x_i'\beta/\sigma$ and ϕ_i is the density which corresponds to that probability.

Equation 7 is the standard normal distribution function and it tells us nothing but the probability that a standardised normally distributed random variable (with mean zero and standard deviation of one) is less than or equal to $x_i\beta/\sigma$. This probability is equal to the proportion of the area under the standard normal curve that lies between $-\infty$ and $x_i\beta/\sigma$. This probability can be estimated by a probit model (Amenya, 1984). In this probit model σ and β are not independently known. The parameters estimated for this model are then $\frac{\beta}{\sigma}$. However most of the time, for the sake of simplicity, we assume $\sigma = 1$ (Breen, 1996).

Outcome stage

The second stage of the estimation is the outcome stage. Note that from condition (4) if $\ln wage^* \leq 0$, we have zero observations on $\ln wage$. Therefore we need to estimate only the expected value of $\ln wage$, conditional on $\ln wage > 0$. This can be written as:

$$\mathrm{E}(\ln wage \mid \ln wage > 0, x_i) = x_i'\beta + \sigma\hat{\lambda}_i, \quad (8)$$

where $\hat{\lambda}_i = \phi_i / \Phi_i$, which is known as the inverse Mills ratio or hazard rate.

Another way to estimate the model is to use the rule of conditional probabilities. [26] This can be written as:

The probability that a normally distributed random variable with a zero mean and a variance of σ^2 is less than or equal to $x_i'\beta$ is denoted by $F(x_i'\beta,\sigma^2)$ or F_i for short. This is given by $F_i = F(x_i'\beta,\sigma^2) = \int_{-\infty}^{x_i'\beta} \frac{1}{\sqrt{2\pi\sigma^2}} \exp(-t^2/2\sigma^2)dt$. This probability is equal to the proportion of the area under a normal curve. With a mean zero and a standard deviation of σ that lies between $-\infty$ and $x_i'\beta$. In turn, however, F_i is equal to a quantity we denote $\Phi(x_i'\beta/\sigma)$ or Φ_i for short, where $\Phi_i \equiv \Phi\left(\frac{x_i'\beta}{\sigma}\right) = \int_{-\infty}^{x_i'\beta/\sigma} \frac{1}{\sqrt{2\pi}} \exp(-t^2/2)dt$.

[26] The expected value of a random variable y is the sum of the products of the probability of y falling into one set of disjoint intervals, and the expected value of y in that interval. Let I_n $(n = 1,2,3...n)$ be the expected value of the intervals, then mathematically: $\mathrm{E}(y) = \sum_{n=1}^{n} pr(y \in I_n)\mathrm{E}(y \mid y \in I_n)$ (1). By the same token with regard to the problem of censoring, where we have an earnings function: $\mathrm{E}(\ln wage \mid x_i) = x_i'\beta$ (2)

$$E(\ln wage_i \mid x_i) = \Phi_i \left[x_i'\beta + \sigma \frac{\phi}{\Phi} \right] \quad (9)$$

To estimate 9 we first need to estimate the probit, which will give us the first stage denoted by Φ_i in equation 9. The conditional expectation of $\ln wage$ is then estimated by replacing Φ_i and ϕ_i with their estimated values from the probit relation, so that we get the following relation

$$E(\ln wage \mid x_i) = \hat{\Phi}\beta x_i + \sigma \hat{\phi}_i \quad (10)$$

Equation 10 can be estimated via OLS, but this time by using all the sample observations.[27] Despite the simplicity of estimating the model via OLS, there are some difficulties. The estimated standard errors of the coefficients and σ are all incorrect (Breen, 1996). These difficulties can be dealt with by using Maximum Likelihood estimation (MLE), though. Therefore this paper estimates the Heckman two-stage model by using this method.

Table 3 summarises the OLS and Heckman two-stage models in columns 1 and 2, respectively. The problem is that the estimates in column 1 are based on information from only those who are working, resulting in a censored sub-sample. The expectation is that the unobserved potential wage rates for those who are unemployed are lower than those observed in the sample. The Heckman estimates in column 2 correct for this difficulty. The results of the Heckman two-stage estimation show that the coefficient for years of schooling is reduced by about 0.3% on average. That is, the rate of return was overstated by 0.3% in the OLS results. The inverse Mills ratio is also negative and significant at the 1% degree of level of significance.

