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Modeling the impact of education on individual earnings: 2019 evidence from Sudan

Hamid H. Hussien

Department of Mathematics, College of Science and Arts, King Abdulaziz University, P.O. Box 344, Rabigh 21911, Saudi Arabia

hamid128@yahoo.com

Abstract. The impact of education on individual earnings has not been adequately discussed in the Sudanese literature. This paper estimates the rate of return on education by modeling individual-level Sudanese survey data for 2019. The importance of these data lies in the fact that they represent the period of Islamist rule in Sudan, which spanned thirty years and ended in April 2019 as a result of a peaceful youth popular revolution. A secondary aim is to trace how demographic characteristics (marital status, gender, locale) affect individual earnings. Results show, on average, an additional year of education increases individual earnings 4% (4.4% for men, 9.2% for women). Marital status exhibits the largest impact on Sudanese individual earnings, with married respondents' earnings 78.7% more than singles. Almost 90% of the variation in wages is determined by all levels of education, and trade pays the highest wage among surveyed occupations. Mincer models prove that the return on education was significantly positive for occupations in healthcare and electricity and significantly negative in real estate.

Keywords. Education, Mincer, Sudan, Wage discrimination

1. Introduction

The rate of return on education is a persistent issue in a large and growing literature since the late 1950s (Dougherty 2005). Previous studies suggest the return on primary education declines slightly over time (Borjas 2004; Psacharopoulos and Patrinos 2018; Psacharopoulos 1981). Additionally, earnings are the highest in primary, general curricula, women's education and lowest per capita income (Psacharopoulos 1985). Returns on education are higher for men and higher in the private than in the public sector (Psacharopoulos 1994). Returns on higher secondary education exceed returns on vocational training because the latter is costlier. Rates of return on education may vary with age, ability, experience, quality, and quantity of education, and quality of vocational training (Rosenzweig 1995). They also may vary with race, ethnicity, or gender (Psacharopoulos and Patrinos 2018).

Studies relate human capital and male laborers' earnings in 18th century Spain. Income and returns on skills were low because skills like literacy related more to social hierarchy than production (Álvarez and Fernando 2018; Mokyr 2001). World Bank classifications in 2015 (Table 1) summarize private returns on education worldwide by income group and assert that private revenues to invest in education are higher in low-income countries (9.3%) than in high income countries (8.2%) (World Bank 2016). This is the case even though the average years of

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education less by almost four years in favor of high income. In countries with low per capita income, returns on education decline as years of education increase.

Table 1. Private Returns on Education by Income Group

Country average national income	Overall rate of return (%)	Mean years of education
Low ($1,045 or less)	9.3	5.0
Middle ($1,046–12,735)	9.2	7.0
High (12,736 or more)	8.2	9.2
World average	8.8	8.0

Note: Per capita country income from the World Bank (2016) in 2015 US$.

Economics offers consistent evidence that highly qualified people earn higher incomes than the less qualified (Becker 2009; Hanushek and Woessman 2008). However, examining African studies reveals theoretical and empirical shortcomings that could undermine credibility of overall education earnings estimates.

Few microsurveys of Arab regions examine rates of return on education (Rizk 2016). However, several studies that examine how education affects labor markets using a Mincer model indicate relatively low or negative returns on education in some Arab countries. Gulf Cooperation Council countries apparently have lower rates of return on education than in Arab countries where this trend affects labor supply and demand (Ali 2006; Al-Qudsi 1989; Assaad 1997; Chishti and Khalaf 2000; Mina 2020). In addition, returns on education in the Arab region depart from general trends worldwide (Psacharopoulos 1994). That finding suggests a Mincer model is invalid for Arab countries during stages of economic growth.

Nonetheless, investigation needs to examine the rate of return on education in Sudan as a nation that has expanded education yet suffered economic deterioration during this millennium. We use 2019 survey data for individual earnings and education to estimate returns on education. We investigate whether education substantially determines personal earnings. In short, do better educated workers earn above-average incomes, and are the benefits of education more significant for the least-developed economies?

