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The Returns to Education in Rwanda

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Abstract

Based on data from the 1999-2001 Household Living Conditions Survey conducted by the Ministry of Finance and Economic Planning, we estimate wage equations for employees in Rwanda, treating the choice of employment sector as an endogenous process, and making separate estimates for workers in the modern and traditional sectors of the economy. The results show that returns to education increase with the level of education, contrary to the pattern typically reported in the literature, and that the returns to higher education is particularly high in Rwanda. A noteworthy feature in the results is that the returns to education are quite different across sectors of employment. In the informal sector, the returns to primary education and those to vocational and secondary general education exceed by a relatively large margin, the returns to the corresponding levels of education in the modern sector. A decomposition of the wage differentials across sectors of employment indicate that personal endowments, particularly in terms of educational attainment, are more important in accounting for the wage gaps, than are the difference in their impact on earnings.

JEL Classification System: J3

Key words: Returns to education, public and private sectors, Rwanda

The Returns to Education in Rwanda

1. Introduction

Rwanda's recent history was marred by a genocide in 1994, in which at least 800,000 people or about 10 percent of the population lost their lives. Stability and security have been restored and the process of recovery has been underway for several years now. Because rebuilding the stock of human capital is a key part of that process, it is of interest to examine the pattern of returns to education and its implications for policy development. Unfortunately, however, no estimate of the profitability of investing in education exists for Rwanda. The purpose of this paper is to fill this information gap. It does so by applying the human capital analytic framework to data on the earnings of workers in the modern and traditional sectors of the economy that were collected in the 1999-2001 Rwanda Household Living Conditions Survey¹. In brief, the findings indicate that education exerts an important influence on workers' accessibility to jobs in the modern sector, and it also affects the wages they receive. In the current context of Rwanda, with its large, if temporary, shortage of educated labor in the aftermath of the genocide, the returns are positive and high at all levels of education, but they are especially sizable for higher education.

The paper proceeds as follows. Section 2 offers an overview of the main characteristics of education in Rwanda in order to set in context our analysis of the pattern of returns. Section 3 describes the dataset, Section 4 elaborates on the estimation technique, Section 5 presents the empirical results and Section 6 summarizes the main findings and conclusions.

2. Some features of education in Rwanda

The education system lost a large number of students in the aftermaths of the 1994 genocide, but recovery had been remarkably rapid despite the massive disruption and devastation,

¹ Workers in the modern sector are employed by the government or hold jobs in formal private sector firms; those in the traditional sector work in informal sector jobs.

and the number of students in primary and higher education now exceeds enrolments in the pre-genocide years. In terms of coverage, the gross enrolment ratio in primary education is now significantly greater than what it was at the start of the 1990s and is comparable to the average for other low-income countries in Sub-Saharan Africa (table 1). In higher education, the ratio has tripled since the early 1990s and is also comparable to the Sub-Saharan average. In secondary education the trend is difficult to establish because of structural changes in the system during the 1990s.² The available data suggest that the ratio in 2000–01 was lower in comparison both to what it was a decade earlier, and relative to the current average for Sub-Saharan Africa. The private sector share of enrolments has remained unchanged during the 1990s: less than one percent in primary education, more than 40 percent at the secondary level, and nearly 40 percent in higher education.

Table 1
Number of students and gross enrollment ratios (GERs) by level of education,
Rwanda 1991-2000 and low income Sub-Saharan countries, late 1990s^a

	Rwanda		Low income Sub-Saharan countries
	1991-92	2000-01	
Primary education			
No. of pupils in grades 1-6 ('000)	962.3	1,428.7	
GER	73.9	106.6	75.0
Secondary education			
No. of students in sec. grades 1-6 ('000)	202.5	125.1	
GER	20.4	17.0	20.0
Higher education			
No. of students	3,389	12,757	
GER	0.5	1.9	1.9

a/ The gross enrollment ratio (GER) for a given level of education is the number of all students (regardless of age) enrolled in that level as a percentage of the population in the relevant age group for that level.
Source: World Bank 2003.

In terms of internal efficiency, several features characterize the Rwandan system. Nearly 90 percent of all children currently start school, about the same share as in the early 1990s, and 73

² Rwanda's education system currently has a 6-3-3-4 structure—six years of primary schooling, three years of lower secondary schooling, three years of upper secondary schooling, and an average of four years of higher education.

percent eventually make it to grade 6, up from about 44 percent 10 years ago. These admirable results are marred, however, by the fact that repetition rates have also risen, from 11 percent in 1990-91 to 34 percent in 2000-01, which puts Rwanda's rate among the highest in the developing world. Persistence of these high rates is likely to compromise the system's ability to sustain the recent gains in survival rates. In secondary education, the survival rate has been stable at around 60 percent for the past decade. In higher education the internal efficiency of the public institutions varies by field of study, but performance is generally weak, with graduation rates ranging between 11 and 50 percent among final year students, and overall survival rates ranging between 53 and 76 percent.

To complete this brief review, we note the pattern of financing for education in Rwanda. As in most other countries, the government is the main source of funding but households also incur significant out-of-pocket expenses³. Total public spending on education rose from 3.2 percent of GDP in 1996 to 5.5 percent in 2001, with much of the increase reflecting large gains in capital spending in the post-genocide years. Nonetheless, aggregate recurrent spending relative to the GDP had also grown, so that it was 65 percent as high in 2001 as it was in 1996. Across levels of education, the increase in spending had benefited higher education the most, raising its share of recurrent spending from just under 15 percent in 1996 to more than 37 percent by 2001. Secondary education also gained, but its share of recurrent spending rose only modestly, from about 15 percent in 1996 to nearly 18 percent in 2001. The combined result of these trends in higher and secondary education is a dramatic fall in the share of primary education, from 70 percent to just over 45 percent over the period. As a result, public spending per student in Rwanda are highly skewed in favor of the post-primary levels (table 2). Each secondary student costs the government 8.6 times as much to enroll as a primary school child; and in higher education, the corresponding ratio is 95 times for local studies and 275 times for studies abroad.