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where the subscript i denotes the ith individual in the sample and both x and β are column vectors. If we assume a dichotomizing of the values of $\ln wage$ around a constant c then it can be written as $E(\ln wage_i \mid x_i) = pr(\ln wage_i > c \mid x_i)E(\ln wage_i \mid \ln wage_i > c, x_i) + pr(\ln wage_i \le c \mid x_i)E(\ln wage_i \mid \ln wage_i \le c, x_i)$ (3). Because $\ln wage_i$ is now dichotomised with respect to c, the probability that $\ln wage_i$ is less than or equal to c is equal to one minus the probability that $\ln wage_i$ is greater than c. Then (3) can be written as $E(\ln wage_i \mid x_i) = pr(\ln wage_i > c \mid x_i)E(\ln wage_i \mid \ln wage_i > c, x_i) + [1 - pr(\ln wage_i > c \mid x_i)]E(\ln wage_i \mid \ln wage_i \le c, x_i)$ (4). If we have truncation of $\ln wage_i$ from below at the value c where $c = 0$ then the expected value of our observed $\ln wage_i$ is simply: $E(\ln wage_i \mid x_i) = pr(\ln wage_i > 0 \mid x_i)E(\ln wage_i \mid \ln wage_i > 0, x_i)$ (5). It follows from equation (5) that we need to estimate the selection stage (the probability of not being censored) and the outcome stage (expected value of the observation conditional on not being censored) to estimate (2) when there is a censoring problem, for instance the sample selection problem in this paper, where $\ln wage_i$ is conditional upon being employed.

[27] The estimator β is known in the literature as the Heckman two-step estimator (Amenya, 1984, and Breen, 1996).

The interpretation of the negative sign of the selectivity term is that actual wage rates are lower than the wage rate of any randomly selected worker. A second possible explanation of this term is that the employed wage earners do not necessarily have a comparative advantage. It is worth noting also that the model is significant as a whole.

Table 3. OLS and Heckman estimates for the standard Mincerian earnings function

	OLS 1	Heckman 2
Constant	4.541036***	4.583506***
	(0.5378)	(0.0582343)
Years of schooling	0.0965125***	0.0937524***
	(0.002913)	(0.00304620)
Experience	0.0416627***	0.0423928***
	(0.002862)	(0.0031436)
Experience squared	-0.0004017***	-0.000438***
	(0.0000449)	(0.0000507)
Inverse Mills ratio		-0.4820429***
		(0.0447243)
N	2043	1948
R^{-2}	0.376	
Log likelihood		-1932.014
χ		1005.61

*** Significant at 1% level of significance
N= number of observations

5.2. Expanded Earnings Function

So far the discussion has been confined to estimating the standard Mincerian earnings function for Eritrea. In this section the model is expanded to include additional independent variables. The assumption to be relaxed is that different levels of schooling have the same effect on earnings. Different schooling splines are thus introduced for elementary (grade 1 to 6), middle (grade 7 and 8), secondary (grade 9-12), university incomplete, first year to fourth year university dropouts, university certificate, university or vocational diploma, bachelors degree and postgraduate

degree. Table 4 below shows the expanded earnings results, based on both OLS and Heckman two-step estimators.[28]

Table 4. Expanded Mincerian Earnings function

Variables	OLS	Heckman
Constant	4.496631***	4.465008 ***
	(0.058695)	(0.0603618)
Elementary	0.081193***	0.086525***
	(0.008532)	(0.00853707)
Middle	0.109812***	0.0890034***
	(0.028501)	(0.0290506)
Secondary	0.1020935***	0.1141493***
	(0.013973)	(0.0143034)
University incomplete	0.1301912***	0.1269287***
	90.037705)	(0.03869450
University certificate	-0.0398634	-.0462724
	(0.441040)	(0.0452419)
Vocational/University diploma	0.284488***	.3215922***
	(0.1181763)	(0.11981730
Bachelors degree	0.2547219***	.253016***
	(0.090497)	(0.0913170
Postgraduate	0.1177023	.1030048
	(0.2190898)	(0.22103390
Experience	0.0335855***	.0363285***
	90.0027950	(0.0030199)
Experience squared	-0.0002657***	-0.0003126 ***
	(0.00004350	(0.00004930
Asmarino	0.1363152***	0.1264625 ***
	(0.029769)	90.0302668)
EPLF	0.6174392***	0.6176762***
	(0.037242)	(0.35311471)
Inverse Mills ratio		-.4507564***
		(0.0472414)
N	2021	1948
R^2	0.4252	
Log likelihood		-1781.285
χ^2		1476.66

