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Estimating the rate of return to education in Sudan

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Estimating the Rate of Return to Education in Sudan

By Dr. Samia Satti Osman Mohamed Nour

(June 2011)

Estimating the Rate of Return to Education in Sudan

By Dr. Samia Satti Osman Mohamed Nour [1]

(June 2011)

Abstract

This paper examines the rate of return to education in Sudan. One advantage and interesting element in our analysis in this paper is that we explain three stylised facts on the rate of return to education using new primary data in Sudan: first, positive but low rate of return to education and correlations between education, experience, its square and wages for men and women defined by gender, second, positive and significant rate of return to education and correlations between education, experience, its square and wages defined by firm size and industry at the micro level across industrial firms and third, an increase in skill levels and firm size leads to improved relationship between actual education, required education, experience, its square and wages at the micro level across industrial firms. Our paper is relevant and consistent with the recent growing interest in the literature that confirms the importance of investment in education and rate of return to education. Different from the Sudanese literature that estimates the return to human capital at the macro level, we investigate the rate of return to education using new primary data at the micro level. A novel element of our analysis is that we use new primary survey data at the micro level obtained from the university survey (2009) and the firm survey (2010), we present a new contribution and fill the gap in the Sudanese literature by estimating first the rate of return to education for men and women and explaining differences defined by gender and second for industrial firms and explaining differences defined by firm size and industry, since these issues are not adequately discussed in the Sudanese literature. Our findings indicate the importance of investment in education to facilitate enhancing educational attainment and improvement of the rate of return to education in Sudan.

Keywords: Education, returns to education, gender, industry, Sudan.

JEL classification: J01, J16, J21, J24, J31, I21

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Estimating the Rate of Return to Education in Sudan

1. Introduction

Since long economists from different schools of thought consider education and investment in human capital as important instruments for the initiation, acceleration, and sustainability of economic growth and improvement of productivity and the quality of life in society. Human capital theory, new growth theories and the empirical literature recognize the importance of human capital accumulation/formulation for economic growth in both developed and developing countries.[2] Based on human capital theory, the rate of return on investment in education implies that an increase in the investment in education and payment of the related costs incurred in the current time is motivated by the potential increase in the compensated benefits in productivity and earnings in the future. This implies that the estimation of the rate of return to education is based on the argument that an increase in investment in education is related to an increase in productivity and earnings in the future.[3, 4] The literature distinguishes between the private and social rates of return to education and indicates that the social rate of return on investment in education is usually less than the private rate of return because the social rate of return often implies the presence of externalities, external benefits or spillover benefits related to education that affect society as a whole, so by including externalities, the social rates of return will probably be higher than private rates of return on education.

In recent years, this discourse has gained ground in the Arab region as well. The United Nations Development Programme (UNDP)-sponsored Arab Human Development Report (AHDR) highlighted the centrality of human capital (higher education) and knowledge (science and technology) for the development of the Arab region.[5] Moreover, several studies in the literature investigated the rates of return to education in the Arab countries.[6]

This paper aims to examine and estimate the rate of return to education at the micro level in Sudan using the well-known Mincer earning function. Our paper is relevant and consistent with the recent growing interest in the international, theoretical and empirical literature and the Arab literature that confirm the importance of investment in education and the rate of return to education. We add to the recent studies in the Arab literature that aim to improve understanding about the rate of return to education in the Arab region. Different from earlier studies in the Arab literature, which examine the rates of return to education in some

[2] See, for example, Barro (1991; 1996), Barro and Lee (1993; 2000), Barro and Sala-i-Martin (1995) Becker (1962; 1964; 1972), Benhabib and Spiegel (1994), Card (1999), Kyriacou (1991), Lucas (1988), Mankiw, Romer and Weil (1992), Romer (1990) and Shultz (1961).

[3] The Mincer earning function is defined by: $\log y_i = \alpha + \beta s_i + \gamma x_i - \delta x^2_i + \mu_i$ and the extended Mincer earning function is defined by: $\log y_i = \alpha + \sum \beta_k D_{ki} + \gamma x_i - \delta x^2_i + v_i$.

[4] For definition and calculation of return to education in the literature and Mincer earning function, see Mincer (1974; 1984; 1989). For more and detailed information about the theoretical and empirical literature on the estimation of the rate of returns to education, see for instance, Benhabib and Spiegel (1994), Mincer (1974; 1984; 1989) and Psacharopoulos (1994).

[5] See the United Nations Development Programme-Human Development Report (2002; 2004), the United Nations Development Programme -Arab Human Development Report (2002; 2003), El-Erian, et.al (1998), Altwaijri (2003) and World Bank (2007).

Arab countries (cf. Al-Qudsi, 1985; 1989; Assad, 1997; Fergany, 1998), an interesting element in our analysis is that we explain the rate of return to education in Sudan as a new case of the Arab countries using most up to date quantitative data and a more comprehensive set of indicators at the micro level for Sudan (2008). Different from the few earlier studies in the Sudanese literature (Ali, 2006) that focused on the estimation of return to human capital in Sudan based on secondary data at the aggregate level obtained from the Migration and Labour Survey (1996) conducted by Sudan Ministry of Labour covering 16 States of Northern Sudan defined by gender and education level at the macro level, our analysis in this paper is different because we focus on the estimation of the rate of return to education at the micro level using more recent, update and new primary data at the micro level based on the university survey of Nour (2009) and the firm survey of Nour (2010). A novel element of our analysis in this paper is that we use new primary survey data at the micro level obtained from the university survey (2009) and the firm survey (2010), we present a new contribution and fill the gap in the Sudanese literature by estimating first the rate of return to education for men and women and explaining the differences defined by gender and second the rate of return to education for industrial firms and explaining the differences defined by firm size and industry, since these issues are not adequately discussed in the Sudanese literature. One advantage and interesting element in our analysis in this paper is that we explain three stylised facts on the rate of return to education using new primary data in Sudan: first positive but low rate of return to education and correlation between education, experience, its square and wages for men and women defined by gender, second, positive and significant rate of return to education and correlation between education, experience, its square and wages defined by firm size and industry at the micro level across industrial firms and third, an increase in skill level and firm size leads to improved relationships between actual education, required education, experience, its square and wages at the micro level across industrial firms in Sudan. We are aware of the practical problems and limitation that statistical information about education from the surveys is to some extent estimated and for relatively small sample of 100 persons covered in the university survey and for 73 firms covered in the firm survey. But due to practical problems regarding the availability of more accurate and reliable data from other reliable sources and for relatively large sample defined by education level, in this paper we limit our analysis to estimate the rate of return to education in Sudan defined by gender and by firm size and industry based on the well-known Mincer earning function for relatively small sample. Therefore, despite the relatively small sample size that may constitute a limitation for making some generalization from our results, but we believe that our results remain useful to improve understanding and provide useful insights from both analytical and policy perspectives.

[6] See for instance, Al-Qudsi (1985; 1989), Psacharopoulos (1994), Benhabib and Spiegel (1994), Assad (1997), Fergany (1998), Lane, Hakim and Miranda (1999), Ali (2001; 2002; 2003) and Salehi-Isfahani (2008).

The rest of this paper is organized as follows: Section 2 briefly presents the literature on the rate of return to education in the Arab countries. Sections 3 explains our hypotheses and stylised facts about the importance and estimates of the rate of return to education and define the data and variables used in our analysis to test them. Section 4 then examines our hypotheses and stylised facts and discusses the main findings on the relationships between education, experience and wages or the rate of return from investment on education, first for men and women defined by gender, and second, for firms defined by firm size and industry across firms at the micro level in Sudan and finally Section 5 provides the conclusions.

2. The rate of return to education in the Arab countries

Before starting with the empirical analysis, it will be useful to briefly explain the several studies in the literature on the rate of return to education in the Arab countries.[7]

Psacharopoulos (1994) estimates the rate of return to education for a large number of countries in the world including only six Arab countries.[8] The average social rate of return to primary education in the Arab countries is estimated for Morocco (50.5 percent); Somalia (20.6 percent); and Yemen (2 percent) compared to the highest social rate of return to primary education estimated in Sub-Saharan Africa (24.3 percent) and the lowest rate that estimated for the Organization for Economic Cooperation and Development (OECD) countries (14.4 percent). The estimated social rate of return to education in all world regions declines with the increase of educational level, i.e. higher for primary education (18.4 percent) followed by secondary (13.1 percent) and tertiary education (10.9 percent). The private rates of return exceed the social rates for all regions and all levels of education as can be seen from the world average private rates of return for the primary level (29.1 percent), secondary level (18.1 percent) and for the tertiary level (20.3 percent). The private rates of return to education for the Arab countries was estimated for Somalia (primary level (59.9 percent), secondary level (13 percent), and tertiary level (33.2 percent)); Yemen (primary level (10 percent), secondary level (41 percent) and tertiary level (56 percent)); Tunisia, (secondary level (13 percent) and tertiary level (27 percent)) and for Sudan, for the secondary level the private rates of return

[7] See for instance, Al-Qudsi (1985; 1989), Psacharopoulos (1994), Benhabib and Spiegel (1994), Assad (1997), Fergany (1998), Lane, Hakim and Miranda (1999), Ali (2001; 2002; 2003) and Salehi-Isfahani (2008). For instance, according to Salehi-Isfahani (2008) "Aggregate data confirm the low productivity of education in the Middle East and North Africa. The so-called social rate of return for education —increase in output due to increase in years of schooling—is estimated to be close to zero (Pritche 1999; Fattah, Limam, and Makdisi 2007). Despite, the high rates of unemployment of the educated youth and the low productivity of education families and youth continue to invest heavily in education, apparently believing it to be the main path to success. As a result, MENA countries have experienced the fastest rate of growth in schooling of any region in the world in the last two decades. One explanation for the earnest pursuit of education despite its low productivity is high private returns, especially for university education. Several studies on returns to education in MENA show that private returns to education are low for schooling below upper secondary, but rise with education level. See, for example, Assaad (1997) for Egypt and Huitfeld and Kabbani (2007) for Syria …. For a survey of recent studies on the rate of returns to schooling see Ali (2002a)"- see for instance, Salehi-Isfahani (2008, pp. 9-13).