³ In 2000, household spending on education was estimated to be about 1.5 percent of the GDP, or about 41 percent of the recurrent spending by the government in that year. Primary education accounted for 26 percent of the total spending by households, while the share for secondary and higher education was, respectively, 62 and 12 percent. The high share for secondary education is not surprising, given the large share of students in independent private schools at this level.

Table 2**Recurrent public spending per student by level of education in the public sector, Rwanda, 1999 ^a**

	Primary education	Secondary education	Higher education	
			Local studies	Studies abroad
Spending per public sector student (FRw)	7,604	65,223	723,899	2,094,422
As a multiple of the per capita GDP	0.10	0.84	9.34	27.03
As a multiple of primary education	1.0	8.6	95.2	275.4

a/ Recurrent public spending on education includes the salaries and benefits of teaching and non-teaching staff in the education sector, as well as recurrent spending on non-staff inputs at the central and school levels (i.e. recurrent spending on administration, school-level operating costs including expenditures on food and bedding, and student financial aid).

Source: World Bank, 2003.

3. The data

The data for our analysis of the returns to education come from the Rwanda Household Living Conditions Survey conducted in 1999-2001 by the Ministry of Finance and Economic Planning. Although not specifically designed for the analysis, the survey contains the needed information. For each sampled households, the questionnaire solicited the usual information on each household member's background (educational attainment, age, gender, marital status and relationship to the household head), as well as information on the person's main activity, occupation, sector of employment, and years of experience in the labor market; and for those who work as employees, it also gathered information on earnings and the number of hours worked during the year.

The survey was administered to 6,400 representative households containing a total of 32,000 individuals. More than half of the sampled individuals were not in the labor force, and many of the workers—84 percent—were self-employed farmers. For the wage regressions, we extracted from this large data set a sub-sample of men and women aged 12-65 who had a primary occupation in the wage sector⁴. In order to obtain a relatively homogenous group of workers, we excluded from this sample the following respondents: individuals without a well-identified employment status; non-wage earners who had a secondary employment in the wage sector; and respondents who were unemployed during

⁴ The sample of non-wage earners is used to fit a multinomial employment choice model in order to correct for selectivity problems related to estimating the wage functions of employees (see section 4 below).

the week prior to the survey and who reported having worked before that week. Constraining the data in this way yielded a sample of 2,000 observations.⁵

Table 3 presents selected sample statistics, for all wage earners and separately for workers in the public sector and the private formal and informal sectors.⁶ Earnings are defined by the hourly wage rates in the current job and include benefits and in-kind payments that employees may receive from their employers. For each person, the number of years of schooling is evaluated from information on the level and type of education and highest class completed. Because the survey questionnaire does not contain an explicit question on the age of entry to the labor force, we estimate a worker's years of work experience by subtracting from his or her age at the time of the survey, the number of years of schooling, and the official age at entry to Grade 1 (which is six in the case of Rwanda).

⁵ As the Rwanda Household Living Conditions Survey is designed to yield a sample that is representative of the whole population, the sub-sample chosen for our analysis is naturally representative of the 10 percent of the country's workers who are employed in salaried jobs.

⁶ Public sector employees work either in public administration (70 percent) or in quasi public enterprises (30 percent); the latter refers to firms controlled mainly by the government.

Table 3
Means of selected variables in the sample ^a

	Public sector	Private sector		Total
		Formal	Informal	
Sector of employment (percent)				
Public	-	-	-	19.72 (39.80)
Private formal	-	-	-	18.38 (38.64)
Private informal	-	-	-	61.90 (48.55)
Male (percent)	66.33 (47.32)	70.62 (45.61)	60.32 (48.94)	63.38 (48.19)
Total years of schooling	9.91 (3.79)	8.43 (3.79)	3.58 (2.91)	5.72 (4.29)
Education level (percent)				
No schooling	2.27 (19.90)	4.32 (20.37)	27.21 (44.52)	18.08 (38.50)
Primary				
Primary 1-3 years	4.03 (19.70)	4.59 (20.37)	21.03 (40.77)	14.65 (35.37)
Primary 4 years and more	17.38 (37.94)	30.27 (46.00)	42.62 (49.47)	35.37 (47.82)
Total	21.41 (41.07)	34.86 (47.72)	63.64 (48.12)	50.02 (50.01)
Vocational and technical	12.85 (33.50)	17.03 (37.64)	4.57 (20.90)	8.49 (27.89)
Secondary general	50.38 (50.06)	34.32 (47.54)	4.49 (20.78)	19.03 (39.26)
Higher	13.10 (33.78)	9.46 (29.31)	0.00 -	4.37 (20.45)
Age (years)	34.14 (9.47)	32.53 (9.67)	26.05 (10.92)	28.84 (11.04)
Professional experience (years)	18.23 (8.02)	18.10 (7.10)	16.47 (8.44)	17.12 (8.14)
Hourly wage rate (log)				
No schooling	4.02 (0.76)	3.97 (0.92)	3.41 (0.91)	3.45 (0.91)
Primary education				
Primary 1-3	4.08 (0.91)	4.50 (1.33)	3.41 (1.04)	3.51 (1.09)
Primary 4 and more	4.24 (0.77)	4.63 (0.98)	3.81 (1.00)	3.98 (1.02)
All primary	4.21 (0.79)	4.61 (1.03)	3.68 (1.03)	3.84 (1.07)
Vocational and technical	4.98 (0.94)	5.11 (0.80)	4.79 (0.86)	4.96 (0.87)
Secondary education	5.21 (0.60)	5.40 (0.75)	4.82 (0.96)	5.19 (0.75)
Higher education	6.44 (1.01)	6.54 (0.70)	- -	6.45 (0.93)
All levels of education	5.13 (1.01)	5.17 (1.07)	3.71 (1.05)	4.26 (1.26)
Number of observations	397	370	1,246	2,013

a/ Standard deviations in parentheses.