***Significant at 1% level of significance
N=number of observations

Almost all the coefficients in Table 4 are in accordance with the theoretical expectations. All the education splines except the university certificate have the

[28] The tobit model was also attempted because of the possible incidental truncation of the sample. However the results were very similar to those of OLS. It follows that our sample does not seem to suffer from the problem of incidental truncation.

expected coefficient sign.[29] The OLS model overstates the rates of return to education in almost all cases. The Heckman two-stage results are deemed more reliable, as they account for sample selection bias; the adjustment term (Inverse Mills ratio) is significant. In terms of the profitability of education, the highest rate of return is found to be for technical school or university diploma. Investing in technical school and college education are thus the most profitable areas for an individual in Eritrea. The rate of return for technical school graduates is 32.2%. The next highest rate of return is found among university degree graduates, 25.3%. The coefficient of postgraduate education is statistically insignificant. This may be explained by the small number of observations for postgraduates. There are only 27 postgraduate degree holders in the sample. The findings from this paper do not support the ongoing Eritrean Human Resources Development (EHRD) programme. As part of the national development plan, the Government of the State of Eritrea is currently investing about 53 million USD in postgraduate training.[30] This is a high cost for Eritrea. The total services expenditure for the Eritrea in 2001 was only about 70 million USD (Ministry of Finance, 2000). Of course there may be some non-wage benefits for the society from the project, such as institution building, for instance. Moreover, this study is somewhat limited in that it does not include the costs associated with each educational level. It is worth remembering that the estimated coefficients are rough estimates of the rate of return to education that could be found from cost benefit analysis.

The highest private rate of return to a technical school graduate is in line with the relatively high demand for technical school graduates. Since the country has entered the reconstruction stage, the demand for technicians has been high. In addition to the fact that there are only two technical schools in the country, the supply is still far behind the demand. This high demand for technical school graduates emanates from two sources. The first direct demand is the demand for technical school graduates in the aftermath of independence in the reconstruction and rebuilding of the nation.

[29] Table 6 suggests that there are increasing returns to education as opposed to the neoclassical theory of diminishing returns to education. The findings from Eritrea tend to disagree with the concave relationship of earnings and years of schooling. The relationship is found to be convex. These findings tend to agree with the South African findings (Keswell and Poswell, 2003). The implication for inequality and poverty is that education exacerbates income inequality and this suggests the prevalence of poverty trap.

[30] The HRD project is mainly being carried out in South African Universities and Technicons, where close to 600 students both at postgraduate and undergraduate levels are studying. This HRD project is funded by the World Bank AIDA loan.

Secondly, since the University of Asmara was only able to produce engineering diploma graduates in 1998; technical school graduates were in the interim in most cases working as engineers, even though they did not have the correct qualifications. This pushed up the demand even further. For instance, technical school graduates were in high demand on the projects that were initiated after independence, such as the Sembel Housing complex, Hirgogo Power plant, Massawa Airport etc. In these specific projects, they were working as assistant engineers and in some instances even as engineers.