[8] Psacharopoulos (1994) uses three standard methods -the "full method" of calculating the rate of return, the "basic Mincer" earnings function, and the "extended" earnings function- for estimating the social and private rates of return to education for the three main levels of education; primary, secondary, and tertiary. The full method includes seventy-eight countries including Morocco (1970); Somalia (1983); Sudan (1974); Tunisia (1980); and Yemen (1985), a Mincer earnings function includes sixty-two countries including Kuwait (1983); Morocco (1970); and Tunisia (1980). See for instance, Psacharopoulos (1994, as cited in Ali, 2003, pp. 19- 23).

(13 percent) is higher than the social rate of return (8 percent) and for the tertiary level the private rates of return (15 percent) is higher than the social rate of return (4 percent). Based on the Mincerian earnings function, the rate of return to education declines with the level of development as measured by the level of per capita income and the average years of schooling in the population. For example, low income countries with an average per capita income of about US$ 842 and 7.4 average years of schooling, recorded an average rate of return to education of about 11.5 percent. High income countries, with an average per capita income of US$ 13,669 and 10.9 average years of schooling, recorded an average rate of return to education of 6.6 percent. The results for the Arab countries are consistent with the world pattern, for instance, the observed average years of schooling with a rate of return to education are respectively (8.9 average years and 4.5 percent) in Kuwait (1983), (4.8 average years and 8 percent) in Tunisia (1980), and (2.9 average years and 15.8 percent) in Morocco (1970). [9]

Benhabib and Spiegel (1994) estimate the rate of returns to education using the Cobb-Douglas production function for a sample of 121 countries including only ten of the Arab countries for which data are available.[10] Benhabib and Spiegel (1994) estimated human capital (schooling years) and the rate of return for the Arab countries includes Jordan (7.470 year and 2.9 percent), Tunisia (5.655 year and 3.8 percent), Algeria (4.657 year and 4.7 percent), Saudi Arabia (2.951 year and 7.4 percent), Sudan (2.089 year and 10.4 percent), Syria (6.623 year and 3.3 percent), Somalia (0.825 year and 26.3 percent), Iraq (4.552 year and 4.8 percent), Kuwait (6.919 year and 3.1 percent), Egypt (5.696 year and 3.8 percent), Morocco (3.485 year and 6.2 percent) and average for all Arab countries (4.629 year and 6.97 percent). Based on Benhabib and Spiegel (1994) estimation, the highest rate of return on human capital in the Arab countries in 1985 was found in Somalia (26.3 percent) and the lowest rate of return was found in Jordan (2.9 percent). Benhabib and Spiegel (1994) estimated average rate of return for the Arab countries was about 7 percent for the year 1985 is near to Psacharopoulos (1994) estimated average rate of return of about 6.2 percent in Tunisia and Kuwait at the beginning of the eighties. [11, 12]

Salehi-Isfahani (2008) uses Mincer equation and provides a comparative analysis of the returns to education in three countries of the Middle East region in Egypt, Iran, and Turkey. Salehi-Isfahani (2008) shows that for university graduates in Egypt and Iran the gain was large and for vocational education graduates in Egypt the average wage doubled in 8

[9] See for instance, Psacharopoulos (1994, as cited in Ali, 2002c, pp. 19- 23 and Ali, 2001).
[10] Benhabib and Spiegel (1994) use the database of Summer and Heston (1991) for GDP, population and labour force, and use time series data on human capital that estimated by Kyriacou (1991), they estimated the Cobb-Douglas production function using the normal ordinary least squares method. See Benhabib and Spiegel (1994) as cited in Ali, 2001, p. 31).
[11] Ali (2001) observes that the insignificance of human capital in this production function model creates some doubt about the relevance of the production function to estimate the rate of return on human capital. Ali (2001) realizes that this result can be expressed as it means the availability of surplus human capital in the developing including Arab countries, but that is not consistent with the currently prevailing situation in these countries (see Ali (2001, p. 31).

years. The average premium for university education in Egypt is much less than the same level of premium in Turkey and Iran. The regression results for the six estimated Mincer equations indicate the relatively tight relation between education and earnings. [13, 14]

It is worth noting that the general aggregated rate of return to education for all population discussed in the literature presented above expressed differently when considering the effect of other factors. For instance, the disaggregated rates of return to education is expected to vary with different characteristics across different population groups due to differences in gender (male-female), geographical location and region (rural-urban), sector (public-private), educational level (primary-secondary-higher education) and nationality (national-foreign).

Al-Qudsi (1985) examines the rate of return on human capital for the case of Kuwait using the method of earning function and the database from the population and income survey for the year 1972-1973.[15] He indicates that the rate of return to education declines with the increase in educational level for Kuwaiti, but it increases with the educational level for the non-Kuwaiti and that the rate of return for Kuwaiti is 8.4 percent and for the non-Kuwaiti is 5 percent. Al-Qudsi (1989) uses different method based on population census for the year 1980, based on labour force survey (1983) to estimate the earning function for Kuwait (1983); he finds that the rate of return on human capital in Kuwait is 4.5 percent in the public sector and 8.2 percent in the private sector.[16]

Assaad (1997: 112-113) estimates the rates of return on education in Egypt defined by gender and employment sector, using the database based on the Egyptian Labor Force Sample Survey of October 1988.[17] Assaad (1997) finds very low rates of return to primary schooling for males (2.3 percent) and females (4 percent) working in the private sector and for males (3.7 percent) and females (8 percent) working in the public sector. Assaad (1997) finds that the rate of return appeared to increase with the level of education for males working in the public sector, the rate of return to education increased from general secondary education (7.8 percent), technical institutes (8.4 percent), a B.A. in engineering (10.6 percent) to a postgraduate degree (11.6 percent). He finds that for female rates of returns in primary private

[12] See Benhabib and Spiegel (1994, as cited in Ali, 2001, p. 31).
[13] The premium is defined as the difference between the coefficients of university and high school education.
[14] Salehi-Isfahani (2008) uses the Mincer equation applied to micro data on earnings and employs similar survey data taken in three points in time and uses uniform definitions of education and wages to estimate the relationship between earnings and schooling for urban wage and salary workers, real wages are measured in 2000 Purchasing Power Parity adjusted US dollars to allow comparison across countries and time. Salehi-Isfahani (2008) shows the rising level of education of wage earners in all three countries, average real wages are about the same in Iran and Turkey and nearly twice wages in Egypt. See for instance, Salehi-Isfahani (2008, pp. 19-23).
[15] Al-Qudsi (1985) shows the divergence and duality in the labour market between Kuwaiti (national) and non-Kuwaiti (foreign) workers and based on this then estimate the earning function for each group separately, considering the log of wage or earning as the dependent variable and the other variables of education and experience as explanatory variables.
[16] See for instance, Al-Qudsi (1985; 1989 as cited in Ali, 2001).
[17] Assaad (1997) estimates an expanded Mincer equation, considering the logarithm of hourly work as the dependent variable and region of residence and sample selection terms as the explanatory variables. The educational attainment variable is defined in terms of 11 classes with the "illiterate" class used as the reference class (see Assaad, 1997, pp. 112-113, as cited in Ali, 2002c, pp. 19- 23).

and public; secondary private; and tertiary public and private are higher than male, whereas female rates of return in secondary public and post graduate public and private are less than male. Fergany (1998) uses a Mincer equation and the same database based on the Egyptian Labor Force Sample Survey of October 1988 used by Assaad (1997) to estimate the rate of return to education for Egypt after considering personal, employment, household characteristics and regions.[18] Fergany (1998) finds that when controlling for other explanatory variables, the "returns to education are conditioned by the length of labor market experience; and that the return to "education is relatively low except for university education (starting with 16 completed years) and higher. But education less than primary was also associated with a rise in earnings" (Fergany [1998: 49]). Chishti and Khalaf (2000) estimate Mincer equations for Kuwaiti employees in the public sector in Kuwait, using the Kuwaiti Civil Service Commission database for 1996. They show relatively low returns to education, the rate of return to the education of Kuwaiti is about 6 percent for Kuwaiti males and about 8 percent for Kuwaiti females, when controlling for experience, and introducing an interaction term between experience and education, the results show that for the two genders the rate of return tends to decline with experience. Lane, Hakim and Miranda (1999) use the World Bank's Living Standard Measurement Survey for 1990/1991, to estimate a Mincer equation and the rate of return to the education in Morocco after considering gender of the employee, the type of employer, the sector of employment, the sector of residence.[19] When using the basic Mincer equation, they find high rate of return to education that estimated as 9.9 percent, but after including other explanatory variables, the rate of return declines to 5.3 percent.[20]… In Syria the rates of returns to education for females are higher in the public sector and for higher education levels in the private sector, for males, higher levels of educational attainment are associated with higher odds of working in the public sector but lower odds of working in the private sector (Huitfeldt and Kabbani, 2007). In Sudan, Ali (2006) estimates the Mincer's Equation for Sudan using Migration and Labour Survey (1996) conducted by Sudan Ministry of Labour covering 16 States of Northern Sudan and shows that the rate of return to investment in human capital is about 6.1 % for the Sudan as a whole, about 6 % for males and 6.3 % for females. Ali (2006) also estimates the extended Mincer equation for Sudan where he used dummies for four levels of education: literate, primary, secondary and tertiary with the illiterate category used as a reference category. For primary education the rate of return is about 4.4 % for the country as a whole: 4.2 % for males and 4.7 % for females. For secondary

[18] Fergany (1998) uses a Mincer equation, using the logarithm of earning as the dependent variable, an interaction term between education and experience, besides a number of other explanatory variables including personal, employment, household characteristics and regions (see Fergany 1998, p. 49, as cited in Ali, 2002c, pp. 19- 23).
[19] Lane, Hakim and Miranda (1999) estimate a Mincer equation where the dependent variable is the logarithm of hourly wages and explanatory variables are experience, education, gender of the employee, the type of employer, the sector of employment, the sector of residence, and whether the worker works for the household (see Lane, Hakim and Miranda, 1999, as cited in Ali, 2002c, pp. 19- 23).
[20] See for instance, Ali (2002c, pp. 19- 23).

education the rate of return is about 1.3 % for males and 3.1% for females. The rate of return to higher education is 15 % for the country as a whole: 14.8 % for males and 17.3 % for females, with a margin of 2.5 percentage points in favor of educating females. The results discussed in Ali (2006) indicate very low rates of return different from the world pattern. The difference in the rates of return between males and females is not very striking and amounts to about 0.3 percentage point much lower than that expected from world patterns. Therefore, the increasing debate concerning the low return to education in the Arab countries as discussed in the literature implies that further efforts are needed to enhance the quality of education at all levels. Ali (2001, 2003) indicates that from the recent results on the rate of return to education, it is probably true that the rate of return to education in the Arab countries does not seem to be consistent with the general patterns based on the compilation of evidence from around the world that explained by Psacharopoulos (1994). This implies a peculiarity of the region, probably because, at this stage, the theoretical basis on which the Mincer equation is based may not be relevant to the development stage of the Arab countries.[21]

Therefore, further studies are needed to examine the rate of return to education in the Arab countries. In the next section we explain our hypotheses (stylised facts), the data and our findings on the rate of return to education at the micro level in the Sudan.