The study proceeds as follows. Section 2 reviews Sudan's economy, labor market, and educational structure and history. Section 3 discusses materials and methods. Section 4 analyzes data and estimates results. Section 5 discusses results. Section 6 concludes.

2. History of Sudan's economy, labor market, and education

Africa's third-largest country, Sudan covers 1,882,000 sq. km. Its population of 41 million exhibits immense diversity in politics, environments, languages, culture, religions, and ethnicity. Since gaining independence, Sudan has endured protracted social conflict (1955–1972) and one of the longest civil wars (1983–2005) in Africa's post-independence history (Hirblinger 2015). That war prompted southern Sudan to secede in 2011, ending the 2005–2010 oil boom. Sudan lost 75% of its oil production, and its exports fell 70% to 90%. After the war ended, peace remained elusive as conflicts erupted in the Blue Nile, Darfur, and Southern Kordofan (Castro 2018). These conflicts prompted Sudan's government to devote much of the country's economy to the military. Making matters worse, in 1993 the United States imposed sanctions on Sudan, and the country experienced a 20-year exile from global commerce and foreign investment.

Since independence in 1956 Sudan has depended entirely on agriculture, with cotton—mainly serving British textile mills—as the money crop, which Sudan's largest economic undertaking, the Gezira Scheme was established to support (Siddig et al. 2020). Instead of rebuilding a

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diversified economy after independence, Sudan's national government persisted with an agri-centric economic model. Until the mid-1980s, agriculture remained Sudan's economic backbone, contributing nearly 40% of GDP versus 12% to 15% for the industrial sector (Elagib et al. 2019).

Significant economic change began in 1992 after economic liberalization. To fight economic stagnation the government liquidated most institutions and privatized government-owned companies. Oil production and structural economic reforms bolstered Sudan's economy during the mid-1990s, but it has eroded since 2009 following eruptions in public expenditures, unemployment, and prices for services and commodities alongside declining agricultural and industrial output as oil revenues vanished.

Sudan's labor market features a traditional and a modern sector. Agriculture drives employment and absorbs 60% of the labor force (Bannaga 2015). Consequently, employment is prominently seasonal and worker productivity is low. Labor market problems were again exacerbated by the 2007–2008 global financial crisis, which dried up capital inflows and reduced exports and investment. Productivity growth declined from 7.6% to 2.4% during 2008–2009. It hit 2.2% in 2010, and inflation surpassed 70%, the deficit rose about 50%, and the exchange rate of the Sudanese pound (SDG) deteriorated against the dollar.

Since a military coup in 1989, Sudan's school system has been partitioned into kindergarten, primary school (eight years), and secondary school (three years). The federal government law enacted in 1994 brought primary education to all localities (PACT 2010). It acknowledged that declining educational opportunities in remote areas had created a rural–urban divide (Mann 2014). Sudanese higher education has expanded rapidly by increasing the number of public universities and establishing several private universities (Ali 2017). The number of students swelled from 6,080 in 1989 to 1,300,033 in 2009. This expansion exceeded the government's education budget, and the result has been erosion in university learnings environments and shortages of faculty (Saeed 2015). Moreover, Sudan's labor market has been unable to absorb the proliferation of graduates, and rates of return on education have been low.

Education in Khartoum State surpasses education in Sudan's 17 other states. Its many superior private and foreign colleges encourage students to enroll and graduate. However, their students often are from Sudan's elite or middle class, for whom the high cost of education and economic difficulties present challenges.

Sudan's 2019 economic dislocations started with escalating prices of goods and services, notably essential commodities (meat, vegetables, dairy, sugar, bread). They persisted with crises in oil derivatives and flour. Besides the lack of liquidity and consequent failure of bank customers to withdraw savings, the Sudanese pound fell to its lowest level against foreign currencies.

The Sudanese have among the world's lowest living standards and have lived in extreme poverty for decades because of the 2003–2010 civil war during which most of the population, especially in the Darfur states, depended completely on remittances from migrant labor and international aid. The percentage of the population below the national poverty line in 2010 was 46.5% (World Bank Group 2019). Earnings inequality has been much higher in urban than in rural areas due to government policy and numerous external factors.

