Female labour supply in Sudan

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Abstract

Female participation in market activities has been increasing in the last decades in Sudan, particularly in the organized modern sector, as women's educational attainment has been rising. This trend, undoubtedly, has vital repercussions on social and economic change and deserves to be studied. This paper looks at the determinants of women's decisions to enter the labour market and their market labour hours. It focuses on the impact of education and changing household behaviour, regarding allocation of time and family formation. The human capital model of the earnings function revealed that education is positively and significantly correlated with the growth in wage earnings and with decisions to enter market activities. It was found that female participation and labour supply decisions respond positively and strongly to own-wage, and negatively and significantly to the spouse's wage. Assets income affects work decisions and hours negatively, but is statistically insignificant. Small children discourage market participation and work but the response to their presence is only marginally significant. Older children, on the other hand, tend to encourage work activity but definitely not significantly.

I. Introduction

Investment in human capital development, such as education and health, is found to contribute significantly to economic development and growth as it raises labour productivity and induces an efficient allocation of resources (Schultz, 1992). The positive association between earnings/wages and schooling has been confirmed in many studies (Psacharopoulos, 1981), as has the importance of education in economic and social spheres. In developing countries it is noted that education reduces fertility and increases child survival (Maglad, 1993). Further, parents'education affects positively the demand for schooling for children (Birdsal, 1985; Chernichovsky, 1985; Jamison, and Lockheed, 1987; Singh, 1992; Maglad, 1994).

Female labour force participation and female labour supply in developed countries has been treated in a number of studies (Smith, 1980). For developing countries, Boserup, (1970) documented women's participation in the labour force and contribution to development. In these countries the bulk of women's work takes place in non-market activities in the home or the informal sector. The contribution of women to modern sector activities has been recent, but is increasing with the expansion of the market economy and advances in women's educational attainment. It is imperative, therefore, to understand the factors that lead to decisions by women to enter the labour market and how their labour supply responds to market wage earnings, income and other variables. Of particular importance are studies of developing countries that examine the impact of education on women's decisions to participate in market activities. In labour supply studies, education is found to affect the probability of female market participation positively. Following the human capital approach, some studies used education, together with such variables as years of experience and age, to derive an imputed wage that is used in the labour supply function. Others included both wages and education, and also found a significant influence (see Section III).

This study looks at female labour supply, emphasizing the importance of human capital to explain the trend of increasing participation of females in market activities. An important stylized fact that has emerged from research in labour supply in developed countries is that labour force participation has gradually, but perceptibly, declined for men as a whole, whereas female labour force participation has risen substantially over time (Killingsworth, 1983; Deaton and Muelbauer, 1980). It has been argued that the observed trend in male labour force participation and supply is explainable in terms of dominance of the negative income effect that resulted from improvements in men's wages and earnings over time. In contrast, a positive and significant substitution effect of females' wages that dominates a small and initially negligible income effect is taken to explain the observed increase in females' labour force participation.

Generally in developing countries a rising trend in market participation of females has been observed. The available data for Sudan suggest that female labour force participation in urban areas of Sudan increased between 1983 and 1993. As Table A1 in Appendix A shows, the refined activity rate for females in urban areas was higher in 1993 than in 1983, increasing from 12.1% to 14.4%. Male labour force participation rates, on the other hand, declined during the period 1983-1993.

Table A2 presents the age-specific activity rates for females in urban areas. As evident from the table, women's participation rates increase with age but start to decline after women reach a certain age. In 1983 the maximum activity rate of 18.5% occurred at age group 25-29. The census of 1993 gives a maximum 23.2% at age group 30-34. Thus, participation at young age groups declined between the two censuses. This is attributed to the enrolment of more children in school, and for longer periods of time, than in 1983. The rise in the maximum activity rate in 1993 and its occurrence at the older age groups compared with 1983 may be explained in terms of demographic changes as reflected in rising age at marriage. This in turn would lead to an increasing tendency by women to stay longer in the active labour force before they marry and withdraw into home production activity.

No systematic study of female labour supply has been undertaken to elucidate the factors responsible for the observed trends in female market participation.[1] In particular, no attempts have been made to study empirically the various socioeconomic factors that influence female labour supply as evoked by the economic model of utility maximization and labour-leisure choice. With the rising trend in women's education and market participation and change in family formation in Sudan in the last decades, the issue deserves in-depth treatment.

This research applies recent econometric techniques to available micro level data on female labour supply to shed light on some of the regularities and facts revealed by labour surveys in Sudan. The importance of the changing role of women and their involvement in labour market activities, and thus the potential importance of intra-family substitution effects, as well as the change in overall educational attainment, will be emphasized. The study continues my examination of the impact of education on development, (Maglad, 1993, 1994)[2] by extending the analysis to labour supply decisions. The data set generated in the earlier project is used in this research, supplemented by recent micro level data collected by the Ministry of Manpower in 1991 (see Section 4).

The remaining sections of this paper proceed as follows: In Section II the theoretical framework is elaborated, while Section III examines the empirical specifications and some conceptual issues and the estimation methodology. Section IV presents the empirical results and Section V concludes the discussion with a summary and implications.

II. Theoretical framework

The simple neoclassical static model of labour supply without uncertainty assumes that the individual maximizes his utility function, *U*, defined as the amount of market (i.e., consumer) goods, *C*, which are assumed to be a composite commodity, and hours of leisure *L*, consumed per period, subject to income and time constraints; that is:

$$Max_{1,c} \quad U(C,L) \tag{1}$$

Where the income constraint is defined as:

$$PC = WH + V \tag{2}$$

P is the price of a unit of *C*, *W* is the fixed price of an hour of *L* (wage per hour) and *V* is other non-labour income, such as property income. So spending on market goods must equal income from work plus other income. Total available time T may be allocated between leisure *L* and work *H*. Thus,

$$H = T - L \tag{3}$$

The optimum occurs where the marginal rate of substitution of consumption for leisure, $M = (\delta u/\delta L)/(\delta u/\delta C)$, is equated to the ratio of prices, W/P, which is the real wage rate. Thus:

$$M = (\delta u/\delta L)/(\delta u/\delta C) = M(C,L) = W/P \tag{4}$$

By solving equations 2 and 4 the optimal quantities of labour supply, *H*, and consumption goods, C, are derived as functions of prices (*P,W*) and property income, *V*. Thus $H = H(W, V, P)$. Writing $w = W/P$ and $v = V/P$, the labour supply for a given individual may be written as $H = H(w,v)$, and indicates the absence of money illusion.

