Impact of fertility on objective and subjective poverty in Malawi

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The paper uses data from the Second Malawi Integrated Household Survey to investigate the impact of fertility on poverty in rural Malawi. We use two measures of poverty: the objective and the subjective. After accounting for endogeneity of fertility by using son preference as an instrumental variable, we find that fertility increases the probability of being objectively poor. This effect is robust to the choice of the poverty line used. It is also robust to accounting for economies of scale, and household composition as well as to measuring poverty using continuous welfare indicators. We also find that when fertility is treated as an exogenous variable its impact is underestimated. When poverty is measured subjectively, the results are opposite to those of objective poverty. We find that fertility lowers the likelihood of feeling poor.

Keywords: objective poverty; subjective poverty; endogeneity; Malawi

1. Introduction

Research looking at the relationship between poverty and fertility at the micro level on the African continent remains scarce. Ironically, Africa has the highest rates of poverty and fertility. A lack of data has often been given as the reason for the paradoxical lack of studies on the continent. Empirically, there has not been any consensus as to the nature of the relationship between fertility and poverty. The mixed empirical results include: no relationship between fertility and poverty in Botswana (Chernichovsky 1984), a positive relationship in Sierra Leone and Ethiopia (Ketkar 1979), and a negative relationship in Burkina Faso (Langani 1997) and in Southern Sudan (Cohen and House 1994). Further to that, Noumbissi and Sanderson (1998) find that in Cameroon where fertility rates are very high, the relationship takes the inverse J shape, implying that both low- and high-income households have lower rates of fertility, whereas medium-level income households have higher fertility. The J shape is explained by the fact that very low-income households tend to be landless farmers, as a result of which they do not depend on children as cheap labor, whereas those with the highest income have lower fertility due to higher investment in child quality. The middle-income families are landholding farms which depend on cheap labor, and therefore have a higher demand for child quantity.

The common factor in all the cited studies is that fertility is treated as an exogenous variable. As such, these studies ignored the fact that fertility can influence poverty, and at same time be affected by it. That is, causality can run in both directions. Technically, they did not take into account the simultaneity that exists between the two variables. Further to that, they also ignored the fact that there are unobserved factors which influence both variables; that is unobserved heterogeneity was not accounted for. Another shortfall of these studies is that they only focused on poverty defined in the objective monetary sense which is a narrower definition of household welfare. Subjective measures of welfare better capture the multidimensional nature of poverty. They are likely to include a household’s feelings of relative deprivation, exclusion from services and institutions, as well as feelings of marginalization related to household or individual status (such as ethnicity or marital status) (Devereux et al. 2006). It is, therefore, also interesting to see how fertility impacts on poverty when poverty is conceived multidimensionally.

Disregarding simultaneity and unobserved heterogeneity leads to biased and inconsistent estimates. It is, therefore, important for the reliability of results of any econometric analysis that they be accounted for. It is also worth noting that despite the poverty–fertility relationship being a demographic issue as well as an economic one, most of the studies on the continent have been done by demographers. These studies have mostly been descriptive in nature. As discussed before, the results have been divergent with some studies finding no relationship, while other studies find a negative or positive relationship. With respect

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to Malawi, there have been a few studies which have looked at factors which influence objective poverty (e.g. Mukherjee and Benson 2003) but none of these have looked at the impact of fertility on objective poverty let alone subjective poverty. The questions that this study, therefore, seeks to answer are twofold. Firstly, taking into account the simultaneity and unobserved effects, how does fertility impact on objective poverty in Malawi? Secondly, taking into account the simultaneity and unobserved effects, how does fertility impact on subjective poverty in Malawi? Answering these questions is significant in the sense that it goes a long way in contributing to the literature on poverty and fertility in Malawi as well as the African continent at large. Additionally, by using a methodology that captures the problems that previous studies have ignored, we are making a contribution with respect to how the two variables should be conceptualized and modeled. Further to that, by using subjective poverty, the study sheds some light on the impact of fertility on a broader definition of household welfare.

The rest of the paper is organized as follows. Section 2 explains why causality between fertility and poverty is bidirectional. Section 3 discusses the measurement of objective and subjective poverty, and fertility. Section 4 presents the empirical model, data, and descriptives. Econometric results are the focus of Section 5. Section 6 concludes.

2. The poverty–fertility nexus

The link between poverty and fertility may run from fertility to poverty. Poor households with big families have large dependency ratios, as a result investments in the human capital of children, which improve the future prospects of the children may be sacrificed to more immediate household needs such as food. This conflict is especially likely when the opportunity cost of certain investments in children (such as education) is high because of the associated loss of child labor in agriculture or home work (Birdsall and Griffin 1988).

Family size may have a negative impact on child development and human capital formation, and hence their future economic status. For instance, studies in both developed and developing countries find that children in big families tend to be shorter, less intelligent, and are even less likely to survive (e.g. Bielicki 1986). Rosenzweig and Wolpin (1980), in a study of families with twins in India found that the additional unexpected child represented by twins reduced enrollment levels of all children in the household. Using Malaysian data, Rosenzweig and Schultz (1987) show that couples with a higher biological propensity to reproduce, also have lower schooling attainment for their children. A child’s ability to learn is influenced by the amount and quality of attention received from parents and other adults in the first few years, and that is generally less in large families. Hence, children from large families are more likely not to be very educated and this makes them more prone to poverty (Birdsall and Griffin 1988).

On the other hand, the link between poverty and fertility may run from poverty to fertility. Parents whose children die may try to replace them, and since mortality is generally high in poor households, parents may try to insure themselves against possible child loss by having more children than they would otherwise want. Olsen (1987) found that parents in Colombia directly replaced at least 0.2 of children who had died, but further compensated by having on average about 0.14 extra children. Thus, hoarding by having extra children can be interpreted as an insurance strategy by parents in the presence of high infant mortality. As the risk of infant mortality diminishes, hoarding becomes unnecessary. Related to this is that poor households may decide to have more children as a source of support in old age given the absence of life insurance markets and social security in many developing countries.