Another variable of interest to consider is the EPLF dummy. The EPLF dummy is included as a party member identifier, as we expect the ex-fighters, as party members, to enjoy some special premium considering the importance of their pre-independence history. According to Table 4 above, the coefficient for EPLF is positive and significant at the 1% level. This is in line with our expectation. The interpretation of the coefficient for the dummy variable for party membership, following Halvorsen and Palmquist[31] (1980), is that the mean salary of ex-fighters is 85.417% higher than that of non-ex-fighters, all other things remaining constant. This matches the ratio of mean earnings of ex-fighters to non-ex-fighters in our sample. This is in fact a shocking result, and may imply an element of discrimination. Although this is a very crude and simple way of estimating discrimination there does indeed seem to be discrimination against non-ex-fighters or "*Gebar*" as the ex-fighters like to call them. This is in line with what Arneberg (1999: 7) reports. He explains this earnings differential as follows: "the reason is that ex-fighters, who commonly work for the government, receive wages above that of persons with an equal level of formal education. This might be justified by the practical experience and training they received during the war or after, but the practice is also a political decision."

The proxy for the regional dummy is also found to be positive and significant. This conforms to expectations. The interpretation of the coefficient for the Asmarino dummy is that the mean salary of an individual who resides in Asmara is about 13.5% higher than of those who stay in other towns or regions, all other things remaining constant. This is in line with the report from the EHIES that the average income in the

[31] The coefficient of a dummy variable is interpreted by taking the natural antilog of the estimated dummy coefficient and deducting one from it. This gives the % premium to EPLF.

capital Asmara is more than twice as high as the average income in towns in the Highlands and Lowlands. The discrepancy between the reports and this study's findings may be explained by the fact that in our model the earnings differential is captured by education and experience. That is to say, because the people around Asmara have better access to schooling, health and other public services, they are also more educated than the individuals in the other regions of the country, and hence able to command higher wages.

5.2.1 Earnings Variation by Sector of Employment

Table 5 summarises the extended Mincerian earnings functions by sector of employment. According to this Table, the rates of return to education differ substantially between private and public sector employment. The rate of return to primary education is higher in the public sector than in the private sector. While the rate of return to primary school completion is about 6.5% for the private sector, it is higher in the public sector, amounting to 10.8%. However, for junior and secondary education the rate of return is higher in the private sector than the public sector, i.e. for junior school the rate of return to schooling is 11.7% and 7.3% in the private and public sectors respectively. The rate of return to secondary education is 13.1% and 9%for the private and public sectors, respectively. This suggests the relative employability of junior and secondary school leavers in the private sector. This may be explained by two factors. Firstly, the private sector wage has been adjusting to relative demand and supply factors. In the public sector however, wages are relatively highly administered. Secondly, the higher rate of return may reflect relatively lower security of employment in the private sector *vis-à-vis* the public sector. Turning to the rate of return to postgraduate education, it is statistically insignificant in both cases, as it is in the whole sample. As mentioned earlier, though, this could be due to the small number of observations available.

University or technical school certificates have no significant effect on earnings. In both sectors the relevant coefficient turned out to be statistically insignificant. This may imply that a certificate programme does not equip workers with any skills that enable them to increase their productivity. This is not surprising though. In most cases

Table 5. Augmented Mincerian earnings function for private and public sectors. Dependent variable: lnwage

Variable	Private	Public	Total
Constant	4.345346***	4.548553*	4.465008 ***
	(0.1064473)	(0.0746449)	(0.0603618)
Elementary	0.0647674***	0.1081993***	0.086525***
	(0.0143128)	(0.0107161)	(0.00853707)
Junior	0.1174847**	0.0728196*	0.0890034***
	(0.0467104)	(0.0353787)	(0.0290506)
Secondary	0.1310741***	0.0897682*	0.1141493***
	(0.0246581)	(0.0173391)	(0.0143034)
University incomplete	0.2439472***	0.0863697***	0.1269287***
	(0.0875529)	(0.0394754)	(0.03869450
University certificate	-0.2109776	-0.0181123	-0.0462724
	(0.1504545)	(0.0439935)	(0.0452419)
Vocational / University diploma	0.7207881	0.2648255***	0.3215922***
	(0.5201637)	(0.1077761)	(0.11981730
Bachelors degree	0.3713923	0.2892931*	0.253016***
	(0.3255098)	(0.0836846)	(0.0913170
Postgraduate	0.3704822	0.0581629	0.1030048
	(0.7614307)	(0.1984536)	(0.22103390
Experience	0.04988628**	0.0244956*	0.0363285***
	(0.0057909)	(0.0034197)	(0.0030199)
Experience square	-0.0005083***	-0.0001484*	-0.0003126 ***
	(0.0000955)	(0.0000549)	(0.00004930
Asmarino	0.1680585***	0.1245668*	0.1264625 ***
	(0.0591509)	(0.0340698)	(0.0302668)
EPLF	0.4016404***	0.7036333*	0.6176762***
	(0.0874952)	(0.0380137)	(0.35311471)
Inverse Mills	-0.655501*	-0.4945951*	-0.4507564***
	(0.0522242)	(0.0103762)	(0.0472414)
Log likelihood	-857.1678	-987.1789	-1781.285
χ^2	374.98	1259.17	1476.66
N	789	1114	1948