The model as outlined above deals with the labour supply decisions of the individual. To extend the model to labour supply decisions by the household, particularly the two-person household (wife and husband), the wage offer available to the other spouse must be added to the list of variables determining the reduced-form equation of market labour hours, if both spouses engage in some market activity (Mincer, 1962; Kosters, 1966; Heckman, 1974; Schultz, 1980; Killingsworth, 1983).

The impact of a change in i's labour supply to a unit change in j's wage is written as the sum of the substitution and income effect:

$$\delta H_i/\delta W_j = S_{wj}(H_i) + H_j(\delta H_i/\delta V)$$

where S_{wj} is the substitution effect, and refers to the effect of a wage change with property income adjusted so as to keep utility constant - that is the effect of an income compensated wage change - and the second term on the right-hand side is the income effect of the change W_j on H_i.

The predictions of the theoretical model are the following:

1. *Negativity of the income compensated own-wage substitution effect*: A rise in the wage rate leads to a decrease in the demand for leisure and hence a rise in labour supply, so the income compensated own-wage elasticity of labour supply is positive:

   $$S_{wi}(H_i)\ W_i/H_i > 0.$$

2. *Symmetry*: Income compensated cross-substitution effects $S_{wi}(H_j)$ and $S_{wj}(H_i)$ must be equal. Also, the income compensated cross-substitution effect of one spouse's wage offer on the other spouse's labour supply may be negative or positive. This depends on whether the leisure time of one spouse is a substitute or complement for leisure time of the other spouse in the household.

3. *Negative income elasticity*: $(\delta H/\delta V)\ (V/H) < 0$. An increase in an individual's income as a result of wage increases leads to demand for more leisure, and consequently to lower labour supply than before the rise in the wage rate.

III. Econometric specification and estimation

Specification

Labour supply functions derived using the theoretical framework in Section II will not provide a complete model for empirical estimation for two reasons. First, the function derived assumes that the individual works, i.e., an interior solution to the maximization problem facing the individual. Second, data used for estimation pertain to different individuals with different tastes for work, that is individuals differ not only in terms of the observable variables (i.e., w,v) but also in terms of the non observable (which are represented by a random error term, ε).

Regarding the first problem, one should observe that an individual would work only if the market wage rate, w, exceeds a reservation wage, w^*. The latter is given by the value of marginal rate of substitution when L=1, that is when no market labour hours are offered, and it represents the marginal value of time in non- market activities. Thus, assuming freedom of choosing hours of work and absence of fixed cost of work, it is assumed that an individual's labour supply behaviour is determined by two relationships: (1) a market wage offer or a market demand function, w, and (2) a shadow value of time or reservation wage, w^*, or the individual's labour supply function:

$$w = f(X, \varepsilon 1) \qquad (5)$$

$$w^* = g(Z,H,\varepsilon 2) \qquad (6)$$

where X and Z are vectors of possibly overlapping exogenous and endogenous variables that determine the market wage offer and the individual's labour supply function, respectively. H is hours of work, ε 1 and ε 2 are randomly distributed stochastic terms that reflect non observable factors such as abilities, taste for work, errors in measurement and purely stochastic variability. The market demand function in Equation 5 is assumed to be independent of hours worked (Heckman, 1974). The individual will work if and only if $w > w^*$ and the hours of work of any individual who works are defined by the relations $w = w^*$, and hence may be obtained by solving this relation for H.

Assuming, for example, that the functional forms for equations 5 and 6 are linear, one can write the demand and supply functions, respectively, as:

$$w = a_0 + \alpha 1\, X_i + \varepsilon 1_i \qquad (7)$$

$$w^*_i = \beta_0 1 + \beta_1 Z_i + \beta_2 H_i + \varepsilon 2_i \quad (8)$$

where *i* refers to individual *i* and α's and β's are parameters to be estimated. Solving for the hours of work equation yields:

$$H_i = 1/\beta_2 (w_i - \beta_0 + \beta_1 Z_i) + (1/\beta_2) H_i + \varepsilon 2_i \quad (9)$$

$$H_i = 1/\beta_2 (w_i - \beta_0 - \beta_1 Z_i) + v_i \quad (9')$$

$$H_i > 0 \text{ if and only if } \varepsilon 2_i > -(w_i - \beta_0 - \beta_1 Z_i) \quad (10)$$

$$H_i = 0 \text{ if and only if } \Pi 2_i < -(w_i - \beta_0 - \beta_1 Z_i) \quad (11)$$

As equations 9', 10 and 11 reveal, the model gives an account of both participation (that is the decision to work or not to work) and hours of work. It also shows that the same parameters, observable variables and unobservable random error affect both kinds of decisions.

Estimation

OLS estimates of a function like that depicted in Equation 9' will suffer from selectivity bias since the error term in samples used for estimating the labour supply parameters will not be a zero-error random variable. The problem arises because the error term that determines the sample selection rule would be correlated with the error term of the supply function. This occurs whenever the selection rule is endogenous to labour supply, e.g., selecting on the basis of income or employment, as in use of the sample of working individuals.

As noted above, labour supply means both participation and hours of work. The analysis begins by considering the female's participation decision, that is the decision of being, or not being, employed. In this case the dependent variable will take the value of one or zero depending on whether a woman works or not. If one makes the assumption that v_i is a normally distributed random variable, a probit equation, whose parameters may be estimated by the method of maximum likelihood, can be estimated.