3. Materials and methods

3.1 Data, variables, and hypotheses

From June through October 2019 we distributed questionnaires to 694 public and private sector employees chosen by purposive sampling from three Sudanese states: Kordofan in western Sudan, Gazira in central Sudan (associated with agriculture and mining), and Khartoum

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(regional capital and site of Sudan's national government). We sought to survey a cross-section of Sudan's economy. Private sector respondents working in agriculture, mining, trade (retail commerce), real estate, and construction. transportation and insurance and banking. Public sector represented by teaching, information and communication, and health. Respondents had the option to declare their sector of employment as 'other.'

Our survey posed nine questions, answers to which provided nine variables for a Mincer model.

1. Gender: The sample includes 547 men (84.3%) and 102 women (15.7%). We constructed a dummy variable taking on the value of 1 if the respondent is men and 0 if women.

2. Marital status: Respondents could answer 'married' if they were heads of households or living with an extended family (47.6%) or 'single' if they were unmarried, divorced, or widowed (52.4%). We transformed responses into a dummy taking a value of 1 for married and 0 otherwise.

3. Residential area: We asked respondents if they lived in an urban or rural area. We created a dummy taking on the value of 1 for urban and 0 if rural.

4. Years of education: Number of years of school completed by the respondent. Respondents with 1 to 8 years of education were classified as primary school education, respondents with 9 to 11 years of education were classified as secondary school education, respondents with 12 to 13 years of education were classified as technical training education, and respondents with more than 13 years of education were classified as university education.

5. Age: Respondents' ages.

6. Occupation: this as a categorical variable for which we assume its values as numbers as follows: 1 = agriculture, 2 = mining, 3 = retail trade, 4 = real estate, 5 = construction, 6 = transportations, 7 = insurance and banking, 8 = education, 9 = information and communication, 10 = health and 11 = other activity. For statistical analysis, we create the following variable:

i. Agriculture: a dummy variable taking the value of 1 if the respondent's occupation is agriculture and 0 otherwise.
ii. Mining: a dummy variable taking the value of 1 if the respondent's functional area of work is artisanal mining and 0 otherwise.
iii. Real estate: a dummy variable taking the value of 1 if the respondent's functional area of work is real estate and 0 otherwise.
iv. Retail trade: a dummy variable taking the value of 1 if the respondent's functional area of work is retail trade and 0 otherwise.
v. Construction: a dummy variable taking the value of 1 if the respondent's functional area of work is construction and 0 otherwise.
vi. Transportations: a dummy variable taking the value of 1 if the respondent's functional area of work is transportations and 0 otherwise.
vii. Insurance and banking: a dummy variable taking the value of 1 if the respondent's functional area of work is insurance or banking and 0 otherwise.
viii. Education: a dummy variable taking the value of 1 if the respondent's job is teaching and 0 otherwise.
ix. Information and communication: a dummy variable taking the value of 1 if the respondent's functional area of work is information or communication and 0 otherwise.
x. Health: a dummy variable taking the value of 1 if the respondent's functional area of work is in health and 0 otherwise.

Other activity: a dummy variable taking the value of 1 if the respondent's profession is not in a above ten mentioned activities and 0 otherwise.

7. Experience: The number of years' experience that respondent held in his current job.

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8. Squared experience: Pauna (2009) suggests squaring the variable for years of experience to indicate what labor skills would increase wages.
9.Wage: 'wage' refers to returns linked directly to employment in a current job. We excluded gifts and rental income.
10. Earnings: all personal income from wages, investments, and other sources.

Our hypotheses are:

1. H_0: There is no positive association between years of education and earnings.
2. H_0: Experience in occupations does not affect earnings.
3. H_0: For any given occupation, the rate of return on 'education and experience combined,' is statically significant and varies with occupation.
4. H_0: There is no statistically significant difference in wage among respondents with the same educational attainment.
5. H_0: There are no statistically significant differences in wage with respect to functional area of work.
6. H_0: Irrespective of occupation, there are no wage differences between equally educated women and men.
7. H_0: There are no statistically significant wage differences between rural and urban workers.

