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Fertility, Agricultural labour Supply and Production - Instrumental Variable Evidence from Uganda

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ABSTRACT

Fertility is likely to affect agricultural production through its effect on the supply of agricultural labour. Using the fact that in traditional, patriarchal societies sons are often preferred to girls, we isolate exogenous variation in the number of children born to the mother and relate it to agricultural labour supply and production outcomes in Uganda, a country that combines a dominant agricultural sector with one of the highest fertility rates in the world. We find that fertility has a seizable negative effect on household labour allocation to subsitence agriculture. Households with lower fertility devote significantly more time to land preparation and weeding, while larger households grow less matooke and sweet potatoes. We find no significant effect on agricultural productivity.

INTRODUCTION

At the most basic level, subsistence farmers in rural Africa combine natural with human resources to make a living. They use mainly household labour on their own small plots to produce for own consumption. As such, the quantity of family labour available for agriculture is an important determinant of well-being. More children means mothers, and to a lesser extend fathers, will need to spend more time on reproductive chores, meaning less time will be available to spend on agricultural activities. Since women are known to supply most of the agricultural labour the loss in time needed for reproductive activities may hurt subsistence households disproportionately.

Uganda has one of the highest fertility rates in the world. Even in the context of large reductions in child mortality rates, total fertility rates remain stubbornly high. On average, Ugandan women in rural areas bear 6.8 children over the course of their reproductive lives (UBOS, 2013). At the same time, a substantial part of the population lives in rural areas making a living out of semi-subsistence agriculture. Ugandan agriculture accounts for about 35 percent of GDP and employs about 73 percent of the of the active labour force. Virtually all households that reside in rural areas are engaged in farming, and about 80 percent are small scale semi-subsistence farmers. The question on how fertility affects well-being through its effect on household labour supply and agricultural production is therefore relevant. For example, knowledge on how fertility affects time allocation by different categories within the household is important to gender-stream efforts related to crop intensification and commercialization.

In this study, we will investigate the effect of fertility on agricultural production at the household level. In particular, we will investigate the effect of the number of biological children on household member labour input in agriculture (further categorized in land preparation, weeding, input application and harvesting). We will also look at the effect of fertility on crop portfolio, area cultivated, production and productivity for the five most important crops. However, fertility is a choice variable to agricultural households. For instance, mothers who work long hours in the field may try to avoid becoming pregnant because this would only increase hardship. If fertility, agricultural labour allocation and agricultural production is jointly determined, just looking at correlations will be misleading, and one needs to find a way to separate the exogenous variation from the part that is jointly determined.

Our identification strategy is a simple but powerful quasi-experimental approach inspired by the work of Angrist and Evans (1998). We use the fact that, in conservative, patriarchal societies such as

Uganda, male off-springs are generally preferred to female children. This preference and the random nature of the sex of a newborn gives rise to particular fertility patterns. For example, households that have a girl as the first-born are likely to have more children (Jayachandran and Kuziemko, 2011). In other words, we use the sex of off-springs as an instrumental variable (IV) to determine the exogenous component of fertility at the household level. Such a Two Stage Least Squares (2SLS) approach is expected to yield consistent estimates for the causal effect of fertility on agricultural labour supply and associated agricultural production within the household.

There is an active debate among scholars in the field of labour economists on the relationship between fertility and labour supply. Angrist and Evans (1998) use the fact that American couples prefer children of different sex, and and are likely to keep trying if the first two children are of the same sex as a source of exogenous variation. We will argue that in a developing country context, the sex of the (first born) child makes more sense as an instrument. Indeed, this instrumentation strategy has been used in such a context. Gupta and Dubey (2006) use the sex of the first two children to predict exogenous variation in fertility in India and its effect on well-being. We feel it is too ambitious to relate fertility directly to poverty and related measures of consumption, as the sex of the first two children may directly affect consumption, violating the exclusion restriction. We restrict ourselves to agricultural labour allocation of adult household members, area planted and production. In addition, most studies that look at the effects of fertility on labour allocation in a developing country context use data from Asian countries. The high incidence of selective abortion in these areas may mean the sex of the first child or children becomes endogenous as well. This is likely to be much less of a problem in our application, which is to our knowledge the first such application to an African country.

We find that the sex of the first-born, the sex of the first two children born, as well as the percentage of girls as a share of total number of children all significantly explain observed fertility, measured as the gap between actual children born and a theoretical maximal fecundity for each age cohort. Fertility has a strong negative effect on number of days worked by the mother in the field. We also find some evidence of a negative effect for the father, but the size of the effect is only half that of the women. Households with lower fertility devote significantly more time to land preparation and weeding. We also find that smaller households grow and produce more matooke. This effect holds to a lesser extent for sweet potatoes. We find no impact on yields.

This article is organized as follows. The next section gives a brief overview of the most prominent papers that are related to our study. Then, we make our case for the use of the sex of the first-born as an instrument using literature that documents child gender and reproductive behaviour. We then present the data we will use in our application, and describe our main variables we will use in the analysis. Next, we present the results. In this section, we first take a close look at the first stage regression. We then look at the effect of fertility on household labour supply, considering differential effects depending agricultural labour activities. We then turn to the effect of household size aspects of agricultural production and productivity. A final section concludes.

RELATED STUDIES

Fertility and the related concept of household size impacts household well-being trough consumption and production. Lanjouw and Ravallion (1995) focus on the consumption side effects of household size in a developing country context. They note the contradiction between widely held views that larger households are often poorer (due to increased competition for a given food stock) and scale economies in consumption. They find that, if economies of scale are accounted for within households, the negative correlation between household size and consumption expenditure disappears. On the production side of the farm household, the effect of household size is equally ambiguous. Some may argue that larger households means that more labour is available within the household. The additional advantage of this labour is that it is not subject to the moral hazard effects often attributed to hired labour[1]. But at the same time, more dependents within the household means more time needs to be allocated to reproductive activities. Also, agricultural labour and agricultural production may be subject to diminishing returns.

The relationship between fertility and household labour supply has been studied most carefully in the field of labour economics. Since this literature is so extensive, we only mention two of the most influential works here. The first is Angrist and Evans (1998), who attempt to quantify the effect of fertility on labour supply in the US. They deal with the endogeneity of the number of children women have by exploiting the fact that Americans tend to prefer mixed sibling-sex in their household. They argue that parents of same-sex siblings are significantly and substantially more likely to go on to have an additional child. They find that more children does indeed reduce labour force participation of women, but the effect is less pronounced than previous studies suggested. They find no effect on the labour supply of the father.

Another paper that tries to answer the same question is Rosenzweig and Wolpin (1980a). In this

[1] For instance, Feder (1985) argues this may the reason why small farms appear to be more efficient than large farms

paper, the exogenous variation in the number of children is obtained by using the occurrence of multiple births (twins) at first birth as an instrument. The authors argue that the comparison between women who gave birth to a single child at first birth and women who gave birth to twins at first birth allows one to identify the causal effect of an extra child on an outcome (in their case labour supply). Since the occurrence of twins is exogenous, there is no danger that heterogeneity in women preferences contaminates the estimated coefficients. The study finds that household size reduces female labour supply, but the effect is only temporary[2].

Gupta and Dubey (2006) use sex of the first two children as a natural experiment and find that household size increases poverty in India. They use essentially the same argument as we will make in the next section. However, welfare, and the related concept of poverty, relies on consumption per capita. Consumption per capita as the independent variable is likely to be problematic in the two stage least squares setting. There is a real danger that the instrumental variable affects the outcome variable directly, instead of only through its influence on family size. For instance, if boys consume on average more than girls, the exclusion restriction is violated. There is also some evidence on Indonesia. Kim et al. (2009) looks at the relation between consumption and fertility. In Kim and Aassve (2006), fertility is related to the allocation of labour within households. However, they move away from the direct instrumental variable approach that is standard and instead estimate a reproduction function taking into account endogenous contraceptive choice.

All the above studies employ data from South East Asia. It is well-known that fertility at birth is already skewed in many Asian countries. For instance India, from which Gupta and Dubey (2006) drawn their sample, is particularly known for selective abortion of girls (Jha et al., 2011). This non-random distribution of sex of children opens the door to potential correlation between the instrument and the error term of the structural equation. One example would be that less educated, poorer households that depend heavily on agriculture engage more in the abortion of female fetuses. In the context of weak instruments, such correlation can seriously bias estimates (Bound et al., 1995).