According to the quantity–quality theory of Becker and Lewis (1973), increases in income lead to an increase in demand for quality of children and a fall in the quantity of children. Thus, as households become wealthier, they will tend to have fewer children. Additionally, increases in women’s wages (and therefore income) leads to fewer children, as this increases the opportunity cost of having more children.

3. Measurement of objective and subjective poverty and fertility

Objective poverty can be measured either by using household income or household consumption expenditure. We use a consumption expenditure based measure of poverty rather than income. In the objective and monetary poverty analysis income or consumption is considered to be a measure of welfare. This approach reflects how most empirical work on poverty in Africa has been done. A household’s subjective assessment of its well-being is, however, much broader. Due to its broader scope, it is possible that some factors might affect the two poverty definitions differently.

There are three alternative subjective questions which are used to measure subjective well-being. Firstly, there is the Income Evaluation Question (IEQ) introduced by Van Praag (1971). The IEQ asks what level of income is regarded as ‘very bad’, ‘bad’, ‘not good’, ‘not bad’, ‘good’, and ‘very good’. The IEQ for example is phrased like so: ‘Taking into account my (our) present living circumstances, I would regard a net weekly/monthly/yearly (encircle period) family income as: excellent, good, bad, very bad.’ Secondly, there is the Minimum Income Question (MIQ). Here people are asked what they consider as a minimum level of income to make ends meet. The MIQ is, for example, phrased like so ‘We would like you to...
tell us the absolute minimum income of money for a household such as yours – in other words, a sum below which you couldn’t make ends meet.’ The MIQ has been criticized for its focus on income, in that the concept of income may be poorly defined for respondents particularly but not only in developing countries (Ravallion and Lokshin 2002). Both the IEQ and MIQ are based on income as a measure of welfare, and therefore they are not broad. A measure of subjective poverty which is much broader and open-minded is the Economic Ladder Question (ELQ). Here the respondents are asked a question framed as follows: ‘Please imagine a 6-step ladder where on the bottom, the first step, stand the poorest people, and on the highest step, the sixth, stand the rich. On which step are you today?’ In the survey data we are using, this question was answered by the household head. Owing to its breadth relative to the IEQ and the MIQ, we employ the ELQ method. The use of subjective well-being is advantageous in the sense that well-being is self-rated. These measures have some limitations worth pointing out. For example, an individual’s answers could be influenced by different factors, for instance, attitudes and anticipations. Individuals may estimate themselves by the means of comparison with socially accepted norms and rules, their group of reference, etc. As noted by Bertrand and Mullainathan (2001), there is a possible problem of individual heterogeneity (unobservable characteristics) with respect to subjective measures in the sense that people may not mean what they say. Further to this, and as noted by Beegle et al. (2012), there may be concerns relating to a frame-of-reference bias, which emanates from non-ignorable heterogeneity in subjective scales, such as what it means to be rich or poor. The ELQ has some inherent limitations, namely an assumption has to be made about which ranks correspond to poverty, and that this is a relative measure of poverty (respondents are required to assess their status in relation to the economic status of other households) (Pradhan and Ravallion 2000). In this study, our measure of fertility is based on the number of biological children of a household head. The biological children include those residing in an institution elsewhere, but still dependent on the household (e.g. boarding school students).

4. Methodology

In order to take into account the fact that fertility and poverty (objective and subjective) are potentially endogenous, we use instrumental variable (IV) estimation. We use a natural experiment as our instrument. A natural experiment is a naturally occurring random event or situation, which can be exploited as an IV. For a discussion on natural experiments in economics, see Rosenzweig and Wolpin (2000). Our use of a natural experiment is inspired by a number of studies in the labor economics literature (e.g. Angrist and Evans 1998). In most developing countries, parents tend to prefer sons to daughters. Gupta and Dubey (2006) in a study of the impact of fertility on poverty in India (which is probably the first to use IV estimation) use son preference as an IV on households with more than two children. A priori parents are more likely to have another child if the first two are girls.

Sons are preferred in the developing world for a number of reasons. First, in many societies, old-age support is exclusively the task of male offspring by way of social practice and tradition. Even though female offspring may be just as able to offer support, there may be a stigma associated with receiving such support from daughters. Second, in societies where female employment is not in demand or is undervalued, males may be potentially more productive future ‘assets’. Finally, sons may be preferred to daughters for the continuation of the family name. We have two dependent variables; poverty status and fertility which are binary. Our unit of analysis is a household.

As discussed earlier, in this study we measure objective poverty using consumption, and a household is defined as poor if its total real annualized per capita consumption expenditure ($Y$) falls below the poverty line. Letting $Y_{PL}$ be a poverty line, then household $i$ is poor ($T_i = 1$) if $Y_i \leq Y_{PL}$ and non-poor ($T_i = 0$) if $Y_i > Y_{PL}$. Parameter estimates of a probit change with the poverty line. This means that the effects of different variables on poverty are strictly speaking specific to that poverty line. To find out whether or not the effect of fertility on poverty is robust to choice of poverty line we use three poverty lines, and look for the presence of sign reversals in the impact of fertility on the alternative poverty lines. When there are no sign reversals, that is, monotonicity holds, then the results can be considered first order dominant, implying that the direction of the impact of a fertility variable on the probability of being poor remains the same regardless of the poverty line selected (Ravallion 1996). The three poverty lines are: two as defined by the National Statistical Office of Malawi (NSO) and the third as defined by the World Bank. The two NSO poverty lines are; one for those considered ultra-poor which is 10,029 Malawi Kwacha per year, and another for the poor which is 16,165 Malawi Kwacha per year. The World Bank poverty line is the US $1 per day (equivalent to an annualized figure of 11,051 Malawi Kwacha after adjusting for purchasing power parity).