3 The hypothesis, stylised facts, data and definition of variable

Based on the above background, and before beginning with the empirical analysis, it will be useful in this section to briefly explain our hypotheses (stylised facts) on the rate of return to education and the data used in our analysis to test them at the micro level in the Sudan.

Our analysis in this paper aims to estimate the rate of return to education using new primary data at the micro level based on the university survey of Nour (2009) and the firm survey of Nour (2010). We estimate the rate of return to education defined by gender for relatively small sample of 100 persons covered in the university survey and 73 firms covered in the firm survey that provide us with the data required for examining the case of Sudan.

Notably, to estimate the rate of return to education for men and women defined by gender we utilize the primary data obtained from the university survey of Nour (2009) and the questionnaire on "The use and Economic Impact of Information and Communication Technology (ICT) in Sudanese universities". In particular, we utilize the general background information presented in Section 1 of the survey questionnaire that focuses on the general characteristics of individuals covered in the survey. This includes quantitative data to measure human capital/skill level indicators, defined by three variables including the educational attainment which we define by average years of schooling, the average years of experience

[21] See for instance, Ali (2002c, pp. 19- 23) and Ali (2001).

and average wages (monthly income) for 100 of the respondents to the university survey (2009).[22]

In addition, to estimate the rate of return to education across firms defined by firm size and industry we utilize the primary data obtained from the firm survey of Nour (2010) and the questionnaire on "Technological change and skill development for the industrial sector in Sudan". In particular, we utilize the general background information presented in Section 3 of the survey questionnaire which focuses on the general characteristics of skill indicators for the firms covered in the survey. This includes quantitative data to measure human capital/skill level indicators, defined by the educational attainment (average years of schooling), the occupational level (measured by the required qualifications/schooling years), the average years of experience and the average wages (monthly income) for the 73 of the respondents firms to the firm survey (2010). For our analysis in this paper and estimation of the rate of return to education we use broad definition and method found in the literature that highlights the importance of both attained/actual and required education and experience defined by both education and occupation definition at the micro level in Sudan. [23, 24]

[22] The field research to collect our primary data was held in the period from March to April, 2009 in Sudan. As for the selection of the sample and composition of the survey, the university survey includes students, academic teaching and support staffs affiliated to ten public and private universities. The five public universities are: Khartoum University, Sudan University of Science and Technology, Juba University, Al-zaim Al-azhari University and Omdurman Islamic University. The five private universities are: Computerman University, University of Medical Sciences and Technology, Sudan International University, Sudan Academy for Banking and Financial Studies and Ahfad University for Women. The university survey was distributed after translation of the English version into the Arabic language in order to increase the response rate. The selection of the individuals was on a random basis; the coverage of individual in the survey is more comprehensive and includes both males (50%) and females (50%) whose age's limit is 20-70 years old. Since ICT is widely used amongst the youth population, the coverage in the university survey was focused on the youth population. The university survey indicates a total response rate of 85%, for all the survey including all academic teaching staffs, support staffs and students. The weighted response rates were: 81%, 82%, 77%, 100% and 100% for all universities academic teaching staffs, for public universities academic teaching staffs, for private universities academic teaching staffs, for the support staffs and for students respectively. For the purpose of this paper we use the information and data presented in section 1 of the survey questionnaire, which requested general background information about the characteristics of the individuals covered in the survey, individuals also requested quantitative data to measure human capital/skill indicators, defined by skill level or the educational attainment (average years of schooling and average years of experience) and average wages (monthly income). For the purpose of this paper, in our estimation of the rate of return to education and the correlation between wages, education, experience and its square, we use the observations for 100 persons, including academic teaching staff, support staff and few part-time workers defined as postgraduate students registered for M.Sc. degree, we exclude the observations of all undergraduate students registered for B.Sc. and Intermediate Diploma degrees.

[23] The field research to collect our primary data was held in the period from January to June 2010 in Sudan. The firm survey (2010) on "Technological change and skill development" covers 100 of the small, medium and large size firms working in four industries in the manufacturing sector: the chemical, food, metal and textile industries. As for the selection of the sample and composition of the survey, the selection of these four industries was based on many reasons, the most important of which is that the argument for both upskilling and technological upgrading is promising in these four industries and can be used to reduce poverty and unemployment problems in the Sudan and also due to important contribution of these industries in total output, value added, capital investment, employment, exports, imports and number of industrial establishments in the manufacturing sector. The sample in the firm survey was drawn from the small, medium and large size firms active in the chemical, food, metal and textile industries, which are located in Khartoum state. The selection of Khartoum state was based on its significant and highest average share in total employment, capital investment and total number of factories and industrial establishments engaged in the chemical, food, metal and textile industries and also because the manufacturing industries in Khartoum state is characterized by being more diversified compared to other states in Sudan. The distribution and representation of firms in the sample is reasonable and representative in view of the fact that the distribution of the sample is based on two facts: the great diversity of the food and chemical compared to metal and textile industries and the potential for upgrading skill and technologies in the large compared to small and medium size firms. The firm survey was distributed after translation of the English version into the Arabic language in order to increase the response rate. In the firm survey, the response rate varied according to firm size and industrial activity, for the total sample, the firm survey indicates a total response rate of 87%, for all the survey including all small, medium and large size firms in the chemical, food, metal and textile industries, the weighted response rates by employment size were 84%, 88% and 83% for small, medium and large size firms respectively, and the weighted response rates by industry were 89%, 88%, 80%, and 83% for the chemical, food, metal and textile industries respectively. For the purpose of this paper we use the information and data presented in section 3 of the survey questionnaire, which requested general background information and quantitative data to measure human capital/skill indicators, defined by the distribution of workers by skill level, educational attainment (average years of schooling), occupational levels, average years of experience, attained and required education and average

In this paper we use the literature and data presented above to examine the following hypotheses (stylised facts) regarding the rate of return to education in Sudan:

1. Positive but low rate of return to education and correlation between education, experience, its square and wages for men and women defined by gender in Sudan.
2. Positive and significant rate of return to education and correlation between education, experience, its square and wages defined by firm size and industry at the micro level in Sudan.
3. An increase in skill levels and firm size leads to improved relationship between actual and required education and experience; and between actual education, required education, experience, its square and wages at the micro level across industrial firms in Sudan.

4 The empirical results

Based on the literature presented above and using Mincer earning function, the linear and log linear OLS regression, E-Views and SPSS statistical programmes and our data from the university survey (2009) and the firm survey (2010) presented in section 3 above, in this section we examine our hypotheses (stylised facts) presented above concerning the rate of return to education in Sudan. We also compare the relevance of our findings on the estimated rate of return to education in Sudan at the micro level to those in the new growth literature presented above. First, we examine the first hypothesis concerning the positive but low rate of return to education and correlation between education, experience, its square and wages for men and women defined by gender in Sudan. Next, we investigate the second hypothesis regarding the positive and significant rate of return to education and correlation between education, experience, its square and wages defined by firm size and industry at the micro level across firm in Sudan. Finally, we examine the third hypothesis that an increase in skill levels and firm size leads to improved relationship between actual and required education and experience; and between actual education, required education, experience, its square and wages at the micro level across industrial firms in Sudan. Table 1 reflects our results for men and women and Tables 2-5 reflect our results for the industrial firms in Sudan.

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wages (monthly income). For the purpose of this paper, in our estimation of the rate of return to education and the correlation between wages, education, experience and its square, we use the observations for 73 firms, including all firms with complete and reliable data and information, because some of the respondents firms were unwilling to provide complete and reliable quantitative data or some of the respondents firms offered somewhat selective answers. For example, some firms seemed hesitant to provide information about quantitative data for the measurement of human capital indicators (education, experience, and wages). So, the hesitance of some firms compelled us to exclude them when their observations were incomplete, missing and unreliable. Therefore, we used only completed and reliable observations in our estimation and analysis in the next section.

[24] We classify the educational qualifications of workers into three groups: high skilled (H) with postgraduate, university and diploma degree (more than twelve years of schooling), medium skilled (M) with secondary education (twelve years of schooling) and low skilled (L) with less than secondary education (less than twelve years of schooling). We define the occupational status according to five categories, including white-collar high (managers, professionals, management executives, scientists, technicians and engineers); white-collar low (clerical and administrative); blue collar high (skilled craftsmen); blue-collar low (plant machinery operators, assemblers and elementary occupation) and other workers. We define the required qualifications by required years of schooling including: postgraduate/ Ph.D. (19-20 years); professional, MSc./ postgraduate (18 years); university graduate (16 years); diploma (14 years); higher secondary schooling (12 years); and less than secondary schooling (less than 12 years). We measure the average wages by average monthly wages (in Pounds, the Sudanese national currency), and average years of experience by both actual and required average years of experience for both educational and occupational definition respectively.