To test these hypotheses, we regressed wages against primary independent variables using ordinary least squares (OLS). We applied t- tests and one-way analysis of variance (ANOVA) as explained next.

3.2 Estimation methods

We tested Hypotheses 1 and 2 via linear cross-sectional OLS using SPSS software. Assuming that investment in education lasts S years and on-the-job training declines linearly over the lifecycle (Polachek 2008), the common form of the Mincer earnings function is

$$\ln Y(s;t) = \beta_0 + \beta_1 S + \beta_2 t + \beta_3 t^2 + \varepsilon \quad (1)$$

where $Y(s;t)$ is the earnings for persons with educational attainment s and work experience t. $\beta 0$ denotes initial earnings capacity and β_1 the rate of return on education (interpreting all education costs as opportunity costs). β_2 and β_3 denote the quantity of and financial return from on-the-job training, respectively. ε is the error term. For further details see Psacharopoulos (1995) and Psacharopoulos and Mattson (1998).

We regressed other influences on wages, including gender, age, experience, marital status, and residential area. The model takes this form:

$$\ln Y = \beta_0 + \beta 1 Si + \beta 2 Xi + \beta 3 X j + \varepsilon i \quad (2)$$

where β_0 relates to initial earnings capacity. Xi and Xj denote factors that influence earnings differently from years of education.

To test Hypothesis 5, we used ANOVA to check whether arithmetic means of wages of two or more occupations differ significantly. We examined Hypotheses 5 and 6 by applying the independent sample t-test.

4. Results

Table 2 displays earnings per education level in our total sample. It shows that 12% of respondents have primary school educations only, 12% have secondary school educations only, 25% have technical training, and 51% are university educated.

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Table 2. Average Monthly Earnings by Education

Education	Earnings	# of workers
Primary school	4,090.17	78 (12%)
Secondary school	12,095.24	78 (12%)
Technical training	13,306.69	161 (25%)
University	16,461.60	332 (51%)
Total sample	13,667.32	649

Table 3 presents the results of an extended Mincer function based on OLS regression with the ln (earnings) as the dependent variable. Keeping all other variables constant, a one-unit increase in years of education increases ln (earnings) 4.4% for men, 9.2% for women, and 4% for the total sample.

Table 3. Mincer Earnings Function

Variable	Total sample			Male			Female		
	Coefficient	t- value	Prob.	Coefficient	t- value	Prob.	Coefficient	t- value	Prob.
Constant	6.719	41.81	0.000	6.706	0.36.28	0.000	5.64	18.652	0.00
Education	0.040	3.006	0.003	0.044	2.858	0.004	0.092	4.430	0.00
exp	0.016	0.773	0.440	0.02	0.854	0.472	0.040	2.445	0.01
M. status	0.787	8.545	0.000	0.847	7.827	0.000	0.285	3.866	0.00
Residence				1.012	7.719	0.000	1.239	15.779	0.00
Exp2	0.000	-0.333	0.739	-0.001	-0.720	0.472	-2.8E-05	-0.053	0.96
R2	0.53			0.496			0.943		
Std error	1.41			1.23			0.28		
F-Value (Prob.)	5,046(0.000)			35.22(0.000)			153(0.000)		

Std error: Std error of the estimate. Dependent variable: (In(earnings)). Predictors: constant, education, experience, marital status, residence. Significance level: 0.05

In the total sample, married workers have a monthly earnings of SDG 0.787 more per month than unmarried workers. After marital status, education has the least influence on individual earnings.

Our three models are statistically significant, and education, marital status, and place of residence affect earnings of individuals differently with statistically significant coefficients ($P < 0.05$).

Table 4 presents the main estimate of Eq. (1). We modeled each of the 12 occupations. We regressed ln (Wage) on years of education, experience and $(experience)^2$ to determine whether the effects of education vary with occupation. R^2 values show that education determined 99% of the variance in ln (Wage) for finance, 96% for banking, 79% for insurance, 70% for healthcare, 60% for electricity, and 56% for education.