Hours of work are accounted for in the analysis, through a Tobin likelihood function. By estimating probit or Tobin probit, one can get estimates of the parameters that govern the labour supply and hence income and wage elasticities. It is also possible to analyse the determinants of the decision to work or not to work, since the estimates can be used to calculate the probability that a given female, with given values of Z and W, will or will not work. If only workers are used in the sample to estimate the labour supply parameters, then consistent estimates can be obtained by correcting for selectivity bias using selection bias corrected regression (Heckman, 1976, 1979, 1980).

One problem with this methodology is that the wage variable is not available for all N observations. To counter this, we assume that the market wage function (Equation 7) estimated for the workers only sample can be used as a basis for imputing wage rates to those with and without observed wages. The imputed wage rate derived using the OLS estimates of the parameters of the function in Equation 7 is:

$$\hat{W} = \alpha_0 + \alpha_1 X_i \qquad (12)$$

which can be used in Equation 9 in place of w. Now the problem is that OLS estimates of Equation 7 will suffer from selectivity bias as the estimation is based on the workers only sample. The practice is to correct for the sample selectivity bias by using the Heckman two-stage procedure (Heckman, 1980). This procedure involves estimating a participation function in the first stage, either a probit or logit depending on the assumptions made regarding the error term, to derive an inverse Mills ratio. The ratio so derived is then used in the second stage OLS estimation as a regressor to correct for specification bias that results from excluding the sample of non-workers from the regression. While the estimates yielded by the Heckman method are consistent, they are not asymptotically efficient. For this reason, the preferred alternative is the full information maximum likelihood (FIMIL) approach.

Generally, the early empirical studies of labour supply found that income compensated own-wage elasticity is positive for males and lies between 0.000 and 0.360; that for females is found significantly positive and ranges between 0.100 and 2.000. As for the income elasticity, for males it is usually weak and negative, lying between 0.000 and -0.160, but in some studies not significantly different from zero. For females, it is generally negative and much greater in absolute value than the male elasticity, ranging between -0.100 and -0.2000 (Killingsworth, 1983).

Also, gross (uncompensated) wage elasticities are indicated in some studies to be positive for women and negative for men. The range of estimates for the uncompensated own-wage elasticity for women is larger than the range of estimates for men: between about 0.200 and 0.900 (0.00 to -0.40 for men) in most aggregative cross-section and micro level cross-section studies of female labour supply (Killingsworth, 1983). In later studies, which took account of sample selectivity bias and endogeneity of the wage rate, female gross wage elasticity is usually at least 0.60 and often yields estimates in excess of 2.0. When education is used as a determining variable, its effect is found to be positive (Schultz, 1980; Malathy, 1989).

Empirical specification of the wage and labour supply function

The wage function that I apply to the data is the well known human capital earnings function (Mincer, 1962; Mincer and Polachek, 1974), which assumes that the proportionate change in wage earnings is determined by a number of wage variables. These include years of schooling, S, years of post-schooling experience, EX, and its quadratic EXSQ. An error term ε_{1i}, representing the effect of unobserved factors (e.g., motivation, innate ability, etc.) on wages, is assumed to be normally distributed with a zero mean and constant variance. Thus the wage function is specified as:

$$1n\ W_i = \alpha_0 + \alpha_1\ S_i + \alpha_2\ EX_i + \alpha_3\ EXSQ_i + \varepsilon_{1i} \qquad (7')$$

where 1n W_i is the natural logarithm of the female's hourly wage rate and *EX* is approximated by age minus age of entry into the school system (seven years) minus years of schooling completed. It is argued that this "potential" experience variable is inadequate to use as a measure of past experience to explain change in female market productivity, since for women the length and continuity of market experience varies a great deal. Nonetheless, once schooling is determined, potential experience is not subject to individual control and may thus be independent of the error term in the right-hand side. On the other hand, if entry and exit from the labour market are assumed to be individual choice variables, this variable cannnot be considered as exogenous and will be simultaneously determined with the wages, and hence correlated with the unobserved abilities and preferences. A test of the exogeneity of this variable will be carried out.

The estimating equation for the labour supply function is:

$$H_i = ß_0 + ß_1\ \hat{W}_i + ß_2\ \hat{W}_h + ß_3\ V + ß_4\ Z_i + \varepsilon 2_i \qquad (9'')$$

where H_i is the annual hours worked by the wife, $\hat{W}_i$ and $\hat{W}_h$ are the wife's and husband's predicted hourly market wage rates, *V* is the household assets in the last five years, and Z_i is a vector describing some demographic characteristics like the wife's age, squared term in age, and children in two age groups: pre-school and schoolage.

The use of an instrumental wage also controls for the average hourly earnings measurement error and purges the wage variable from the correlation with the error term that arises from endogeneity of the actual wage rate. Similarly, the inclusion of children among the right-hand variables would give rise to simultaneity problems, since fertility and labour supply decisions are thought to be endogenously determined. This will be dealt with in two ways: (1) by estimating the function without this variable and (2) by testing for the exogeneity assumption.

IV. Empirical analysis

Data

Official statistics pertaining to the labour force, its size, socioeconomic characteristics, participation, earnings and migration have been collected through the Ministry of Manpower (MOM) (formerly Ministry of Labour). Some information on labour size, participation, employment status, distribution by occupation and industry is also part of the various population censuses carried out by the Central Bureau of Statistics in 1973, 1983 and 1993. The Ministry of Manpower carried out two surveys on labour and migration, one in 1990 another in 1994, and a third is being completed this year (1996). None of these surveys meet all the data requirements for the analysis proposed in this study.

For this reason the main data set I use to analyse the determinants of female labour supply in Sudan come from a demographic survey I conducted in 1990/91 with the financial support of the Rockefeller Foundation. The survey sample contains information on female participation and labour supply and a variety of socioeconomic variables relevant to the proposed analysis. (For a description of this sample see Maglad, 1993.) The official data of the Ministry of Manpower will be used whenever possible during the process of analysis.

The 1990/91 survey covered both rural and urban areas in the central and western states of Sudan. The primary unit in the survey was the household, which was chosen by a multi-stage stratified random sampling. Information was collected separately for women in the household, with emphasis on the wife and other married women. Thus, data on female marital status, education attainment, number of children, market participation, wages, husband's income, household assets etc., are available.

