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The Influence of Fertility and Household Composition on Female Labor Supply: Evidence from Panel Data on Tanzania

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Abstract

The influence of fertility on female labor supply has been studied extensively in Western societies, but little evidence is available in Sub-Saharan Africa. This article studies the impact of fertility on female time allocation to income-generating activities in Northern Tanzania. Because of the importance of extended households in African societies, we control for household composition and the position of women in their household. Possible endogeneity issues are addressed by estimating a first difference panel data model with instrumental variables. We find that the influence of fertility depends on the position of women in their household and the corresponding life cycle. Fertility has a negative effect for women who recently started their own household, but has a positive effect for women who had split off long before. We attribute this to the close relation between women's position in the household and their social status. With increased status women obtain more bargaining power, hence more possibilities to spend time on income-generating activities. Consequently, over time the income effect becomes stronger than the substitution effect, leading to a positive effect of fertility on labor supply. We also find that women's time spent on income-generating activities may be influenced by the number of older biological children, male adults, elderly and mother substitutes in the household.

1. Introduction

The link between fertility and female labor supply has been extensively studied in industrialized countries. There is, however, little evidence on this relationship in Sub-Saharan Africa. Most studies in Western countries have found a negative relation between fertility and female labor supply (e.g. Angrist & Evans, 1998; Uunk et al., 2005). This relationship, however, might be very different in Sub-Saharan Africa where household composition as well as intra-household labor division tend to be very different from Western settings.

First, in African societies households tend to have a complex and dynamic composition. When young adults find a partner, they often remain part of the household and only separate from the mother unit once they have sufficient earning capacity. At the same time, elder people may join the household of their children once they become unable to fulfill their own needs (Cox and Fafchamps, 2008). The importance of such extended households in African societies invalidates the assumption of nuclear households on which most Western studies are based. This is important as differences in the number of adults in the household may explain differences in labor supply. Having more male adults in the households, for instance, may lower the need of women to participate in the labor market (Hammel, 2005) whereas female adults may function as 'mother substitutes' increasing the possibilities of engaging in income-generating activities (Wong and Levine, 1992). When considering adult household members it may also be necessary to distinguish the elderly from other adults, who instead of contributing to economic activities, may actually increase the burden through their need of care (Blackden & Wodon, 2006). Moreover, in contrast to Western societies, not only adults contribute to economic activities, but children may be very important in supporting economic activities (Punch, 2001). Given the much larger variation in household composition in Sub-Saharan Africa and its possible importance for intra-household division of labor, it is necessary to control for this when analyzing the influence of fertility on female labor supply.

Second, African societies also differ from western societies in the social status and individual responsibilities that depend one's individual position in the household and the corresponding life cycle. With the status of women in Sub-Saharan Africa being highly dependent on motherhood (Bryceson, 1995; Mason & Taj, 1987; Mason, 2001), fertility is expected to strongly reduce female labor supply for women who recently split off from the mother unit and started their own household. However, with increased status women obtain more bargaining power and possibilities to

spend time on income-generating activities. Consequently, over time the effect of fertility on labor supply may reduce or even become positive.

Making use of the Kagera Health and Development Survey (KHDS), a panel data set that covers more than 900 households in the Northern region of Tanzania, we estimate the influence of fertility on female labor supply while controlling for household composition. According to our results, the expected negative relation is found only for a specific group of women: those who recently started their own household. Contrary to most empirical work, however, a positive effect of fertility on female labor supply is found for women who had become autonomous long before. We also find that household composition is important to understand female labor supply. An increase in the number of elderly in the household lowers the number of hours worked by women. Moreover, women's time spent on income-generating activities may be influenced by the presence of older biological children, male adults and mother substitutes in the household.

By studying the causal relationship between fertility and female labor supply this article also makes a methodological contribution on how to tackle possible endogeneity issues. As there are strong reasons to believe that labor supply and fertility are jointly determined, studies that present a causal interpretation based on mere associations of correlation are increasingly criticized. Disentangling the causal relationship requires more sophisticated analyses. Previous studies either have made use of instrumental variables with cross sectional data (e.g. Agrist and Evans, 1998) or have exploited the strengths of panel data (e.g. Heckman and Macurdy, 1980). In this article, we will combine panel data and instrumental variables, which allows us to benefit from the strengths of both and to tackle different sources of endogeneity.

The remainder of this article is structured as follows. In the next section, we will review existing literature and elaborate several hypotheses. In section three, we will explain the model and describe the data set and variables used. The results are presented in section four, after which the discussion and conclusion follow in a final section.

2. Insights from the literature and new hypotheses

There is a large literature that looked at the influence of fertility on female labor supply. A priori there is no reason to believe that this influence should be positive or negative. There may be two processes at work, each going in the opposite direction. First, child rearing is time consuming, and therefore women will have less time available to work; the so-called 'substitution effect'. On the other hand, an additional income might be required to cover the costs of raising children, also referred to as the 'income effect' (Iacovou, 2001). If the income effect outweighs the substitution effect the final relationship will be positive.

Nevertheless, most scholars have found a negative relationship, which indicates that the substitution effect is stronger than the income effect. For example, Bloom and colleagues (2009) made use of time series data (period 1960-2000) from 97 countries of all continents and found that each birth reduces a woman's labor supply by 1.9 years during her reproductive life. Gregory (1982) found similar results in the Soviet Union and Eastern Europe, using national aggregates in the period 1950-1977. Uunk et al. (2005) used panel data from 13 European countries and found that the first child leads to a reduction in weekly working hours of 2 to 20 hours, pointing to considerable differences across countries. They explain these differences by the institutional arrangements such as the provision of childcare. Angrist and Evans (1998) are two of the many authors who have studied the relationship in the US. They observe a reduction in the probability to work for women after having a third child.

Similar studies have been conducted in less-developed countries. According to Wong and Levine (1992) in Mexico young single and childless women have the highest labor force participation rates. After marriage, there is a sharp decrease and newlyweds with children are least likely to work. Chun and Oh (2002) found in Korea that having children reduces the female labor force participation by 27.5% and also in Indonesia it is shown that fertility reduces female labor (Kim & Aassve, 2006).

Little evidence exists on Africa, however. In this article we will make use of panel data from Northern Tanzania. We hypothesize that - similar to the above described studies - the influence of fertility on female labor supply will be negative (hypothesis 1).