Healthcare occupations exhibit the highest rate of return on education (91.8%) as measured by ln (Wage), followed by electricity (17.4%) and agriculture (0.2%). Occupations exhibiting a negative rate of return with (ln Wage) include real estate (-23.3%), teaching (-0.5%), and finance-banking-insurance (-0.1%). Occupations with a non-significant model are construction, trade, mining, information & communication, and other.

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Table 4a. Mincer Earning Function by Occupation

	Agriculture			Construction			Education		
Variable	Coefficient	t-value	Prob.	Coefficient	t-value	Prob.	Coefficient	t-value	Prob.
constant	5.86	33.827	0.00	8.34	34.168	0.000	7.442	10.425	0.000
education	0.002	0.160	0.87	0.009	0.526	0.601	-0.005	-0.112	0.911
exp	0.010	0.786	0.43	0.037	1.388	0.170	0.42	2.731	0.008
Exp2	000	0.774	0.44	-0.001	-0.6.2	0.549	0.000	-0.459	0.648
R2	0.586			0.324			0.697		
Std error	0.223			0.361			0.256		
F- value	14.32			2.378			19.16		
(Prob.)	(0.000)			(0.780)			(0.000)		

Table 4b. Mincer Earnings Function by Occupation

	Electricity			Finance-banking-insurance			Healthcare		
Variable	Coefficient	t-value	Prob.	Coefficient	t-value	Prob.	Coefficient	t-value	Prob.
constant	6.119	10.190	.000	8.322	206.43	.000	-7.521	-2.267	.028
education	0.174	4.532	.000	-0.001	-0.36	.723	0.918	4.650	.000
exp	0.026	1.083	.290	0.081	20.68	.000	0.081	2.809	.007
Exp^2	-5.18E-05	-0.059	.953	-0.001	-4.55	.000	-0.001	-1.625	.111
R^2	0.785			0.998			0.961		
Std error	0.255			0.026			0.245		
F- value	12.316			4465.898			187.152		
(Prob.)	(0.000)			(0.000)			(0.000)		

Table 4c. Mincer Earnings Function by Occupation

	Mining			Professional & technical			Real estate		
Variable	Coefficient	t-value	Prob.	Coefficient	t-value	Prob.	Coefficient	t-value	Prob.
constant	8.742	121.66	.000	7.683	8.262	.000	11.378	7.463	.000
education	0.001	.221	.826	0.045	0.604	0.550	-0.233	-2.391	.024
exp	0.022	.617	.540	0.141	0.849	0.402	0.068	1.918	.065
Exp^2	-0.003	-.911	.367	-0.009	-0.550	0.586	-0.002	-1.218	.233
R^2	0.189			0.400			0.596		
Std error	0.185			0.380			0.260		
F- value	0.616			2.098			4.458		
(Prob.)	(0.608)			(0.119)			(0.011)		

Table 4d. Mincer Earnings Function by Occupation

	Trade			Information & communication			Other		
Variable	Coefficient	t-value	Prob.	Coefficient	t-value	Prob.	Coefficient	t-value	Prob.
constant	9.926	11.758	.000	7.676	8.553	.000	8.010	50.778	0.000
education	0.088	1.987	.054	0.076	1.256	.217	-0.007	-.603	0.548
exp	0.048	.771	.445	-0.010	-.317	.753	0.080	1.333	0.186
Exp^2	-0.002	-.826	.414	0.001	.456	.651	-0.008	-1.125	0.264
R^2	0.313			0.370			0.181		
Std error	0.685			0.189			0.533		
F- value	1.483			2.012			0.938		
(Prob.)	(0.233)			(0.129)			(0.426)		

Std error: Standard error of the estimate. Source: Author calculations from survey data; sample of 649 labor. Notes: Dependent variable is (Ln (wage)).

Table 5 presents results for the extended regression of wage (ln) in Model 1 on different educational attainments (primary, secondary, technical, university). ln is the dependent variable. Explanatory variables are construction, electricity, mining, information &

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communication, healthcare, finance-banking-insurance, professional & technical, real estate, trade, and other. Some occupations in Model 1 are omitted for lack of workers.
In Model 1, R^2 values are 90% for primary school, 97% for secondary school and technical training, and 89%, for university education. Model 1 determines nearly 90% of the variation in wages. All coefficients bear positive signs and are significant at 0.01 or .05.