Fertility ($Z$) is defined as equal to one if a household has more than two children and zero if it has two. The focus is on biological children only of the household head. The biological children include those living elsewhere for reasons of education say at a boarding school. We identify children and birth order by using information on the relationship to the household head, and the ages of the biological children.² Our study is essentially about
large families versus small families. It should also be pointed out that son preference would be more evident in the birth of the third child and not the second child since most families prefer having at least two children (Gupta and Dubey 2006). This implies that the son preference IV only works in the transition from the second to the third child. The poverty and fertility equations are jointly estimated in a recursive bivariate probit which is formally specified below.

Consider the following levels regression:

$$Y_i = \beta X_i + \delta Z_i + \epsilon_i,$$ \hspace{1cm} (1)

then poverty status is defined as

$$T_i = \begin{cases} 1 & \text{if } Y_i \leq Y_{\text{PL}} \text{ (poor)} \\ 0 & \text{if } Y_i > Y_{\text{PL}} \text{ (non-poor)}. \end{cases}$$ \hspace{1cm} (2)

Consider the following levels regression for number of children ($C_i$):

$$C_i = \theta' X_i + \lambda M_i + \eta_i,$$ \hspace{1cm} (3)

then fertility is defined as

$$Z_i = \begin{cases} 1 & \text{if } C_i > 2 \\ 0 & \text{if } C_i = 2. \end{cases}$$ \hspace{1cm} (4)

The recursive bivariate probit is, therefore, defined as

$$\Pr(T_i = 1, Z_i = 1 | X_i, Z_i, M_i) = \Phi_{12}(Y_{\text{PL}} - (\beta' X_i + \delta Z_i), (\theta' X_i + \lambda M_i) - 2, \rho),$$ \hspace{1cm} (5)

where $\Phi_{12}(\cdots)$ is the bivariate normal cumulative density function, $X_i$ is a vector of exogenous variables which influence both fertility and poverty, $M_i$ is a zero-one dummy IV defined as equal to one if the first two children are girls and zero otherwise. $\beta$ and $\theta$ are vectors of parameters to be estimated, and $\delta$ and $\lambda$ are scalar parameters of the fertility dummy and the IV, respectively, $\epsilon_i$ and $\eta_i$ are error terms, and $\rho$ measures the correlation between $\epsilon_i$ and $\eta_i$. The parameters are estimated by maximum likelihood. Testing the null hypothesis, $\rho = 0$, using a Wald test amounts to testing for the exogeneity of fertility. The specified recursive bivariate probit corrects for simultaneity (through the IV) and at the same time controls for unobserved heterogeneity (by allowing correlation between the errors which capture unobserved factors among other things). Our two equation system is identified by way of exclusion restriction, that is, the poverty equation does not have $M_i$ the IV as a regressor. It should, however, be pointed out that theoretically it is possible to achieve identification by functional form only, that is, without exclusion restrictions. This type of identification depends entirely on the bivariate normality of the errors. The exclusion restrictions help in making results robust to distributional misspecification (Monfardini and Dubey 2006). Further, in our case the instrument allows us to check the robustness of our probit results to assuming that poverty is continuous.

4.1. **Subjective poverty**

As indicated earlier, this study uses the ELQ method to measure subjective poverty. Using this method, one can model subjective poverty using an ordered probit model (see, e.g. Ravallion and Lokshin 2002), where the rungs of the ladder represent ordered outcomes. Following Devereux et al. (2006) and Kalugina and Najman (2002), we define a subjective poverty dummy as follows; households are subjectively poor if they fall on the bottom two rungs of the ladder and non-poor if they fall on rungs three to six. So the impact of fertility on subjective poverty is modeled using the recursive bivariate probit presented in the preceding section for objective poverty. In addition to the variables already discussed, we control for household demographics, education, employment, agriculture, religion, and community level characteristics. We also control for regional effects by including regional dummies.

4.2. **Data and descriptives**

The data for this analysis come from the Second Malawi Integrated Household Survey (IHS2). The survey collects demographic information which inter alia includes age and sex, together with the relationship of each household member to the household head. This information allows us to identify children and their birth orders, which we then use to generate the son preference IV. The survey also collects information on subjective assessment of well-being. Of a total of 11,280 households, we focus on 9827 rural households (87%), as it is the rural areas where son preference may be more evident. Through a variable which captures the relationship to the household head, we can identify who is a husband and who is a wife. The survey collected information on non-resident biological children who were residing in an institution elsewhere (e.g. boarding school students) but were still dependent on the household. Because biological children who were not dependent on the household were not tracked; we impose the following restriction on the rural sample. The sample is limited to wives (mothers) aged 20–40, whose oldest child was less than 17 years of age at the time of the survey. Since we are focusing on households with at least two children, we would not expect many women younger than age 20 to have two children. Besides, it is to be expected that a child over age 17 has moved to a different household. Similar restrictions are used by Angrist and Evans (1998) and Gupta and Dubey (2006).
We relax these age restrictions to see if our results are not affected by the possibility of sample selection. We also relax the restriction on family size to those with at least a child. The general findings are not different from those found using a sample of mothers aged 20–40 and families with at least two children. We, therefore, have about 3400 rural households constituting the restricted sample.

In Table 1, we present results of the relationship between poverty headcounts and fertility measured as number of children. We find that for all poverty lines the poverty headcount rate is increasing with the number of children. For example, using the poor poverty line we find that for the unrestricted (restricted) 47.3% (46.2%) of households with less than three children are poor; this is in contrast to a head count rate of 71.6% (74.5%) for those households with more than six children. This suggests that poverty and fertility might be positively related. This pattern holds for both samples; we should also note that the head counts are not very different for the two samples, implying that our restricted sample represents quite well the total rural sample.