To study this relation, however, we argue that because of the importance of extended households in African societies due attention needs to be paid to household cycle effects as well as the household composition. First, the household structure may exert an important influence on the intra-household division of labor. The composition of households has been given a significant role in economic theory since the 1960s (see e.g. Becker, 1965). The household structure is crucial for the internal division of labor. The presence of both older children and other adults may influence mothers' labor supply to income-generating activities, which we will test under the following hypotheses.

In many low developed countries older children contribute to the household economy, for example by fulfilling household duties (Punch, 2001). Therefore, we expect that the presence of older children will have a positive effect on female labor supply, as the woman will partly be relieved from the household tasks (hypothesis 2a). There may, however, be important differences between girls and boys, with girls being more involved in these tasks compared to boys. Girls may also be more productive at a younger age compared to their brothers (Hammel, 2005).

Also the number of adults in the household may exert an influence on female labor supply. In particular, the time spent on income-generating activities by women may reduce with more male adults (hypothesis 2b). At the same time, it may increase with additional female adults in the household who can share household tasks and act as so called 'mother substitutes' (hypothesis 2c). Whereas most studies in industrialized settings focus on formal child care arrangements, this is often not applicable in low income settings. A study in Mexico found that the presence of these mother substitutes increased the likelihood to participate in the labor market (Wong & Levine, 1992). When considering adult household members it may also be

necessary to distinguish the elderly from other adults, who instead of contributing to the household economy may actually increase the burden through their need of care (Blackden & Wodon, 2006). Thus, time spent on the care for elderly may directly compete with the time available for income-generating activities and a negative effect is hence anticipated (hypothesis 2d).

Besides household composition, the position of mothers in the household may be important as well. In particular, it may matter whether or not women are married and if they belong to an extended household. From the literature on life-cycle labor supply and household division of labor we know that in Western societies single women and men show little difference in time spent on income-generating activities. This changes dramatically after marriage. The biological advantage of women regarding child care (e.g. breast feeding) and their interrupted careers due to pregnancy makes that women specialize in home production, and men are mostly engaged in the labor market (Becker, 1985; Kooreman & Wunderink, 1997; Lord, 2002). This prominent role of marital status has been reproduced in studies on fertility and female labor.

However, it can be questioned whether in Sub-Saharan Africa it is really marital status that is the most important factor. In this region, marriage does not always coincide with leaving the parental home, as it is not uncommon for couples to stay with their parents (in law) for some time before starting their own household. Extended households are very common, especially in rural settings. They are found to act as safety nets and autonomy is postponed as long as the risk for income shocks remains too high (McElroy, 1985; Cox & Fafchamps, 2008). The responsibility of the extended household (including decisions about labor division) largely lies with the head of the household and his spouse(s). Hence, the position of women in the household (i.e. whether or not they are the (spouse of the) head) may be a more important determinant of female labor supply than marital status per se.

The position of women in their household may influence female labor supply in the following ways. First, with women's status largely depending on their

motherhood (Bryceson, 1995; Mason & Taj, 1987; Mason, 2001), women in rural Tanzania who recently started their own household will focus on the household tasks and their role as wife and mother, hence spend less time in income-generating activities (hypothesis 3a). Second, the position of women in their household may also interact with the effect of fertility. Because of the social status attached to motherhood in rural Tanzania it is expected that the substitution effect outweighs the income effect for women who recently started their own household. With increased status based on their motherhood, however, women obtain more bargaining power and access to social networks, and therefore more possibilities to spend time on income-generating activities. Consequently, over time the income effect might become stronger than the substitution effect, leading to a positive effect of fertility on labor supply. We will test this life cycle effect on the influence of fertility on female labor supply as hypothesis 3b.

3. Modeling the effects of fertility on labor supply

Most scholars have used cross-sectional data to study the influence of fertility on female labor supply. However, two types of endogeneity problems can arise. The first problem points to unknown time-invariant factors affecting both the number of children and labor supply (e.g. ability, preferences). This issue can be resolved by using panel data. We apply a first difference model, controlling for individual fixed heterogeneity. In particular, the following equation will be estimated.

$$\Delta y_{it,t-1} = \beta_0 + \beta_1 \Delta k_{it,t-1} + \beta_2 \Delta h_{it,t-1} + \beta_3 \Delta x_{it,t-1} + \beta_4 z_{it} + \varepsilon_{it} \qquad (1)$$

The change in the number of hours spent on income-generating activities (Δy) by woman *i* over time period *t,t-1* is determined by the change in the number of young biological children (aged 0-5 years) residing in the household (Δk), and the change in the household structure the woman lives in (Δh). x and z stand for two vectors of factors influencing the time allocation of woman i; Δx representing changes in

control variables over time, while the baseline attributes are symbolized by z. The error term ε corresponds to the non-systematic error.

Although this model resolves the endogeneity issue as explained above, it does not tackle possible endogeneity between the *change* in the number of children and the *change* in income-generating activities. Endogeneity may be the result of inverse causality or because of unknown factors affecting both the change in the number of children and the change in labor supply. To reduce the bias caused by this endogeneity we will make use of instrumental variables (IVs).

For the analysis we will make use of panel data from the Kagera Health and Development Survey (KHDS), which was originally conducted by the World Bank and Muhimbili University College of Health Sciences as a Living Standard Measurement Survey. The original sample consisted of 915 households who were interviewed four times: 1991, 1992, 1993 and 1994. In 2004 these households were re-interviewed. Of the original households, 877 were traced. These households were multiplied into 3,051 households as a result of marriage and separation. Thanks to intensive tracking activities, attrition was very low: over 90 percent of the households were re-contacted and 82% of the original individuals were re-interviewed (Beegle et al., 2007).[1] For this article the 1991 wave is used as a baseline to be compared to the 2004 wave.[2]

[1] Because of the original research objective in 1991, the sampling procedure of the KHDS favored high risk HIV/AIDS areas and households. Weights (as provided by the World Bank, 2004) are calculated based on the probability being selected. By weighting the results for each household, the outcome can be extrapolated to the whole population of the Kagera region.

[2] Including the additional waves 2 up to 4 does not add much variation to the model. In addition, some observations would be lost, due to missing values. Therefore, we focus on the first and last wave.