Source: authors' calculations based on data from the 1999-2001 Rwanda Household Living Conditions Survey.

According to table 3 about 40 percent of the sample worked in the modern sector while 60 percent worked in the informal sector. Women represent 40 percent of the workers in the informal sector, but only 30 percent in the private formal sector and 34 percent in the public sector, implying that Rwandan women are more likely than men to work in the traditional sector of the economy.

In terms of educational attainment, the sample averaged less than six years, but there are important differences across sector of employment. Workers in the public sector have, on average, ten years of schooling compared with eight years among workers in the private formal sector, and only three years among their non formal sector counterparts. Workers with one to three years of primary schooling or no education at all can be found in all sectors of employment, but they represent almost half of the workers in the informal wage sector, compared with only six percent in the public formal sector, and nine percent in the private formal sector. Less than 10 percent of informal sector workers have attended vocational or secondary general education, while the share rises to 63 and 51 percent, respectively, for workers in the public and formal private sectors. Finally, whereas virtually no-one with higher education works in the informal sector, those with this level of education represent about 13 and 10 percent of workers in the public and formal private sectors.

In terms of age and work experience, workers in the public and formal private sectors are older by nine and six years, respectively, than their informal sector counterparts. Both the former groups of workers have about two more years of work experience than those in the informal sector. For the whole sample of wage earners, the workers have a mean age of 29 years and an average work experience of 17 years; for informal sector workers, the mean age is 26 years, and the mean experience, 16 years. These statistics suggest that while workers in Rwanda tend to enter the labor force at relatively young ages, the age of entry is especially low for workers in the informal sector.

With regard to earnings, workers in the public and formal private sectors have similar mean earnings per hour, but the wage differential is relatively wide between the modern and traditional sectors of employment. The average worker in the public and formal private sectors earns about 4.2

times as much as his or her counterpart in the informal sector. Differences among workers become even more striking by level of education. Those with higher education receive on average 20 times the wages of those with no schooling; those with secondary general and vocational education earn about five and six times as much as these workers, while those with primary education have an earnings premium of only 50 percent. These patterns persist within each of the three sectors of employment, although the wage differentials are smaller in the public sector than in the formal private sector, with the highest and lowest wages differing by 11 percent in former sector, and 13 percent in the latter.

4. The conceptual framework

The earnings functions by sector of employment are specified in the traditional human capital manner (Mincer 1974), namely:

$$(1) \quad \text{Ln } w = \beta' x + u$$

where w stands for hourly wage rate, x is a vector of individual characteristics including education, experience, and other exogenous socioeconomic factors, β is a parameter vector, and u is the random error term.

Because this relation is observed only for wage earners, we first estimate a model of the choice of employment sector in order to deal with selectivity bias in the earnings functions. In this model an individual faces five mutually exclusive choices: not working or being unemployed ($j=0$); employment in the public sector ($j=1$); employment in the formal private sector ($j=2$); employment in the informal private sector ($j=3$); and self-employment ($j=4$) or employment as an unpaid family worker ($j=5$). The probability that the alternative j will be chosen is:

$$(2) \quad P_j = \frac{\exp(\alpha_j' z)}{1 + \sum_{j=1}^5 \exp(\alpha_j' z)}$$

which is a conditional logit model, where z is a vector of explanatory variables affecting the employment decision, and α_j is a parameter vector of the alternative chosen.

To correct for selectivity bias we use the two-step method developed by Trost and Lee (1984) based on Heckman's approach (1979) in order to compute a selection term for choices involving more than two alternatives. In the first stage, we estimate a polychotomous model of the choice of employment sector using the logit maximum likelihood method and generate the following selection term for the alternative j :

$$(3) \quad \hat{\lambda}_j = \varphi[J(\hat{\alpha}_j' z_j)] / F(\hat{\alpha}_j' z_j)$$

where φ is the standard normal density function, F is the logistic marginal distribution, J is $\Phi^{-1}F$, and Φ denotes the standard normal distribution function. In the second stage $\hat{\lambda}_j$ is included among the explanatory variables of the earnings function, and we estimate the following equations by ordinary least squares:

$$(4) \quad \ln w_j = \beta_j' x + \sigma_j \hat{\lambda}_j + v_j \quad \text{for } j=1,2,3$$

5. The results

We present below estimates of the proximate determinants of a worker's choice of employment sector and the results for the wage equations; we then use the results to evaluate the sources of wage gaps across sectors of employment.