In this paper, we will try to address some of the above challenges. We will use the sex of the first-born and variations thereof as our instrumental variables. We will relate fertility to agricultural labour supply and agricultural production, since there is a direct link between these three variables. We will also concentrate on Africa. Here, while there is a boy preference, reproduction rate norms are high and the cost

[2]In addition to studies that investigate the causal effect of household size on (female) labour supply, there are also a range of papers that test Becker's quantity-quality fertility model (Becker, 1960; Becker and Lewis, 1973). Many of these articles also use twins (Rosenzweig and Wolpin, 1980b; Black et al., 2005) and/or sibling sex composition (Conley, 2000; Angrist et al., 2010).

of raising children is low. This means that selective abortion is much less of a concern.

BOY PREFERENCE AND FERTILITY

There is quite some evidence that parents prefer boys over girls in many developing countries[3]. For instance there is a large body of literature that looks at correlations between sex and variables related to well-being or quality of children. Significant differences in these outcomes are then considered proof of sex bias. Das Gupta (1987) and Sen (1990) look at excess mortality among female infants in India. Chen et al. (1981) and Pande (2003) investigate differential access to health, in Bangladesh and India respectively. Behrman (1988) and Hazarika (2000) find a correlation between sex and nutrition and Behrman et al. (1982), Davies and Zhang (1995) and Alderman and King (1998) all investigate correlations between the gender of children and education.

However, at a more basic level, boy preference is already revealed by parents who, if asked in for example surveys, often state clearly that they prefer boys to girls. Such preferences lead to a particular decision rule with respect to fertility, where the likelihood that children are added to the household is positively correlated to the number of surviving girls in the household. The preference for boys over girls results in what Jayachandran and Kuziemko (2011) refer to as the "stop-after-a-son" fertility pattern. There are indeed many studies that show empirically that in settings with characterized by son preference, a couple that just had a son is more likely to stop having children (Das, 1987) or wait longer to have the next child (Trussell et al., 1985; Arnold et al., 1998; Clark, 2000; Drèze and Murthi, 2001).

Jayachandran and Kuziemko (2011) argue that son preference leads mothers to breastfeed daughters and children without brothers relatively less long. Since breastfeeding is an effective birth control method, this observed behaviour also explains why couples with a son seem to wait longer before they have the next child. In addition, this underlying consequence of sex bias may partly explain a range of outcomes observed in the area of health, mortality and possibly even educational attainment. Their model shows that even when parents want both boys and girls to have the same health and education, disparities can arise passively because of fertility preferences. They show that a "try until you have a boy" fertility rule results in girls having on average more siblings, leading to more competition for resources within the household.

The occurrence of boy preference is explained by various cultural and economic factors documented

[3] In developed countries, there is a preference for a mix of sexes among children, as shown in, for example Angrist and Evans (1998).

in the anthropological and demographic literature. In countries where no formal, risk free old age insurance (such as a pensions) is available, parents may choose to invest more in children that have a higher chance of being able to support them at old age (Behrman et al., 1982). Anthropological and demographic evidence emphasize the dominant role of males in traditional patrilineal societies where descent and inheritance are transmitted through the male line. Furthermore, male children strengthen the relationship between the wife and her husband's kin (by guaranteeing the continuation of his lineage) and secure (the mother's) access to residence and inheritance upon the husband's death. Older women have power through their sons and rule over their daughters-in-law (Kandiyoti, 1988). The spread of primary schooling in sub-Saharan Africa has also affected fertility patterns (Lloyd et al., 2000). Since boys are more likely to be sent (and kept) in school than girls, the extra cost associated with primary schooling will be higher in families with more boys. This, in turn, will encourage families who already have boys to reduce fertility.

Most of the evidence on the existence of boy preference comes from Asian countries. There are relatively few inquiries into sex preference in Sub Saharan Africa. Even more, it is often assumed that gender preferences are much lower or even absent in Sub-Saharan Africa. This is surprising, as many of the cultural and economic factors that are observed in Asia equally apply to Africa. One study that documents significant gender bias in Africa is Anderson and Ray (2010), who find skewed sex ratios at older age in favor of men. Another study in a small community on Nigeria reports almost 90 percent of respondents report male sex preference (Eguavoen et al., 2007). What is different from the Asian context, though, is that the vast majority of women are not missing at birth, but throughout the entire age spectrum[4]. Milazzo (2012) argues that gender bias is likely not to be found at birth in the African context where high fertility is culturally valued and less costly for families that still rely on the support from the extended family system. In Uganda, preference for boys has been extensively documented in Beyeza-Kashesya et al. (2010).

Even in Western societies, preference for the first-born to be a son has been observed. For example, Marleau and Saucier (2002) report an extensive list of studies that find men and/or women prefer a boy rather than a girl as their first-born. Even in the United States, the Angrist and Evans (1998) provides some evidence of an association between having a male child and reduced childbearing at higher parities, in addition to the mixed-child preference. As such, we feel that the sex of the first-born (or closely related indicators) provide a valid instrument for fertility at the household level in Uganda.

[4]The large effects documented in Anderson and Ray (2010) have recently been attenuated in Klasen and Vollmer (2013), who confirm only missing young adult women.

DATA AND DESCRIPTIVE STATISTICS

We will use the Uganda National Household Survey (UNHS) 2005/06. While being somewhat dated, we have chosen this survey because it has much more information on agriculture than the more recent UNHS of 2009/10, or 2012/13. Structured with a standard Living Standard Measurement Survey - Integrated Survey on Agriculture (LSMS-ISA) in mind, the UNHS 2005/06 collected detailed information on a sample of almost 43,000 people in 7,500 households in Uganda.

Ideally, we would like to have a sample of households where all desired children were born. The fact that we are working with a cross-section of households, where households are at different stages in their reproductive lives, creates some problems. Assume a couple that has just formed and is entering their reproductive stage. In our sample, such households will show up with a smaller than average household size. Now, if the first-born happens to be a girl, this may mistakenly be interpreted as running against our hypothesis that households where the first-born is a girl have higher fertility. On the other hand, if the first child is a boy, this may lead us to put too much confidence in our hypothesis, as the smaller household size is not only due to the fact that the first-born is a son, but also due to the fact that the household only just entered their reproductive stage. The fact that we are working with a cross section of households rather than historical data on all births by women that have reached the end of their reproductive lives is also reflected in the average number of children. This is only 3.13 children, while women bear almost 7 children over their entire reproductive period.

To deal with this problem, we work with the difference in the actual number of children reported and the maximum reproductive capacity for a woman at a certain age, rather than simply the number of children in the household[5]. We will refer to this measure of fertility as the gap or shortfall in fertility. To get the latter, we would need to estimate the average age at menarche within the population, and then simply divide into age the pregnancy period plus post pregnancy lactation in-fecund period. In addition, one would also need to corporate the maternal mortality ratio for "censoring" women's lives who have too many children and thus increasing her mortality rate (and exit from the sample). Instead, we took the 95th percentile of total fertility rates per age from the Demographic and Health Survey of Uganda (2011). This is probably a good approximation of the upper bound by age of fertility in the population.

The selection of children is base on the household roster of the UNHS 2005/06. In particular, we

[5] Alternatively, one could use the number of children within the household and control for the age of the mother. We have also run the analysis using this strategy and came to virtually the same conclusions.

will select individuals that are indicated as son or daughter of the household head. There is another potential problem when using a cross sectional survey such as the UNHS that only looks at reported dependents currently living within the household to calculate the difference between actual and theoretical fertility. Older women may be living in households where some of the older children have already left the household. Thus, at around the age of thirty, the gap between reported children in the household and theoretical fertility starts to increase more rapidly because of children growing old enough to start household of their own. More troubling, the reported gender of the oldest son or daughter living in the household may not be the gender of first-born. To overcome this problem, we restrict our sample to households where the mother is between 16 and 32. The cut off age of 32 is because at this age, the first-born of the mother will turn 16, which is our entry age into the sample of mothers. Restricting our sample in this way has a second advantage. For some of the indirect outcome variables we will use, such as productivity, one may argue that the gender of the first-born has a direct effect on the outcome, instead of only through fertility. Restricting our sample to households with only young mothers means that the children are also likely to be younger, and thus less likely to engage in agricultural production, making a violation of the exclusion restriction less likely.

Looking at the sex of the first-born is only one possible strategy. One may argue that the sex of the first born is not very relevant in a context where women bear on average almost 7 children. Indeed, it is likely that households will get a second child irrespective of the sex of the first. This is supported by Jayachandran and Kuziemko (2011), who find that the difference in breastfeeding duration between boys and girls is largest near target family size, when gender is most predictive of subsequent fertility. Therefore, we will not only use the sex of the first-born child as an instrument for fertility, but also experiment with alternative instruments such as an indicator that the first two children are girls or a variable that expresses the share of female children in the total family size. The next section presents some preliminary statistics that suggest how gender patterns in the household are related to fertility.