Constructing the dependent and independent variables

The dependent variable is defined as the change (between 1991 and 2004) in total number of hours spent per week on income-generating activities. The number of hours spent was measured in the week prior to the interview. Three types of income-generating activities are included: 1) own farm business (work on land and caring for own livestock); 2) own non-farm self-employment and 3) off-farm work as an employee. For each type of work the number of hours spent per day was recorded and summed up. Outliers above 84 hours a week are set at 84. Fertility is included in the model as the change (between 1991 and 2004) in the number of biological children, aged 0-5 years, currently living in the household. The estimated coefficient of this variable in equation 1 allows us to test hypothesis 1, which looks at the direct influence of fertility on female labor supply. In addition, as explained in the literature review, we argue that when studying the influence of fertility on female labor supply we should control for the position of women in the household as well as household composition.

To test the influence of household composition (hypotheses 2a, 2b, 2c and 2d) we include the following indicators: the change in the number of adult women (aged 15-64, excluding the woman herself and her biological daughters); the change in the number of biological daughters aged 10 and older (both variables are included as indicators of mother substitutes); the change in the number of adult men (aged 15-64); the change in the biological sons aged 10 and over; and the change in the number of elderly (65+).

To investigate the effect of women's position in their household (hypothesis 3a and 3b), we distinguish the following three groups. The first group is composed of women who were head (or spouse of the head) of the household in both 1991 and 2004. As such, they were already autonomous during the first wave of the survey. The second group refers to the women who were not yet head (or spouse of the head) of the household in 1991, but did occupy that position in 2004. The majority of

this group was a (grand)daughter of the head of household in 1991. As such, they have split-off from their original household, and started their own household somewhere between 1991 and 2004. This variable is strongly correlated with marital status, and therefore, marital status itself is not included in the model to avoid multicollinearity. Nearly 90 per cent of the first group was already married in 1991, while the large majority (72%) of the second group had not yet been married at that time. Women who were not head or spouse of head of household in both 1991 and 2004 make up the third group. To test whether there is any direct effect of the women's position in the household on their labor supply (hypothesis 3a) we add two dummy variables representing the three groups of women. To investigate the influence of women's position in their household on the influence fertility exerts on labor supply (hypothesis 3b) we will estimate specification 1 for the groups separately.

We also include several control variables. First, because of the importance of seasonal effects on labor supply we control for differences in the season in which the interviews were conducted (represented by X in equation 1). We distinguish three possible combinations: 1) in both years the interview was conducted in the dry season; 2) in 1991 the interview was conducted in the dry season, and in 2004 the interview was held in the wet season; and 3) the first interview was held in the wet season, and the last interview was organized in the dry season.[3]

Second, we control for relevant base-line attributes (indicated by Z in the equation). We incorporate age and age squared to control for life cycle effects. Third, as educational levels are considered to be an important predictor for both female labor and fertility (e.g. Joshi & Schultz, 2007; Wong & Levine, 1992), we include relative educational level in 1991, measured as the absolute difference to the mean number of years of education. As women in the age-group up to 20 years have not

[3] There are only very few cases (N=11) in which the interviews were held in the wet season in both years. These cases are deleted from the analyses.

necessarily finished their education yet, we construct the variable of education relative to their peers.[4] In addition, we include the tribe and religion of the head of household. We also control for the location of the respondent, distinguishing between rural and urban settings. Finally, consumption per capita in 1991 is included as a measurement of baseline poverty.[5] Several authors (e.g. Uunk et al., 2005; Rosenzweig & Wolpin, 1980; Eckstein & Wolpin, 1989) have shown that the household or husband's income is one of the major determinants of labor supply, as it may point to a need to work, especially if income is very low. We largely follow Beegle et al. (2008) in their measurement of consumption. The data come from an extensive consumption section, including both food and non-food items (for more detail see Beegle et al., 2008; and KHDS, n.d.). Contrary to Beegle and colleagues (2008), but in line with Collier et al. (1986) we correct consumption per capita per annum for the adult equivalent scale and household economies of scale.[6] To somewhat smooth the distribution of this variable we use the natural logarithm of this variable.

Instrumental variables

Instrumental variables are increasingly used to study the influence of fertility on female labor supply. At country level, Bloom et al. (2009) have made use of variation

[4] For each year of age (16 up to 20), a separate mean is computed. E.g. for 16 year old women, the educational level is compared to the average educational level of the other 16 year old females. For women above the age of 20, the educational level is compared to the overall mean for this age group (20+).

[5] Poverty and labor supply are strongly interlinked. However, it is highly unlikely that the change in the number of hours worked between 1991 and 2004 can influence the poverty status in 1991. Therefore, we consider consumption in 1991 as exogenous.

[6] Each household member is assigned a weight according to sex and age (based on calorie intake). These weights are summed up for each household, resulting in a measurement of the household size in adult equivalent units. Next, this score is multiplied by the average cost factor for a household with that many adults, as there may be economies of scale in e.g. housing, or the preparation of food.

in national abortion legislations as exogenous determinant of fertility. At micro level, twins and sex preferences have been exploited. Rosenzweig and Wolpin (1980) used the exogeneity of twin births to study the effect of an unexpected additional child on female labor supply. The rarity of the phenomenon, however, is considered an important limitation for this instrument. Sex preferences have proven to be a good alternative instrument as they may determine fertility, without directly influencing female labor supply. Generally, in most Western countries there is a preference for a mixed sex composition of the children. Consequently, having two children of the same sex increases the chance of having a third child (Angrist & Evans, 1998; Iacovou, 2001; Cruces & Galiani, 2007). In other countries a preference for sons is very common (Haughton & Haughton, 1998). According to Filmer et al. (2009) mothers in Sub-Saharan Africa tend to have a preference for sons. It is expected that this son preference will also be important in Tanzania, which is characterized by a patriarchal system. We will therefore use a dummy variable equal to one when a woman has at least one son in 1991.

We will also make use of the following four instruments. First, the number of biological children (of the women) residing in the household in 1991 is included. Having (many) children reduces the chance of getting more children. It can be argued that, even while this indicator reduces the probability for women to generate an income in 1991, it is unlikely that it directly influences the *change* in the number of hours worked. Second, we follow Munshi and Myeaux (2005) who found that individual reproductive behavior is strongly affected by social norms. We therefore include fertility rates at community level (measured as the average number of children ever born to women who were aged 40 or older in 1991). Finally, two instruments are used that measure the use of or access to contraceptives. In particular, we use the percentage of (married) women in the community who have ever used one or more modern contraceptives (in 1991) and the distance between the community and the closest dispensary in kilometers. The dispensary is the lowest level of the health system where, usually, contraceptives are available.