4.2. Estimated the rate of returns to education defined by gender in Sudan

Based on the above, in this section it is useful to begin by examining the first hypothesis concerning the positive but low rate of return to education and correlation between education, experience, its square and wages for men and women defined by gender in Sudan.

To examine the rate of return to education in Sudan defined by gender we use the Mincerian earning function, the Ordinary Least Squares (OLS) method and we use human capital/skill level indicators, defined by educational attainment (average years of schooling and average years of experience) and average wages (monthly income) which we obtained from the university survey of Nour (2009) for relatively small sample of 100 respondents persons - presented in section 3 above. Our results show the correlation between wages (log), education, experience and its square and the differences defined by gender which imply that the correlation between wage and education, experience and its square for women are relatively higher than men in Sudan. Our findings reported in Table 1 below verify our first hypothesis concerning the positive but low rate of return to education and correlation between education, experience, its square and wages for men and women defined by gender in Sudan. We show positive sign and hence correlation between wages as independent variable and both education and experience but negative sign and hence correlation between wages as independent variable and squared year of experience as explanatory variable. Our results with respect to correlation between wage, education, experience and its square imply that the sign of all these explanatory variables used in our analysis are quite consistent with the findings based on Mincerian earning function and the theoretical and empirical literature on the rate of return to education.

Our findings reported in Table 1 below indicate that the rate of return to education for all the sample tends to explain only 16% of the change in wage, compared to 41% for all men and 45% for all women. We find that the rate of return to education and experience together for all the sample tend to explain only 48% of the change in wage, compared to 48% for all men and 62% for all women. We find that the rate of return to education, experience and its square together for all the sample tend to explain only 53% of the change in wage, compared to 56% for all men and 72% for all women. These results imply that the over whole significance on the rate of return to education tends to increase when adding experience as explanatory variable next to education as explanatory variable and show further increase when adding squared years of experience explanatory variable next to education and experience as explanatory variables. These results imply that the correlation becomes more significant when adding the variable experience, and further when adding squared years of experience and imply the importance of all the variables of education; experience and its

square. This also implies that the importance of the rate of return to education in determining or affecting wage tends to decline when adding the variables experience and its square.[25]

When examining the coefficients of the years of education our findings presented in Table 1 below imply that the rate of return to education is about 10.9 percent for all the sample, about 7.9 percent for all men and about 9.6 percent for all women. When including the year of experience we find that the rate of return to education declined to about 3.8 percent for all the sample, about 4.6 percent for all men and about 5.1 percent for all women. When including the years of experience and its square, we find that the rate of return to education declined further to about 2.1 percent for all the sample, about 2.0 percent for all men and about 2.2 percent for all women. Our findings imply the very low rate of return to education for all the sample, men and women. Our results at the micro level seem consistent with the results at the macro level discussed in the Sudanese literature (Ali, 2006) which indicate very low rates of return different from the world pattern. Our findings imply that the slightly gender gap or difference in the rate of return to education in favour of women is only 0.2 which is not very noticeable. Our findings at the micro level seem consistent with the results at the macro level discussed in the Sudanese literature (Ali, 2006) which indicate that the difference in the rates of return between males and females is not very striking and amounts to about 0.3 percentage point much lower than that expected from world patterns.

Table 1-Correlation between wages, education and experience defined by gender in Sudan (2008)

		Coefficient (t-value)			**R^2**	**F**	**N**
Independent variable	Gender Group	Education	Experience	Experience^2			
Dependent variable: Average wages (log)							
Average wages (log) high, medium and low education	All sample	0.109** (4.370)			0.160	19.098	100
	Males	0.079** (6.123)			0.410	37.490	55
	Female	0.096** (6.039)			0.452	36.473	43
Average wages (log) high, medium and low education	All sample	0.038* (1.751)	0.060** (7.735)		0.481	44.886	99
	Males	0.046** (2.795)	0.009** (2.826)		0.483	23.827	53
	Female	0.051** (2.925)	0.023** (4.175)		0.624	34.089	43
Average wages (log) high, medium and low education	All sample	0.021 (0.958)	0.135** (5.306)	-0.002** (3.088)	0.528	35.734	99
	Males	0.020 (1.114)	0.041** (3.519)	-0.001** (-2.833)	0.555	20.750	53
	Female	0.022 (1.305)	0.082** (4. 849)	-0.002** (-3.616)	0.717	33.776	43

Correlation is significant * at the 0.05 level (one-tailed) ** at the 0.01 level (one-tailed)
Source: Own estimation based on the survey of Nour (2009). Note (1) estimation is based on linear equation

4.2. Estimating the rate of return to education across firms

Based on the above, in this section it is useful to proceed to examine our second and third hypotheses on the rate of return to education for firms defined by firm size and industry

[25] For all the sample when using the log of wage, our results seem to be somewhat inconsistent with our findings reported in Table 1 defined by gender for each group of male and female separately. Therefore, our estimation for all the sample is based on linear estimation that is relatively consistent with our findings defined by gender for each group of male and female separately.

across industrial firms in Sudan as presented above. Notably, we investigate our second hypothesis concerning the positive and significant rate of return to education and correlation between education, experience, its square and wages defined by firm size and industry at the micro level across industrial firms in Sudan. Also, we examine our third hypothesis that an increase in skill levels and firm size leads to improved relationship between actual and required education and experience; and between actual education, required education, experience, its square and wages at the micro level across industrial firms in Sudan.

4.2.1. Differences in skill level and requirements (education and experience) across firms

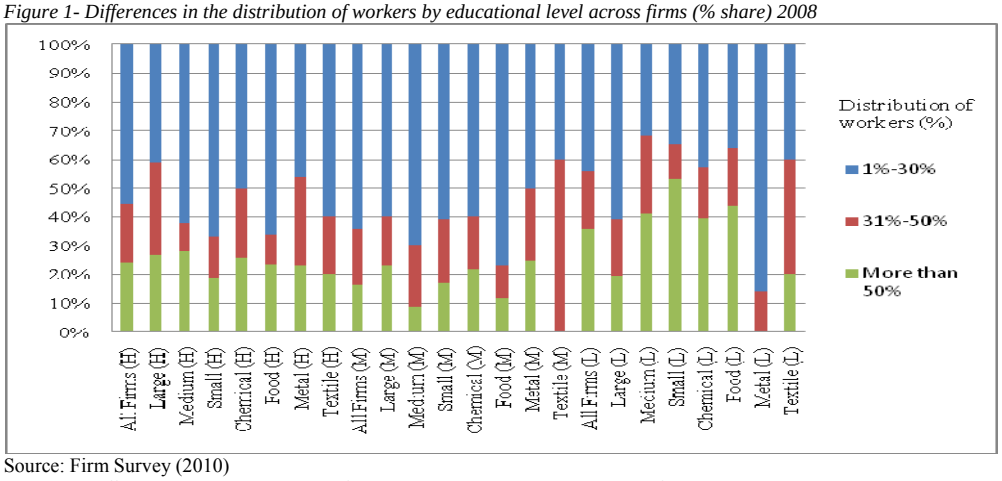
Prior to examining our second and third hypotheses on positive, significant and differences in the rate of return to education for firms, it is convenient to begin with explaining differences in skill levels and requirements across firms because understanding why and how they vary with industry and firm size can help in investigating our second and third hypotheses. In the next section, we broaden our analysis by examining and providing in-depth analysis of the relationships between required education/actual education; occupation/required education; and experience and wages at the micro level across firms. Figures 1-5 below explain differences in skill levels and requirements defined by education and occupation groups across firms defined by size and industry.[26] For instance, Figures 1-2 below indicate the differences in the share of high, medium and low skilled workers– measured by education and the share of white-collar, blue-collor and other workers measured by occupation level for all firms, moreover, Figures 3-4 below show that skill requirements– average required years of schooling – vary and increase with occupation level across firms.[27] In addition, Figure 5 below showes the variation in skill requirements (required years of experience), defined by educational and occupational levels, and illustrates that average years of experience are increasing in educational and occupational levels respectively. Moreover, Figure 6 below implies that the share of high skilled workers in total employment, are higher within large size and chemical and textile firms as compared to medium and small size and food and metal firms respectively. Our results presented in Figures 1-6 below imply that skill levels and requirements (actual and required education and experience) are not homogenous across firms and vary with industry and size. These results are useful to verify our third hypothesis tha, irrespective of these differences, an increase in skill levels and firm size lead to improved relationships between actual and required education and experience; between actual education, experience and wages across firms.[28]

[26] In Figures 1-3, the horizontal axis defines firms, industry, size (chemical, food, metal and textile, large, medium and small), and skill level (high (H), medium (M) and low (L)). The vertical axis defines the intensity/share of H, M and L across firms. The information in the right margin defines the distribution of workers in Figures 1-2, and the average required years of education in Figure 3.

[27] White collar (WC) includes white collar high and low. Blue collar (BC) includes blue collar high and low.