Table 6 presents ANOVA for wage differences in Model 1. Results show that the probability value is significant at 0.05. Evidence rejects the null for Hypothesis 4. At least one occupation exhibits significantly different means. We conducted a post hoc test to see whether any occupation contributes the most to differences in statistical significance. Results in Table 7 constitute three subgroups; trade has a 95% confidence interval for mean (SDG 10,972–16,363) and contributes the most to significant differences in wages.

Table 5. Occupational Regression Coefficients for Levels of Education

	Model 1		Model 2		Model 3		Model 4	
	Primary school		Secondary school		Technical training		University	
Occupation	coefficients	t-value	coefficients	t-value	coefficients	t-value	coefficients	t-value
(Constant)	6.240	58.147**	6.065	89.040**	6.056	100.11**	7.671	125.40**
mining	2.523	15.391**	2.699	19.810**	2.748	28.29**	1.104	5.98**
Construction	2.091	5.874**	2.682	16.788**	2.660	30.55**	1.009	8.93**
trade	4.357	8.860**	5.189	32.484**	5.451	49.54**	3.860	32.25**
other	1.860	14.149**	1.922	14.535**	1.981	23.52**	0.793	2.24*
Professional & technical			2.635	6.359**	2.384	17.14**	1.167	10.60**
Information & communication					2.658	28.95**	1.147	8.92**
Finance-banking-insurance					2.462	19.55**	1.323	14.26**
Electricity							1.554	13.76**
Healthcare							1.848	19.92**
Real estate							0.505	4.74**
R^2	0.90		0.97		0.97		0.89	
Std error	0.480		0.40869		0.331		0.493	
F- value	80.916**		265.153**		391.873**		122.656**	

Dependent Variable: ln(wage). **significant at 0.01. *significant at 0.05. Std error: Standard error of the estimate

Table 6. Monthly Average Wage by Occupation

			95% Confidence Interval for Mean	
Occupation	Mean	Std	Lower Bound	Upper Bound
Agriculture	463.41	126.67	436.25	490.56
Construction	6,268.42	1,598.85	5,872.24	6,664.59
Education	2,294.31	975.68	2,052.55	2,536.07
Electricity	10,537.04	2,824.77	9,419.59	11,654.48
Finance-banking-insurance	8,169.49	3,567.83	7,239.71	9,099.27
Healthcare sector	18,360.00	12,208.66	14,890.34	21,829.66
Mining	6,598.24	1,099.75	6,298.07	6,898.41
Professional & technical	7,248.65	6,544.83	5,066.49	9,430.80
Real estate	3,712.50	1,104.46	3,314.30	4,110.70

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Trade	116666.67	76,254.65	93,757.23	139,576.10
Information & communication	6,498.90	1,251.85	6,108.80	6,889.01
Other	3,711.49	2,761.42	3,122.96	4,300.03
Total	13,667.32	34,968.50	10,971.97	16,362.66
F-value = 114.15			Prob. = 0.000	

Table 7. Income among Homogeneous Subgroups

Occupation		Homogeneous Subgroup for alpha = .05		
	N	Group1	Group 2	Group 3
Agriculture	86	463.41		
Education	65	2,294.31		
Other	87	3,711.49		
Real estate	32	3,712.50		
Constructions	65	6,268.42	6,268.42	
Information & communication	42	6,498.90	6,498.90	
Mining	54	6,598.24	6,598.24	
Professional & technical	37	7,248.65	7,248.65	
Finance-banking-insurance	59	8,169.49	8,169.49	
Electricity	27	10,537.04	10,537.04	
Healthcare	50		18,360.00	
Trade	45			116,666.67
P-value		0.402	0.147	1.000

Means for groups in homogeneous subsets are displayed. Harmonic Mean Sample Size = 47.87

Table 8 presents results from the independent sample t-tests for gender-wage differences. It displays statistically significant wage differences between women and men with equal educations ($P < 0.001$). This finding suggests men earn more than women, with an average gender pay gap across all surveyed occupations of 149.2% for workers with technical training and 98.2% for workers with university educations.