Sector of employment choice model

The results are reported in table 4 and are expressed in terms of an individual's probability of working in the public, private formal or non formal sectors, or in self-employment or in unpaid family work, relative to being unemployed or out of the labor force.⁷ The explanatory variables we used include: age, educational attainment, place of residence, marital status, household dependency ratio, household income, and family background.⁸ The educational attainment variable is defined in terms of a set of dummy variables corresponding to the levels of education shown in the table, with no schooling treated as the omitted category. Place of residence was included to capture possible differences in labor market opportunities, and is coded 1 if the individual lives in an urban area and 0 otherwise. Marital status is defined in terms of three dummy variables: (a) married, (b) divorced, and (c) single and living with a relative; the residual group, single and living with a non-relative, defines the omitted category. The dependency ratio of the household is included to take into account the cost of entering the labor market. The ratio is defined as the number of non working family members relative to the number of economically active members. Family income is defined as the household's per adult equivalent annual expenditures on food and non-food items, and is computed by dividing total expenditure on these items by the number of equivalent adults in the household, the latter being estimated using the equivalence scale of the Ministry of Finance's National Poverty Reduction Program and Statistics Department.⁹ Finally, the regressors include family background as proxied by the job held by the respondent's father.

⁷The table shows the marginal effect of the variables and the absolute value of their robust z-statistics.

⁸ Descriptive statistics of the variables are reported in Appendix table A1.

⁹ See Republic of Rwanda (2002) for further details.

Table 4
Multinomial employment sector choice model
-Marginal effects-

	Wage sector			Non wage sector		Out of the labor force
	Public sector	Private sector		Self employed	Unpaid family workers	
		Formal	Informal			
Age	0.0002 (3.24)	0.0001 (2.14)	-0.0014 (5.63)	0.0071 (13.54)	-0.0053 (10.37)	-0.0007 (2.49)
Male	0.0108 (6.03)	0.0138 (7.26)	0.0638 (12.59)	0.2467 (23.59)	-0.3360 (37.53)	0.0009 (0.20)
Married	-0.0026 (1.36)	-0.0028 (1.72)	-0.0945 (12.01)	0.1921 (10.06)	-0.0205 (1.10)	-0.0718 (8.27)
Divorced	-0.0030 (1.49)	-0.0059 (3.69)	-0.0535 (10.75)	0.3883 (26.59)	-0.2590 (19.95)	-0.0670 (14.76)
Single cohabiting with family	-0.0025 (1.40)	-0.0045 (2.94)	-0.0826 (18.72)	-0.2920 (15.77)	0.3568 (18.67)	0.0249 (3.23)
Primary 1-3 years	0.0136 (1.87)	0.0031 (0.80)	-0.0102 (1.79)	-0.0087 (0.58)	0.0063 (0.46)	-0.0041 (0.65)
Primary 4 years and more	0.0224 (4.35)	0.0124 (3.82)	-0.0345 (6.76)	0.0257 (2.04)	0.0053 (0.46)	-0.0313 (5.81)
Vocational and secondary general	0.3851 (6.61)	0.0563 (3.80)	-0.0516 (12.29)	-0.2027 (5.85)	-0.1510 (7.25)	-0.0361 (6.42)
Higher education	0.8253 (15.45)	0.0546 (2.21)	-0.0673 (22.91)	-0.4692 (16.4)	-0.2945 (15.04)	-0.0490 (5.86)
Dependency ratio	0.0015 (3.14)	0.0013 (2.98)	0.0107 (5.51)	0.0175 (3.27)	-0.0792 (14.02)	0.0481 (24.84)
Per capita expenditures	-0.0014 (0.25)	0.0043 (0.89)	0.1300 (5.22)	-0.7082 (6.50)	0.5090 (4.91)	0.0664 (2.29)
Father's job farmer	0.0021 (1.87)	-0.0026 (1.76)	0.0108 (1.90)	0.0014 (0.08)	0.0081 (0.51)	-0.0197 (2.85)
Living in urban area	0.0075 (3.43)	0.0419 (7.06)	0.1885 (15.11)	-0.0510 (3.05)	-0.2964 (29.27)	0.1095 (10.43)

Note: Number of observations: 15,541 (public sector: 401; formal private sector: 371; non formal private sector: 1,248; self-employed: 6,945; unpaid family workers: 5,269; out of the labor force: 1,307:). Pseudo-R²: 0,311. Absolute value of z-statistics in parentheses.
Source: authors' estimates based on the 1999-2001 Rwanda Household Living Conditions Survey.

Overall, the estimates in table 4 confirm the expected patterns: all else being the same, age increases the probability that an individual works in the public and formal private sectors and reduces the probability that he or she works in the informal sector; men are more likely than women to work as paid employees or in self-employment, while the opposite is true with regard to unpaid family work.

Educational attainment exerts a powerful influence on an individual's sector of employment. Relative to workers with no schooling, those with a primary or secondary education are less likely to work in the informal private sector, and more likely to do so in the public or formal private sectors. Workers with higher education have a predicted probability of working in the public sector that exceeds by about 70 percent their probability of working in the formal private sector. Marital status affects a person's sector of employment in that, all else being equal, married persons have a smaller probability than single individuals of working in the informal private sector or of being unemployed. As expected, family income correlates negatively with labor force participation while the dependency ratio correlates positively with it. Finally, individuals in urban areas are more likely to be employed in a paid job (mostly in the informal private sector), while rural residents are more likely to work as unpaid family workers.

Estimates of the returns to education by level

Following the procedure described in Section 4 above, we use the regression results in table 4 to correct for selection bias in the estimation of wage equations. We estimate equations for the whole sample of wage earners¹⁰ and separately for workers in the public, formal private and informal private sectors. The results are reported in table 5. The dependent variable, (log) hourly earnings, is expressed as a function of education, estimated length of work experience (represented by a linear and a quadratic term), sex, father's education in years of schooling, and a selection term, λ_j . We estimate the returns to schooling in two ways. In the first specification, the education variable is expressed in years of schooling completed by the individual, and we assume that each year of schooling increases the log earnings by the same amount. In the second specification we test for possible discontinuity in the marginal returns to education by introducing a set of four dummy variables which denote whether or not the person has completed (a) primary education; (b) technical and vocational education; (c) secondary general education; and (d) higher education.