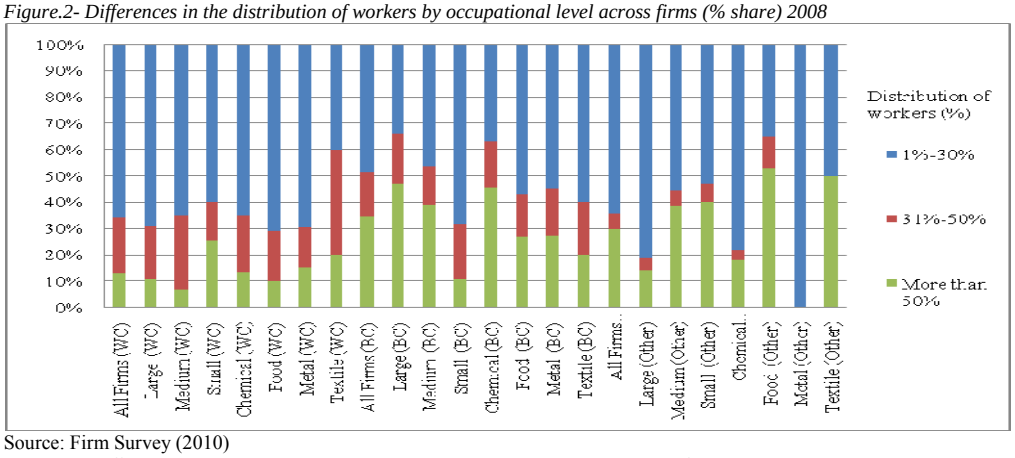
[28] Our definition of actual education refers to educational attainment classified under three groups: high (post secondary) educational attainment: university degree and above (16 years of schooling); medium educational attainment: secondary

Figure 1- Differences in the distribution of workers by educational level across firms (% share) 2008



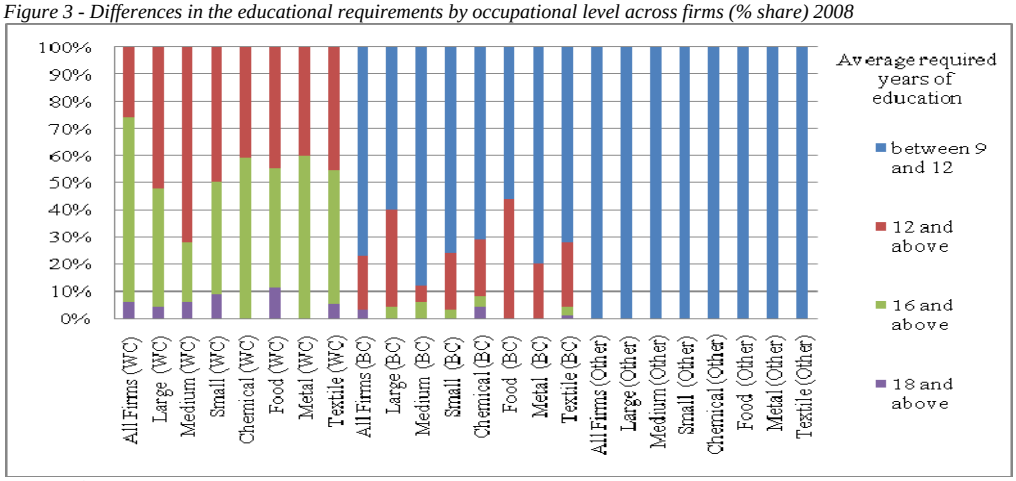
Source: Firm Survey (2010)

Figure.2- Differences in the distribution of workers by occupational level across firms (% share) 2008



Source: Firm Survey (2010)

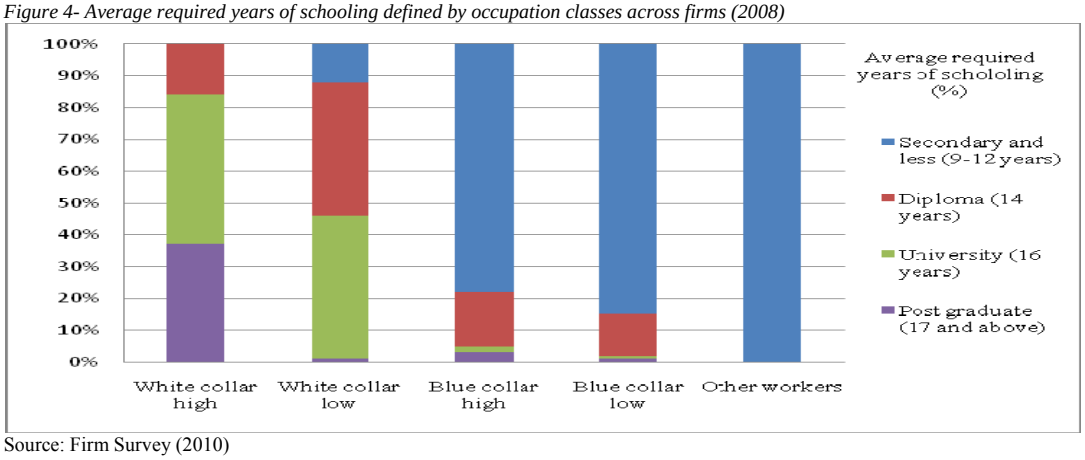
Figure 3 - Differences in the educational requirements by occupational level across firms (% share) 2008



Source: Firm Survey (2010)

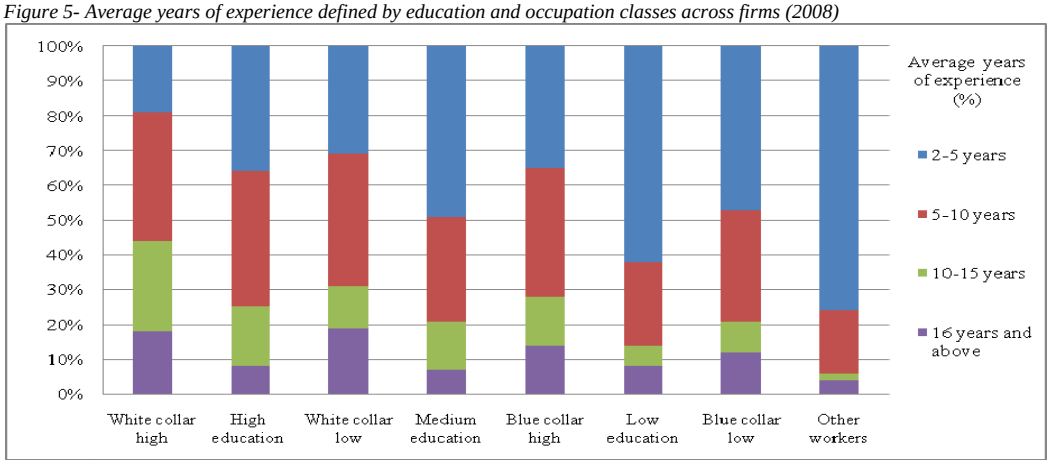
education (12 years of schooling); and low educational attainment: less than secondary education (9 years of schooling). We define the required education by the translated merged required qualifications for each occupation group defined by average years of schooling. The occupational classification includes the following five categories/ groups: (1) Managers, professional, management executive, scientific, technical and engineers; (2) Clerical and administrative; (3) Skilled craftsmen; (4) Plant machinery operators, assemblers and elementary occupation; and (5) Other workers. We translate the required qualifications associated with each occupational class into average years of schooling and group them in the following way: (1) PhD/postgraduate (19-20 years); (2) Professional, MSc./ postgraduates (18 years); (3) University graduate (16 years); (4) Diploma (14 years); (5) Higher/ Secondary Schooling (12 years) and (6) Less than Secondary Schooling (9 years). We then merge the required qualifications into three groups, assuming that the high occupation group includes both the first and second occupation categories, the medium occupation group includes both the third and fourth occupation categories and, finally, the low occupation group includes the fifth occupation category. We then use this definition to compare between the required education for each occupation class and actual/ attained education, and we examine their relationship with experience and wages.

Figure 4- Average required years of schooling defined by occupation classes across firms (2008)



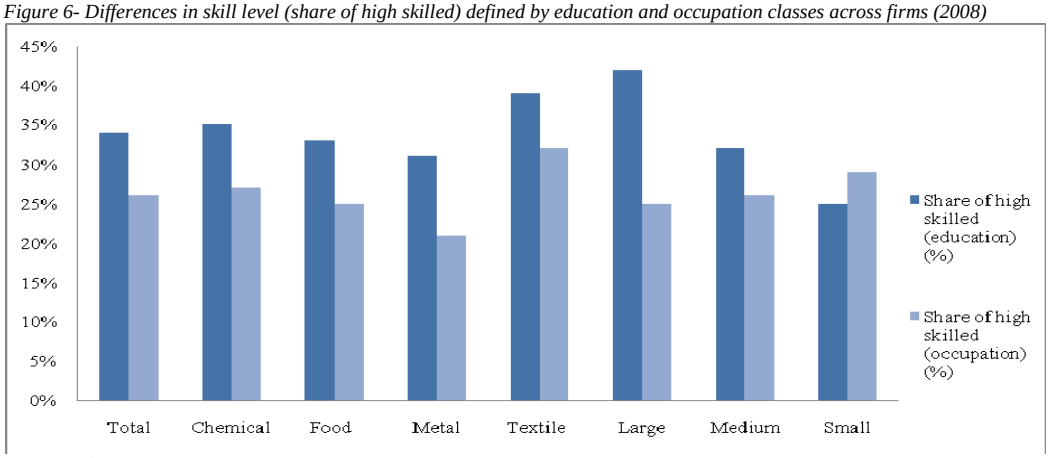
Source: Firm Survey (2010)

Figure 5- Average years of experience defined by education and occupation classes across firms (2008)



Sources: Firm Survey (2010)

Figure 6- Differences in skill level (share of high skilled) defined by education and occupation classes across firms (2008)



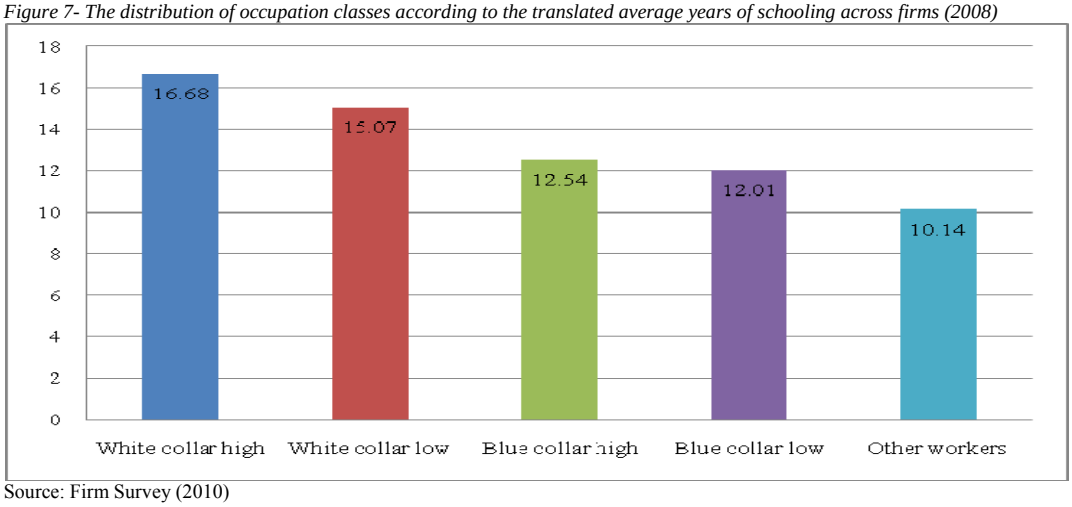
Sources: Firm Survey (2010)