In Table 2, we check the relationship between subjective poverty headcounts and the number of children. The results show an opposite relationship to that found under the objective poverty analysis (Table 1). Whereas before we found that the more the number of children the higher the poverty rate, the results here show that the more the number of children a household has, the lower the subjective poverty. This suggests that there might be a negative relationship between subjective poverty and fertility.

In Table 3, we report the results of the descriptive analysis of the explanatory variables used in the study. The average number of children is 2.9. About three quarters of households have more than two children. Households which have two girls first make about 19% of our sample.

In Table 3, we also show descriptive statistics for all rural households. This is done in order to check the representativeness of the variables used in our regression analyses. The results indicate that the restricted sample is generally not very different from the sample of all rural households; suggesting that it is a realistic representation of rural households. For example, the average number of children for the two or more children sample is slightly higher than that of all households, 2.9 against 2.4 for all households.

5. Econometric results

5.1. Impact of exogenous fertility on objective poverty

In this section results (Table 4) of naïve univariate probit regressions which assume that fertility is exogenous for the three poverty lines are presented and discussed. These results serve as our base for comparison with the scenario where we assume that fertility is endogenous.

Similar to the findings of Gupta and Dubey (2006), the univariate probit results suggest a positive and statistically significant effect of fertility on poverty. This implies that exogenous fertility increases the likelihood of being poor. The size of the effect ranges from 11% to 23%, and these values are economically substantial. This relationship is monotonic, as it holds for all the three poverty lines, suggesting that our results are robust to choice of a poverty line and that the first-order dominance assumption is not violated. We also observe that the impact of

| Table 1. Poverty headcount and fertility. |
|-------------------------------------------|
| **Poverty line name** | **Number of children** | **Restricted (%)** | **All (%)** |
|----------------------|------------------------|-------------------|------------|
| Ultra-poor           | Less than three        | 15.9              | 17.5       |
|                      | Between three and six  | 33.1              | 33.9       |
|                      | Greater than six       | 45.3              | 42.8       |
| Poor                 | Less than three        | 46.2              | 47.3       |
|                      | Between three and six  | 69.1              | 69.8       |
|                      | Greater than six       | 74.5              | 71.6       |
| World Bank (US $1)   | Less than three        | 21                | 22.8       |
|                      | Between three and six  | 40.8              | 41.2       |
|                      | Greater than six       | 52.3              | 48.8       |

Notes: Restricted rural households are those which have a mother aged between 20 and 40, the oldest child under 17, and have at least two biological children. All refers to the total rural sample with at least one child.

| Table 2. Subjective poverty and number of children. |
|-----------------------------------------------------|
| **Number of children** | **Subjectively poor headcount** |
|------------------------|---------------------------------|
| Less than three        | Restricted (%) | All (%) |
| 83.5                  | 85.38            |
| Between three and six  | 84.6             | 85.12   |
| Greater than six       | 76               | 76.51   |

Notes: Restricted rural households are those which have a mother aged between 20 and 40, the oldest child under 17, and have at least two biological children. All households are rural households with at least one child.
exogenous fertility on poverty increases as the poverty line increases, that is, moving from ultra-poor to poor. This might indicate that children become more expensive as your income increases as households opt for good-quality children. Our discussion above has been based on the assumption that fertility is exogenous, but as discussed before fertility might be endogenous. In the next section, we address this issue of endogeneity of fertility.

5.2. Controlling for endogenous fertility

5.2.1. Validity of the IV

As discussed before, to account for endogeneity we are using son preference as our IV. Before we go on to use the IV we first check two things. Firstly, we test using a hazard model whether indeed son preference exists in rural Malawi. Secondly, we check the validity of son preference as an IV. We address each one of these issues below.
Table 4. Marginal effects of the impact of exogenous fertility on poverty.

| Variable                  | Ultra-poor | World Bank | Poor |
|---------------------------|------------|------------|------|
| Demographics              |            |            |      |
| Two children or more      | 0.109***   | 0.134***   | 0.225*** |
|                           | (0.013)    | (0.016)    | (0.027) |
| Mother’s age              | 0.004***   | 0.004**    | 0.006*** |
|                           | (0.001)    | (0.001)    | (0.002) |
| Dependency ratio          | 0.040***   | 0.057***   | 0.109*** |
|                           | (0.007)    | (0.009)    | (0.016) |
| Age at first birth        | -0.010***  | -0.010***  | -0.017*** |
|                           | (0.002)    | (0.002)    | (0.003) |
| Education                 |            |            |      |
| Females with primary      | -0.028     | -0.042     | -0.123*** |
|                           | (0.026)    | (0.033)    | (0.046) |
| Males with primary        | -0.013     | -0.013     | -0.013   |
|                           | (0.019)    | (0.023)    | (0.038) |
| Females with JCE          | -0.017     | -0.042     | 0.043    |
|                           | (0.034)    | (0.039)    | (0.060) |
| Males with JCE            | 0.041      | 0.033      | 0.055    |
|                           | (0.026)    | (0.033)    | (0.051) |
| Males with MSCE           | -0.047     | -0.049     | -0.117   |
|                           | (0.045)    | (0.051)    | (0.075) |
| Father primary            | -0.006     | -0.008     | -0.056   |
|                           | (0.025)    | (0.031)    | (0.047) |
| Mother primary            | -0.010     | 0.017      | 0.084    |
|                           | (0.035)    | (0.048)    | (0.065) |
| Father secondary          | -0.053**   | -0.088***  | -0.189*** |
|                           | (0.024)    | (0.028)    | (0.053) |
| Mother secondary          | -0.070***  | -0.066*    | -0.184*** |
|                           | (0.025)    | (0.038)    | (0.062) |
| Employment                |            |            |      |
| Father works              | -0.038***  | -0.038**   | -0.060** |
|                           | (0.013)    | (0.016)    | (0.024) |
| Mother works              | -0.034     | -0.039     | -0.012   |
|                           | (0.025)    | (0.031)    | (0.047) |
| Children work at home     | 0.008      | 0.026      | 0.020    |
|                           | (0.014)    | (0.017)    | (0.025) |
| Children work outside home| 0.020      | 0.046      | 0.071    |
|                           | (0.028)    | (0.036)    | (0.051) |
| Number of enterprises     | -0.020***  | -0.033**   | -0.095*** |
|                           | (0.011)    | (0.013)    | (0.019) |
| Agriculture               |            |            |      |
| Loan                      | -0.031**   | -0.041*    | -0.049** |
|                           | (0.002)    | (0.021)    | (0.024) |
| Grows tobacco             | -0.012     | -0.036**   | -0.096*** |
|                           | (0.014)    | (0.016)    | (0.023) |
| Land                      | -0.021***  | -0.028***  | -0.034** |
|                           | (0.004)    | (0.003)    | (0.017) |
| Livestock                 | -0.032***  | -0.040***  | -0.062*** |
|                           | (0.004)    | (0.005)    | (0.007) |
| Religion                  |            |            |      |
| Muslim                    | 0.031      | 0.023      | 0.035   |
|                           | (0.026)    | (0.030)    | (0.042) |
| Catholic                  | 0.029      | 0.032      | 0.018   |
|                           | (0.019)    | (0.024)    | (0.033) |
| Protestant                | 0.036**    | 0.021      | 0.001   |
|                           | (0.017)    | (0.022)    | (0.032) |
| Community                 |            |            |      |
| Has clinic                | -0.033***  | -0.048***  | -0.071*** |
|                           | (0.012)    | (0.014)    | (0.021) |
Since the focus of this study is not on measuring son preference, we will not be too detailed about the methodology (for details see Haughton and Haughton 1998). In order to test for evidence of son preference, we need to first define what we mean by son preference. There are basically two concepts of son preference. The first is called lexicographic preferences; also referred to as the threshold, fixed minima, or target view of son preference, this approach assumes that the $i^{th}$ household desires $S_i$ sons, regardless of the number of daughters which it will need to have to achieve this goal. In practice, the target is likely to vary over households, and it may vary within a household over time, either way it is an unobservable quantity. The second concept of son preference is what is called sequential preference. This obtains when for any given number of sons and daughters, parents prefer an additional son to an additional daughter.