¹⁰ In this case, we correct for selectivity bias by estimating a sector of employment choice model in which each person faces four mutually exclusive choices: (a) not working or being unemployed, (b) wage employment, (c) self-employment or (d) unpaid family worker. Results are available from the authors on request.

Table 5
Earnings function by sector of employment

	Public sector		Private sector				All sectors	
			Formal		Informal			
Constant	2.987 (6.01)**	5.412 (11.75)**	3.964 (10.93)**	5.201 (14.91)**	2.029 (21.79)**	2.525 (28.42)**	2.229 (25.45)**	2.768 (33.72)**
Total years of schooling	0.173 (7.58)**		0.122 (8.15)**		0.151 (16.36)**		0.175 (35.82)**	
Level of education completed								
Primary education		0.121 (0.74)		0.038 (0.23)		0.448 (6.19)**		0.459 (7.43)**
Technical and vocational education		0.164 (0.77)		0.042 (0.30)		1.134 (9.31)**		1.019 (14.63)**
Secondary general education		0.424 (2.01)*		0.426 (3.19)**		1.303 (10.43)**		1.467 (27.63)**
Higher education		1.195 (4.02)**		1.039 (5.84)**				2.314 (21.00)**
Experience	0.020 (1.54)	0.009 (0.66)	0.081 (4.88)**	0.085 (5.00)**	0.101 (10.19)**	0.080 (8.26)**	0.091 (12.38)**	0.085 (11.45)**
Experience ²	-0.000 (0.08)	0.000 (0.21)	-0.001 (4.08)**	-0.002 (4.42)**	-0.001 (6.78)**	-0.001 (5.77)**	-0.001 (7.55)**	-0.001 (7.55)**
Male	0.123 (1.65)	-0.065 (0.76)	-0.102 (1.10)	-0.202 (2.05)*	0.341 (6.38)**	0.413 (7.61)**	0.200 (4.81)**	0.270 (6.18)**
Father's years of schooling	0.040 (3.67)**	0.038 (3.36)**	0.034 (3.24)**	0.040 (3.62)**	0.018 (2.05)*	0.027 (2.93)**	0.037 (6.24)**	0.044 (7.04)**
λ_j	-0.101 (0.83)	-0.586 (4.47)**	-0.430 (3.76)**	-0.680 (5.86)**	-0.141 (3.31)**	-0.099 (2.30)*	-0.220 (6.29)**	-0.232 (6.08)**
Number of observations	397	397	370	370	1,246	1,246	2,013	2,013
R-squared	0.51	0.48	0.46	0.44	0.33	0.29	0.55	0.51

Robust t-statistics in parentheses

* significant at 5% level; ** significant at 1% level

Source: authors' estimates based on the 1999-2001 Rwanda Household Living Conditions Survey.

According to the results in table 5 about 50 percent of the earnings variation in the whole sample is explained by the variables used in the regression. The models for workers in the modern sector (i.e. the public and private formal sectors) achieve a better fit with the data than do the models for workers in the informal sector. A Chow test on the equality of the regression coefficients for the three sectors of employment yields statistically significant *F*-statistics, implying statistically

significant differences in the underlying wage determination process. Selection terms have negative coefficients and all but one of them are statistically significant at the 1 percent level. The results imply that a negative correlation exists between the omitted factors in the sector of employment model and those in the wage equations. In other words, unobserved characteristics that raise the probability of wage employment also tend to depress earnings.

The wage regressions for the whole sample of wage earners imply that an additional year of schooling at the sample mean yields, on average, a private return of 17.5 percent¹¹. However, this average hides wide variation by level and type of education. According to last column in table 6, the returns to education rises with the level of education, a pattern that runs counter to what is usually found in the literature (see, for example, Psacharopoulos 1994; Psacharopoulos and Patrinos forthcoming 2004) but one that is consistent with more recent findings documenting low returns (see for example, Bennell 1996). The returns to primary education are lower than those for secondary education: an additional year of primary schooling yields a return of 19.4 percent, compared with 12.5 and 29.0 percent, respectively, for vocational and general secondary education. The smaller returns to vocational education relative to those for general secondary education is at odds with the commonly held belief that vocational (and technical) education tends to confer significant labor market advantages to students who follow this curriculum. While deficiencies in the content of courses offered in the past may explain the lowest returns, the possibility that such courses are inherently less responsive than general education to labor market needs cannot be dismissed. This possibility is, moreover, consistent with the findings in most developing country settings regarding the labor market performance of public sector vocational and technical education and training (see for example, Johanson and Adams 2003).

¹¹ Results that are not shown here to save space indicate that correcting for selectivity bias lowers the average rate of return to education by about 2 percentage points on average.

Table 6
Rates of returns to education by level and sector of employment ^a

	Public sector	Private sector		Total
		Formal	Informal	
Primary education	n.s.	n.s.	18.8	19.4
Technical and vocational education	n.s.	n.s.	16.4	12.5
Secondary general education	5.9	7.9	22.6	29.0
Higher education	29.1	21.2	-	33.3

Note: n.s. denotes non significant. ; « - » denotes variable excluded for lack of a sufficient number of observations in the cell.
^{a/} Based on regression models in table 5 with education expressed by the highest diploma obtained. Rates of returns to different levels of education are calculated as $[(\exp(b_j \cdot b_i) - 1) / (s_j - s_i)]$ where b_i and b_j are the regression coefficients of two successive levels of completed education and s_j and s_i stand for the total number of years of schooling in both levels i and j . We have assigned 3 years of forgone earnings for wage earners with primary education completed, 6 years for those with vocational and secondary general education and 4 years for those with higher education completed.