4.2.2. Estimating the rate of return to education defined by firm size and industry across firms

We begin with the relationship between occupation and education. Using the above definitions of occupation and education/actual and required education respectively, we translate the required qualifications for each of the occupation groups into average years of schooling and use the OLS regression, assuming that the required schooling in

each occupation class is dependent on the actual/attained education. Our findings in Table 2 and Figure 7 below illustrate that improvement in occupational status (measured by the required education) is positively and significantly correlated with education (measured by actual/attained education) across all firms. In addition, Table 2 illustrates that an increase in firm size and industry level lead to improved relationships between required and actual education. For instance, the required education appears to be more sensitive to and increasing in actual education within both large size and chemical and food firms, and more sensitive within all firms. This result is plausible since the skill level – share of high skilled measured by educational attainment – is higher within large size and chemical, textile and food firms compared to metal, medium and small size firms– see Figures 1, 2 and 6 above. This is also probably because large size firms are more prevalent in the chemical and food industries– see Nour (2011) – and may have more consistent recruitment strategies. These results confirm our earlier observations that skill levels and requirements (actual and required education) are non-homogenous across firms and are determined by size and industry.

Figure 7- The distribution of occupation classes according to the translated average years of schooling across firms (2008)



Source: Firm Survey (2010)

Concerning the relationship between education, occupation and experience, Table 2 above shows that average years of experience are positively correlated and increasing in education and occupation i.e. attained/actual and required education respectively. This result is consistent with Figure 5 above, and probably implies that skill indicators –education and experience – are complementing rather than substituting each other.

Table 2 – Correlation between the required and actual/ attained education and experience across firms (2008)

		Coefficient (t-value)			R^2	N[29]
Independent Variable		Actual education	Required education	Constant		
Dependent Variable	Group of firms and skill					
Required education All groups (High, medium and Low)	All firms	0.873** (25.172)		2.101 (4.691)	0.759	74
	Large	0. 905** (16.672)		1.849 (2.627)	0.772	26
	Medium	0.864 ** (14.592)		2.291 (2.999)	0.766	18
	Small	0.825 ** (11.761)		2.297 (2.554)	0.742	15
	Chemical	0.883** (15.390)		1.895 (2.540)	0.731	27
	Food	0.879** (15.816)		2.037 (2.850)	0.777	21
	Metal	0.814 ** (9.387)		3.262 (2.913)	0.793	7
	Textile	0.875** (8.338)		1.749 (1.316)	0.842	4
Average years experience All groups (High, medium and Low)	All firms	0.412** (3.469)		0.767 (0.505)	0.056	73
	Large	0.539** (3.059)		-0.521 (-0.231)	0.102	26
	Medium	0.388* (1.576)		0.777 (0.245)	0.390	18
	Small	0.295* (1.429)		2.232 (0.852)	0.306	15
	Chemical	0.274* (1.452)		3.424 (1.404)	0.023	27
	Food	0.617** (4.010)		-3.065 (-1.568)	0.185	21
	Metal	0.371 (0.940)		2.131 (0.423)	0.032	7
	Textile	0.068 (0.164)		3.810 (0.724)	0.003	4
	All firms		0.641** (4.260)	-1.810 (-0.892)	0.089	71
	Large		0.439** (2.407)	0.880 (0.354)	0.070	26
	Medium		0.566* (1.606)	-0.697 (-0.145)	0.043	18
	Small		1.156** (4.311)	-8.273 (-2.369)	0.288	15
	Chemical		0.465* (1.875)	1. 528 (0.458)	0.039	27
	Food		0.658** (3.305)	-3. 490 (-1.304.)	0.148	21
	Metal		1.402** (3.621)	-12.262 (-2.290)	0.373	7
	Textile		0628 (1.034)	-1.047 (-0.129)	0.106	4

Correlation is significant * at the 0.05 level (one-tailed) ** at the 0.01 level (one-tailed)

Table 3 below illustrates a considerable variation in the distribution of average wages amongst high, medium and low skill – educational and occupational – levels across firms. When using the occupational rather than the educational definition, the distribution of wages shows less fluctuation across firms. Therefore, the effect of occupation/required education on the distribution of average wages across firms seems

[29] For this regression we use relatively few observations, because some of the respondent firms were particularly reluctant to provide adequate quantitative data on skill indicators. Sometimes we exclude some observations due to inconsistency or unreliability. As we explained in Nour (2011), the main problem is the varying response rate for different questions (e.g. to measure education, occupation and wages) across firms. Moreover, the classification of firms into chemical, food, metal and

to be less sensitive to differences in firm size and industry. In contrast, when using the educational definition, we observe that the effect of the actual/attained education on the distribution of average wages across firms seems to be more sensitive to differences in firm size and industry. Our interpretation of the observed differences across firms implies the presence of significant wage differential, the lack of a coherent, homogeneous, unified and sound wage policy and the lack of systematic and consistent recruitment strategies across firms that most probably related to the observed lack of systematic regulations to organise the labour market in the Sudan

Table 3- Differences in the distribution of average wages defined by firm size and industry level and secto and defined by education and occupation classes across firms (2008)

(a) Skill variables: Education											
Characteristics	All firms	Industry/ activity				Size			Sector		
Wages defined by skill level		Chemical	Food	Metal	Textile	Large	Medium	Small	Public	Private	Mixed
High educated/ white collar high											
4,001- 5,000	1%	0%	0%	13%	0%	3%	0%	0%	0%	2%	0%
3,001- 4,000	4%	6%	0%	13%	0%	7%	0%	5%	0%	5%	0%
2,001- 3,000	13%	19%	11%	0%	0%	10%	13%	16%	0%	11%	40%
1,001- 2,000	46%	41%	44%	50%	80%	50%	48%	37%	0%	45%	60%
0,200- 1,000	36%	34%	44%	25%	20%	30%	39%	42%	100%	38%	0%
Medium educated/ white collar low											
1,001- 2,000	4%	6%	0%	12%	0%	3%	0%	11%	0%	3%	20%
0,200- 1,000	96%	94%	100%	88%	100%	97%	100%	89%	100%	97%	80%
Low educated/ blue collar high											
0,200- 1,000	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
(b) Skill variables: occupation											
Characteristics	All firms	Industry/ activity				Size			Sector		
Wages defined by skill level		Chemical	Food	Metal	Textile	Large	Medium	Small	Public	Private	Mixed
High educated/ white collar high											
4,001- 5,000	8%	6%	11%	11%	0%	13%	9%	0%	0%	7%	20%
3,001- 4,000	11%	12%	11%	11%	0%	13%	9%	11%	0%	10%	20%
2,001- 3,000	28%	21%	30%	33%	60%	29%	30%	26%	0%	29%	20%
1,001- 2,000	34%	39%	26%	33%	40%	35%	26%	42%	100%	32%	40%
0,200- 1,000	19%	21%	22%	11%	0%	10%	26%	21%	0%	21%	0%
Medium educated/ white collar low											
2,001- 3,000	1%	3%	0%	0%	0%	3%	0%	0%	0%	2%	0%
1,001- 2,000	24%	23%	25%	33%	0%	27%	26%	14%	0%	22%	50%
0,200- 1,000	75%	73%	75%	67%	100%	70%	74%	86%	100%	76%	50%
Low educated/ blue collar high											
1,001- 2,000	6%	4%	9%	13%	0%	3%	10%	7%	0%	7%	0%
0,200- 1,000	94%	96%	91%	88%	100%	97%	90%	93%	100%	93%	100%
Blue collar low											
1,001- 2,000	3%	0%	5%	13%	0%	0%	9%	0%	0%	3%	0%
0,200- 1,000	97%	100%	95%	88%	100%	100%	91%	100%	100%	97%	100%
Others											
4,001- 5,000	2%	0%	4%	0%	0%	0%	5%	0%	0%	2%	0%
0,200- 1,000	98%	100%	96%	100%	100%	100%	95%	100%	100%	98%	100%

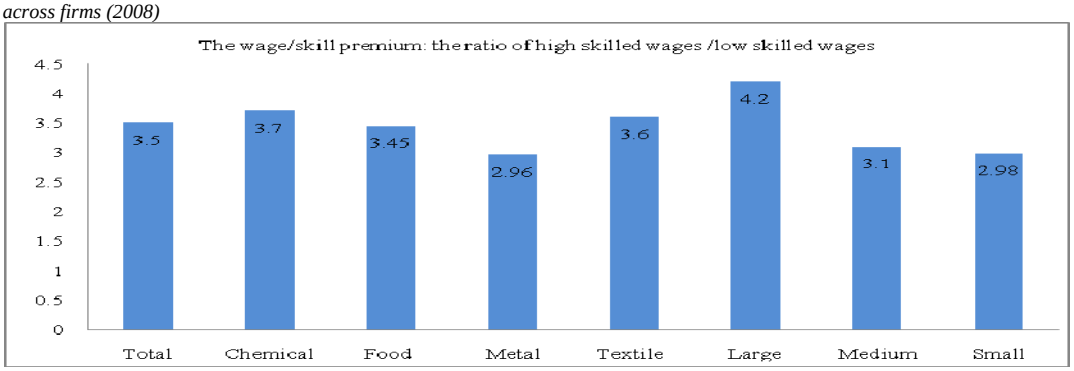
Sources: Firm Survey (2010)