Gender of Offspring and Fertility

In this section, we make a case for the different instruments we will use in the analysis. While we will run first stage regression in the next section, we present some simple descriptive statistics here to show that gender of the first few children, as well as the share of male children in the total number of children, affects fertility. Table 0.1 summarizes our findings. The first two columns in the top panel checks if households that have a daughter as first-born are more likely to have extra children. We simply calculated the percentage of households that had more than one child conditional on their first born being a son or a girl. In other words, we calculate the probability that a household has at least one additional child (prop +1). We find that in the sub-sample where the first child is a boy, about 37.46 percent of households will have at least one more child. However, if the first child happened to be a girl, almost 40 percent of households will have at least one more child. This confirms our hypothesis that households have a higher chance of adding children if the firstborn is a girl.

We also look at the the effect of the gender of the first-born on shortfall in actual fertility to theoretical fertility. In the first two columns in the bottom panel, we report this fertility gap for these two groups of households. We find that households that have a boy as the first-born child have an average fertility gap of about 2.46 children. Consistent with the proposition that households that have a first-born girl are likely to have more children conditional on age, we find that the gap is smaller than the first-born is a girl (2.26). In other words, households where the first-born is a girl will be closer to the theoretical maximal fertility than those that had a boy as the first-born. The difference in the fertility gap between the group of households with a first born boy and a first born girl is significant (p=0.003).

The third and fourth column present the same statistics, but now looks a the sex of the first two children. We now look three possible scenarios. If the first two children are both boys, we expect that the chance that they have extra children will be lowest. We find the probability of adding children in this case to be just over 13 percent (top panel). If the first was a girl and the second was also a girl, we expect the probability to have additional children to be highest. In this case, there is indeed an almost 14 percent chance that they add at least one child to the household. For those that had a first girl but their second child was a boy, we expect the probability of increasing household size to lie between the two, which is indeed the case. The lower panel shows that the gap between actual and potential household size is also largest when the first two children are boys. The gap is smallest when the first two children are both girls. All this again confirms our proposition that boy preference affects fertility.

Finally, in columns 5 and 6, we propose the share or female children in the total number of children as a potential instrument. As already stated above, because of boy preference, female children are likely to live in larger families and so we expect a positive correlation between this measure and household size. For now, we simply divide the sample in two, conditional on whether more or less than half of the children are female. We find that the average number of children is indeed smaller in the sub-sample where less than half of the children are girls as opposed to the sub-sample where the majority are girls (top panel, 2.78 children as opposed to 2.88). We also find a difference in the fertility gap that is significant with associated p-value of 0.021 (bottom panel). Households where girls are in a majority are closer to the theoretical maximal household size.

Agricultural Labour Supply

In this section we will briefly look at some descriptive statistics on labour supply in agriculture, one of the prime pathways through which fertility is likely to affect productivity and well-being. Most of Uganda has two cropping seasons. The first runs from January to June. The second cropping season is from July to December. The UNHS 2005/06 interviewed households twice over the course of one year to capture this feature. It visited households in the beginning of 2005 to capture the second cropping season in 2004 (that is, running from July to December 2004). Households were revisited at the end of 2005 to record information from the first cropping season in 2005 (running from January to June 2005). In our study, we will only consider the 2004 July to December cropping season, as data for labour allocation in agriculture was unavailable for the 2005 cropping season.

Figure 0.1 shows time reported on the field along different dimensions[6]. Women seem to do most of the work, and child labour is restricted to about one day per crop and activity during the entire season[7]. This already indicates that the trade-off between the time lost by the mother because of rearing the children and the time gained by extra hands is likely to work against agricultural production. Typical for Uganda is the low amount of time spent on applying inputs. Farmers in Uganda use very limited amounts of fertilizer and other inputs, so also the time spend on applying them is small. There is also some heterogeneity in the time spend on different crops. For instance, matooke is allocated less time than maize, both for men and for women. However, there are also difference between the sexes. For instance, women spend much more time cultivating sweet potatoes, and to a lesser extent beans, than men.

[6]The dimensions are mother, father or child; land preparation, input application, weeding and harvesting; and crop. The crops are the five most widely grown crops in Uganda.

[7]While the relationship between fertility and child labour is an important research question, we will not consider this in the present study. Reported child labour seems small in Uganda. More importantly, the instruments we propose in this study (gender of first born child/children and sex composition of children within the household) are likely to directly influence days worked in agriculture by the children, instead of only through fertility, risking to violate the exclusion restriction.

Production

We also investigate the effect of fertility on production of some of the most important crops. More in particular, we look at the effect of fertility on the likelihood that a household cultivates each of the five most important crops. The first row in table 0.2 reports on the percentage of households that grow each of the crops. Over 50 percent report growing maize, beans and cassava. We also look at the impact on area cultivated, measured in acres. Households on average allocate about half an acre to maize. The least space is reserved for sweet potatoes. We also express area cultivated as a share of total area under cultivation. We find that about 17 percent of total land area is allocated to maize, while only 8 percent is allocated to sweet potatoes. The next line reports average production in kilograms at the household level. This may seem low, but this because households that report not to produce the crop are also part of the average. We also divide by household size. Finally, we report yields for the five crops, defined as the amount of each crop harvested per unit of land (per acre).

We also aggregate the different corps by weighing them to average prices. We use prices from FoodNet. In particular, we average prices observed in Kampala's Nakawa market over the July to December 2004 period. Doing so, we find that the average total value derived from these five crops is about UGX98,500, which translates to about UGX45,000 per capita[8]. About 40 percent of the households in their reproductive age does not cultivate any of these five crops. On average, about 0.69 acres is allocated to these five crops. The yield per acre is about UGX220,220.

RESULTS

In this section, we present the results of our two-stage least squares estimates that look at the causal impact of fertility on various agricultural related outcomes. We start by presenting the first stage regression that regresses the our proposed instruments on the fertility gap. We then give a detailed description of the second stage regression that focuses on the effect of fertility on agricultural labour supply. We also explore the effect of fertility on area planted, production and productivity.

[8]UGX stands for Ugandan Shillings, the national currency. At the time of the survey, USD1 = UGX1,780.

The first stage regression

Results for the first stage regression that link sex of first child/children to fertility are reported in table 0.3. The dependent variable, as explained above, is the difference between the maximum number of children of a typical woman at her age and the actual number of children born from the mother[9]. We refer to this as the fertility gap (*fgap*) or fertility shortfall. It actually is the reverse of fertility, as the higher the gap, the lower the number of children in the household in a given age cohort. Apart from the exogenous variable that is excluded from the second stage regression elaborated in the next sections, we include a series of control variables that are clearly exogenous to fertility in all 4 specifications of the first stage. The first exogenous control variable, *femhead,* is a an indicator variable that takes the value of 1 if the household head is female. The second, *urban*, is an indicator variable that takes the value of 1 if the household resides in an urban area[10]. Next, we include three dummies to account for the education level of the mother. *mprim* take the value of 1 if the mother has completed primary eduction. *msec* is the additional effect of having completed secondary education. *mthird* is the additional effect of the mother having completed tertiary education. The comparison category are therefore households where the mother did not complete at least primary education. We also add two community variables which are likely to influence household size. These are *school* which is a dummy variable that takes the value of one if there is a school in the village, and *health,* which is a dummy that takes the value of one if there is a public health centre or clinic in the community. Finally, we also add an indicator (*cdied*) that takes the value of one if a son or daughter of the mother has died in the past.

We experiment with four different possible excluded instruments. Model (1) uses an indicator that takes the value of one if the first-born in the household is a girl as an excluded instrument (*oldestgirl*). The coefficient is significant at the one percent level and has the expected sign. Having a girl as the first-born offspring reduces that fertility gap by about 0.2 children. In other words, households that have a girl as a first-born tend to be closer to maximal fecundity. For the controls, we find that households where females are the head have a significantly larger fertility gap. The effect is very large, suggesting such mothers have more than 1 child less. Also in urban areas, households seem to have significantly less children. Schooling of the mother seems to reduce the number of children only at secondary and tertiary level. There seems

[9]The maximum number of children has been estimated from the DHS and is actually the 95th percentile.

[10]In some specifications where we expect regional variation in the outcome variable to be important, such as for production and yields for certain crops, we also include dummies for the four regions in both the first and second stage equations. This addition did not significantly change other estimated parameters in the first stage.

to be some indication that mothers that completed primary education have a slightly smaller fertility gap than mothers that did not even complete primary education. The community variables do not seem to have an effect on the fertility gap. Finally, having lost a child in the past leaves a significant additional fertility gap compared to households that never lost a child. However, the additional gap is much lower than one, suggesting a substantial replacement effect in Ugandan fertility. The constant indicates that the overall average fertility gap is about two children.