4. Results

Before presenting the regression results we present the data and some descriptive statistics of the variables used. Thereafter, we present and discuss the regression results with and without instrumental variables. Finally, we disaggregate the results for different samples.

4.1 The study area

Kagera is located in the North of Tanzania, bordering Uganda and Burundi. It is characterized by a diverse ethnic composition, partly due to the refugee flow from neighboring countries. The region is predominantly rural (Litchfield & McGregor, 2008). Tanzania has experienced rapid economic growth between 1994 and 2004, but poverty rates have declined only slightly, especially in the rural areas. Approximately one third of the inhabitants in Kagera live below the national poverty line (Beegle et al., 2008). Most women are involved in agriculture, working on the plots of land belonging to their families. Since the early 1970s Tanzanian women have experienced a boost in income-generating activities, particularly in the informal sector. Structural adjustment programs and economic crises have forced women to take up economic activities (Creighton et al., 1995; Tripp, 1989; Koda, 1995). This has not only led to an additional burden, but also improved bargaining power and independence.

To regulate population growth via fertility reduction, the Family Planning Association of Tanzania (UMATI) introduced family planning services in 1959, followed by a National Child Spacing Program and a five-year National Family Planning Program in the 1980s. Since that time, modern contraceptives have been made available country-wide (Hollos & Larsen, 1997). Despite these efforts, the country is characterized by low and only slowly increasing contraceptive use (approximately 20%) and consistently high fertility rates: 5.7 nationally and 6.7 in Kagera. Adolescent fertility is very high. In the lake region (including Kagera) 34.7%

of the women aged 15-19 years have started childbearing (which is considerably higher than the national figure of 26%) and the median age at first birth is 19.1 years (NBS & ORC Macro, 2005).

4.2 Data and descriptive statistics

To estimate equation (1), we include all women older than 15 on whom we have information on fertility and economic activities in both the 1991 and 2004 waves. As explained in the literature review and further elaborated upon below, an important variable to include is the position of the woman in the household.

The group of women in the sample is quite diverse. Table A1 in the Appendix shows the descriptive statistics of the major characteristics. The average age in 1991 was 23.4 years with a range from 16 to 45, reflecting different phases of the life cycle. The average number of biological children living in the household (all ages) was 1.5 in 1991 (standard deviation 1.8), with a range of zero to nine. Over 41% had no biological children at all. The average number of children increased to 2.8 in 2004 (standard deviation 2.0), with only 13.8% being childless. The average number of biological children living in the household aged 0-5 years is just under one in both years (standard deviation 0.9).

Table 1 presents descriptive statistics on female labor supply. We observe that the number of hours spent on income-generating activities has increased over the two time periods from 19.5 to 24.3 hours per week on average (see Table 1). Approximately one sixth of the women do not spend any time on income-generating activities. Own farm business is by far the most important activity, especially in 1991. For example, only 4.7% of the women have spent time on own non-farm business and less than 8% worked as an employee in that year. The figures of 2004 display a slightly more diversified picture.

A first glance on the bivariate relationship between fertility and total labor supply shows mixed results. Women with many children (four or more) in 2004, work on average 21.2 hours a week, considerably less than the 26.1 hours a week for

women with fewer children (maximum three). A t-test shows that this difference is significant at the 10% level (t value is 1.81; one-sided p-value of 0.072)[7]. However, a Pearson's correlation coefficient between the change in the number of young children (between 1991 and 2004) and the change in the number of hours worked shows no obvious relation (correlation coefficient is 0.065 with a two-sided p-value of 0.178).

Table 1: Average number of hours spent by women on three types of income-generating activities, in 1991 and 2004

	1991					2004				
		Including all		Excluding non workers			Including all		Excluding non workers	
	% not performing this type of activity	Mean	St. Dev.	Mean	St. Dev.	% not performing this type of activity	Mean	St. Dev.	Mean	St. Dev.
Own farm business	21.0 %	17.1	13.8	21.6	12.0	30.4 %	15.1	13.9	21.8	11.5
Own non-farm business	95.3 %	0.9	5.7	19.0	19.1	82.9 %	5.3	16.2	30.9	27.4
Work as employee	92.1 %	1.6	7.5	19.8	19.1	85.3 %	3.9	12.1	26.6	19.9
Total	18.7 %	19.5	15.1	24.0	13.2	16.8 %	24.3	19.3	29.2	17.4

Source: KHDS; N = 428; own calculations

4.3 OLS and 2SLS compared

This lack of correlation is not confirmed by the OLS regressions as presented in Table 2.[8] The difference between models A and B is the additional control in model B for the position of the woman in the household. Regarding this dimension, three groups are distinguished. First, those women who were not yet at the head of their household in 1991 (i.e. they were not 'autonomous'), but have gained that position somewhere between 1991 and 2004. A second group refers to women who were already the head or spouse of head of household in 1991; a third group with women

[7] Weights have been applied in this analysis.

[8] As we have multiple observations within communities (46 communities are included), the error term will be correlated within these communities. Therefore, robust standard errors are calculated in all regressions.

who were not autonomous in 2004 and have never been before. Two dummy variables are used with the second group as reference category. The results of model B indicate that women who have started their own household between 1991 and 2004 have reduced their labor supply in comparison with women who became autonomous before 1991. This provides evidence for hypothesis 3a.

Regarding the influence of fertility we observe that whereas the estimated effect of a change in the number of small children is not significantly different from zero in model A, when controlling for the position of the woman in the household (model B) this coefficient becomes significant at the 5% level. Contrary to expectations, this effect is positive: an increase in the number of small children leads to an increase in the number of hours worked. This rejects hypothesis 1 and suggests that the income effect is larger than the substitution effect.

With respect to the other variables, we observe that household structure also exerts a direct influence on labor supply. The regression results from model B show that an increase in the number of daughters residing in the household aged ten or older results in a decrease of the number of hours worked by the mother. This rejects hypothesis 2a, according to which daughters would act as mother substitutes, leading to a positive effect on female labor supply. A possible explanation for the observed negative influence on labor supply is that these children are engaged in income-generating activities themselves, which lowers the need for women to work (on child labor in Tanzania see for example Beegle *et al.*, 2005). Sons do not appear to have the same effect, which points to a gender difference in the contributions made to the household economy. The effect of older daughters, however, is only present when we control for the position of the mother in the household, and is therefore not robust.[9]

[9] Previous studies have found that sons are more invested in, expressed in higher school enrolment, whereas girls have a larger chance to be withdrawn from school in case of need (e.g. Meena, 1996; Ota & Maffatt, 2007).