The above results are consistent with the OLS regression reported in Table 4 below, which supports our second hypothesis and indicates positive and significant rate of return to education for firms as the average wages are positively and significantly correlated with and more sensitive to attained/actual education. For instance, Table 4 below illustrates that the average wages are increasing in actual/attained education, experience and its square (cf. Mincer, 1974) and therefore, is biased against less

textile industries, small, medium and large size also divided the few observations between them and so allow for only few observations for regression for each group independently.

educated and experienced workers. These findings support our results from the firm survey, which indicate that wages are increasing in education and biased against low educated workers because the ratios of high skilled to low skilled wages, which can be interpreted as wages/skills premium, exceeds one- see Figure 8 below.[30] These results are consistent with the findings in the new growth literature, particularly skilled biased technical change theorems (cf. Aghion and Howitt, 1992; 1998; Acemoglu, 1998; Autor, Katz and Krueger, 1998). Our results from Table 4 indicate that required education also has significant impact on wages are plausible and consistent with our expectation in view of the results of the overeducation literature (Hartog, 2000; Muysken et al. 2001; 2002a;b; 2003). We find that the positive correlations between actual education, experience, its square and wages seem more sensitive to firm size and industry level and are particularly significant for large and medium size firms and chemical and food industries, which may not be surprising since these firms have sufficient scope for a coherent wage policy (Muysken and Nour, 2006; Nour, 2005). This is also probably because large size and medium size firms and chemical, food and textile industries may have more consistent recruitment strategies and high skill levels– share of high skilled workers in total employment– see Figure 1 above. These results verify our third hypothesis and imply that an increase in skill level/actual education and firm size and industry leads to an improved relationship between actual education, experience and wages -see Figure 6 above and Table 4 below.

Figure 8 - Differences in wage/skill premium (the ratio of high skilled wages /low skilled wages) defined by education levels across firms (2008)



Source: Firm Survey (2010)

[30] From the firm survey (2010) we find that the proportion of high skilled wages/low skilled wages accounts for 3.5, 3.7, 3.45, 2.96, 3.6, 4.2, 3.1 and 2.98 for all firms, chemical, food, metal, textile, large, medium and small size firms respectively. We find that the wage premium for Sudan in 2010 is less than the wage premium which we estimated for the large and medium size firms active in the chemical and metal industries in the United Arab Emirates (UAE) in 2002 (Nour, 2005). This result at the micro level is not surprising and it is expected in view of the observed wage differential between Sudan and UAE at the macro level, in particular, this result is consistent with the observed differences in percapita income levels in Sudan and the UAE at the macro level, notably, when using UNDP-HDR (2010) most recent data on per capita income for the year 2008, we realize the low percapita income level in Sudan (US$1,353) as compared to high per capita income in the UAE (US$ 56,485) at the macro level.

One interesting observation from the firm survey data (2010) and the follow-up interviews with firms managers and the results presented in Tables 3-5 is that in most cases, the OLS regression results seem to be more significant when using the education definition as compared to occupation definition. This finding seems to be consistent with the observations from Table 3 above but seems to be opposite to the observations from the follow-up interviews and the wide belief among firm's mangers which probably imply that across firms wage's policy is most probably more consistent based on occupation definition instead of education definition. This also implies that from firms perspective the decision of determining wages levels for workers is most probably determined by the nature of jobs that the workers will do in the firms rather than the years of schooling the workers have already obtained. This also most probably implies the positive but weak return and incentives for additional years of schooling to compensate the costs of additional years of schooling. Another interesting observation is that for all groups of firms when using both education and occupation definitions the OLS regression reported in Tables 4-5 below indicate that the correlations between wages levels and years of education variable are more significant as compared to the correlations between wages levels and average years of experience variable. This result implies that the rate of return to the worker's average years of education is higher and more significant than the average years of experience. This finding is also opposite to the observations from the follow-up interviews and the wide belief among some firm's managers which probably imply that across some firms and from some firm's perspective, the decisions of hiring and offering wages are largely determined by worker's average years of experience which is more important than average years of education for some firms that prefer to hire more experienced than educated workers.

Our findings reported in Table 4 below indicate that the rate of return to education for all the sample tends to explain only 59.5% of the change in wage, compared to 65.6%, 56.4%, 59.6%, 60.5%, 65.7%, 52.3% and 72.4% for the large, medium and small size firms, and for the chemical, food, metal and textile industries respectively. We find that the rate of return to education and experience together for all the sample tend to explain only 62.5% of the change in wage, compared to 65.3%, 67.5%, 60.1%, 63.4%, 68.9% and 91.2% for the large, medium and small size firms, and for the chemical, food and textile industries respectively. We find that the rate of return to education, experience and its square together for all the sample tend to explain only 62.5% of the change in wage, compared to 65.3%, 67.8%, 63.6%, 68.9% and 91.7% for the large and medium size firms, and for the chemical, food and textile industries respectively. These results imply that the over whole significance on the rate of return to education tends to increase when adding experience as explanatory variable next to education as explanatory variable and often show even further increase when adding squared years of experience explanatory variable next to education and experience as explanatory variables- except for only few cases. These results imply that the correlation becomes more significant

when adding the variable experience, and further when adding squared years of experience and imply the importance of all the variables of education; experience and its square. This also implies that the importance of the rate of return to education in determining or affecting wage tends to decline when adding the variables experience and its square. When examining the coefficients of the years of education our findings presented in Table 4 below imply that the rate of return to education is about 19.6 percent for all the sample for all firms as compared to 22.3 percent; 17.8 percent; 17.8 percent; 20.6 percent; 19.2 percent; 17.2 percent; and 19.7 percent for the large, medium and small size firms, and for the chemical, food, metal and textile industries respectively. When including the year of experience we find that the rate of return to education declined to about 18.7 percent for all the sample for all firms as compared to 22.1 percent; 16.1 percent; 17.5 percent; 19.8 percent and 17.5 percent for the large, medium and small size firms, and for the chemical, food, and metal industries respectively but only slightly and exceptionally increased to about 21.9 percent for textile industries. When including the years of experience and its square, we find that the rate of return to education seem to be stable at the same earlier declined level to about 18.7 percent for all the sample for all firms and to about 22.1 percent for the large size firms, while the rate of return to education declined to about 15.6 percent; 19.5 percent and 20.5 percent for the medium size firms and for the chemical and textile industries respectively but only slightly and exceptionally increased to about 17.6 percent for the food industries.

Hence, our findings in this section corroborate the second and third hypotheses on the positive, significant and differences in the rate of return to education across firms that an increase in skill levels and firm size leads to improved relationship between actual and required education and experience; and between actual education, required education, experience, its square and wages at the micro level across industrial firms in Sudan.

Therefore, our finding in this section verify our three hypotheses (stylised facts) on the rate of return to education at the micro level in the Sudan. We verify the first hypothesis on the positive but low rate of return to education and correlation between education, experience, its square and wages for men and women defined by gender in Sudan. We support our second hypothesis on the positive and significant rate of return to education and correlation between education, experience, its square and wages defined by firm size and industry at the micro level in Sudan. Finally we corroborate our third hypothesis that an increase in skill levels and firm size leads to improved relationship between actual and required education and experience; and between actual education, required education, experience, its square and wages at the micro level across industrial firms in Sudan.

Table 4- Correlation between wages (log) actual and required education and experience (2008) (education definition)

		Coefficient (t-value)					**R^2**	**N[31]**
Independent variable	Group of firms	Actual education	Experience	Experience^2	Required education[32]	Constant		
Dependent variable: Average wages (log)								
Average wages (log) high, medium and low skilled	All firms	0.196** (17.478)				3.948 (27.570)	0.595	73
	Large	0.223** (12.532)				3.663 (16.114)	0.646	26
	Medium	0.178** (9.099)				4.045 (16.121)	0.564	18
	Small	0.178** (8.972)				4.248 (16.838)	0.596	15
	Chemical	0.206 ** (11.742)				3.860 (17.156)	0.605	27
	Food	0.192** (12.131)				3.896 (19.349)	0.657	21
	Metal	0.172** (4.906)				4.591 (10.337)	0.523	7
	Textile	0.197** (5.834)				3.715 (8.668)	0.724	4
	All firms	0.187** (16.398)	0.021** (3.188)			3.951 (27.877)	0.625	70
	Large	0. 221** (11.383)	0.010 (0.866)			3.652 (15.407)	0.653	26
	Medium	0. 161** (9.054)	0.033** (3.674)			4.101 (18.465)	0.675	18
	Small	0.175** (8.582)	0.010 (0.780)			4.225 (16.575)	0.601	15
	Chemical	0. 198** (11.519)	0.023** (2.418)			3.817 (17.268)	0.634	27
	Food	0. 175** (10.097)	0.027** (2.240)			3.976 (19.533)	0.689	21
	Textile	0.219** (9.289)	0.040** (2.228)			3.378 (11.057)	0.912	4
	All firms	0.187** (15.360)	0.024 (1.249)	-0.0001 (-0.156)		3.951 (27.806)	0.625	70
	Large	0.221** (10.626)	0.009 (0.263)	0.00003 (0.18)		3.652 (15.302)	0.653	26
	Medium	0.156** (8.192)	0. 055* (1.924)	-0.001 (-0.792)		4.113 (18.192)	0.678	18
	Chemical	0.195** (10.919)	0.043* (1.397)	-0.001 (-0.687)		3.789 (16.818)	0.636	27
	Food	0.176** (9.783)	0.022 (0.822)	0.000 (0.197)		3.977 (19.396)	0.689	21
	Textile	0.205** (6.546)	0.093 (1.148)	-0.004 (-0.673)		3.433 (10.536)	0.917	4
	All firms	0.153** (6.019)	0.028* (1.360)	-0.0004 (-0.356)	0.038* (1.532)	3.868 (23.996)	0.621	69
	Large	0.172** (4.125)	0.030 (0.808)	-0.001 (-0.482)	0.047 (1.221)	3.579 (13.676)	0.654	26
	Medium	0.126** (2.866)	0.045* (1.420)	-0.001 (-0.384)	0.037 (0.852)	4.018 (15.438)	0.668	18
	Small	0.175** (3.587)	-0.059 (-0.989)	0.004 (1.076)	0.016 (0.314)	4.228 (12.664)	0.614	15
	Chemical	0.162** (4.064)	0.047* (1.360)	-0.001 (-0.725)	0.031 (0.850)	3.791 (14.547)	0.609	27
	Food	0.136** (3.939)	0.024 (0.861)	0.000 (0.100)	0054* (1.545)	3.751 (16.511)	0.718	21
	Textile	0.119* (1.486)	0.104* (1.305)	-0.004 (-0.756)	0.092 (1.172)	3.291 (9.657)	0.931	4

Correlation is significant * at the 0.05 level (one-tailed) ** at the 0.01 level (one-tailed)

[31] For this regression we use relatively few observations, because some of the respondent firms were particularly reluctant to provide adequate quantitative data on skill indicators. Sometimes we exclude some observations due to inconsistency or unreliability. As we explained in Nour (2011), the main problem is the varying response rate for different questions (e.g. to measure education, occupation and wages) across firms. Moreover, the classification of firms into chemical, food, metal and textile industries, small, medium and large size also divided the few observations between them and so allow for only few observations for regression for each group independently.