Only the sub-sample of women resident in urban areas is used for the analysis of labour supply in this study. There were 627 households in the urban areas. A total of 693 married women lived in these households, and this sample forms the basis of the analysis of female labour supply in urban areas. Out of this total, 128 (18%) participated in market work. About 90% were employees, the majority of whom worked in professional and clerical occupations, a pattern also observed in the 1993 Population Census. Because of the small size of the sample all observations are used, including the few self-employed in service activities.

Some measurement problems of labour supply, hours of work, and the wage variable and its imputation will need to be addressed. I use the hourly wage rate for the wage variable, which is defined as weekly earnings divided by usual hours worked last week.

For the labour supply I use annual hours worked last year, which is defined as the product of the usual average hours worked last week and the weeks worked last year.

The means and standard deviations of the variables used in the empirical analysis are provided in Table 1. It is seen from the table that a female labour force participation of 0.18 is observed for the sample used in the study. For the purpose of this study participation is equated with employment. This is unlike the definitions of Table A1 and Table A2 in Appendix A, where participation means being in the labour force, and hence includes the unemployed among the participants. In Table A2, a participation rate of 19.6% is noted for women in their forties in 1993 (which is the mean sample value).

Table 1: Variable definitions, means and standard deviations (SD)

Variable	Working women		All women	
	Mean	SD	Mean	SD
Labour force participation			0.18	0.39
Annual market hours	1,456	684.3	273.9	641.6
Wife's imputed hourly wage	3.08	0.86	2.66	0.76
Explanatory				
Years of schooling	8.78	5.78	5.91	5.55
Experience	22.12	13.03	27.25	16.06
Experience square	658.1	737.9	1,000	1,006
No. of children < 6 years	0.68	0.81	0.69	0.92
No. of children 6-15 years	1.08	1.25	1.06	1.29
Husband's imputed hourly wage	18.35	9.95	16.6	10.25
Asset (x10^{-4})	7.985	55.71	12.83	90.16
Age	37.9	9.07	40.2	12.3
Age square	1,518	777.3	1,765	1,094
Males 16 years & over	1.80	1.74	2.56	1.98
Females 16 years & over	2.82	2.58	2.81	2.22
Household structure	0.22	0.41	0.17	0.37
Life-time migration dummy: non-migrant=1, else=0	0.67	0.47	0.61	0.49
Sample size		128		693

The wage function

Table 2 presents estimates of the Mincerian wage function. Each column shows two regressions, one without the experience square term and the other including the quadratic of experience. Other specifications, which included the square of education and interaction terms of education and experience, were tried and estimated (not reported) but didn't give better estimates than those in Table 2. Column 1 gives the traditional estimates of the equation, which uses the sample of working women to estimate the parameters of the wage function through OLS. The regression corrected for sample selection bias is presented in column 2 and column 3, where in the former Heckman two-stage procedure is followed and in the latter full information maximum likelihold (FIML) is used. FIML is preferred since it provides asymptotically efficient estimators.

Adopting the sample selection correction procedure increases the estimated returns on schooling for women from an average of 3%, obtained through traditional regression, to 8%; the coefficient on the selectivity term, λ, indicates that there is some evidence that the sample of wage earning women is not a random sample of the population with regard to their wage rate.

Table 2: Estimates of the wage equation (t values in parentheses) Dependent variable: ln hourly wage

Explanatory variable	(1) Traditional regression		(2) Traditional regression corrected censoring[a]		(3) Maximum likelihood estimates[a]	
Education	0.033	0.029	0.082	0.077	0.070	0.056
	(1.81)	(1.58)	(2.41)	(1.50)	(1.94)	(1.07)
Experience	0.003	-0.018	0.012	0.007	0.011	-0.008
	(0.37)	(-0.88)	(1.22)	(0.17)	(1.15)	(-0.19)
Exp. square		0.037		0.007		0.030
($x10^{-2}$)		(1.11)		(0.12)		(0.50)
			0.639	0.579		
			(1.50)	(0.87)		
Intercept	1.425	1.689	-0.148	0.026	0.225	0.804
	(4.32)	(4.15)	(-0.16)	(0.01)	(0.22)	(0.46)
R^2	0.04	0.04	0.04	0.03		
Rho					0.507	0.328
					(1.14)	(0.43)
Log Likelihood					-451.1	-450.9
N	128		128		128	

Note: a. Estimates of the reduced form participation equation used for sample selection correction is given in column 1 of Table 3.

The estimates of the wage function confirm the positive effect of schooling on earnings, which is reported in the literature. The estimates of the experience coefficients, however, are not precise and are statistically insignificant in all regressions. It is often argued that experience cannot be treated as an exogenous variable, since the number and periods of stay in the marketplace could be affected by a woman's own choice and hence the variable would be correlated with the error term and the estimated coefficients would be biased. It is to be noted that the variable used in the analysis is more a measure of potential experience than of actual experience. In fact, when the variable is replaced by an instrumental variable estimate, the impact of education is obscured and no change is observed in the estimates of experience term.[2] It is therefore decided to use the maximum likelihood estimates of the wage equation, where experience enters in a linear form (first regression in column 3, Table 2), for predictions of the wife's wage equation.[3]

Labour force participation decision

Table 3 provides estimates of the labour force participation equation. These are the maximum likelihood estimates of parameters of the probit model. The latter estimates are preferred to the OLS estimates since it is established that MLL provides asymptotically consistent and efficient estimates.