Model (2) uses an indicator that equals one if the first two children born to the mother in the household are both girls as excluded instrument (*2oldestgirls*). Using this instrument only makes sense if we confine ourselves to households that have at least two children, hence the reduction in the sample size. As in (1) the parameter on the excluded instrument is significantly negative, in line with our hypothesis. The control variables are very close to the what they were in model (1). Model (3) goes one step further and considers the first three children. In this case, the indicator, *3oldestgirls* is one only if the three first children are all girls. This again only makes sense in households that have at least three children, further reducing the sample size. The coefficient estimate is again negative, but this time it is not significant anymore. We assume that the reduced sample size in this model may have reduced the power of the t-test too much.

Model (4) uses a continuous variable as an excluded instrument (*percentfemales*). We calculated the share of girls among children as a share of the total number of children in the household. Again, the coefficient on this instrument has the expected sign. A higher share of females within the households is associated with a smaller fertility gap. This is consistent with Jayachandran and Kuziemko (2011), who observe the “try until you have a boy” fertility rule leads to an outcome where larger households have on average more girls. Again, the other variables are similar to the previous models. We find that an all female siblings household (*percentfemales* = 1) will be on average 0.28 children larger than an all boys siblings household (*percentfemales* = 0).

While most of our instruments are significant and have the expected sign, they explain only a small part of the variance in the outcome. When all exogenous controls are included, the R-squared is indeed rather low. If we run partial regressions, regressing the excluded instruments one by one on the dependent variable, the R-square drops below 1 percent. The F-value of a regression with only excluded instruments, another important indicator of the strength of the instruments according to Bound et al. (1995), also drops to 9.46[11]. In other words, we have serious concerns that our instruments are weak. We therefore use inference

[11] As a rule of thumb, it is often stated that one has weak instruments if this F-statistic is smaller than 10.

that is robust to weak instruments. In particular, we rely on the Anderson-Rubin test statistic to gauge the significance of the endogenous variable in all subsequent regressions (Staiger and Stock, 1997).

Household labour supply

We now turn to the effect of fertility on total household adult labour supply (table 0.4). We will also look at labour supply separately for the mother and the father (table 0.5). We will also look at labour supply by activity (table 0.6).

In table 0.4, we investigate the effect of our main variable of interest, the fertility shortfall, on the number of days worked in agriculture (land preparation, input application, weeding and harvesting)[12]. The first column of the table reports the result without taking into account endogeneity of number of children. It reports Ordinary Least Squares (OLS) estimates that explain the number of days adults reported to have worked on the household farm in the 2004 agricultural season. Agricultural work is defined as work related to land preparation, input application, weeding and harvesting. We see that there is no significant correlation between the number of days worked and fertility as measured by the fertility gap. We do find significant and negative effects of the household being headed by a female (*femhead*) and the household being located in an urban area (*urban*). Primary and secondary education of mothers (*mprim* and *msec*) does not seem to be systematically related to the number of days worked in agriculture, but mothers that finished tertiary education (*mthird*) appear to work less in agriculture. The OLS estimates also show positive correlations between a school in the community (*school*) and days worked in agriculture and between a deceased child in the past (*cdead*) and days worked. There is also some indication of a positive correlation between health centers in the community (*health*) and days worked.

Models (2) to (4) estimate the same models, but instrument the fertility gap with a single excluded instrument. In model (2), the instrument is an indicator taking the value of one if the first-born is a girl. The coefficient on the fertility gap now becomes positive and significant at a 10 percent level, implying that higher fertility (and hence a shrinking fertility gap) causes a reduction in the number of days worked on the family fields. Model (3) uses the sex of the first and second born as instruments for the fertility gap. Model (4) uses the share of daughters as an instrument. The estimate of the fertility effect becomes higher, and is now significant even at a 1 percent significance level.

[12]We have also done this analysis using days worked per acre of land held by the household. However, since average land holdings are about 1.1 acre and there seems to be no systematic relationship between farm size and labour supply, the results are very similar.

Finally, model (5) uses both the gender of the first-born and the share of daughters as the excluded instruments[13]. According to the Hansen-J statistic, our model that uses multiple instruments is valid (Hansen-J=0.849; p-val=0.357). We thus assume this is the best specification. Each additional child causes a reduction of about 66 days of labour in agriculture. With respect to the other variables in the regression, we find some signs that households with women that have finished tertiary education appear to be less engaged in agriculture.

In table 0.5, we differentiate between work done by the mother and the father. For the sake of space, we only show the coefficient on the fertility gap, but we also added the exogenous control variables that were also included in the first stage regression. Full results can be found in the appendix. The top panel in table 0.5 shows the effect of fertility on time worked in agriculture by the mother. The OLS estimate is not significant (model (1)). Accounting for endogeneity of fertility using the exogenous variation caused by the sex of the first-born renders the fertility gap significant at a 5 percent level (model (2)). An increase in the fertility gap per age cohort by one child leads a mother to work almost 30 days more in subsistence farming. Cycling through the results with the alternative instruments, the results change little with respect to significance. In all, an additional child seems to reduce number of days worked by the mother in agricultural production by about 40 days. Full results are reported in table 0.9.

In the first column of the second panel, we report the same OLS regression but with the number of days worked by adult males as the dependent variable. As is the case with female labour, the fertility gap does not seem to be correlated to male layout supply when we do not take into account the endogenous nature of fertility choices. Table 0.10 in the appendix gives full results and the OLS results are in the first column. We find that residing in urban areas leads farmers reporting less days worked on the field. We also find a large negative effect of female headedness on days worked on agriculture related activities by the male. This is because, in most cases, households are headed by females because the male head is missing, leading to less days reported on the field. We also find some evidence of males working less if the mother has higher eduction. This is most likely because higher educated men choose higher educated women to marry and the other way around.

Judged by the instrumental variable models from (2) to (5) the effect of fertility on labour supply by the father is less clear cut. When using the sex of the first born (model 2) and the sex of the first two children born (model 3) as instruments, the coefficient is positive but not significantly different from zero. If

[13]We use Limited Information Maximum Likelihood (LIML), as this is known to have better small sample properties than 2SLS in overidentified models with weak instruments (Angrist and Krueger, 2001).

we instrument the fertility gap using the percentage of females, we find some indication that more children may reduce time allocated to working on the field my males. The effect, however, is only half the size of the reductions found for women. The over-identified model in model (5) shows a significant effect at the 10 percent level only. These findings are similar to what others have found. For instance, in their study on labour supply response to fertility in the United States, Angrist and Evans (1998) also find that women work less while men do not alter their labour supply in response to more children. Kim and Aassve (2006) find that women reduce their working days in response to the higher fecundity in both rural and urban areas in Indonesia.

Table 0.6 looks at reported labour by activity instead of by sex. Again, the results reported in table 0.6 only show the coefficients on the fertility gap. Full results are in the appendix. Model (1) in the top panel presents OLS results for number of days worked on land preparation. There are no effects from fertility in this specification. Again, as expected, households residing in urban areas spend significantly less time preparing land. Female headed households also allocate less time to land preparation. There is also some indication that women that have tertiary education are less engaged in land preparation.

Model (2) presents the same model, but instruments fertility with the indicator for the first child being a girl. The fertility effect now becomes positive, but is not significantly different from zero. In model (3), where we look at the sex of the first two children, the fertility gap effect becomes significant. The effect remains significant when we instrument the fertility shortfall by the percentage of females born (model (4)) and in the over-identified model (5), but the effect size reduces. An additional child reduces time allocated to land preparation by about 25 days.

The second panel repeats the same five models, but uses days spent on input application as the dependent variable. In none of the five specifications, fertility seems to have a significant impact. Overall, time spend on input application is very limited anyway, as can be seen in figure 0.1. In all, households spend only about one day applying inputs (including planting). The only significant effect we find is that households where the mother has at least primary education allocate more time to input application (table 0.12).

The third panel presents results for time spend on weeding. The results are similar to the ones for land preparation, but the effects are smaller. Each extra child reduces time allocated to weeding by about 20 days. Full results in the appendix (table 0.13) show significant negative effects for female headed households and for households in urban areas. We also find that communities that have a health center are spending less days on weeding. Finally, the last panel looks at the effects of fertility on days worked for harvesting. There is no significant positive association between the number of children in the family and the number of days spend harvesting if we use only our binary instrument. We find a positive effect if we instrument the fertility gap by the share of girls among siblings, but the effect is small compared to the other effects.