[32] The required education is not used as a variable in the upper half of Table 4, because, we want to check the relation with respect to actual/attained education and experience independently and then compare the result when the required education is also included in the regression.

Table 5 – Correlation between wages (log) actual and required education and experience (2008) (occupation definition)

		Coefficient (t-value)					**R^2**	**N[33]**
Independent variable	Group of firms	Actual education[34]	Experience	Experience^2	Required education	Constant		
Dependent variable: Average wages (log)								
Average wages (log) high, medium and low skilled	All firms				0.212 ** (12.176)	3.713 (15.884)	0.429	73
	Large				0.245 ** (13.152)	3.318 (13.061)	0.678	26
	Medium				0.210 ** (7.977)	3.749 (10.636)	0.503	18
	Small				0. 204** (7.855)	3.871 (11.500)	0.568	15
	Chemical				0.219 ** (12.130)	3.639 (15.041)	0.637	27
	Food				0.225 ** (9.034)	3.551 (10.662)	0.531	21
	Metal				0. 102 (0.904)	5.142 (3.306)	0.036	7
	Textile				0.274 ** (13.055)	2.972 (11.047)	0.929	4
	All firms		0.034** (4.056)		0.189** (10.315)	3.792 (16.074)	0.472	70
	Large		0.023* (1.930)		0.236** (11.832)	3.289 (12.518)	0.688	26
	Medium		0.029** (3.349)		0.190** (7.998)	3.800 (12.120)	0.627	18
	Small		0.040** (2.991)		0.154** (5.231)	4.252 (12.288)	0.625	15
	Chemical		0.025** (3.527)		0.206** (12.160)	3.629 (16.255)	0.691	27
	Food		0.055** (3.683)		0.194** (7.620)	3.641 (11.365)	0.638	21
	Textile		0.018* (1.611)		0.236** (10.982)	3.376 (12.444)	0.950	4
	All firms		0.086** (3.148)	-0.002* (-1.985)	0.172** (8.592)	3.840 (16.322)	0.483	70
	Large		0.088** (2.202)	-0.003* (-1.697)	0.223** (10.538)	3.255 (12.505)	0.699	26
	Medium		0.066* (1.647)	-0.001* (-0.956)	0.173** (5.866)	3.902 (11.772)	0.633	18
	Small		0.069* (1.464)	-0.001 (-0.632)	0.147** (4.649)	4.259 (12.217)	0.628	15
	Chemical		0.079** (3.237)	-0.002** (-2.307)	0.188** (10.297)	3.663 (16.795)	0.710	27
	Food		0.044 (1.025)	-0.000 (-0.269)	0.197** (6.994)	3.631 (11.181)	0.639	21
	Metal		0.271* (1.314)	-0.009 (-0.879)	-0.065** (-0.439)	6.230 (3.585)	0.176	7
	Textile		0.037 (0.850)	-0.001* (-0.455)	0.233** (10.042)	3.344 (11.360)	0.951	4
	All firms	0.132** (3.658)	0.062** (2.281)	-0.001* (-1.344)	0.068* (1.964)	3.637 (15.526)	0.519	70
	Large	0.193** (4.969)	0.031 (0.838)	-0.001 (-0.720)	0.076** (2.183)	3.013 (12.983)	0.775	26
	Medium	0.111** (2.169)	0.063* (1.612)	-0.001 (-0.979)	0.076* (1.449)	3.794 (11.698)	0.663	18
	Chemical	0.120** (3.710)	0.056** (2.364)	-0.001* (-1.559)	0.097** (3.243)	3.434 (16.206)	0.753	27
	Textile	0.080 (1.161)	0.019 (0.417)	-0.0003 (-0.145)	0.163** (2.519)	3.337 (11.611)	0.960	4

Correlation is significant * at the 0.05 level (one-tailed) ** at the 0.01 level (one-tailed)

[33] For this regression we use relatively few observations, because some of the respondent firms were particularly reluctant to provide adequate quantitative data on skill indicators. Sometimes we exclude some observations due to inconsistency or unreliability. As we explained in Nour (2011), the main problem is the varying response rate for different questions (e.g. to measure education, occupation and wages) across firms. Moreover, the classification of firms into chemical, food, metal and textile industries, small, medium and large size also divided the few observations between them and so allow for only few observations for regression for each group independently.

[34] The actual/attained education is not used as a variable in the upper half of Table 5, because, we want to check the relation with respect to required education and experience independently and then compare the result when the actual/attained education is also included in the regression.

5. Conclusions

In this paper we use the data from the university Survey of Nour (2009) and the firm survey of Nour (2010) to estimate the rate of return to education and relationships between education, experience, its square and average wages, at the micro level in Sudan.

Different from the few earlier studies in the Sudanese literature (Ali, 2006) that focused on the estimation of return to human capital in Sudan based on secondary data at the aggregate level obtained from the Migration and Labour Survey (1996) conducted by Sudan Ministry of Labour covering 16 States of Northern Sudan defined by gender and education level at the macro level, our analysis in this paper is different because we focus on the estimation of rate of return to education at the micro level using more recent, update and new primary data at the micro level based on the university survey of Nour (2009) and the firm survey of Nour (2010). A novel element of our analysis in this paper is that we use new primary survey data at the micro level obtained from the university survey (2009) and the firm survey (2010), we present a new contribution and fill the gap in the Sudanese literature by estimating first the rate of return to education for men and women and explaining the differences defined by gender and second the rate of return to education for firms and explaining the differences defined by firm size and industry, since these issues are not adequately discussed in the Sudanese literature. One advantage and interesting element in our analysis in this paper is that we explain three stylised facts on the rate of return to education using new primary data in Sudan: first positive but low rate of return to education and correlation between education, experience, its square and wages for men and women defined by gender, second, positive and significant rate of return to education and correlation between education, experience, its square and wages defined by firm size and industry at the micro level across industrial firms and third, an increase in skill levels and firm size leads to improved relationship between actual education, required education, experience, its square and wages at the micro level across industrial firms in Sudan. We are aware of the practical problems and limitations that statistical information about education from the surveys is to some extent estimated and for relatively small sample of 100 persons covered in the university survey and for 73 firms covered in the firm survey. But due to practical problems regarding the availability of more accurate and reliable data from other reliable sources and for relatively large sample defined by education level, in this paper we limit our analysis to estimate the rate of return to education in Sudan defined by gender and by firm size and industry based on the well-known Mincer earning function for relatively small sample. Therefore, despite the relatively small sample size that may constitute a limitation for making some generalization from our results, but we believe that our results remain useful to improve understanding and provide useful insights from both analytical and policy perspectives.

Our results in Section 4 estimate the rate of return to education for men and women defined by gender in Sudan. We use a new primary quantitative data based on the university survey of Nour (2009), the Ordinary Least Squares (OLS) method to estimate the Mincerian earning function. Our results corroborate our first hypothesis on the positive but low rate of return to education and correlation between education, experience, its square and wage defined by gender, our results imply very low rate of return to education for all the sample, men and women in Sudan (Table 1). Our results at the micro level seem consistent with the results at the macro level discussed in the Sudanese literature (Ali, 2006) which indicate very low rates of return to education different from the world pattern. Our results imply that the slightly gender gap or difference in the rate of return to education in favour of women is only 0.2 which is not very noticeable. Our results at the micro level seem consistent with the results at the macro level discussed in the Sudanese literature (Ali, 2006) which indicate that the difference in the rates of return between males and females is not very striking and amounts to about 0.3 percentage point much lower than that expected from world patterns.

Our results in Section 4 corroborate our second hypothesis concerning the positive, significant and differences in the rate of return to education and correlations between actual and required education, experience and average wages at the micro level across industrial firms defined by firm size and industry level in Sudan (Tables 2-5). We verify the third hypothesis in section 3 above that an increase in skill level and firm size lead to improved relationships between actual and required education (Table 2), between actual education, experience and wages (Table 4) and between required education, experience and wages at the micro level across industrial firms in Sudan (Table 5). Taken together, all these results imply the importance of a good education for bridging differences between firms and also for enhancing economic growth and rate of return as indicated in the literature. Finally, our results in Section 4 estimate the rate of return to education for industrial firms defined by firm size and industry and show the relationships between actual and required education, experience and wages defined by firm size and industry level. These results are consistent with our findings in Nour (2005, 2011), which imply that skill vary across firms and increase with both firm size and industry level.

Our findings indicate the importance of investment in education to facilitate enhancing educational attainment and improvement of return to education for men and women and for all industrial firms in Sudan. The major policy implications and recommendations from our analysis are that Sudan needs to improve the rate of return to education by investing large amount of resources in increasing and improving educational attainment for men and women, and improving returns to education for men and women and for all industrial firms in Sudan.

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