Noteworthy too is the exceptionally high profitability of higher education which yields a private return of 33.3 percent. High rates of return to this level of education are not uncommon in low-income countries. In such countries, the modern sector is usually small and wages at the high end tend to be “sticky” in that imbalances in the supply and demand for highly educated workers are accommodated more often through quantity than through price adjustments. These forces are reinforced in Rwanda by the need to set sufficiently high wages in order to attract highly educated Rwandans and others to fill positions in government and elsewhere in the aftermath of the genocide.

Importantly, the regression results reveal wide differences in the pattern of returns across the three sectors of employment. In particular, public sector workers receive higher returns to education than workers in both the formal and informal private sectors. Noteworthy too is that although workers are generally better educated and better paid in the formal private sector than in the informal private sector, the returns to education in the former sector are nonetheless smaller than they are in the informal sector. In other words, the relation between education and earning is flatter in the formal private sector than it is in the informal private sector. One plausible interpretation is that in the unconstrained informal sector, education does equip workers with the skills to process information, identify economic opportunities and take advantage of them.

Consider now the pattern of returns across levels of education and sector of employments. In the public and formal private sectors, the returns to primary education are practically non-existent.

The result does not necessarily mean that the skills imparted by primary education are useless in the labor market; rather it is probably attributable to the fact that very few wage earners in the modern sector have only primary schooling. The returns to an extra year of general secondary education are slightly greater in the formal private sector than in the public sector. In both sectors the returns to higher education are well above those to general secondary education. In the informal sector, primary education yields a return of 18.8 percent, which is about three times as high as those to secondary education in the public sector; both vocational and general secondary education give an attractive returns of 16.4 percent and 22.6 percent respectively to wage earners in the traditional sector.

Returning to the wage regressions in table 5 the results suggest that the male-female wage gap is insignificant in the public and formal private sectors. In the informal private sector, however, men receive a significant and large earnings premium compared with women: holding all else constant a male worker earns about 40 percent more than his female counterpart.¹² Finally, father's years of education appear to exert a significant positive effect on earnings; the impact is greater in the modern sector than in the informal sector, pointing to the stronger influence of family connections on wages in the former sector.¹³ This result is consistent with the findings from studies on the effect of family background on earnings (see, for example, Altonji and Dunn 1996; Liu, Hammitt and Lin 2000).

With regard to the impact of work experience on earnings, table 7 shows that mean earnings in the public sector do not increase significantly over the life cycle. By contrast, the marginal return to experience is significant in the private sector. Within the private sector, the returns to experience in the informal sector exceed those in the formal sector, suggesting that earnings rise faster over the life cycle in the former sector.

¹² Since the earnings models are semi-logarithmic, the male-female wage gap is calculated as $\exp(b)-1$, where b is the regression coefficient of male (see, Halvorsen and Palmquist 1980).

¹³ Estimates not shown here to save space indicate that controlling the earnings-generating process by father's education lower the average rate of return to schooling up to 1 percentage point depending on the sector of employment.

Table 7
Marginal effect of work experience by sector of employment ^a
(percent per year)

Years of experience	Public sector	Private sector		Overall
		Formal	Informal	
5	2.0	7.1	9.1	8.1
10	2.0	6.1	8.1	7.1
15	2.0	5.1	7.1	6.1
20	2.0	4.1	6.1	5.1
25	2.0	3.1	5.1	4.1

^{a/} Based on regression models in table 5 with education expressed by the total number of years of schooling.

Decomposition of wage gaps across sectors of employment

We turn now to evaluate the share of the differences in earnings across sector of employment that is attributable to: (a) differences in the personal characteristics of the workers; (b) differences in returns to education in each employment sector; and (c) selection bias. For this purpose we apply the wage decomposition method of Blinder (1973), Oaxaca (1973), and Idson and Feaster (1990) to the regression results in table 5. The wage gap between workers in sectors i and j is decomposed as follows:

$$(6) \quad \text{Ln } \bar{w}_i - \text{Ln } \bar{w}_j = 0.5(\beta'_i + \beta'_j)(\bar{x}_i - \bar{x}_j) + 0.5(\bar{x}_i + \bar{x}_j)(\beta'_i - \beta'_j) + \sigma_i \bar{\lambda}_i - \sigma_j \bar{\lambda}_j$$

where the wages and x vectors are mean values over the individuals in a particular sector of employment. The three right-hand-side terms correspond, respectively to items (a), (b) and (c) above.

Table 8 reports the results of this decomposition applied to the selectivity-corrected regressions in table 5. D is the log wage differential, DN is the log wage differential net of selectivity, E is the amount of the differential attributable to the characteristics of workers, C is the portion attributable to the differences in the returns to the characteristics of workers (regression coefficients except the constant term), S is the part attributable to selection bias and U is the portion associated with the constant term.

Table 8
Decomposition of sector wage gaps ^a

	Public/Formal private	Public/Informal private	Formal private/ Informal private
Wage differential (<i>D</i>)	-0.041	1.417	1.458
Endowments (<i>E</i>)	0.210	1.178	0.846
Coefficient (<i>C</i>)	0.152	-0.750	-0.774
Selectivity (<i>S</i>)	0.574	0.036	-0.538
Constant (<i>U</i>)	-0.977	0.958	1.935
Wage differentials net of selectivity (<i>DN</i>)	-0.615	1.382	1.996

a/ Based on regression models in table 5 with education expressed by the total number of years of schooling.