Three regressions are provided in the table. The first regression does not include the numbers of pre-school and schoolage children, while in the second regression these variables are introduced in the function. Since fertility and labour supply decisions are simultaneously determined, these variables would be endogenous and hence correlation with the error term would give biased and inconsistent estimates of the parameters. In order to test for endogeneity of the children variables in the labour supply equations, instrumental variables estimates are used in place of actual values and test of endogeneity is applied.[4]

The problem arises in finding appropriate instruments to identify the children equations, since most of the variables that enter the labour supply equations can be thought of as determinants of fertility. In want of such variables, I have assumed that adult members of the household, household structure, and lifetime migration status could be treated as identifying variables. The structure of household is a dummy variable used to reflect whether the household is made up of an extended family or a single unit (nuclear) family. It takes the value of one for an extended household and zero otherwise. It is suggested that household structure plays a role in decisions regarding work or number of children. This is because it is easier to find substitutes for the mother's time at home when other adults, particularly females, live in the same household and can provide the required child care where these inputs could not be easily purchased in the market (Wong and Levine, 1992).[5]

The instrumental variable regressions of the suggested children equations are shown in Appendix B, Table B1. From Table B1 it is seen that of the identifying variables, only adult males and adult females are significantly and negatively related to young children. There are two possible interpretations for the negative relationship between these variables and small children. One is that married women at the start of their marriage, and hence with few small children, may be living in extended households, with large number of adults. The other is that the adults may include the daughters and sons of the woman, as those women with a large number of children at old age are less likely to still have a large number of young children. The labour force participation regression including the instrumental variables of small and older children is shown in column 3 of Table 3.

The estimates in Table 3 indicate the positive and significant influence of education on the woman's decision to enter the labour force. Moreover, in the first and second column of Table 3, post-schooling experience is positively associated with labour force participation of the woman. The negative quadratic experience term indicates that participation is concave on experience; that is, the probability of being in labour market activities is higher the longer the woman spends in market activity, but declines after she reaches a certain age. Also, the coefficient of the head's instrumental wage indicates that a woman's participation in the labour market is reduced significantly as the head's predicted wage rises.[6] Household assets have a negative effect on the woman's entry into labour market activities but is not statistically significant.

Regarding the effect of young children on market participation by women, the results in column 2 of the table, when actual values of children are entered, indicate a negative but insignificant impact, and no change in the estimated parameters of the other variables is noticeable. However, when the instrumental variables of children are introduced in column 3, presence of pre-school children in the family strongly discourages participation in market activities by the woman. In contrast, a positive and significant relationship between schoolage children and a woman's decision to participate in the market is noted.

But the introduction of instrumental value of children affects the magnitude and significance of other estimated parameters in the model. Most notable, the coefficients of experience are now imprecisely estimated. So, it appears that there is some interaction between the wife's labour force experience variables and the number of children in the household. This might be because post-schooling experience is a residual of age over years spent at school, and these post-schooling years overlap in time spent in having children, childcare and market activity. In fact, as it will be seen later, when a woman's age is introduced in labour supply function together with predicted children the effect of the former on labour supply is obscured (this is discussed further in the next section).

Moreover, with predicted children in the regression, in column 3 of Table 3, both the magnitude and significance of household assets and the husband's instrumental wage are increased. Note that the test of endogeneity, at the bottom of Table 3, implies that children cannot be treated as exogenous variables in participation equation, at least when experience and not the woman's age is introduced in the function.

The labour supply function

Estimates of the labour supply function are presented in Table 4a and 4b. Table 4a provides two sets of estimates:

- Column 1 shows the estimates of a standard Tobit, in which instrumental wage corrected for selectivity bias is used (for both woman and head) and introduced as a regressor in the supply of hours equation.
- Column 2 introduces the instrumental wage corrected for sample censoring into the structural participation and hours worked decisions. These are estimated separately, in the first case for all women and in the second case for working women only. The selectivity bias in the conditional hours equation is corrected by using FIML approach.

Each column of Table 4a supplies two regressions. The first regression excludes actual

Table 3: Regression on female labour force participation (t values in parentheses)

Explanatory variable	(1)	(2)	(3)
Education	0.128	0.124	0.071
	(6.060	(5.78)	(1.91)
Experience	0.087	0.088	-0.042
	(4.48)	(4.15)	(-0.76)
Experience square (x10^{-2})	-0.121	-0.128	0.010
	(-4.02)	(-3.88)	(0.17)
Husband's wage[a]	-0.019	-0.019	-0.023
	(-2.64)	(2.67)	(-3.05)
Assets (x10^{-4})	-0.001	-0.001	-0.002
	(-0.86)	(-0.84)	(-1.67)
Children < 6	-0.082	-1.420	
	(-1.05)	(-2.28)	
Children 6-15	-0.029	0.737	
	(-0.57)	(2.38)	
Constant	-2.59	-2.412	0.206
	(-7.49)	(6.34)	(0.15)
Log likelihood	-331.6	-331.6	-295.8
X^2	64.63	66.35	71.55
Endogeneity test:			
X^2			6.393
N	693	693	693

Note: [a]predicted wage.

values of children, whereas the second one introduces these variables. A test of endogeneity of children is given in Table 4b, where the instrumental variables of children are introduced for both standard Tobit and generalized Tobit.

The results of the standard Tobit in column 1 of Table 4a indicate that hours of work are positively and significantly affected by the woman's own wage. The response of the woman to the head's wage is negative and significant. The household's non-labour income, though it reduces market hours provided by the woman, is not statistically significant. Market labour hours of the woman are related to her age in a positive and declining manner reflecting the life cycle effects. A negative, but not important, impact of children's presence on the hours a woman provides is noted. In fact, none of the estimated coefficients of the regressions offered in Table 4a are changed appreciably in magnitude or significance by the introduction of children, when the latter are assumed exogenous.