The above suggests that fertility affects time allocated to land preparation and weeding in a negative way. Harvesting seems to be less related to family size. Probably, when crops are ready to be harvested, farmers are more likely to put in the extra effort. This seems to be less evident for work that has an uncertain payoff in the future, such as weeding. The reductions of time allocated to land preparation and weeding may reduce both area planted and agricultural productivity. We will turn to this in the next section.

Area planted, Production and Productivity

We will now look at the effect of fertility on production and productivity. We will look at productivity defined as kilograms harvested per acre of the five most important products separately. We will also look the value of total production, the value of production per acre and the value of production per capita.

Table 0.7 reports on the second stage regressions of different aspects of production for the five most important crops. The table only reports the results for the coefficient on the fertility gap for the instrumental variable regression that uses the share of girls as excluded instrument. The regressions include the same control variables as in the previous sections. However, we now also added regional dummies, as some crops are grown more in some regions than in others. If the dependent variable is binary or censored, a tobit or probit is estimated using the methods described in Newey (1987).

The first row looks at the probability that a household grows the respective crop. For instance, the first entry in the first row tells us that the fertility gap does not affect the probability that households cultivate maize. The third entry, however, shows that households that have a higher fertility gap are more likely to grow beans. Similarly, we find that higher fertility significantly reduces the probability that matooke is grown. The next row looks at the total area reported to be used to grow each crop, measured in acres. We find a positive effect of the fertility gap on the area used to grow matooke. Fertility seems to be unrelated to the area used to grow any of the other crops. However, smaller households that grow more matooke may simply have larger land holdings. Therefore, it will be useful to also relate fertility to the share of each crop in total in terms of land size. This gives an idea of the relative importance of each crop within the household. This is presented in the next row. In this case, it seems that households with more children allocate less land as a share of total land to sweet potatoes. The next row looks at the value of production in kilograms. Only for matooke, larger households seem to obtain a significantly lower quantity of matooke. The next row looks at production per capita. The lower production of matooke persists if we account for household size. Finally, for none of the products, the fertility gap has a significant effect on yield.

Finally, in table 0.8 we present results on total production and productivity, using the prices for the different crops. We present again five different models. The first one is again regression that does not take endogeneity into account. While in the previous regressions this was typically OLS, this may now change to a probit or tobit regression, depending on the nature of the dependent variable. The second regression instruments the fertility gap with the sex of the first-born. The third model uses the sex of the first two children born to the mother and the fourth uses the share of women amongst the children. As before, the fourth model instruments the fertility difference by two instruments: the sex of the first-born and the share of girls among the children.

The first row gives results for the change in production. There seems to be no detectable effect from fertility on the total value of the production of the five crops. The second row expresses this production in per capita terms. The OLS estimates show a positive effect of an increase in the fertility gap. However, if we confine to the exogenous part of fertility in the IV regressions, the effect disappears. The next row looks at a change in the total area allocated to the five crops. There is again no significant effect from fertility. The final row, which looks at productivity defined as the total value of the five crops divided by the total area allocated to these five crops, also finds no causal impact from family size.

CONCLUSION

In this paper, we look at the effect of fertility, defined as the number of biological children born to the mother, on agricultural production and its determinants. One of the most evident determinants is household agricultural labour. The identification strategy we use relies on the premise that, in partilineal societies, boys are preferred to girls in terms of offspring. Households that have a girl as the first child will have a higher propensity to add more children to the household. The fact that the sex of the first child is exogenous can be used to identify the causal impact of additional children on other variables such as labour supply and productivity. Similarly, the fertility rule whereby one is more likely to stop having children after a boy means that, on average, larger households consist of more girls. Therefore, the share of females in the total number of children can also be used as an instrument.

Our first stage regression performs reasonably well. We find a significant negative effect of an indicator variable that the first-born is a girl on a variable that measures the shortfall from fecundity. We equally find a negative effect of an indicator that the first two children are female. Finally, we also find that households with a relatively higher share of girls are negatively related to the fertility gap. While our instruments are significant and have the correct sign, explanatory power as measured by the partial R-squared is low. We therefore use inference methods in the second stage that are robust to weak instruments.

In the second stage regression, we find that fertility affects both time women and men allocated to agricultural production. However, most of the labour time lost as a consequence of an exogenous increase in children is born by the woman. Especially land preparation and weeding are activities that seem to suffer from excessive fertility. When we look at crops, we find that only matooke and sweet potatoes are significantly affected by fertility.

Matooke is the most important stable crop in Uganda, providing 18 percent of caloric intake (Haggblade and Dewina, 2010). The finding that young households that have higher fertility are reducing the most important source of calories suggests that higher fertility also causes under-nutrition. Sweet potatoes is also a typical food security crop, with a low return but also low risk (Dercon, 1996). It is also a crop that is mostly under the control of the woman, who does much of the work on the field.

That said, the fact that we rely on a cross-section of households also limits to what extent our conclusions can be generalized. It may well be that households that are at a later stage in their life cycle profit much more from larger household size. For instance, in households where the mother has reduced fertility, she may have more time to work in agricultural activities. In addition, children may provide cheap and flexible labour at a later age. Therefore, we want to stress that our results only hold for the subset of "young" households, where the women is between 16 and 32.

There are different ways in which the negative effect of fertility on labour and production can be influenced. First, our analysis reconfirms the need for fertility reducing policies. Apart from known fertility reducing policies such as women education and improved maternal health care, the most promising policies would try to work on the root cause of increased fertility. This should be done by reducing the propensity of households to have higher fertility if the first-born is a girl. We think of a host of policies that go against the patrilineal nature of these societies. For example, Uganda may consider changing its land act similar to what Kenya recently did and give equal inheritance rights to both girls and boys.

The above policy response involves addressing cultural issues related to high fertility, some of which may face considerable resistance. Changing a set of cultural values is likely to be a very slow process. Meanwhile, the government of Uganda should support the nutritional needs of young families. It should also consider introducing agricultural technologies that save on agricultural labour, especially for women.

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TABLES

Table 0.1—gender and fertility

	prob +1		prob +1		av fertility
1st=boy	0.375	1st=boy, 2nd=boy	0.132	% daughters<0.5	2.78
1st=girl	0.393	1st=girl, 2nd=boy	0.134	% daughters>0.5	2.88
		1st=girl, 2nd=girl	0.139		
	gap		gap		gap
1st=boy	2.46	1st=boy, 2nd=boy	2.46	% daughters<0.5	2.41
1st=girl	2.26	1st=girl, 2nd=boy	2.38	% daughters>0.5	2.32
		1st=girl, 2nd=girl	2.06		

Table 0.2—Descriptive statistics for crop production

	maize	beans	s potatoes	cassava	matooke
growing crop (% of households)	59.1	52.6	38.8	51.8	43.1
crop area (acre)	0.473	0.263	0.165	0.301	0.264
crop area (% of total area)	17.1	12.6	8.2	12.0	10.2
production (kg)	38.7	12.8	85.1	83.2	348.9
production per capita (kg)	18.1	6.4	38.7	38.4	168.6
yield (kg per acre)	358.2	128.5	1096.3	1030.8	2067.3

Table 0.3—First stage regression - OLS estimation of fertility gap

oldestgirl	-0.203**			
	(0.067)			
2oldestgirls		-0.190*		
		(0.082)		
3oldestgirls			-0.147	
			(0.117)	
percentfmales				-0.278**
				(0.094)
femhead	1.186**	1.168**	1.201**	1.186**
	(0.098)	(0.105)	(0.118)	(0.098)
urban	0.322**	0.273**	0.077	0.325**
	(0.083)	(0.097)	(0.115)	(0.083)
mprim	-0.155*	-0.025	-0.009	-0.159*
	(0.075)	(0.082)	(0.094)	(0.075)
msec	0.259*	0.220+	0.193	0.257*
	(0.101)	(0.121)	(0.150)	(0.101)
mthird	1.058**	0.914**	0.755+	1.060**
	(0.192)	(0.250)	(0.403)	(0.192)
health	0.095	0.107	0.151	0.090
	(0.124)	(0.146)	(0.171)	(0.124)
school	0.040	-0.005	-0.118	0.043
	(0.070)	(0.078)	(0.090)	(0.070)
cdied	0.284**	0.204+	0.117	0.285**
	(0.100)	(0.108)	(0.127)	(0.100)
cons	2.172**	1.946**	1.782**	2.209**
	(0.074)	(0.075)	(0.079)	(0.081)
r2	0.091	0.075	0.065	0.091
N	2656	2036	1391	2656

Note: Huber-White standard errors in parentheses, +, * and ** denote significance at the 10, 5 and 1 percent level respectively.