Table 2: Estimating the change in the number of hours spent by women on income-generating activities, between 1991 and 2004 (pooled models).

	OLS estimates		IV (2SLS) estimates	
	(A) Coef. (Robust S.E.)	(B) Coef. (Robust S.E.)	(C) Coef. (Robust S.E.)	(D) Coef. (Robust S.E.)
Change children < 6 yr	3.176	5.604**	8.386***	10.309***
	(2.299)	(2.284)	(2.663)	(2.829)
Change daughters aged 10+	-2.854	-4.061**	-1.717	-3.470*
	(2.033)	(1.925)	(2.255)	(1.899)
Change sons aged 10+	-1.827	-.416	-2.781*	-.628
	(2.405)	(2.383)	(1.666)	(1.866)
Change male adults (15-64)	-2.463	-2.144	-2.700	-2.361
	(1.973)	(1.981)	(2.047)	(2.002)
Change female adults (15-64)	3.380*	-.077	5.003***	-.063
	(1.707)	(2.278)	(1.630)	(2.128)
Change elderly (65+)	-10.790**	-14.335**	-11.185**	-16.199***
	(5.099)	(5.408)	(5.576)	(5.836)
Position in HH[a] (autonomous in both years = ref)				
Not autonomous in 1991, autonomous in 2004		-21.291**		-27.573***
		(9.051)		(10.344)
Not autonomous in 1991 and 2004		.380		3.701
		(7.804)		(8.196)
Constant	-72.773	-19.628	-101.330*	-30.154
	(56.415)	(64.073)	(56.185)	(60.394)
N	428	428	428	428
F	34.33	15.82	48.17	16.37
Prob > F	.000	.000	.000	.000
R-squared	0.4690	.5097	.4240	.4810
Under identification test (Kleibergen-Paap rk LM stat)			7.329	8.335
Chi-sq. p-value			.0256	.0155
Weak Identification test (Wald F statistic)			12.487	16.056
Over identification test (Hansen J statistic)			1.666	1.888
Chi-sq. p-value			.1968	.1695

Source: KHDS; own calculations

*** $p < .01$ ** $p < .05$ * $p < .1$

Controlled for age and age squared (1991); relative educational level (1991); Ln consumption (1991); location (rural, urban) in 1991; religion in 1991; tribe in 1991; and time of interview (dry or wet season during the interviews) in 1991 and 2004.

[a] Autonomous = head or spouse of head of household

Instruments incorporated: number of children in 1991; contraceptive use in community

We find no effect for the change in the number of male adults (hypothesis 2b). The results from model A do confirm the expected effect of a change in the number female adults (hypothesis 2c). The positive effect supports the idea of mother

substitutes. However, these effects disappear in model B. We also observe a significant effect of a change in the number of elderly: an increase in the number of elderly in the household is negatively related to female labor supply. This confirms hypothesis 2d: the care for elderly competes with the time available to women to dedicate to income-generating activities.

Models C and D in table 2 show the two staged least squares (2SLS) estimations, using instrumental variables. In this model, the effect of a change in the number of young biological children is considerably larger. One increase of one child leads to an average increase of more than eight hours per week spent on income-generating activities. Most other variables show similar results as the OLS models.

To test whether our main variable of interest – change in the number of pre-school aged children – is endogenous, an endogeneity test is performed. Because we use weights and robust standard errors, we test endogeneity using a method numerically equal to a Hausman statistic (Baum et al., 2007). The null hypothesis, which states that the regressor can be considered exogenous, is rejected, validating the choice for instrumental variable analysis.

We also tested for redundancy in selecting the appropriate and relevant instruments for each model, as using a large number of instruments may deteriorate the finite sample performance and hence lead to less reliable estimations. Only two of the five instruments were retained in models C and D (number of children in 1991 and contraceptive use in the community in 1991).[10] All test statistics support the validity of the use of these two instrumental variables.

In particular, we tested whether the instruments used are correlated with the endogenous regressors making use of the Kleibergen-Paap test for under-

[10] The number of children residing in the household in 1991 is strongly correlated with the son preference instrument. It does not seem to lead to any multicollinearity problems. Moreover, male preference does not seem to be relevant in any of the models. According to Filmer et al. (2009) mothers in Sub-Saharan Africa generally do have a subjective preference for sons, but it does not influence actual fertility behavior.

identification. The null hypothesis states that the equation is under-identified. The statistic rejects the null hypothesis, confirming that the models are well identified. The weak instruments test statistic tests the null hypothesis that the estimator is weakly identified and therefore subject to bias. As we use robust standard errors, the reported Wald F statistic is based on the Kleibergen-Paap test (Baum et al., 2007). As the reported statistics in these models rejects the null hypothesis (and is far above the rule of thumb of 10) it can be concluded that there is no weak instruments problem. Finally, the Hansen J statistic tests whether the instruments are uncorrelated with the error term. The statistic in these models are far from rejecting its null hypothesis, strengthening the idea that the instrument set is appropriate.

4.4 The position of women in the household: additional model specifications

As argued before, controlling for the position women occupy in their household in terms of being or not the (spouse of the) head of the household) is important when studying female labor supply in Sub-Saharan Africa because of corresponding life cycle effects. Besides a direct effect of women's position in the household on female labor supply (hypothesis 3a) there may also be an indirect effect, through its interaction with fertility. In particular, with the status of women in Sub-Saharan Africa being highly dependent on motherhood, fertility is expected to strongly reduce female labor supply for women who recently started their own household. However, over time women obtain more status and bargaining power, hence more possibilities to contribute to income-generating activities. As this strengthens the income effect relative to the substitution effect, it reduces the effect of fertility on labor supply or may even make its effect positive (hypothesis 3b).

To test this hypothesis, we run equation (1) for the two categories of women separately.[11] The first category represents those women who were not yet at the head of their household in 1991, but have gained that position somewhere between 1991 and 2004. In the tables they are referred to as 'not autonomous in 1991'. The women who were already the head or spouse of head of household in 1991 (and still in that position in 2004) are categorized as 'autonomous in 1991'. Table A2 in the Appendix presents descriptive statistics of these two groups. Overall, the first group is unmarried, slightly younger and has fewer children in 1991, compared to the second group. The first two columns in Table 3 present the OLS estimates.