The generalized Tobit method estimates are shown in column 2 of Table 4a. The participation decision estimates are presented first, where the dependent variable is a dummy variable taking the value of one if a woman is working, and zero if she is not working. Since OLS are inappropriate for estimation, a probit is estimated. The exercise reveals that the woman's decision to enter the labour market is positively and significantly

Table 4: Estimates of labour supply equations (asymptotic t values in parentheses)

a. Without instrumental variables of children

Explanatory Variable	(1) Standard Tobit Hours		(2) Generalized Tobit Part	Hours[b]	Part	Hours[b]
Female's wage[a]	1386	1386	0.6394	76.80	0.6306	89.17
	(6.60)	(6.50)	6.70	(0.24)	(6.56)	(0.28)
Husband's wage[c]	-49.89	-49.56	0.0203	-15.93	-0.0201	-16.40
	(-3.10)	(-3.09)	(2.70)	(-1.26)	(-2.69)	(-1.24)
Assets $x10^{-4}$	-2.502	-2.417	-0.001	-1.249	-0.001	-1.284
	(-1.00)	(-0.97)	(-0.85)	(0.14)	(0.81)	(-0.14)
Female's age	345.2	360.4	0.1829	-29.39	0.1899	-37.81
	(4.01)	(3.84)	(4.36)	(-.035)	(4.17)	(-0.42)
Fem. age square($x10^{-2}$)	-426.1	-439.9	-0.2206	42.18	-0.2324	52.73
	(-4.08)	(-3.97)	(-4.43)	(-0.42)	(-4.31)	(0.48)
Children < 6		-100.9			-0.0560	24.66
		(-0.62)			(-0.70)	(0.25)
Children 6-15		-80.15			-0.0394	30.89
		(-0.76)			(-0.77)	(0.50)
Constant	11513	-11511	-5.832	2344	-5.810	2398
	(-5.89)	(-5.50)	(-6.44)	(0.77)	(-5.97)	(0.78)
Log likelihood	-1323	-1323	-293.3	-1289	292.6	1288
Rho				-0.3812		-0.3582
				(-0.49)		(-0.45)
N	693		693	128	693	128

a. Predicted wage, obtained by using maximum likelihood estimates of the wage coefficients shown in Table 2, column 3.
b. The reduced form participation equations used as the basis for selection into the sample are the probit equations of column 1 and column 2 of Table 3.
c. Predicted wage.

affected by her predicted wage rate. Moreover, a woman is less likely to enter labour market activities if her husband's wage rate increases and this wage effect is statistically significant. Non employment income of the household negatively affects the decision to participate in market activities, but is not statistically significant. The effects of age show that younger women are more likely than older women to participate in market activities. The peak in the estimated participation rate occurs at about age 40.

Column 2 of Table 4a also shows estimates of the conditional hours (hours worked by women working). These estimates are corrected for sample selection bias, but as the results indicate, sample selectively bias appears not to be an important problem in the estimation of the hours of work function in this instance. With the exception of the head's wage rate, which is only weakly related to hours supply, none of the other variables seem to have an impact on labour supply decisions. This suggests that the income effect of the head's earnings plays an important part in hours of work supplied by the woman. Again, no further insight is gained by the inclusion of actual value of children in the estimated labour supply functions.

The standard Tobit framework is based on the assumption that the participation and hours of work decisions arise from a single framework. If this is correct, the sign and statistical significance of the related parameters should be similar. As the results in column 2 of Table 4a show, the participation decision is more responsive to the determining variables than the hours of work decision, implying that the generalized Tobit is to be preferred to the standard Tobit.

In Table 4b the instrumental variable estimates of children are introduced for the standard Tobit in column 1 and for the generalized Tobit in column 2; the test of exogeneity of the variables is reported at the bottom of the table. The introduction of predicted children alters the size of the parameter estimates of the standard Tobit and the generalized Tobit.

Most notably, the previous conspicuous influence of the wife's age in labour supply in the standard Tobit, and in the labour force participation decision in the generalized Tobit, is no longer apparent. Probably this arises because of the strong correlation between the wife's age and the number of children (Table A3), which apparently has been carried over in the predicted variables. In this formulation, the size and significance of the husband's wage and household assets are increased. The presence of young children appears to discourage participation and reduce the number of hours a woman offers in the market. The presence of older children, who are likely to be in school and thus release her of day-time activities at home, encourages her participation in market work.

The effect of children, however, is not statistically significant and the test of the exogeneity of children indicates that the hypothesis that children are exogenous cannot be rejected in the standard Tobit and the participation function in column 2. In the Tobit with sample selectivity (second regression in column 2 of Table 4b), the test rejects the exogeneity assumption of children. Moreover, there is an indication of sample selection bias in the generalized Tobit when children are endogenized. In this regression a positive and weakly significant effect of the female's predicted wage on market hours is noted, and a strong negative relationship with the husband's wage is indicated. Young children, who require home care and attendance, cause a woman to spend less time in market activities but the effect is only marginally significant.

Labour supply, uncompensated own-wage, cross wage and income elasticities are calculated at sample mean values using the estimated parameters of the alternative estimating procedures for specifications where children are excluded, as their presence did not much affect the estimates in most regressions. The elasticities are presented in Table 5. If the terms of the participation equation and hours worked equation are assumed to be independent, then the sum of the elasticity of participation and the elasticity of conditional hours worked should approximate the Tobit elasticity of the expected value locus.[7] As seen from Table 5, expected labour supply elasticities with respect to own-wage and spouse's wage are slightly larger than Tobit expected value locus elasticities, with the difference reaching 0.2. These elasticities are difficult to compare with estimates obtained for other developing countries because of differences in sample composition,

Table 4.2: Estimates of labour supply equations (asymptotic t values in parenteses)

b: With instrumental variables of children

Variable	Standard Tobit	Generalized Tobit	
	Hours	Part	Hours
Female's wage[a]	1465	0.6825	475.1
	(6.03)	(6.10)	(1.40)
Husband's wage[c]	-56.86	-0.0234	-33.66
	(-3.32)	(2.89)	(-2.37)
Assets x10^{-4}	-4.310	-0.001	-2.420
	(-1.42)	(-1.23)	(-0.26)
Female's age	-64.02	0.013	-129.0
	(-0.17)	(0.07)	(-0.61)
Fem. age	-38.71	-0.0618	79.11
square (x10^{-2})	(-0.11)	(-0.36)	(0.40)
Children[d] < 6	-2434	-0.9756	-1691
	(-1.10)	(-0.88)	(-1.26)
Children[d] 6-15	1197	0.5173	500.4
	(1.10)	(0.96)	(0.69)
Constant	-1383	-1.734	4231
	(-0.15)	(-0.38)	(0.87)
Log likelihood	-1323	-292.8	-1284
			-0.6880
Rho			(-1.77)
Endogeneity			
text χ^2	1.26	0.918	6.52
N	693	693	128

[a] Predicted wage, obtained by using maximum likelihood estimates of the wage coefficients shown in Table 2 column 3.
[b] The reduced form participation equation used as the basis for selection into the sample is the probit equation of column 3 of Table 3.
[c] Predicted wage.
[d] Instrumental variables estimates.

coverage, variable definitions, etc. In particular, and as Mroz (1987) has shown, the estimated response of the variables is sensitive to choice of identifying variables and the specifications used. Nonetheless, compared with findings for India (Malathy, 1992), for example, these estimates, especially own-wage elasticities, are higher.