Table 0.4—Effect of fertility on total time worked in agriculture

	(1) OLS	(2) 2SLS	(3) 2SLS	(4) 2SLS	(5) LIML
fgap	-0.122	46.799+	64.297+	69.227**	66.349**
	(1.245)	(32.112)	(48.865)	(35.208)	(36.319)
femhead	-38.213**	-95.268*	-116.211+	-122.540**	-119.040**
	(4.793)	(39.623)	(59.496)	(44.167)	(45.268)
urban	-23.411**	-35.338**	-40.541**	-41.038**	-40.307**
	(5.780)	(11.352)	(13.796)	(13.622)	(13.516)
mprim	1.392	8.132	6.058	11.354	10.940
	(4.897)	(7.802)	(8.092)	(9.128)	(9.065)
msec	-6.121	-10.595	-7.207	-12.734	-12.459
	(6.516)	(8.899)	(11.617)	(11.167)	(10.850)
mthird	-20.792*	-70.642+	-83.864	-94.470*	-91.412*
	(9.946)	(39.814)	(54.795)	(45.224)	(46.122)
health	-15.118*	-21.809*	-18.573	-25.008+	-24.597+
	(7.694)	(11.099)	(14.923)	(13.928)	(13.544)
school	12.570**	7.633	9.887	5.274	5.576
	(4.793)	(6.914)	(9.145)	(7.881)	(7.879)
cdead	13.573*	3.161	1.904	-1.816	-1.177
	(6.273)	(10.788)	(12.672)	(12.954)	(12.801)
cons	87.193**	-7.527	-29.950	-52.803	-46.992
	(4.718)	(64.960)	(90.557)	(70.927)	(73.206)
N	2016	2016	1620	2016	2016
instrument:	-	1st = girl	1st & 2nd = girl	% girl	1st = girl & % girl

Note: Huber-White standard errors in parentheses, +, * and ** denote significance at the 10, 5 and 1 percent level respectively.

Table 0.5—2SLS estimates of household labour supply

	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	2SLS	2SLS	LIML
			days worked mother		
	0.533	29.890*	54.070**	40.841**	38.773**
	(0.735)	(17.769)	(33.364)	(19.353)	(19.085)
			days worked father		
	-0.620	10.928	5.915	22.327*	20.076+
	(0.668)	(13.983)	(25.595)	(13.580)	(14.756)
N	2016	2016	1620	2016	2016
instrument:	-	1st = girl	1st & 2nd = girl	% girl	1st = girl & % girl

Note: Huber-White standard errors in parentheses, +, * and ** denote significance at the 10, 5 and 1 percent level respectively.

Table 0.6—2SLS estimates of household labour allocation

	(1) OLS	(2) 2SLS	(3) 2SLS	(4) 2SLS	(5) LIML
	time allocated to land preparation				
	-0.048	15.876	41.127**	26.028**	25.278*
	(0.528)	(12.737)	(25.884)	(13.720)	(14.761)
	time allocated to input application				
	0.051	1.812	0.849	2.372	2.224
	(0.136)	(1.632)	(1.686)	(1.829)	(1.741)
	time allocated to weeding				
	0.026	17.708*	25.959*	21.385*	20.492*
	(0.468)	(11.724)	(17.541)	(11.730)	(11.253)
	time allocated to harvesting				
	-0.082	5.315	-3.591	13.852+	12.485+
	(0.468)	(10.597)	(20.563)	(8.987)	(10.379)
N	2015	2015	1619	2015	2015
instrument:	-	1st = girl	1st & 2nd = girl	% girl	1st = girl & % girl

Note: Huber-White standard errors in parentheses, +, * and ** denote significance at the 10, 5 and 1 percent level respectively.

Table 0.7—2SLS estimates of effect of fertility on crop mix, area, production and yield

	maize	beans	s pot	cassava	matooke
growing	0.431	-0.193	0.556+	-0.003	0.622+
	(0.359)	(0.332)	(0.401)	(0.302)	(0.428)
total area	0.432	-0.119	0.187	0.105	0.603+
	(0.425)	(0.199)	(0.254)	(0.289)	(0.425)
area share	0.028	-0.085	0.169+	-0.027	0.043
	(0.087)	(0.080)	(0.115)	(0.081)	(0.081)
production	56.799	-4.677	182.878	29.714	1931.785+
	(71.795)	(22.600)	(176.010)	(189.684)	(1255.565)
production per capita	26.593	-1.079	55.706	-11.725	2026.613*
	(38.247)	(12.727)	(87.191)	(103.129)	(1135.716)
yield	-22.060	41.329	69.834	-480.421	-383.889
	(169.179)	(54.371)	(694.248)	(728.459)	(882.517)

Note: Huber-White standard errors in parentheses, +, * and ** denote significance at the 10, 5 and 1 percent level respectively. All regressions use the share of female children in total number of children as instrument.

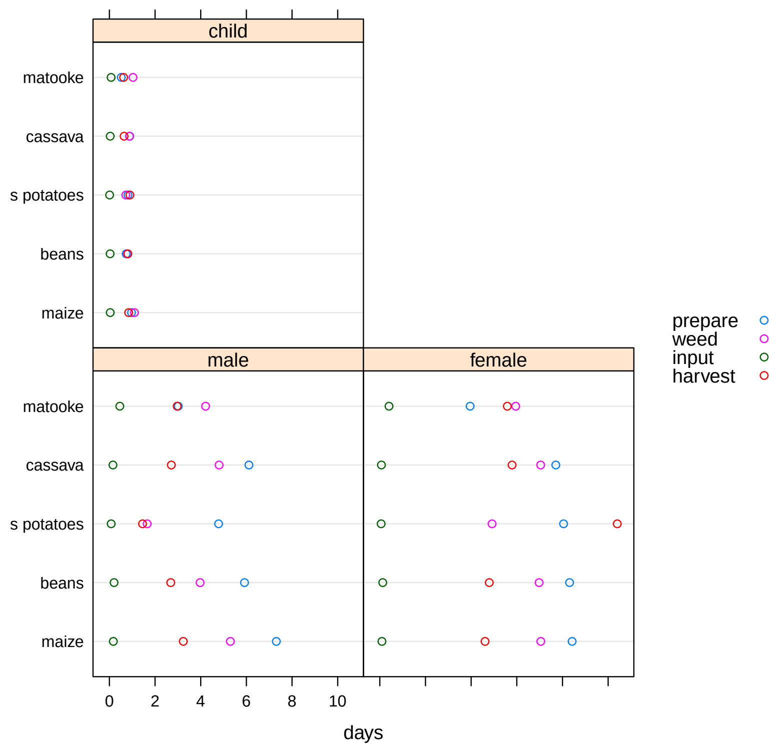
Table 0.8—2SLS estimates of total production

	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	2SLS	2SLS	LIML
production	-3.411	21.056	-20.275	16.988	19.334
(x UGX1000)	(2.697)	(46.911)	(57.977)	(48.493)	(44.172)
production/capita	4.133**	10.501	-9.251	14.518	12.340
(x UGX1000)	(1.527)	(26.009)	(24.107)	(27.183)	(24.605)
area	-0.033	0.120	0.042	0.145	0.132
	(0.023)	(0.343)	(0.443)	(0.359)	(0.325)
yield	-1.697	43.088	-96.861	0.013	8.818
	(2.862)	(81.451)	(140.870)	(61.118)	(69.674)
instrument:	-	1st = girl	1st & 2nd = girl	% girl	1st = girl & % girl

Note: Huber-White standard errors in parentheses, +, * and ** denote significance at the 10, 5 and 1 percent level respectively.

FIGURES

Figure 0.1—Average number of days worked



APPENDIX

Table 0.9—Effect on days worked by mother (full results)

	(1) OLS	(2) 2SLS	(3) 2SLS	(4) 2SLS	(5) LIML
fgap	0.533	29.890*	54.070**	40.841**	38.773**
	(0.735)	(17.769)	(33.364)	(19.353)	(19.085)
femhead	-7.906*	-43.577*	-71.806+	-56.883*	-54.370*
	(3.715)	(21.981)	(40.831)	(24.354)	(23.883)
urban	-13.317**	-20.758**	-25.334*	-23.534**	-23.009**
	(3.536)	(6.910)	(10.247)	(8.041)	(7.811)
mprim	0.023	4.177	3.472	5.726	5.434
	(2.754)	(4.566)	(5.864)	(5.194)	(5.085)
msec	1.115	-1.624	2.608	-2.646	-2.453
	(4.706)	(5.869)	(9.177)	(6.913)	(6.676)
mthird	-15.001*	-46.192*	-70.087+	-57.827*	-55.630*
	(6.961)	(23.251)	(38.987)	(25.869)	(25.530)
health	-7.274	-11.634+	-9.296	-13.260	-12.953
	(4.607)	(6.967)	(11.406)	(8.326)	(8.044)
school	6.740*	3.705	3.073	2.573	2.786
	(2.703)	(3.837)	(6.100)	(4.461)	(4.334)
cdied	6.810+	0.209	-2.949	-2.253	-1.788
	(3.874)	(6.592)	(9.328)	(7.510)	(7.333)
cons	49.054**	-10.209	-48.668	-32.314	-28.140
	(2.815)	(36.011)	(61.945)	(39.017)	(38.525)
N	2016	2016	1620	2016	2016
instrument:	-	1st = girl	1st & 2nd = girl	% girl	1st = girl & % girl

Note: Huber-White standard errors in parentheses, +, * and ** denote significance at the 10, 5 and 1 percent level respectively.