***Significant at 1% level. **Significant at 5%. *Significant at 10%.
Values in parentheses are standard errors

the University of Asmara offers certificate programmes tailored for government employees, mainly ex-fighters, to justify their positions. That is, whether they get the certificate or not does not affect their earnings, except for providing them with credentials, which can help them to retain their position.

With regard to the rate of return to university/ vocational diplomas and bachelor degrees, they are found to be positive and significant only in the public sector. According to Table 5, the coefficients of vocational/university diploma and

bachelors degree holders in the private sector are found to be statistically insignificant. This, too, is not surprising though. It may be explained by the small number vocational/university diploma and bachelor degree holders employed in the private sector. The majority of graduates are employed by the government. Government employs 80% of the people with post-secondary education, whereas the private sector and the field of self-employment are more important for unskilled people, employing about 50% of those with no formal education (Arneberg and Pedersen, 2001). However, according to their report, wage rates for highly skilled personnel in the private sector were higher than those paid by the government. The report does not identify the specific skills though.

The coefficient of the EPLF dummy is found to be positive and significant in both cases. The coefficient of EPLF is substantially higher in the public sector than in the private sector. This is in line with expectations. In the public sector, party premium is 52.21% higher than in the private sector. This is in line with the fact that the government can influence wage determination in the public sector by giving high wages according to the pre-independence history of an employee.

With regard to experience, Table 5 shows that the effect of experience on earnings is higher in the private sector than in the public sector. The coefficient of experience is about 0.50 in the private sector and 0.02 in the public sector. This may be explained by the relative competitiveness of demand for experienced workers in the private sector. Private sector workers get higher wages as their experience increases, and as they master their job and increase their productivity. If employers fail to pay higher wages with an increase in experience workers may change jobs. Employers thus have to pay higher wages for experience to retain experienced workers. A high wage or an increase in wages encourages that person to stay with the company for a longer period. The assumption is that not only is there an increase in productivity, but also in the loyalty and obedience of workers. Those who are self-employed may also benefit from experience via an increase in productivity. By contrast, in the government sector, experience was not valued when the salary scale

was designed in 1994,[32] except for that of ex-fighters. During the retrenchment programme of the government the number of years that workers had worked for the previous Ethiopian regimes were not counted as experience in wage determination. Moreover, since there is relative security of employment in the public sector, workers are generally willing to accept lower rewards for their experience. Consequently, it is not surprising that the rate of return from experience is higher in the private sector than in the public sector.

5.2.2 Earnings Variation by Gender

As discussed in Section 5.1, the influence of years of schooling and experience on earnings is different for males and females. In this section we replicate the procedure but now incorporate the extended Mincerian earnings function. Without resorting to the complexities of estimating discrimination, we estimate separate equations for both sexes to gain a sense of any gender differential in the determination of earnings. The accurate measurement of discrimination of course needs a separate treatment, as it is controversial and as it raises the common problems of measurement error.

Table 6 reports extended Mincerian earnings functions for males and females separately. This procedure was followed in order to investigate possible differences in the determination of earnings between sexes. In other words we checked whether the relationship between earnings and the independent variables in our model were uniform or not across the sexes. According to Table 6, the rates of return to education were indeed substantially different for males and females. The private rates of return from elementary, middle and secondary education are higher for females than males.