There is a striking difference in the effect of small children on female labor supply. The positive sign that we observed in the pooled models is now only apparent for the second category ('autonomous in 1991') whereas the positive sign has changed into a significant negative sign for the first category.[12] An increase in the number of small children leads to a decrease in the number of hours worked for the latter group. For the first category, all other effects are driven into insignificance. For the second category, most estimated coefficients are (slightly) larger than the OLS estimates of the pooled model (model B in Table 2). Changes in the household composition appear to be very relevant. The increase in the number of older biological daughters and the number of elderly in the household still shows a

[11] The third group of women consists of only 57 observations, which is too few to run a separate model. We decided to regress separate models because including interaction terms in the 2SLS models deteriorates the IV tests. In addition, splitting up the model into separate models gives a clear picture of the differences between the groups.

[12] To test whether the two groups of women have equal parameters for fertility and intercept, we performed the Chow-test. We regressed an OLS model including an interaction term between fertility (change in the number of children under the age of six) and the position of the woman in the household. The estimate of the interaction term is significant at the 1% level (coefficient of -11.898 and robust standard error is 4.096). The null hypothesis of the Chow-test is rejected (F is 4.48 and Prob>F is 0.017) implying that the two groups of women do not share the same intercept and slope of fertility (Chow, 1960).

significant negative effect. In addition, an increase in the number of male adults leads to a decrease in the number of hours worked. This provides support for hypothesis 2b. Contrary to the pooled model in Table 2, we find no longer any evidence for the effect of mother substitutes (hypothesis 2c).

Table 3: Estimating the change in the number of hours spent on income-generating activities by women, between 1991 and 2004 (estimates of subsamples)

	OLS estimates		IV (2SLS) estimates	
	Not autonomous in 1991 Coef. (Robust S.E.)	**Autonomous in 1991 Coef. (Robust S.E.)**	**Not autonomous in 1991[a] Coef. (Robust S.E.)**	**Autonomous in 1991[b] Coef. (Robust S.E.)**
Change children < 6 yr	-5.501*	9.383***	-14.289***	10.602***
	(3.115)	(2.421)	(4.402)	(2.927)
Change daughters aged 10+	-12.659	-3.079*	-14.495**	-3.063*
	(8.628)	(1.730)	(7.355)	(1.607)
Change sons aged 10+	2.444	-.183	4.016	-.057
	(5.935)	(2.231)	(5.565)	(2.029)
Change male adults (15-64)	-1.455	-10.593**	-.166	-10.766***
	(2.316)	(4.491)	(2.245)	(4.135)
Change female adults (15-64)	3.316	.764	2.030	.612
	(3.400)	(2.446)	(3.326)	(2.401)
Change elderly (65+)	-2.715	-21.597***	-1.379	-22.072***
	(7.324)	(6.116)	(6.272)	(5.835)
Constant	21.900	-39.420	111.144	-41.294
	(158.631)	(95.997)	(162.583)	(87.218)
N	185	186	185	186
F	17.28	158.28	18.27	87.70
Prob > F	.000	.000	.000	.000
R-squared	.4385	.7491	.3877	.7476
Under identification test (Kleibergen-Paap rk LM stat)			16.166	10.906
Chi-sq. p-value			.0010	.0276
Weak Identification test (Wald F statistic)			23.098	37.232
Over identification test (Hansen J statistic)			.304	4.667
Chi-sq. p-value			.8592	.1978

Source: KHDS; own calculations

*** $p < .01$ ** $p < .05$ * $p < .1$

Controlled for age and age squared (1991); relative educational level (1991); Ln consumption (1991); location (rural, urban) in 1991; religion in 1991; tribe in 1991; and time of interview (dry or wet season during the interviews) in 1991 and 2004.

[a] Used instruments: number of children in 1991; fertility rate in community; distance to dispensary

[b] Used instruments: number of children in 1991; fertility rate in community; distance to dispensary; contraceptive use in community

Table 3 also shows the instrumental variable (2SLS) estimates for the two groups. We observe that effects are stronger after applying 2SLS. An increase of one young biological child in the household leads to an average *reduction* of over 14 hours per week spent on income-generating activities for the first group. For the second group, however, this leads to an *increase* of the time spent on income-generating activities of 10.6 hours per week. Similar to the pooled model, the change in the number of preschool aged children is found to be endogenous in both models. Again, the three tests in both models give no reason to doubt the instrument sets.[13] Together these results confirm hypothesis 3b.

4.5 Robustness checks and testing alternative options

To test the robustness of the effects found we briefly discuss the estimation results of alternative specifications. The results are presented in the Appendix. First, as most previous studies used samples with only married women, it is interesting to analyze whether our results remain robust to limiting our sample to married women. Table A3 in the Appendix presents the regression results when only taking into account women who were married in 1991, regardless of their position in the household. Although some of the coefficients and standard errors are slightly different compared to the second model in Table 4, the main effect of the change in the number of young children remains unchanged.[14]

[13] A potential limitation of 2SLS analysis is the finite sample bias. LIML (limited-information maximum likelihood) is considered a better alternative as the finite-sample performance is superior to the standard 2SLS (Baum et al., 2007). Applying LIML does not change the outcomes, as the effects (both the coefficients and robust standard errors) as well as the IV-tests are very similar.

[14] In Tanzania, polygamy is practiced. Although we control for the change in the number of other adult women, it could be argued that the position of the woman in a polygamous marriage might be different from a monogamous marriage. However, in our sample polygamy is practiced in less than five per cent of the households and will therefore not affect the results.

Second, in our analyses so far we took female-headed households together with households in which the spouse is present. Although we have accounted for changes in the number of male adults, it is useful to check whether our results are robust to excluding female-headed households from the sample. Table A4 in the Appendix shows the results. No notable differences are found with the models presented before.[15]

Third, following Cain and Dooley (1976) it is plausible that non-working women respond differently to determinants of labor. In particular, women who worked before getting children are more likely to return to their job after giving birth. To investigate this, we test whether our results remain robust to excluding women who did not work in 1991. Although some estimates change slightly, the effect of preschool aged children remains significant (see Table A5 in the Appendix).