Table 0.10—Effect on days worked by father (full results)

	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	2SLS	2SLS	LIML
fgap	-0.620	10.928	5.915	22.327*	20.076+
	(0.668)	(13.983)	(25.595)	(13.580)	(14.756)
femhead	-30.349**	-44.381**	-39.124	-58.231**	-55.496**
	(2.216)	(16.903)	(30.436)	(16.952)	(18.155)
urban	-10.103**	-13.030**	-14.318**	-15.919**	-15.349**
	(2.902)	(4.347)	(5.249)	(5.056)	(5.016)
mprim	1.374	3.008	2.241	4.620	4.302
	(2.717)	(3.271)	(2.967)	(3.769)	(3.687)
msec	-7.239*	-8.317*	-9.670*	-9.381*	-9.171*
	(3.120)	(3.454)	(3.770)	(4.404)	(4.175)
mthird	-5.829	-18.098	-9.522	-30.209+	-27.817
	(4.926)	(16.387)	(26.183)	(17.049)	(17.973)
health	-7.849*	-9.564*	-9.534*	-11.257*	-10.922*
	(3.589)	(4.045)	(4.444)	(5.168)	(4.913)
school	5.826*	4.632	7.310	3.454	3.687
	(2.843)	(3.630)	(4.782)	(3.620)	(3.742)
cdied	6.756*	4.159	5.314	1.596	2.102
	(3.272)	(4.374)	(5.030)	(5.209)	(5.089)
cons	38.067**	14.756	26.774	-8.254	-3.711
	(2.377)	(28.289)	(47.345)	(27.361)	(29.750)
N	2016	2016	1620	2016	2016
instrument:	-	1st = girl	1st & 2nd = girl	% girl	1st = girl & % girl

Note: Huber-White standard errors in parentheses, +, * and ** denote significance at the 10, 5 and 1 percent level respectively.

Table 0.11—Effect on days spend on preparing fields (full results)

	(1) OLS	(2) 2SLS	(3) 2SLS	(4) 2SLS	(5) LIML
fgap	-0.048	15.876	41.127**	26.028**	25.278*
	(0.528)	(12.737)	(25.884)	(13.720)	(14.761)
femhead	-15.173**	-34.568*	-64.891*	-46.932**	-46.018*
	(2.023)	(15.704)	(31.846)	(17.259)	(18.412)
urban	-6.940**	-11.013*	-17.002*	-13.610*	-13.418*
	(2.623)	(4.481)	(7.827)	(5.417)	(5.493)
mprim 2	-2.251	-0.069	-0.597	1.322	1.219
	(2.209)	(3.307)	(4.513)	(3.585)	(3.703)
msec	-2.980	-4.482	-2.924	-5.439	-5.368
	(2.832)	(3.537)	(6.729)	(4.377)	(4.336)
mthird	-11.214**	-28.140+	-51.405+	-38.931*	-38.133*
	(3.993)	(15.545)	(29.529)	(17.591)	(18.553)
health	-3.914	-6.215	-6.296	-7.682	-7.573
	(3.233)	(4.293)	(8.266)	(5.446)	(5.379)
school	2.919	1.343	0.511	0.338	0.412
	(1.932)	(2.546)	(4.654)	(3.079)	(3.073)
cdead	5.262+	1.632	-2.547	-0.682	-0.511
	(2.719)	(4.291)	(7.133)	(5.142)	(5.203)
cons	35.817**	3.741	-39.561	-16.708	-15.197
	(2.261)	(26.072)	(47.770)	(27.523)	(29.771)
N	2015	2015	1619	2015	2015
instrument:	-	1st = girl	1st & 2nd = girl	% girl	1st = girl & % girl

Note: Huber-White standard errors in parentheses, +, * and ** denote significance at the 10, 5 and 1 percent level respectively.

Table 0.12—Effect on days spend on input application (full results)

	(1) OLS	(2) 2SLS	(3) 2SLS	(4) 2SLS	(5) LIML
fgap	0.051	1.812	0.849	2.372	2.224
	(0.136)	(1.632)	(1.686)	(1.829)	(1.741)
femhead	0.349	-1.795	-0.493	-2.478	-2.297
	(0.747)	(1.611)	(1.756)	(1.717)	(1.628)
urban	-0.514	-0.964	-0.674	-1.107	-1.069
	(0.386)	(0.713)	(0.615)	(0.788)	(0.763)
mprim	0.466*	0.707*	0.657**	0.784*	0.764*
	(0.182)	(0.325)	(0.246)	(0.376)	(0.358)
msec	0.978	0.812	1.158	0.759	0.773
	(0.881)	(0.814)	(1.126)	(0.802)	(0.804)
mthird	-0.684	-2.555	-1.897	-3.151	-2.993
	(1.202)	(2.575)	(2.550)	(2.835)	(2.745)
health	0.198	-0.057	-0.088	-0.138	-0.116
	(0.489)	(0.611)	(0.613)	(0.687)	(0.663)
school	-0.045	-0.219	-0.108	-0.275	-0.260
	(0.289)	(0.302)	(0.339)	(0.302)	(0.300)
cdead	-0.142	-0.543	-0.235	-0.671	-0.637
	(0.222)	(0.513)	(0.401)	(0.591)	(0.564)
cons	0.526	-3.021	-0.935	-4.150	-3.851
	(0.448)	(3.370)	(3.238)	(3.793)	(3.609)
N	2015	2015	1619	2015	2015
instrument:	-	1st = girl	1st & 2nd = girl	% girl	1st = girl & % girl

Note: Huber-White standard errors in parentheses, +, * and ** denote significance at the 10, 5 and 1 percent level respectively.

Table 0.13—Effect on days spend on weeding (full results)

	(1) OLS	(2) 2SLS	(3) 2SLS	(4) 2SLS	(5) LIML
fgap	0.026	17.708*	25.959*	21.385*	20.492*
	(0.468)	(11.724)	(17.541)	(11.730)	(11.253)
femhead	-13.623**	-35.158*	-45.639*	-39.637**	-38.550**
	(1.728)	(14.648)	(21.645)	(14.779)	(14.180)
urban	-9.339**	-13.862**	-15.649**	-14.802**	-14.574**
	(2.340)	(4.495)	(5.509)	(4.756)	(4.613)
mprim	-0.489	1.934	1.010	2.438	2.315
	(1.772)	(2.772)	(3.137)	(2.968)	(2.880)
msec	-2.274	-3.942	-2.715	-4.289	-4.205
	(2.594)	(3.488)	(4.834)	(3.904)	(3.775)
mthird	-5.350	-24.143	-30.226	-28.052+	-27.103+
	(4.259)	(14.960)	(20.546)	(15.193)	(14.766)
health	-8.375**	-10.930**	-10.259+	-11.461**	-11.332**
	(2.059)	(3.844)	(5.363)	(4.270)	(4.136)
school	4.598**	2.848	3.290	2.484	2.572
	(1.751)	(2.336)	(3.165)	(2.470)	(2.417)
cdead	5.040*	1.010	0.656	0.172	0.375
	(2.323)	(4.315)	(5.183)	(4.525)	(4.412)
cons	29.534**	-6.083	-17.387	-13.490	-11.692
	(1.783)	(23.464)	(32.493)	(23.516)	(22.524)
N	2015	2015	1619	2015	2015
instrument:	-	1st = girl	1st & 2nd = girl	% girl	1st = girl & % girl

Note: Huber-White standard errors in parentheses, +, * and ** denote significance at the 10, 5 and 1 percent level respectively.