To measure lexicographic preferences you need families which have stopped child-bearing, that is, complete families (Haughton and Haughton 1998). To measure sequential preference you can use incomplete families. Since in the IHS2 data there is no distinction between complete and incomplete families, we use the concept of sequential preference to measure son preference. Sequential preference can be measured by using a hazard model. The hazard model estimates the risk (hazard) of having another child at any point in time. For an accelerated failure time (AFT) model, if the hazard is higher for families with a son (or sons), the implication is that son preference is present. The dependent variable is the length of the interval (in months) between one birth and the next, a by-product of recording the birth dates of the children born in the household. Specifically, we focus on two intervals namely the transition from the second to the third child, and the transition from the third to the fourth child. In addition to the covariates included in the other regressions we use the number of existing boys in a household.

If son preference is present, we would expect the coefficient for number of existing boys to be positive, implying that the higher the number of boys, the longer the duration between births. It is supposed that households that do not have as many sons as they wish, will hurry to have another before it is too late. Underlying this idea is the notion that households may have sequential son preference. Results in Table 5 are based on the AFT Weibull hazard model. For the two transitions, the coefficient for number of boys is positive and significant, suggesting the presence of son preference in rural Malawi.2 Among other variables, we controlled for the employment of the father, and for the interval 2–3 we find that fathers’ employment increases the duration of the birth interval though this effect is insignificant on the next birth interval. Having found that son preference is present in rural Malawi the next thing to be done is to check if it is a valid instrument.

For a variable to be a good IV, it firstly must be uncorrelated with the error term, which in our case means that it must not be correlated with poverty. Secondly, it must be correlated with the endogenous variable. The consistency of our results may be affected by the possibility that the IV may be correlated with the error term, that it may be endogenous. There are two possible scenarios in which this can happen. Firstly, there is a possibility of using ultrasound services to know in advance the sex of a child which
the rich can access, which can then be used to do prenatal sex screening. This would make our IV correlated with economic status (poverty). It, however, has to be said that while this is possible in rich countries where medical services are very advanced, this cannot be the case in rural Malawi where medical facilities are quite basic. Besides, abortion including sex selective abortion is illegal in Malawi.

The second issue which can lead to endogeneity is what Rosenzweig and Wolpin (2000) call the hand-me-down effect. They argue that the cost of children depends on sex composition and show that there is strong evidence for a hand-me-down effect. This is an economies of scale effect where if you have children of the same sex you spend less because there are some things like clothing which can be used by the child coming after. Now if households with children of the same sex spend significantly less money than households with children of different sexes, this difference in consumption may affect the poverty situation of the household. In this case, therefore, the IV is endogenous. In Table 6, we report results of two sample t-tests of mean differences to check for evidence of the hand-me-down effect. If the hand-me-down effect is present, we would expect there to be a statistically significant difference in expenditure on clothing and education by sex of the child. That is, if the hand-me-down effect is present, the expenditure on the two items should be significantly lower for the case where two girls or two boys are first than the case where there is a mix of a boy and a girl. However, we do not find a statistically significant difference in expenditure on the two items between households with son preference or two boys first and those with a girl and a boy. The implication of this finding is that son preference is not endogenous through the hand-me-down effect.