While the rate of return for females who completed primary school is about 7.7%, it is 4.2% for males. The rate of return to middle education is about 13% for females, whereas as the rate of return to education for males is only 46% of that of females. The rate of return from secondary education is about 13.5% for females, whereas that for males is only 9.8%. However, the rates of return to university diploma and bachelors degree for females are statistically insignificant, whereas for males they are positive and significant. This may, however, be partially attributed to

[32] There was a retrenchment of public sector employers in 1994 for the purpose of creating a more effective and slimmer public sector.

the sample size, i.e. the number of female vocational or university graduates was very small.

Table 6. Augmented Mincerian earnings function by gender. Dependent variable: lnwage[33]

	Female	Male
Constant	4.410008***	4.752795***
	(0.0913763)	(0.0779972)
Elementary	0.0769576***	0.0423625***
	(0.01199660)	(0.0116039)
Middle	0.129557***	0.060126***
	(0.0420993)	(0.0358129)
Secondary	0.1350554***	0.0983895***
	(0.02153650	(0.0173849)
University incomplete	0.1919295**	0.0953742**
	(0.0752112)	(0.0434948)
University certificate	-0.0804505	-0.0198757
	(0.0805971)	(0.0532624)
Vocational/University diploma	0.191263	0.3664549**
	(0.1585)	(0.1537841)
Bachelors degree	0.2587287	0.2146431**
	(0.1708332)	(0.1064691)
Post graduate	0 .01031458	0.1051458
	0.2345378	0.2263378
Experience	0.0359324	0.0402868
	(0.005487)	(0.003577)
Experience square	0.000402***	-0.0004701***
	(0.0001024)	(0.000058)
Asmarino	-0.0163201	0.2841291***
	(0.0454264)	(0.0386106)
EPLF	0.8895834***	0.4708481***
	(0.0567918)	(0.0386106)
Inverse Mill's Ratio	-0.3715174	-0.4659583
	(0.0736089)	0.0632922
Log Likelihood	-452.9735	-1748.2252
χ^2	994.29	1194.36
N	658	1290

* **Significant at 1%. **Significant at 5%. values in parenthesis are standard errors

When we look at the other variables, however, the above trend is reversed. The rate of return to experience is marginally higher for males than for females in linear terms. Moreover the coefficient of the regional dummy Asmarino is positive and significant only in the male equation. Its interpretation, following Halvorsen and

[33] The regressions for males and females were tested for independence via Chow test and were found to be independent.

Palmquist (1980), is that males who are from the capital city Asmara earn 32.9% more than males from the other regions, all other things remaining constant, whereas for females the results suggest that there is no regional income differential. Finally, Table 6 shows that the rate of return for EPLF party membership is higher for females than for males. Following Halvorsen and Palmquist (1980), the mean earnings of ex-fighter females are 143% higher than non-ex-fighter female, all other things remaining constant. Using the same technique, the coefficient of the EPLF dummy in the male equation can be interpreted as follows: the mean earnings of ex-fighter males are 60%higher than male non-ex-fighters, all other things remaining constant[34]. This may be explained by the affirmative actions pursued to ensure the political representation of females in many posts.[35]

5.2.3 Earnings Variation by Occupation

Work activities have remarkable differences in their pecuniary and non-pecuniary nature. Specific working conditions differ from one occupation to another, for example the elements of risk, safety and other working conditions. Hence, to equalize for these differences, employers pay different wage rates to compensate for the relative disutility of any occupation. In most cases, there are also personal preferences and perceptions towards many occupations. Adam Smith in his famous book The Wealth of Nations argues that wages paid should equalize the differences in amenities and disamenities (1947). For example, when there are two jobs, which differ in their non-monetary disamenities, the wage paid should compensate for the difference. Of course there is also a demand and supply interaction in the final analysis. Smith states his argument as follows:

> "The whole of advantages and disadvantages of different employment of labour and stock must, in the same neighborhood, be either perfectly equal or continually tending to equality. If in the same neighborhood there was any employment evidently either more or less advantageous than the rest, so many people would crowd into it in one case, and so many would desert it in the other, that its advantages would soon return to the level of other employments" [Adam Smith, 1947: Chapter one, Book I]

The idea of equalizing differential is a long-run concept, though. In the end, the demand and supply of labour after adjustments to the pecuniary and non-pecuniary costs and benefits will adjust accordingly to set the wage rate. People will ultimately respond to the long-term benefits and costs of different