Table 0.14—Effect on days spend on harvesting (full results)

	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	2SLS	2SLS	LIML
fgap	-0.082	5.315	-3.591	13.852+	12.485+
	(0.468)	(10.597)	(20.563)	(8.987)	(10.379)
femhead	-10.650**	-17.223	-6.270	-27.620*	-25.955*
	(1.771)	(12.609)	(24.287)	(11.128)	(12.624)
urban	-6.876**	-8.257**	-8.124*	-10.440**	-10.091**
	(1.873)	(2.977)	(3.852)	(3.362)	(3.402)
mprim	2.741	3.481	3.569+	4.650+	4.463+
	(1.906)	(2.131)	(2.042)	(2.511)	(2.448)
msec	-1.835	-2.344	-2.761	-3.149	-3.020
	(2.343)	(2.335)	(2.849)	(2.969)	(2.822)
mthird	-3.720	-9.457	-0.912	-18.530+	-17.078
	(3.366)	(11.938)	(20.598)	(11.097)	(12.290)
health	-2.340	-3.120	-0.215	-4.353	-4.156
	(3.167)	(3.283)	(4.032)	(4.004)	(3.853)
school	5.394*	4.860+	6.889+	4.015	4.150
	(2.150)	(2.803)	(3.685)	(2.604)	(2.760)
cdead	3.501	2.271	3.443	0.325	0.637
	(2.351)	(2.914)	(3.565)	(3.384)	(3.345)
cons	22.551**	11.680	29.707	-5.516	-2.763
	(1.469)	(21.379)	(38.106)	(18.133)	(20.921)
N	2015	2015	1619	2015	2015
instrument:	-	1st = girl	1st & 2nd = girl	% girl	1st = girl & % girl

Note: Huber-White standard errors in parentheses, +, * and ** denote significance at the 10, 5 and 1 percent level respectively.

Table 0.15—Total production (full tobit results)

	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	2SLS	2SLS	LIML
fgap	-3.411	21.056	-20.275	16.988	19.334
	(2.697)	(46.911)	(57.977)	(48.493)	(44.172)
femhead	-69.276**	-97.608+	-41.725	-92.870	-95.599+
	(13.700)	(55.994)	(67.508)	(57.696)	(52.888)
urban	-191.662**	-199.111**	-183.271**	-197.891**	-198.597**
	(13.527)	(18.843)	(19.978)	(19.209)	(18.219)
mprim	31.542**	35.247**	40.222**	34.604**	34.970**
	(9.652)	(12.321)	(11.070)	(12.382)	(12.050)
msec	-14.660	-20.572	-17.281	-19.563	-20.150
	(14.527)	(17.768)	(20.052)	(17.924)	(17.324)
mthird	29.624	2.888	78.249	7.286	4.749
	(35.753)	(58.152)	(63.402)	(59.720)	(55.538)
health	-12.603	-15.259	-10.523	-14.869	-15.089
	(15.952)	(16.802)	(19.526)	(16.816)	(16.688)
school	37.105**	36.348**	39.394**	36.483**	36.411**
	(9.238)	(9.316)	(10.397)	(9.273)	(9.279)
cdied	15.566	8.472	9.039	9.642	8.970
	(12.878)	(18.682)	(18.569)	(18.990)	(18.093)
cons	153.527**	100.065	197.728	108.964	103.831
	(12.388)	(103.164)	(121.588)	(106.568)	(97.211)
N	2637	2637	2020	2637	2637
instrument:	-	1st = girl	1st & 2nd = girl	% girl	1st = girl & % girl

Note: Huber-White standard errors in parentheses, +, * and ** denote significance at the 10, 5 and 1 percent level respectively.

Table 0.16—Total production per capita (full tobit results)

	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	2SLS	2SLS	LIML
fgap	4.133**	10.501	-9.251	14.517	12.340
	(1.527)	(26.009)	(24.107)	(27.183)	(24.605)
femhead	-39.851**	-47.223	-10.658	-51.859	-49.346+
	(7.938)	(31.039)	(28.068)	(32.335)	(29.453)
substrat	-98.207**	-100.147**	-67.933**	-101.377**	-100.709**
	(8.560)	(10.451)	(8.290)	(10.764)	(10.150)
mprim	20.087**	21.052**	17.671**	21.646**	21.324**
	(5.220)	(6.835)	(4.606)	(6.946)	(6.716)
msec	-3.727	-5.265	-4.161	-6.221	-5.707
	(8.632)	(9.846)	(8.330)	(10.040)	(9.644)
mthird	20.268	13.311	55.245*	8.899	11.294
	(24.284)	(32.189)	(26.298)	(33.422)	(30.880)
health	-8.756	-9.447	-8.607	-9.909	-9.653
	(8.925)	(9.326)	(8.131)	(9.440)	(9.308)
school	12.227*	12.030*	11.697**	11.910*	11.976*
	(4.969)	(5.167)	(4.325)	(5.203)	(5.172)
cdied	5.932	4.085	2.685	2.916	3.551
	(7.121)	(10.360)	(7.726)	(10.649)	(10.082)
cons	49.910**	35.996	68.721	27.226	31.979
	(6.365)	(57.199)	(50.558)	(59.739)	(54.151)
N	2637	2637	2020	2637	2637
instrument:	-	1st = girl	1st & 2nd = girl	% girl	1st = girl & % girl

Note: Huber-White standard errors in parentheses, +, * and ** denote significance at the 10, 5 and 1 percent level respectively.

Table 0.17—Total area (full tobit results)

	(1)	(2)	(3)	(4)	(5)
	OLS	2SLS	2SLS	2SLS	LIML
fgap	-0.033	0.120	0.042	0.145	0.132
	(0.023)	(0.343)	(0.443)	(0.359)	(0.325)
femhead	-0.511**	-0.689+	-0.530	-0.718+	-0.703+
	(0.097)	(0.410)	(0.516)	(0.427)	(0.389)
urban	-1.351**	-1.398**	-1.345**	-1.406**	-1.401**
	(0.111)	(0.138)	(0.153)	(0.142)	(0.134)
mprim	0.172*	0.196*	0.250**	0.199*	0.197*
	(0.071)	(0.090)	(0.085)	(0.091)	(0.089)
msec	-0.175	-0.212	-0.215	-0.218	-0.215+
	(0.111)	(0.130)	(0.153)	(0.133)	(0.127)
mthird	-0.035	-0.202	0.088	-0.230	-0.215
	(0.210)	(0.428)	(0.487)	(0.443)	(0.411)
health	-0.133	-0.150	-0.158	-0.153	-0.151
	(0.108)	(0.123)	(0.150)	(0.125)	(0.123)
school	0.310**	0.306**	0.331**	0.305**	0.305**
	(0.070)	(0.068)	(0.080)	(0.069)	(0.068)
cdied	0.103	0.058	0.012	0.051	0.055
	(0.093)	(0.137)	(0.142)	(0.140)	(0.133)
cons	0.793**	0.459	0.630	0.403	0.432
	(0.080)	(0.755)	(0.930)	(0.788)	(0.715)
N	2637	2637	2020	2637	2637
instrument:	-	1st = girl	1st & 2nd = girl	% girl	1st = girl & % girl

Note: Huber-White standard errors in parentheses, +, * and ** denote significance at the 10, 5 and 1 percent level respectively.

Table 0.18—Total yield (x1000 UGX per acre)

	(1) OLS	(2) 2SLS	(3) 2SLS	(4) 2SLS	(5) LIML
fgap	-1.697	43.088	-96.861	0.013	8.818
	(2.862)	(81.451)	(140.870)	(61.118)	(69.674)
femhead	-32.827*	-82.434	62.869	-34.721	-44.474
	(13.620)	(91.141)	(149.672)	(69.314)	(78.576)
urban	-19.120	-31.562	-17.771	-19.596	-22.042
	(17.498)	(29.340)	(36.155)	(24.900)	(26.586)
mprim	9.668	12.719	17.577	9.785	10.384
	(11.889)	(14.153)	(21.954)	(12.962)	(13.267)
msec	34.954+	32.322	24.785	34.854+	34.336+
	(20.106)	(22.005)	(27.654)	(20.229)	(20.478)
mthird	11.594	-41.631	115.467	9.562	-0.903
	(38.115)	(99.945)	(156.775)	(78.774)	(87.257)
health	-9.314	-18.619	0.558	-9.669	-11.498
	(17.760)	(26.018)	(27.844)	(21.578)	(22.827)
school	10.851	5.932	28.583	10.663	9.696
	(11.524)	(15.622)	(23.309)	(13.193)	(13.852)
cdied	1.373	-14.487	22.702	0.767	-2.351
	(16.065)	(30.019)	(38.702)	(25.321)	(27.246)
cons	178.153**	154.719	449.143	244.882+	226.452
	(16.668)	(171.814)	(283.600)	(130.707)	(148.357)
N	1567	1567	1278	1567	1567
instrument:	-	1st = girl	1st & 2nd = girl	% girl	1st = girl & % girl

Note: Huber-White standard errors in parentheses, +, * and ** denote significance at the 10, 5 and 1 percent level respectively.