We check for the second condition regarding the relationship between fertility and our IV by estimating a reduced form univariate probit model of fertility. The results are presented in Table 7. Column 1 leaves out religion, Column 2 leaves out region but includes religion, and Column 3 has all covariates. Most of the variables have the expected signs. A father’s education is a strong predictor of fertility though the education of mother does not have a significant effect on fertility. This probably reflects the fact that in rural households a father has a final say on everything including, for example, contraceptives. And the more educated a father is, the more likely the family is to adopt family planning. We find that if children work at home it leads to more fertility as more hands

| Variable                  | Mean | Hazard ratio | Transition 2–3 | Hazard ratio | Transition 3–4 |
|---------------------------|------|--------------|----------------|--------------|----------------|
| Number of boys            | 1.94 | 1.12         | 0.114***       | 1.11         | 0.113***       |
|                           |      |              | (0.018)        |              | (0.023)        |
| Father works              | 0.2328 | 2.71        | 0.100**        | 0.92         | –0.073         |
|                           |      |              | (0.046)        |              | (0.062)        |
| Children work at home     | 0.5048 | 0.90        | –0.103**       | 0.74         | –0.299***      |
|                           |      |              | (0.048)        |              | (0.081)        |
| Children work outside home| 0.0446 | 0.77        | –0.259***      | 1.16         | 0.156*         |
|                           |      |              | (0.074)        |              | (0.081)        |
| F-statistic               | 4.79 |              |                | 5.50         |                |
| Prob > F-statistic        | 0.00 |              |                | 0.00         |                |
| Sample size               | 2720 |              |                | 1651         |                |

Notes: The dependent variables are birth intervals moving from 2 to 3 children, and moving from 3 to 4 children. In addition to the new variable number of boys, the models also include all the other covariates included in the previous models. The hazard ratio is an exponentiated coefficient. Numbers in parentheses are standard errors.

* p < 0.10.
** p < 0.05.
*** p < 0.01.

| Variable                  | Sample mean (µ) | Mean difference (µ – µ_mix) |
|---------------------------|-----------------|----------------------------|
| Two girls first           |                 |                            |
| Education                 | 1458.875        | 322.929                    |
|                           | (264.87)        | (197.309)                  |
|                           |                 | [0.1017]                   |
| Clothing                  | 4431.883        | 324.835                    |
|                           | (7022.024)      | (199.979)                  |
|                           |                 | [0.1043]                   |
| Two boys first            |                 |                            |
| Education                 | 1199.512        | 63.566                     |
|                           | (70.881)        | (100.73)                   |
|                           |                 | [0.5280]                   |
| Clothing                  | 4173.29         | 66.249                     |
|                           | (91.23)         | (118.75)                   |
|                           |                 | [0.5769]                   |

Notes: Mean differences are defined as the sample means of rural households which have two girls first (two boys first) (µ) minus the sample of rural households which have a mix in the first two children i.e. boy and a girl (µ_mix). The means are weighted. Numbers in parentheses are standard errors. Numbers in square brackets are p-values.

* p < 0.10.
** p < 0.05.
*** p < 0.01.
Table 7. Marginal effects of reduced form univariate probit regressions of fertility.

| Variable                        | (1)       | (2)       | (3)       |
|---------------------------------|-----------|-----------|-----------|
| **Demographics**                |           |           |           |
| Mother’s age                    | 0.001*    | 0.001*    | 0.001*    |
|                                 | (0.001)   | (0.001)   | (0.001)   |
| Dependency ratio                | 0.148***  | 0.149***  | 0.148***  |
|                                 | (0.023)   | (0.023)   | (0.023)   |
| Two girls first                 | 0.102***  | 0.103***  | 0.102***  |
|                                 | (0.020)   | (0.020)   | (0.020)   |
| Age at first birth              | -0.019*** | -0.019*** | -0.019*** |
|                                 | (0.004)   | (0.004)   | (0.004)   |
| **Education**                   |           |           |           |
| Females with primary            | -0.003    | -0.004    | -0.003    |
|                                 | (0.019)   | (0.019)   | (0.018)   |
| Males with primary              | 0.027     | 0.025     | 0.025     |
|                                 | (0.016)   | (0.017)   | (0.016)   |
| Females with JCE                | 0.020     | 0.023     | 0.019     |
|                                 | (0.025)   | (0.024)   | (0.024)   |
| Males with JCE                  | 0.074***  | 0.074***  | 0.073***  |
|                                 | (0.020)   | (0.020)   | (0.020)   |
| Males with MSCE                 | 0.084***  | 0.085***  | 0.083***  |
|                                 | (0.028)   | (0.028)   | (0.028)   |
| Father primary                  | -0.029    | -0.029    | -0.024    |
|                                 | (0.027)   | (0.027)   | (0.026)   |
| Mother primary                  | -0.005    | -0.007    | -0.007    |
|                                 | (0.025)   | (0.025)   | (0.026)   |
| Father secondary                | -0.152*** | -0.151*** | -0.146*** |
|                                 | (0.052)   | (0.052)   | (0.051)   |
| Mother secondary                | -0.044    | -0.052    | -0.046    |
|                                 | (0.043)   | (0.044)   | (0.043)   |
| **Employment**                  |           |           |           |
| Father works                    | 0.007     | 0.006     | 0.007     |
|                                 | (0.008)   | (0.008)   | (0.008)   |
| Mother works                    | 0.017     | 0.018     | 0.017     |
|                                 | (0.011)   | (0.011)   | (0.011)   |
| Children work at home           | 0.103***  | 0.103***  | 0.104***  |
|                                 | (0.026)   | (0.025)   | (0.026)   |
| Children work outside home      | 0.026     | 0.028*    | 0.027*    |
|                                 | (0.016)   | (0.016)   | (0.016)   |
| Number of enterprises           | -0.001    | -0.001    | -0.001    |
|                                 | (0.006)   | (0.006)   | (0.006)   |
| **Agriculture**                 |           |           |           |
| Loan                            | 0.003     | 0.005     | 0.002     |
|                                 | (0.006)   | (0.004)   | (0.002)   |
| Grows tobacco                   | 0.011     | 0.016**   | 0.010     |
|                                 | (0.007)   | (0.008)   | (0.007)   |
| Land                            | -0.002    | -0.001    | -0.003    |
|                                 | (0.003)   | (0.002)   | (0.003)   |
| Livestock                       | -0.005*   | -0.004    | -0.005    |
|                                 | (0.003)   | (0.003)   | (0.003)   |
| **Religion**                    |           |           |           |
| Muslim                          |           |           |           |
|                                 |           |           |           |
| Catholic                        |           |           |           |
|                                 |           |           |           |
| Protestant                      |           |           |           |
|                                 |           |           |           |
| **Community**                   |           |           |           |
| Has clinic                      | 0.007     | 0.008     | 0.007     |
|                                 | (0.007)   | (0.007)   | (0.007)   |