Table 5: Labour supply elasticity according to alternative estimation procedures

Procedure	Own-wage	Husband wage	Assets
Standard Tobit[a]	2.16	-0.48	-0.019
Generalized Tobit			
1. Hours worked (H.0)	0.15	-0.21	-0.006
2. Probability of working	2.21	-0.44	-0.014
Expected labour supply (1+2)	2.36	-0.65	0.018
OLS[b]	2.71	-0.52	-0.012

[a] The elasticities are with respect to the expected value locus (not the Tobit Index) and hence analogous with the OLS elasticities at the bottom of the table. Note that $\delta E(H)/\delta x_i = \beta_i \phi(\beta' x)$, where, ϕ (.) is the distribution function evaluated at the mean values.

[b] Based on OLS estimates of hours worked using the sample of all women; these are shown in Appendix B, Table B2.

V. Summary and implications

This research examined the economic variables determining women's decisions to enter market activities. The price and income variables were found to affect these decisions in accordance with the underlying theoretical framework of the utility maximization and leisure-labour choice. Maximum likelihood and bias-corrected regressions were used to get unbiased and consistent estimates of the participation and labour supply functions and the wage function.

Regarding the wage functions, the human capital earnings function was applied to the data. It was revealed that education affects growth in the wage earnings positively and significantly. When sample selection-corrected estimates of the earning function were used, a higher average rate of return on women's education was found (8%) compared with those obtained using conventional methods, and some evidence of sample selection bias was detected. But still these rates of return on human capital investment for females are lower than those one gets for males. Experience as defined by number of post-schooling years was not found to affect wage growth significantly. This result may be peculiar to the sample analysed, since data from other sources show that post-schooling experience significantly influences wage growth.

As for the labour force participation decision and labour supply, the study found that both are affected positively by predicted own wage and negatively by the spouse's predicted wage earnings. While market entry was positively and significantly correlated with a woman's years of education, and subsequently with the market wage rate, it appears that the amount of time a woman puts in labour market activities is determined largely by the earnings of her husband. The negative effect of the husband's earnings on the woman's labour supply may reflect the dominance of the income effect of the husband's wage change and also the substitutability of time of husband and wife in non-market activity. This negative effect of the husband's predicted wage on market hours appreciates in magnitude and significance when children are endogenized in the regression of conditional hours.

One striking result of the analysis is the effect of the presence of children on women's market participation and labour supply. When children are taken as exogenous, their effect is found to be small and marginally significant. Evidently, small children tend to discourage participation by a woman in market work (but this is only marginally significant), whereas older children encourage market work and their effect is definitely not significant. Since age is controlled for in the regressions, it was argued that the large and significant effect of age on market participation could also reflect the impact of children on women's market activity, since the presence of children is found to be positively linked with age. In fact, the inclusion of an instrumental variable for children gives a significant response coefficient of the latter and brings a drastic reduction in the response and significance of age on the probability of market participation.

Some further explanation for the minor effect of children's presence on market participation seems to be called for. The provision of child care and the ease of getting it could explain why children might not significantly deter a woman from market work. In the context of the traditional society within which the studied women live, I suspect that young women are more likely to be living with their extended families at the start of their marriage and can easily get help with child care from relatives. On the other hand, this result may be peculiar to the sample I studied and therefore analysis of other samples is required.

Another striking finding of this study is the strongly positive link between women's education and their market participation in urban Sudan. Obviously, the human capital investment in women through education increases their access to opportunities to work in market activities and raises their market productivity compared with home production. As the analysis has shown, a woman's wage is positively and significantly associated with her years of schooling, and the labour she supplies to the market responds positively to increases in the predicted wage offer. Also, as is found in studies of fertility and child health, an educated woman, with a higher opportunity value of time, tends to bear fewer children and to invest more in them through better education and health. Thus it would seem that inter-generational links in education of parents and their children persists. It should be noted that the impact of human capital investment on poverty and inequality are beyond the aims of this research and need to be addressed in a separate study.

Own-wage elasticities in magnitude of 2.2 to 2.4 were obtained, whereas a cross-wage elasticity of 0.65 to 0.90 is implied by the regression estimates. Though it is difficult to compare these estimates with findings of other studies, because of differing sample composition, coverage and selection, they are within the received empirical findings range. Compared with a study for urban India, for example, own-wage elasticity is higher, but as in the Indian study, the wage elasticity is higher in the generalized Tobit than in the standard Tobit estimation method.

In sum, the findings of this study imply that investment in women's education would lead to expansion of women's involvement in market activities, as education affects directly their decision to engage in market work, and has an indirect effect by its positive impact on market wage growth. Given that own-wage elasticity for participation largely exceeds the husband's cross-wage elasticity, a general wage rise that leaves men's to women's wage ratio constant is expected to lead to an expansion in women's labour market participation in urban Sudan.

Notes

1. The household production model deals directly with the allocation of time between market and home production activities, and the implications for labour supply when treated within the household framework (Becker, 1965). More recently, family labour supply behaviour has been treated in some studies (Schultz, 1990) in the context of bargaining models of family members (Manser and Brown,1980; McElroy and Horney, 1981).

2. The study presented in Maglad (1993, 1994) was conducted with financial support from Yale University and the Rockefeller Foundation; it studied household behaviour in terms of family size and investment in children.