Table 8. Results of Independent Sample t-tests for Gender-Wage Differences

Education	Gender	N	Mean	Standard deviation	Statistic t
Technical	Male	144	14,204.63	36,102.774	2.815**
	Female	17	5,700.59	1,078.758	
University	Male	247	18,853.56	45,114.144	3.139**
	Female	85	9,510.82	7,259.378	

Note: Sample includes only women with technical or university educations.
**significant at 0.1.

Table 9. Results of Independent Sample t-tests for Urban-Rural Wages Differences

Occupation	Residence	N	Mean	std	t Statistic
Education	Urban	47	2,487.45	1,074.28	4.06**
	Rural	18	1,790.00	297.58	
mining	Urban	18	6,339.39	215.68	-1.23
	Rural	36	6,727.67	195.30	
Trade	Urban	28	129,285.71	16,088.62	1.44
	Rural	17	95,882.35	13,334.18	

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Other	Urban	36	2,758.33	1,354.02	-2.81**
	Rural	51	4,384.31	3,273.61	
Total sample	Urban	441	15,197.78	3,7044.84	1.62
	Rural	208	10,422.45	2,9921.65	

**significant at 0.01

Table 9 presents results for independent t-tests of wage differences between urban and rural workers. Because some occupations are not rural and others are not urban, analysis includes only occupations evident in both locales. Excluded occupations are agriculture, construction, transportation, real estate, finance-banking-insurance, healthcare, information & communication, and electricity. Results reject Hypothesis 6. Statistically significant rural–urban differences exist in teaching and other occupations ($P < 0.01$). Results show no compelling evidence of significant urban-rural wage differentials in mining and trade ($P > 0.01$). Generally, these results accept the hypothesis of a zero wage differential between rural and urban employees in the total sample.

5. Discussion

This study has estimated the rate of return on education in Sudan by applying Mincer earnings functions. Hypothesis 1 assumes in H_0 there is no association between years of education and earnings. The result in Table 1 rejects the hypothesis ($P < 0.05$).

Although the result suggests the rate of return on education in Sudan is 0.04, it is below average rates of return in other developing economies (9.3%) (Tables 1 and 3). This finding coincides with Barney and William (1994) can be explained by imperfections in Sudan's labor market as a reflection of the country's poor quality of education and the exodus of skills out of Sudan over the past three decades.

Hypothesis 2 asserts that occupational experience does not affect earnings. The unexpected result is that work experience exhibits no significant effect on individual earnings for the total sample, coinciding with the null hypothesis. Experience exhibits a significant effect on female workers and does not affect the earnings of males (Table 3). Although women earn less than men with whom they share equal educational attainment in identical jobs, women's earnings are more likely affected by work experience than men's.

Further, the result suggests that one additional year of education increases earnings 4.4% among men and 9.2% among women. This result aligns with findings by the United Nations Industrial Development Organization (UNIDO 2015). Therefore, it is important to encourage people to educate daughters.

Hypothesis 3 asserts that for the same occupation rate of return (earnings) on education and experience is statically significant. Results vary substantially from occupation to occupation. Years of education varies from statistically significant in agriculture, teaching, electricity, finance-banking-insurance, and healthcare to non-significant for construction, mining, professional & technical, trade, information & communication, and other (Table 4). The healthcare sector exhibits the largest return (91.8%) followed by electricity (17.4%).

Coefficients are negative for finance-banking-insurance (-0.001), real estate (-0.233), and teaching (-0.005). One explanation may be that education is important in developing the industrial, agricultural, and service sectors. That education exhibits no positive impact on individual earnings in mining, professional & technical, construction, trade, and information & communication seems inconsistent with a Mincer model. The reason likely is that mining, professional & technical, and construction in Sudan are suffering from the country's general recession attributable to political and economic changes.