(Continued)
are needed for domestic work. Of particular interest is the relationship between the IV and fertility. Having two girls first significantly increases the probability of having more than two children. The relationship holds for all the three specifications presented in Table 8. This suggests that fertility and the IV are correlated. It is worth noting that whether or not we control for religion and region the effect of having two girls first on the probability of having more than two children is not affected by religion or regional effects.

5.2.2. Impact of endogenous fertility on objective poverty

The Chi-square values (p-values) of the Wald test for exogeneity of fertility are 9.05 (0.00), 4.77 (0.03), and 4.80 (0.03) for the ultra-poor, poor, and World Bank poverty lines, respectively. We, therefore, conclude that fertility is endogenous with respect to objective poverty. In Tables 8–10, we report the marginal effects of the recursive bivariate probit of the impact of fertility on poverty for the three poverty thresholds. The results indicate that fertility and poverty are positively related. The effect is statistically significant. This implies that fertility increases the probability of being poor. The impacts are economically significant with values ranging from 0.139 to 0.304. This relationship is monotonic, as it holds for the three poverty thresholds, suggesting that just like in the base scenario where we assumed fertility to be exogenous, our results are robust to choice of a poverty line. This means that the first-order dominance assumption is not violated. Just like the naive results of exogenous fertility, the impact of endogenous fertility across the poverty lines increases as the poverty line increases, that is, moving from ultra-poor to poor.

We note, however, that the total effect of fertility on poverty is larger than the one we got when we assumed that fertility is exogenous. This implies that assuming that fertility is exogenous underestimates its impact on poverty. For all poverty lines, the underestimation is about 1.3 times. It should be pointed out that the statistically significant effect of endogenous fertility is not in conformity with a finding by Gupta and Dubey (2006) for India. They find that the impact of fertility on poverty is statistically insignificant after controlling for endogeneity. This finding that treating fertility as an endogenous variable increases its effect on poverty merits further speculative comment. If endogeneity was arising from reverse causation, then the IV would purge the reverse causality problem, making the relationship less positive, that is, the effect of endogenous fertility should be smaller than that of exogenous fertility. This means that our result does not conform to this expectation. However, if the endogeneity problem arises from omitted variables which influence both fertility and poverty, then there might be downward omitted variable bias, and thus by purging out the endogeneity problem we get rid of this bias.

So far our analysis has been based on real per capita annualized consumption expenditure. This analysis does not take into account household composition and economies of scales. We next investigate whether or not the impact of fertility on objective poverty that we have found is robust to accounting for household composition and economies of scale. The use of per capita consumption expenditure is common in poverty studies; however, this procedure has two problems. First, different individuals have different needs. For example, a young child typically requires less food than an adult. Second, there are economies of scale

| Variable                           | (1)       | (2)       | (3)       |
|-----------------------------------|-----------|-----------|-----------|
| Lives in trading centre           | −0.001    | −0.001    | −0.001    |
|                                   | (0.022)   | (0.022)   | (0.021)   |
| Region                            |           |           |           |
| North                             | −0.004    |           | −0.002    |
|                                   | (0.012)   |           | (0.012)   |
| Centre                            | 0.020**   | 0.022**   |           |
|                                   | (0.008)   | (0.009)   |           |
| Loglikelihood                     | −867.28   | −870.62   | −864.89   |
| Chi-square                        | 2006.61   | 2001.93   | 2013.39   |
| Prob > Chi-square                 | 0.00      | 0.00      | 0.00      |
| Sample size                       | 3402      | 3402      | 3402      |
| McFadden R²                       | 0.536     | 0.535     | 0.538     |

Notes: The dependent variable is a dummy for more than two children. The coefficients are marginal effects evaluated as partial changes at the mean value of the continuous covariates. For dummy covariates, the partial changes are measured as a discrete change in the poverty indicator as the dummy covariate changes from 0 to 1. Numbers in parentheses are standard errors. JCE is Junior Certificate of Education, and MSCE is Malawi School Certificate of Education.

*p < 0.10.