[34] This may also mean greater gender earnings differential among non ex-fighters.
[35] One third of the EPLF members in the armed struggle were females.

occupations. This concept of equalizing differentials is often used as a justification for the analysis of occupational earnings differentials[36]. A decision whether to supply labour or not is a function of the wage *vis-à-vis* the utilities and disutilities of the job in question. Given a high-risk element, the supplier of such labour would expect a higher reward. Hall (1970) notes that some workers are willing to trade off insecurity in employment for higher wages during their term of employment. This paper also finds that the private sector pays more than the government sector, taking into account the security of employment among others.

Table 7. Occupational earnings differential, Heckman two-step method. Dependent variable lnwage

Variable	Coefficients	Standard Deviation
Constant	4.539536 ***	0.0905222
Elementary	0.0550749***	0.0085686
Middle	0.0646154**	0.027426
Senior secondary	0.0938662 ***	0.0139256
University	0.0793416**	0.0372158
Certificate	-0.0126756	0.0428383
Vocational/Diploma graduate	0.2902948**	0.1129074
Bachelors degree	0.1797724**	0.0867629
Postgraduate	0.1308052	0.2057132
Experience	0.0315213***	0.0029445
Experience squared	-0.0002961***	0.0000475
Asmarino	0.1578536***	0.0311676
EPLF	0.515638***	0.0369157
Gender	0.18149198 ***	0.0312471
Professional &Technical	0.2465288***	0.087314
Administrative and managerial	0.3567572***	0.0964576
Government and executive officer	0.0004927	0.1795915
Clerical work	0.2411533***	0.0856927
Sales worker	-0.0746364	0.0974866
Service worker	-0.247500***	0.0790852
Military	0.6875252***	0.1519656
Agriculture/fishing	0.0567833	0.0914478
Production and related	0.1230183	0.075897
Transport Equipment operator	0.3512504	0.0902356
Daily Labourer	Base category	
Inverse Mill's Ratio	-0.3634045	0.0589125
χ^2	1962.81	
Log likelihood	-1652.586	
N	1948	

***Significant at 1% degree of significance. N=number of observations

[36] Imperfect worker mobility may also explain persistent earnings differential.

**Significant at 5% degree of significance. All the occupational dummies are jointly significant at 1% level.

The idea of equalizing differentials has strong empirical practicability and can be employed to explain occupational earnings differentials. This section explores the occupational earnings differential in Eritrea. The occupations are classified into 11 groups, namely: professional and technicians, administrative and managerial, government and executive officer, clerical work, sales worker, service worker, military, agriculture/fishery, production related, transport equipment operator, and daily labourers. Table 7 reports the expanded earnings function by including dummies for each occupational group.

Table 7 clearly shows that the introduction of occupational dummies to the expanded earnings function reduces the size of all coefficients. This may be an indication that the model was suffering from an omission of variables bias. The exclusion of occupation dummies overstated the parameters of education and other variables in the model. Of the 11 occupations only four of them turned out to be significant. These occupational groups are: professional and technical, administrative and managerial, clerical work, service worker and military. The interpretation of the coefficients follows Halvorsen and Palmquist's technique of conversion. The interpretation of the coefficient of military occupation is that earnings of soldiers are on the average 98.9% higher than those of daily labourer, keeping all other things constant. The coefficients for other occupational groups can be interpreted likewise. The highest premium for military workers (soldiers) may be explained as a reward for the high risk involved. This tends to agree with the principle of equalizing differentials. What is most striking is that the coefficient for service workers is negative and significant. This may be explained by the fact that most workers in the service sector are rewarded neither in wages nor in terms of their working conditions. Moreover, most of the jobs under this occupation demand unskilled labour, which is relatively abundant in Eritrea. This may be the cause of the lower wages associated with these jobs.

6. Conclusions

The most common economic theory in wage determination is human capital theory. The first issue in any empirical findings regarding the relationship between earnings and schooling is the methodology of estimation, which takes into account the nature of the data. This paper finds that OLS and tobit estimation results are not significantly different. That is, there is no incidental truncation. However, it was found that there is sample selection bias. The Heckman two-stage estimation technique was found to be the most appropriate econometric method because it avoids the selectivity bias.