Finally, it can be argued that the effect of fertility is dependent on the type of income-generating activity, as some (e.g. on-farm activities) may provide an easier match with the care of the children than other types of economic activities. In the analyses so far we did not distinguish among different types of economic activities. The data set allows us to identify the following three types of work: own farm business, own non-farm business and off-farm work as an employee. As shown in the descriptive results, the largest share of time spent on income-generating activities is dedicated to own farm business. Table 4 provides an overview of the results of the main effect of the change in the number of young children on the time spent on the different types of income-generating activities. Running the analyses for these three different types of activities separately we observe that the results shown above are mainly the result of the combination of own farm and non-farm business. The negative effect of fertility on female time allocation on income-generating activities of the first category of women ('not autonomous in 1991') is driven into insignificance if

[15] Due to the low number of observations (N=73), an analysis including only the female headed households is undesirable.

we only focus on own farm business. The negative effect as found before is therefore mainly caused by the own non-farm activities undertaken by these women. The lack of significant effects in some models can well be due to the low level of variance. For example, 78.7% of the women in the sample did not show any change in time spent on work as an employee between 1991 and 2004. It is therefore difficult to make firm conclusions on the lack of any effect in these models.

Table 4: The influence of fertility on different types of female labor

	Pooled model	Not autonomous 1991	Autonomous in 1991	% score 0 on dependent variable (no change between 1991 and 2004)
Employee	0	0	0	78.7 %
Own farm business	+	0	+	10.5 %
Own non-farm business	0	-	0	80.3 %
Own business (farm + non-farm)	+	-	+	8.1 %
All types of work	+	-	+	6.2 %

0 = not significant (at 10 % level); - = significant negative ; + = significant positive

5. Discussion

In this article, we studied the link between fertility and female labor supply in Tanzania, estimating a first difference panel data model with instrumental variables. Whereas in industrialized countries, a negative correlation has been consistently shown, the outcomes of our study provide a different picture. Including all women in our sample, we observe that the number of biological children of pre-school age residing in the household exerts a positive influence on the mother's labor supply, measured as the number of hours spent on income-generating activities. However, as we expect a strong influence of this dimension on the intra-household labor division and a possible interaction with the effect of fertility on labor supply, we split up the

sample in two different categories of women: one category that recently started their own household; the other category consisting of women who had split off from the mother unit long before.

Estimating regressions separately for both categories, we observe that the influence of fertility on female labor supply has opposite signs. For women who recently started their own household we observe a negative relation, which is consistent with most existing empirical work. In contrast, for women who had become autonomous long before, we find a positive effect of fertility on female labor supply. We attribute this to the close relation between women's position in the household and their social status. Young women who recently split off from the mother unit have a lower status and bargaining power than those who have become autonomous long before. With the status of women in Sub-Saharan Africa being highly dependent on motherhood, it is not surprising to observe that fertility strongly reduces female labor supply for women who recently started their own household. With increased status, however, women obtain more bargaining power hence more possibilities to spend time on income-generating activities. Consequently, over time the income effect becomes stronger than the substitution effect, leading to a positive effect of fertility on labor supply.

Additionally, we noticed that household composition matters in explaining changes in the time spent on income-generating activities. In particular, we found that women's time spent on income-generating activities may be influenced by the number of older biological children, male adults, elderly and mother substitutes in the household.

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Appendix: Descriptive statistics and additional regressions

Table A1. Descriptive statistics

	Mean/percentage	St.dev.	Min.	Max.
Change in number of hours worked	4.764	24.749	-66	84
Change children < 6 yr	.096	1.428	-4	4
Position in HH				
Autonomous in 1991 and 2004	43.5%			
Not autonomous in 1991, autonomous in 2004	13.3%			
Not autonomous in 1991 and 2004	43.2%			
Change daughters aged 10+	.346	.845	-3	4
Change sons aged 10+	.535	.949	-4	4
Change male adults (15-64)	-.379	1.072	-4	4
Change female adults (15-64)	-.939	1.367	-7	3
Change elderly (65+)	-.103	.596	-2	2
Age (1991)	23.386	6.602	16	45
Age squared (1991)	590.372	344.706	256	2025
Relative educational level (1991)	-.164	2.793	-7.07	6.09
Ln household consumption (1991)	11.814	.591	10.31	13.75
Location (0=urban; 1=rural) in 1991	83.9%			
Religion of head of household				
Muslim	14.3%			
Catholic	57.9%			
Protestant	20.8%			
Other	7.0%			
Tribe of head of household				
Mhaya	54.7%			
Mnyambo	14.3%			
Mhangaza	15.2%			
Other	15.9%			
Time of interview				
Dry season in 1991 and 2004	35.0%			
Dry season in 1991, wet season in 2004	27.1%			
Wet season in 1991, dry season in 2004	37.9%			
Number of children in 1991	1.498	1.842	0	9
Childless women in 1991 (%)	41.36 %			
Number of biological children in HH in 2004	2.822	1.999	0	9
Childless women in 2004 (%)	13.79 %			
Number of biological children 0-5 yrs in HH in 1991	.871	.968	0	4
Number of biological children 0-5 yrs in HH in 2004	.967	.948	0	4
Son preference (dummy = 1 if at least one son in 1991)	42.3%			
Fertility rate in 1991 (community variable)	7.198	1.443	4.10	10.29
Contraceptive use in 1991 (community variable)	9.828	8.332	0	35.29
Distance to dispensary in 1991 (community variable)	5.822	6.705	0	30.00

Source: KHDS; own calculations; N=428

Table A2. Two groups compared

		Not autonomous in 1991	**Autonomous in 1991**
Age (in 1991)	Range	16-39	17-45
	Mean	19.81	27.54
	St.dev.	4.69	6.30
Number of biological children residing in HH in 1991	Mean	0.45	2.80
	St.dev.	0.90	1.91
Change in the number of children aged 0-5 between 1991 and 2004	Mean	0.85	-0.66
	St.dev.	1.31	1.22
Number of hours worked in 1991	Mean	16.72	21.66
	St.dev.	14.69	14.64
Number of hours worked in 2004	Mean	24.41	24.20
	St.dev.	21.77	16.36
Change in the number of hours worked between 1991 and 2004	Mean	7.69	2.54
	St.dev.	26.29	22.19
Marital status in 1991	Married/partner	13.51 %	90.31 %
	Separated/divorced	10.81 %	1.08 %
	Widowed	3.24 %	7.53 %
	Never married	72.44 %	1.08 %
	Total	*100.0 %*	*100.0 %*
Marital status in 2004	Married/partner	79.99 %	74.20 %
	Separated/divorced	7.57 %	8.06 %
	Widowed	7.03 %	17.74 %
	Never married	5.41 %	0.00 %
	Total	*100.0 %*	*100.00 %*
N		185	186

Table A3: Estimating the change in the number of hours spent by married women on income-generating activities, between 1991 and 2004. IV (2SLS) estimates.