The results show that differences in the personal endowments of workers are more important in accounting for wage differentials across sectors than are differences in the regression coefficients. These differences account for 83 percent of the log wage differentials between workers in the public sector and those in the private sector; and for 58 percent of the gap between workers in the formal sector and informal private sector. The selection correction term also has an impact, widening the wage gap in the comparison between workers in the public and formal private sectors, and that between the public and informal private sectors; and narrowing it in the comparison between workers in the formal and informal private sectors.

More detailed analysis of the impact of personal endowments, reported in table 9, suggests that education is the most important aspect of a worker's profile in accounting for wage differences among sector of employment. The superior educational profile of the workers in the public sector confers an earnings advantage of 0.22 points over workers in the formal private sector, and an advantage of 1.03 points over those in the informal private sector. The same factor gives workers in the formal private sector a wage advantage of 0.66 points over their counterparts in the informal sector. These are large amounts: a difference of 0.22 points is equivalent to 5.3 times the overall wage

gap between workers in the public and formal private sector; and the gaps of 1.03 and 0.66 points are equivalent, respectively to 73 and 45 percent of wage gaps between the corresponding two sets of workers.

A further detail in the results pertains to the role of differences in workers' average educational endowment relative to that of differences in the returns to education (i.e. magnitude of the coefficient in the wage equations) in accounting for wage gaps across sectors. The former is by far the more important factor in the comparison between workers in the public and informal private sector, and between workers in the formal private and informal private sectors. In contrast, for workers in the public and formal private sectors, differences in the returns to education rather than differences in the mean educational endowment of the workers play a more important role.

Table 9
Relative contribution of characteristics to the earnings differential

	Years of schooling	Experience	Male	Father's years of schooling	Total
Public/Formal private					
Due to endowments	0.219	0.006	0.000	-0.014	0.210
Due to coefficients	0.466	-0.492	0.154	0.024	0.152
Total	0.685	-0.486	0.154	0.009	0.362
Public/Informal private					
Due to endowments	1.028	0.085	0.014	0.046	1.173
Due to coefficients	0.145	-0.819	-0.138	0.063	-0.750
Total	1.173	-0.734	-0.124	0.109	0.423
Formal private/Informal private					
Due to endowments	0.663	0.108	0.012	0.051	0.835
Due to coefficients	-0.176	-0.356	-0.290	0.049	-0.774
Total	0.487	-0.248	-0.278	0.100	0.061

a/ Based on regression models in table 5 with education expressed by the total number of years of schooling.

With regard to experience, the results in table 9 suggest that for all three sets of workers being compared the variable contributes to a narrowing of wage gaps, in contrast to the impact of education. Nonetheless, in absolute terms, its contribution is smaller than that of education. Further, in all three sets of comparisons, differences in mean years of experience make a much smaller contribution to the

total impact of the variable on wage gaps than do differences in the variable's impact on earnings. This finding is what one would expect given the pattern in the marginal impact of experience on earnings reported in table 7.

Differences in the gender composition of the workers across the three sectors of employment also make a non-trivial contribution to the wage gaps across sectors, its contribution being largest in the comparison between workers in the formal private and informal private sectors. Nonetheless its impact, in absolute terms, remains smaller than that of education or experience. In all three sets of comparison, almost all of the contribution of this variable arises from differences in the impact of gender on earnings rather than to differences in the gender composition of the workers in each sector of employment.

Finally, with regard to father's years of schooling (which is used as a proxy here for family background not elsewhere captured), differences in the variable accounts for about 22 percent of the total wage gap between workers in the public and formal private sectors. Its contribution to explaining the wage gap for the other two pairs of comparison is smaller at less than 8 percent in each case.

6. Conclusion

In this paper we applied the human capital analytic framework to data from the 1999-2001 Rwanda Household Living Conditions Survey to estimate the relation between education and the probability that a worker is employed in the public sector, the formal private sector or the informal private sector. The results of the choice model were then used to correct for selection bias in the estimates of the returns to education by level and type of education. The wage equations in turn provide a basis for examining the sources of differences in wages across workers in the three sectors of employment.

The results from the choice model suggest that the better educated a worker is, the more likely he or she is to work in the wage sector, whether in the formal or informal segments of the economy. The impact is exceptionally strong in the public sector: a person with higher education has a probability of working in this sector that is nearly 37 times as high as that of a person with only four or more years of primary schooling; and more than twice as high as that of a person with secondary education. In the private sector, the role of education remains important, albeit weaker: a worker with higher education is 4.5 times as likely to work in the formal private sector as a worker with only four years or more of primary schooling, and about as likely to do so as a worker with secondary education. These results are consistent with the expected pattern of sorting of workers by level of education in a low-income economy on the cusp of modernization. The modern sector is tiny and is likely for the foreseeable future to show a strong preference for employing only the better-educated; and within the modern economy, the public sector is likely to seek out the best educated as these are the very workers needed to set up a working public administration, particularly in Rwanda's post-genocide context. Note, however, that even in the non-wage sector, education makes a difference to people's employment: relative to workers with one to three years of schooling or no schooling at all, those with just four years of schooling are already more likely to be self-employed than to be working as an unpaid family worker.