Overall the rate of return to education increases as years of education increases. The average rate of return to education was found to be 9.3 percent. Females have a higher rate of return to education than males. These results are in line with many findings and are attributed to the lower foregone earnings of females compared with their male counterparts. The higher private rate of return to education may also explain the relative scarcity of education.

In terms of the profitability of education, the highest rate of return is found for technical school or university diploma, which suggests that investments in technical schools and colleges are the most profitable areas for an individual. The next highest rate of return is found to be for people with a university degree, followed by secondary, middle and elementary school respectively. The coefficient for postgraduate education was found to be statistically insignificant. Of course, all these conclusions may be a little slanted, given the nature of the sample

The rate of return to education differs substantially between private and public sector employment. The private rate of return from primary education is higher in the public sector than in the private sector. However, with regard to secondary school education, the rate of return is higher in the private sector than in the public sector. The rate of return from a university or vocational diploma and the rate of return from a bachelor degree are only significant in the public sector.

Ex-fighters do enjoy some special wage premium, indicating the importance of their pre-independence history. In fact, there seems to be discrimination against non-ex-fighters in the labour market. Although the higher mean wage can be partially attributed to the fact that ex-fighters have a marginally higher level of education, the results can mainly be explained by a political decision. The EPLF party premium is higher in the public sector than in the private sector. Moreover, surprisingly the party premium is higher for females than for males.

The effect of experience is found to be positive and significant in linear terms. Experience squared was introduced and it is found to be significant and negative. There is a peak level of experience, at which experience affects earnings positively. Experience also adds positively to earnings until the age of 52. Moreover, the effect of experience on earnings is higher in the private sector than in the public sector.

Occupational choice is one of the determinants of earnings in Eritrea. However, not all occupational groups affect earnings significantly. The occupational groups, which were found to be statistically significant, are: professional and technical, administrative and managerial, clerical work, service worker and military. Military workers, soldiers, earn the highest premium, followed by administrative and managerial, professional and technical, respectively.

Policy Implications

A positive and significant association between earnings and higher level of technical training implies the urgent need for such institutions that can train individuals along modern lines in order to cope with rapidly changing technology. Three or more years of training would seem to play an important role in the labour market; there is therefore a dire need to keep workers up to date about the technological advancements through high quality technical training.

With regard to the investment in university education, the results support the strengthening of the University of Asmara. The University of Asmara should improve

its programmes and emphasis on a market-oriented approach. The market-oriented approach should be introduced at the school level. This may imply the overhauling of the school system not only in the curriculum but also in its teaching methods.

The coefficient of postgraduate schooling is statistically insignificant. Although this may be explained by the small sample observations for postgraduates, its implication is not simple. The findings from this paper do not support the ongoing Eritrean Human Resources Development (EHRD). There is a need for proper evaluation of the rate of return for this investment. This study could be a starting point for such practice. Of course, there may also be some non-wage benefits to the society from the project, for instance institution building. Moreover, this study is limited in the sense that it does not include the costs associated with each educational level. It is worth remembering that the estimated coefficients are rough estimates of the private rate of return to education that could be found in cost benefit analysis, whereas for policymaking we need to look more at the social rate of return.

A positive party premium for ex-fighters could skew incentives. Even though it is true that ex-fighters lost productive time in the liberation struggle and hence may not compete using their skills in the labour market, other means of compensation should be designed. For instance, some kind of training could be organized or a basic income grant could be arranged for ex-fighters. In this way the government could minimize the disincentive effect for education by rewarding schooling rather than party membership. If individuals are not rewarded for their private investment in human capital, the demand for education may decline and the country would continue to suffer from a shortage of skilled manpower. A competition-based wage-setting mechanism would encourage more investment in education and thereby stimulate innovation. At present, the government cannot be both efficient and effective because it is in a sense subsidising its workers.

The last policy implication is that there is a need for further in-depth studies with regard to investment in education, regional income inequalities and gender earnings differentials. The preliminary results contained in this paper could be a base for such studies.

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