	Coef. **(Robust S.E.)**
Change children < 6 yr	11.918***
	(3.540)
Change daughters aged 10+	-2.759
	(1.755)
Change sons aged 10+	.381
	(1.986)
Change male adults (15-64)	-6.136**
	(3.045)
Change female adults (15-64)	-1.501
	(2.428)
Change elderly (65+)	-16.917***
	(5.466)
Constant	-6.385
	(82.028)
N	211
F	109.52
Prob > F	.0000
R-squared (centered)	.7258
Under identification test (Kleibergen-Paap rk LM stat)	11.289
Chi-sq. p-value	.0235
Weak Identification test (Wald F statistic)	42.814
Over identification test (Hansen J statistic)	4.374
Chi-sq. p-value	.2238

Source: KHDS; own calculations

*** $p < .01$ ** $p < .05$ * $p < .1$

Controlled for age and age squared (1991); relative educational level (1991); Ln consumption (1991); location (rural, urban) in 1991; religion in 1991; tribe in 1991; and time of interview (dry or wet season during the interviews) in 1991 and 2004.

Instruments incorporated: number of children in 1991; fertility rate in community; distance to dispensary

Table A4: Estimating the change in the number of hours spent by women on income-generating activities, between 1991 and 2004. IV (2SLS) estimates, female headed households excluded

	Pooled model[b]	**Not autonomous in 1991[c]**	**Autonomous in 1991[d]**
	Coef.	**Coef.**	**Coef.**
	(Robust S.E.)	**(Robust S.E.)**	**(Robust S.E.)**
Change children <6 yr	11.475***	-16.225**	8.658***
	(2.975)	(6.490)	(2.699)
Change daughters aged 10+	-5.360	-22.429**	-4.828*
	(3.308)	(7.468)	(2.491)
Change sons aged 10+	1.497	-.908	3.919
	(2.602)	(4.701)	(3.469)
Change male adults (15-64)	-1.288	1.445	-11.125**
	(2.110)	(2.238)	(4.384)
Change female adults (15-64)	-.269	2.614	-2.769
	(1.980)	(3.803)	(2.601)
Change elderly (65+)	-15.847***	5.018	-20.752***
	(5.782)	(5.372)	(5.166)
Position in HH[a] (autonomous in both years = ref)	-	-	-
Not autonomous in 1991, autonomous in 2004	-27.890***	-	-
	(10.382)		
Not autonomous in 1991 and 2004	6.985	-	-
	(9.744)		
Constant	-50.803	-21.008	-2.002
	(69.515)	(164.775)	(116.810)
N	333	145	131
F	36.33	12.36	367.37
Prob > F	.0000	.0000	.0000
R-squared (centered)	.5099	.3918	.7869
Under identification test (Kleibergen-Paap rk LM stat)	9.900	9.687	11.856
Chi-sq. p-value	.0017	.0214	.0185
Weak Identification test (Wald F statistic)	35.965	13.447	122.921
Over identification test (Hansen J statistic)	-[e]	.069	7.961
Chi-sq. p-value		.9660	.0468

Source: KHDS; own calculations

*** $p < .01$ ** $p < .05$ * $p < .1$

Controlled for age and age squared (1991); relative educational level (1991); Ln consumption (1991); location (rural, urban) in 1991; religion in 1991; tribe in 1991; and time of interview (dry or wet season during the interviews) in 1991 and 2004.

[a] Autonomous = head or spouse of head of household

[b] Instruments incorporated: number of children in 1991

[c] Instruments incorporated: number of children in 1991; distance to dispensary; fertility rate in community

[d] Instrument incorporated: number of children in 1991; distance to dispensary; fertility rate in community; contraceptive use in community

[e] As we only included one instrument the Hansen J statistic cannot be calculated.

Table A5: Estimating the change in the number of hours spent by women on income-generating activities, between 1991 and 2004. IV (2SLS) estimates, excluding women who did not work in 1991

	Pooled model[b]	**Not autonomous in 1991[c]**	**Autonomous in 1991[d]**
	Coef.	**Coef.**	**Coef.**
	(Robust S.E.)	**(Robust S.E.)**	**(Robust S.E.)**
Change children < 6 yr	9.712***	-10.973**	9.180***
	(3.441)	(4.786)	(3.257)
Change daughters aged 10+	-2.819	-3.114	-2.582*
	(1.752)	(6.399)	(1.491)
Change sons aged 10+	-.758	11.620**	.796
	(2.525)	(4.968)	(2.648)
Change male adults (15-64)	.250	.929	-8.698*
	(2.051)	(2.401)	(4.512)
Change female adults (15-64)	-.512	-2.555	.311
	(2.526)	(2.490)	(2.729)
Change elderly (65+)	-14.730**	-7.250	-20.879**
	(5.972)	(4.969)	(8.083)
Position in HH[a] (autonomous in both years = ref)	-	-	-
Not autonomous in 1991, autonomous in 2004	-32.035**	-	-
	(13.085)		
Not autonomous in 1991 and 2004	-.528	-	-
	(8.233)		
Constant	.856	211.155	-55.916
	(65.379)	(147.957)	(81.393)
N	348	145	155
F	25.20	32.55	45.08
Prob > F	.0000	.0000	.0000
R-squared (centered)	.4125	.4819	.6802
Under identification test (Kleibergen-Paap rk LM stat)	8.773	14.436	10.069
Chi-sq. p-value	.0124	.0024	.0393
Weak Identification test (Wald F statistic)	16.781	31.808	64.305
Over identification test (Hansen J statistic)	2.490	2.423	6.272
Chi-sq. p-value	.1145	.2977	.0991

Source: KHDS; own calculations

*** $p < .01$ ** $p < .05$ * $p < .1$

Controlled for age and age squared (1991); relative educational level (1991); Ln consumption (1991); location (rural, urban) in 1991; religion in 1991; tribe in 1991; and time of interview (dry or wet season during the interviews) in 1991 and 2004.

[a] Autonomous = head or spouse of head of household

[b] Instruments incorporated: number of children in 1991; contraceptive use in community

[c] Instruments incorporated: number of children in 1991; distance to dispensary; fertility rate in community

[d] Instrument incorporated: number of children in 1991; distance to dispensary; fertility rate in community; contraceptive use in community