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The result of the extended regression of ln (wage) in Models 1 through 3 shows that rate of return increases with education in mining, construction, trade, and other occupations, with lower returns obtained from primary education. These findings indicate convexity between education and earnings. From these results, revenue is influenced by occupations that require equivalent educational attainment. Therefore, we reject Hypothesis 4 and conclude there are statistically significant wage differences in Model 1 for equivalent education. Further, workers in professional & technical occupations, information & communication, finance-banking-insurance, electricity, healthcare, and real estate have technical training or university educations (Table 5). Models 1 through 5 suggest Model 1 determined the variation in wages.

Results in Table 6 generally reject Hypothesis 5, which asserts there is no significant wage difference according to economic activities, among the study's total population ($F = 114.15$, $P < 0.1$). Across Model 1, monthly average wages range from SDG 463.41 for agriculture to SDG 116,666.67 (95% CI (10,972–16,363)) for trade. This result indicates trade is the best occupation for earning money.

With average wages spanning SDG 6,268.42 to 18,360, Model 1 can be arranged as follows: construction (average wage SDG 6,268.42), information and communication (SDG 6,498.90), mining (SDG 6,598.24), professional & technical (SDG 7,248.65), finance-banking-insurance (SDG 8,169.49), electricity (SDG 1,0537.), and healthcare (SDG 18,360.00). Those figures are followed by agriculture (average wage SDG 463,410), other (SDG 3,711.49), real estate (3,712.50), and teaching (SDG 2,294.31) (Tables 6 and7).

These results argue that trade contributes most to significant differences in wages. There are three possible reasons. First, trade and investment in Sudan have suffered three decades of international constraints. For example, Sudan's ranking on Transparency International's Corruption Perception Index is 175th of 180 countries (Transparency International 2019). Second, Sudan is 170th of 190 countries in the World Bank's 2018 ease-of-business rankings (The World Bank Group 2019). corruption was spread in all government institutions and traders took advantage of this situation to raise prices without reason or legal justification to achieve wealth. Third, trade enjoys wider profit margins than other occupations, perhaps because opportunities for investment are diverse among natural resources, mining, agriculture, livestock, transportation, and industry.

Results in Tables 3 and 8 reject Hypothesis 6. There are statistically significant gender differences in monthly salary: men with technical (university) educations typically earn 149.2% (98.2%) more than women. In general, an additional year of education increases ln (wages) 4.4% for males and 9.2% for females.

Hypothesis 7 surmises there are no statistically significant wage differences between rural and urban areas. To investigate, we used data for teaching, mining, and other. Results in Table 9 reject the hypothesis for education and for the total sample but not for trade and mining. A striking finding is that the more educated a rural resident, the less he earns versus her urban counterpart, possibly for three reasons. First, Sudan's provinces exhibit varying living expenses, economic development, and labor forces. More-productive sectors may have greater capacity to pay. Second, some workers may earn more because they are more skilled and productive. Third, higher-paying overtime work is available in urban Sudan

6. Conclusion

This paper has estimated the rate of return on education in Sudan. Its importance is in using updated primary survey data from 2019 reflecting the situation of Sudan during the past decade. In those 10 years, the United States imposed sanctions on Sudan and blocked funding from the International Monetary Fund and World Bank. As a result, businesses have been unable to

conduct dollar transactions and GDP is hard to measure given currency depreciation. Sudan's estimated external debt was 62% of GDP, and inflation was estimated at 43%, driven by sharp devaluation of the Sudanese pound. An overvalued official exchange rate triggered a parallel market emergency. Therefore, estimating the rate of education under these circumstances is a new contribution that fills a 10-year gap in Sudanese literature.

Based on our findings, we conclude that investment in education is key to raising individual earnings in Sudan. The conclusion for Sudanese planners is to optimize the quality of education nationwide because doing so enhances educational attainment and improve the return on education for individuals and industry. Therefore, the government of Sudan should allocate considerable funds to education. Variables for gender, marital status, and place of residence affect workers' earnings differently and significantly. Findings also argue that the more you learn, the more you earn. For example, earnings for workers with university educations were more than triple those of workers with primary school educations. In general, 'educated workers earn more' is a rational finding.

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