The results on the private returns to education show that an extra year of schooling yields, on average, a return of 17.5 percent. The returns vary substantially by level of education: it is only 19.4 percent for primary education, compared with 29.0 and 33.3 percent, respectively, for general secondary and higher education. They also vary by sector of employment: in the public and formal private sectors, primary education and vocational and technical secondary education yield hardly any returns; general secondary education yield a respectable return of 7 percent on average; while higher education fetches a return up to 30 percent. Because workers with modest levels of schooling are likely to work in the informal sector, the returns to education in this part of the economy is of special interest. The results show that among workers in this sector, even primary education yields an attractive return of nearly 19 percent; and general and vocational and technical education at the

secondary level both generate returns of 16 and 23 percent respectively, which is substantial by any benchmark. Taken as a whole, these results imply that the private incentives to investing in education in Rwanda are strong at all levels. In both secondary and higher education the private returns are so high that even in the absence of public subsidies, one would expect the demand for education to be strong. That this is the case is confirmed by the rapid growth of private higher education in recent years and the continued high share of students in private secondary schools.

Finally, with regard to the sources of disparities in earnings among workers in the three sectors of employment, our analysis indicates that differences in workers' personal endowments—in terms of educational attainment, experience, gender, and family background—matter more than the impact of those endowments on earnings, particularly in the comparisons between workers in the public and formal private sectors, and between workers in the public and informal private sectors. And among the measures of personal endowment, it is differences in educational attainment that matter the most.

Taken as a whole, the findings carry several implications for the development of education policy in Rwanda. First, they indicate that while investment at post-primary levels are undeniably the leading edge for modernizing the economy, expansion of the system at the primary level also plays a crucial role by increasing the chances of paid work or self-employment. The fact that educational endowments are the most important aspect of workers' personal profile in accounting for differences in wages across sector of employment means that public policies that prevent large gaps in educational attainment from emerging can help to ensure that wage differentials across workers do not become excessive. Such policies would be consistent with the country's avowed intention to reduce poverty. One aspect of such policies have to do with the public subsidization of education. Currently higher education receives the heaviest subsidies, eating up nearly 40 percent of total public spending. As a consequence, social returns to this level of education are particularly low. As a matter of fact, by combining results on age earnings profiles with data on public and private costs of education it can be shown that the social returns to higher education average about 5 percent a year, compared with

returns of 13 and 10 percent a year respectively for primary and secondary general education¹⁴. In light of the very low social returns to higher education, it would make sense to rebalance resources in favor of the lower levels, particularly primary education. The government has indeed begun moving in this direction, having taken the first steps toward reducing government subsidies to university students.

¹⁴ These estimates were computed using the “elaborate method” explained in Psacharopoulos and Mattson (1998). The age-earnings profiles required for the calculation were generated from the estimated Mincerian wage equations (based on data for the whole sample) in which the education variable is represented by dummy variables for each level of education; the required information on the direct costs incurred by individuals and by the government at each level of education are extracted from World Bank (2003). For the estimates on private returns, only the direct costs incurred by individuals are taken into account, while for the social returns, the cost incurred by the government is also taken into account. Further details on the calculations are available upon request to the corresponding author.

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Appendix

Table A1
Means of variables in the multinomial employment sector choice model ^a

	Wage sector			Non wage sector		Out of the labor force
	Public sector	Private sector		Self employed	Unpaid family workers	
		Formal	Informal			
Age	34,07 (9,47)	32,56 (9,67)	26,03 (10,89)	37,27 (12,95)	25,15 (11,11)	26,43 (13,82)
Male	66,33 (47,32)	70,62 (45,61)	60,34 (48,94)	49,01 (49,99)	30,31 (45,96)	44,07 (49,67)
Married	64,09 (48,03)	62,26 (48,54)	31,01 (46,27)	62,91 (48,31)	35,28 (47,79)	31,98 (46,66)
Divorced	9,73 (29,67)	5,39 (22,61)	7,61 (26,53)	22,36 (41,67)	3,91 (19,38)	7,19 (25,85)
Single cohabiting with family	13,97 (34,71)	11,86 (32,38)	13,38 (34,06)	8,98 (28,60)	53,92 (49,85)	42,54 (49,46)
Dependency ratio	1,57 (1,50)	1,53 (1,56)	1,30 (1,26)	1,23 (1,11)	0,89 (0,71)	2,94 (2,26)
Per capita expenditures	122,06 (103,35)	144,28 (140,73)	107,36 (138,88)	38,57 (57,46)	36,38 (41,36)	84,22 (102,20)
Father's job farmer	70,32 (45,74)	58,22 (49,39)	84,21 (36,47)	91,09 (28,50)	89,85 (30,21)	69,40 (46,10)
Primary 1-3 years	3,99 (19,60)	4,58 (20,94)	20,99 (40,74)	18,60 (38,92)	23,04 (42,11)	21,81 (41,31)
Primary 4 years and more	17,46 (38,01)	30,46 (46,09)	42,63 (49,47)	38,23 (48,60)	46,16 (49,86)	38,87 (48,76)
Vocational and secondary general	63,34 (48,25)	51,21 (50,05)	9,05 (28,71)	6,51 (24,67)	4,33 (20,35)	15,23 (35,94)
Higher education	12,97 (33,64)	9,43 (29,27)	0,08 (2,83)	0,12 (3,39)	0,02 (1,38)	0,92 (9,54)
Living in urban area	45,89 (49,89)	22,91 (42,08)	44,55 (49,72)	88,52 (31,88)	96,15 (19,25)	47,74 (49,97)
Number of observations	401	371	1,248	6,945	5,269	1,307

^{a/} Standard deviations in parentheses.