3. The question of identifiability of an experience function arises, since most of the variables that might be suggested to influence experience also simultaneously determine labour supply. The experience equation I used included, in addition, such variables as other adult males, other adult females, household structure and lifetime migration.

4. Using the Migration and Labour Survey of 1991, the following semi-logarithmic wage function is estimated by OLS:

$$\begin{aligned} L_n \text{ Wife's Wage} = & -0.113 + 0.052^{*} \text{ Education} + 0.044^{*} \text{ Experience} \\ & (-1.15) \quad (8.35) \qquad\qquad (6.27) \\ & -0.0005^{*}(\text{Experience})^2;\ R^2 = 0.12,\ N = 654. \\ & (3.45) \end{aligned}$$

   Figures in parentheses are t statistics.

5. The likelihood ratio is used to test for the endogeneity of the variables. This ratio is defined as $LR = [L(w)/L(\phi)]$; $L(w)$ and $L(\phi)$ are, respectively, the likelihood values of the constrained and unconstrained models. It can be shown that -2 log (*LR*) is distributed as χ^2 with degrees of freedom equal to the number of constraints.

6. According to the 1993 Population Census, extended family households in urban Northern Sudan were 37.5% of total private households. Moreover, composite family households, which form a larger component that includes some relatives with/without

their spouses, amount to 14.6%. Other relatives constituted 13.5% of the total population in private households in urban areas. In rural Northern Sudan extended plus composite households amounted to 49.2%. The other relatives proportion of the total population of private households was 6.5% (Department of Statistics, 1996). The growth in the number of extended households relative to nuclear ones in urban areas in the 1990s can be attributed to the growing number of immigrants, displaced persons and refugees after the 1980s.

7. The wage function for men is estimated using the sample of working men only, since about 9% of the men in the sample are either retired or not working. Sample selectivity bias is corrected for by using maximum likelihood estimates, and the sample selection probit equation is identified by the family's landholding, adult males, adult females, lifetime migration and household assets. Of these variables only that for adult males is statistically significant and negatively related to probability of being employed. However, the selection-corrected maximum likelihood estimate of schooling returns was not found different when the conventional OLS method was used. The sample selection corrected estimate of the wage was:

$$L_n \text{ Husband wage} = \underset{(1.50)}{0.656} + \underset{(5.89)}{0.111}^{*} \text{ Education} + \underset{(3.11)}{0.058}^{*} \text{ Experience}$$

$$\underset{(2.62)}{-0.006^{*}} (\text{Experience})^2 \; ; \; \rho = \underset{(-0.99)}{-0.321};$$

N = 629. Figures in parentheses are the t ratios.

8. See Schultz (1980) for derivation.

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Appendix A: Selected historical labour data for Sudan

Table A1: Refined labour force participation rates (%), by sex and mode of living in Northern Sudan, 1983-1993

Mode of living and sex	1983[a]	1983[b]
Urban:		
Females	12.1	14.4
Males	69.2	68.4
Both sex	42.5	42.4
Rural:		
Females	34.7	34.5
Males	77.9	73.0
Both sex	55.0	51.8

Sources:
[a] 1983 Census: National Report, Summary Analysis and State Tables, Table 19 and 46.
[b] 1993 Census: Sudan Northern States, vol. 2, Table El and vol 1, Table P1.

Table A2: Females' age-specific refined activity rates (%) in urban Northern Sudan, 1983 and 1993

Age group	1983[a]	1993[b]
10 - 14	5.184.37	
15 - 19	8.77	8.72
20 - 24	17.93	14.70
25 - 29	18.15	21.31
30 - 34	14.87	23.18
35 - 39	13.01	19.64
40 - 44	14.00	19.56
45 - 49	13.21	18.00
50 - 54	14.25	16.29
55 - 59	13.13	13.41
60 - 64	13.98	13.57
65 +	10.34	10.4
10 +		
Not stated	9.26	-
All ages	12.1	-

Sources:
[a] 1983 Census: National Report, Summary Analysis and Statistical Tables, Table 46B.
[b] 1993 Census, Final Tabulations, Sudan Northern States, vol. 2, Economic and Social Characteristics, Table E1.

Appendix B: Selected results of model runs

Table B1: Instrumental variable estimates of children equations (t-value in parentheses)

Variable	Children < 6		Children 6-15	
Wife's education	-0.0125	(1.54)	0.0301	(-2.42)
Wife's age	-0.0933	(-6.28)	-0.1363	(5.98)
Wife age square ($x10^{-2}$)	0.0632	(3.91)	-0.1753	(-7.07)
Husband's wage	0.0062	(0.93)	0.0351	(3.43)
Husband's education	-0.0197	(-1.47)	-0.0743	(-3.61)
Husband's age	-0.0019	(-0.53)	-0.0049	(-0.91)
Asset	0.0002	(0.56)	0.0018	(3.66)
Other males	-0.0416	(-2.27)	-0.0949	(-3.38)
Other females	-0.0408	(-2.39)	-0.0553	(-2.11)
Household structure	-0.0294	(-0.33)	-0.0794	-0.58
Lifetime migrant	-0.0341	(-0.55)	-0.0599	(-0.63)
Constant	3.7977	(10.82)	-0.4465	(-0.83)
R^2	0.309		0.174	
F	29.10		14.28	
N	693		693	

Table B2: Ordinary least squares of the labour supply function (t-values in parentheses)

Explanatory variable	Hours		Hours	
Female's wage	281.0	(7.59)	280.5	(7.51)
Husband's wage	-8.697	(-3.20)	-8.714	(-3.20)
Asset ($x10^{-4}$)	-0.255	(-0.98)	-0.255	(-0.98)
Female's age	39.50	(3.60)	38.22	3.20
Female's age square $x10^{-2}$	-46.66	(3.78)	-45.71	(-3.46)
Children < 6			-11.80	(-0.38)
Children 6-15			1.349	(0.07)
Constant	-1087.	(4.26)	-1044.	(-3.72)
R^2	0.08		0.08	
F	14.4		10.3	
N	693		693	