**p < 0.05.

***p < 0.01.
Table 8. Impact of endogenous fertility on poverty (ultra-poor).

| Variable                          | Poverty equation | Fertility equation |
|-----------------------------------|------------------|--------------------|
|                                   | Direct effect    | Indirect effect    | Total effect | Total effect |
| **Demographics**                  |                  |                    |                          |              |
| Two children or more              | 0.139***         | 0.139***           | 0.105***      |              |
|                                  | (0.014)          | (0.014)            | (0.020)       |              |
| Two girls first                   |                  | 0.011**            | 0.011**       | 0.151***     |
|                                  | (0.005)          | (0.005)            | (0.023)       |              |
| Mother’s age                      | 0.003***         | 0.001              | 0.004***      | 0.001        |
|                                  | (0.001)          | (0.001)            | (0.001)       |              |
| Dependency ratio                  | 0.057***         | -0.028***          | 0.043***      | 0.151***     |
|                                  | (0.008)          | (0.006)            | (0.007)       |              |
| Age at first birth                | -0.011***        | 0.003***           | -0.009***     | -0.020***    |
|                                  | (0.002)          | (0.001)            | (0.002)       | (0.005)      |
| **Education**                     |                  |                    |                          |              |
| Females with primary             | -0.027           | -0.002             | -0.028        | -0.002       |
|                                  | (0.023)          | (0.004)            | (0.024)       | (0.017)      |
| Males with primary               | -0.010           | -0.007*            | -0.013        | 0.028*       |
|                                  | (0.015)          | (0.004)            | (0.016)       | (0.016)      |
| Females with JCE                 | -0.014           | -0.006             | -0.017        | 0.020        |
|                                  | (0.031)          | (0.006)            | (0.033)       | (0.024)      |
| Males with JCE                   | 0.047**          | -0.012**           | 0.042*        | 0.074***     |
|                                  | (0.024)          | (0.005)            | (0.025)       | (0.021)      |
| Males with MSCE                  | -0.032           | -0.022***          | -0.043        | 0.085***     |
|                                  | (0.042)          | (0.008)            | (0.044)       | (0.029)      |
| Father primary                   | -0.009           | 0.005              | -0.006        | -0.030       |
|                                  | (0.020)          | (0.006)            | (0.022)       | (0.028)      |
| Mother primary                   | -0.007           | 0.001              | -0.007        | -0.007       |
|                                  | (0.029)          | (0.006)            | (0.031)       | (0.025)      |
| Father secondary                 | -0.063***        | 0.014              | -0.057**      | -0.146***    |
|                                  | (0.020)          | (0.009)            | (0.023)       | (0.054)      |
| Mother secondary                 | -0.065***        | -0.001             | -0.066***     | -0.048       |
|                                  | (0.022)          | (0.006)            | (0.024)       | (0.043)      |
| **Employment**                   |                  |                    |                          |              |
| Father works                     | -0.035***        | -0.005**           | -0.037***     | 0.007        |
|                                  | (0.012)          | (0.002)            | (0.013)       | (0.008)      |
| Mother works                     | -0.031           | -0.006**           | -0.034        | 0.019*       |
|                                  | (0.022)          | (0.003)            | (0.023)       | (0.11)       |
| Children work at home            | 0.018            | -0.021***          | 0.007         | 0.105***     |
|                                  | (0.014)          | (0.006)            | (0.014)       | (0.025)      |
| Children work outside home       | 0.027            | -0.006             | 0.024         | 0.030*       |
|                                  | (0.026)          | (0.004)            | (0.027)       | (0.016)      |
| Number of enterprises            | -0.019*          | -0.002             | -0.020*       | -0.001       |
|                                  | (0.011)          | (0.001)            | (0.011)       | (0.006)      |
| Loan                             | -0.021***        | -0.032***          | -0.053***     | 0.001        |
|                                  | (0.001)          | (0.002)            | (0.002)       | (0.001)      |
| **Agriculture**                  |                  |                    |                          |              |
| Grows tobacco                    | -0.010           | -0.003             | -0.012        | 0.010        |
|                                  | (0.014)          | (0.002)            | (0.015)       | (0.007)      |
| Land                             | -0.011***        | -0.003             | -0.012**      | -0.001       |
|                                  | (0.001)          | (0.003)            | (0.002)       | (0.001)      |
| Livestock                        | -0.030***        | -0.002**           | -0.031***     | -0.005       |
|                                  | (0.004)          | (0.001)            | (0.005)       | (0.003)      |
| **Religion**                     |                  |                    |                          |              |
| Muslim                           | 0.031            | -0.002             | 0.031         | 0.017        |
|                                  | (0.028)          | (0.003)            | (0.029)       | (0.012)      |
| Catholic                         | 0.025            | 0.002              | 0.027         | 0.000        |
|                                  | (0.019)          | (0.003)            | (0.020)       | (0.011)      |

(Continued)
in consumption for such items as housing, kitchen utensils, and utilities such as electricity. It costs less to house two people than to house two individuals separately. Larger households can do bulk buying which can attract discounts. Some studies have shown that the impact of household size on poverty disappears once these two problems are addressed (e.g. Lanjouw and Ravallion 1995; White and Masset 2003). The solution to these problems is to use adult equivalent (AE) scales. An AE scale measures the number of adult males (typically) to which that household is deemed to be equivalent. In this study, we use the arbitrary method to measure equivalence scales; in the literature there are different methods for measuring equivalence scale, none of them commands universal assent (see Deaton and Zaidi 2002). The number of AEs is defined as follows:

\[ \text{AE} = (A + \pi K)^\kappa, \quad (6) \]

where \( A \) is the number of adults in the household, \( K \) the number of children in the household, parameter \( \pi \) the cost of a child relative to that of an adult, and lies between 0 and 1. The parameter \( \kappa \) which also lies between 0 and 1 controls the extent of economies of scale since the elasticity of AEs with respect to ‘effective’ size, \( A + \pi K \) is \( \kappa \), \( (1-\kappa) \) is a measure of economies of scale. When both \( \pi \) and \( \kappa \) are unity (the most extreme case with no discount for children or for size) the number of AEs is simply household size, and deflation by household size is equivalent to deflating to a per capita basis. If \( \kappa \) is zero, then economies of scale are so extreme that welfare is the same for different households with the same total consumption expenditure regardless of household size. The choice of the values of the parameters \( \pi \) and \( \kappa \) is arbitrary, we use the following values \( \pi = 0.65 \) and \( \kappa = 0.9 \). For the cost of children parameter, our value is based on the one used for Zambia by the World Bank (2005). Being neighbors, we would expect the Zambian figures to be similar to Malawi’s. Our choice of \( \kappa \) is motivated by the fact that, in an economy such as Malawi’s, where the budget share of privately consumed goods is high, the true \( \kappa \) is likely to be high, probably in the neighborhood of 0.8 (Deaton 1997). It should, however, be noted that even in the case of food, economies of household size can arise through practices such as bulk purchasing. The annualized real consumption expenditure for each household is divided by the AE to have consumption per AE. With this adjustment a household is considered poor if its annualized real consumption per AE is below the three poverty lines discussed before.

The previous regressions were re-estimated in order to check the robustness of our findings to accounting for household composition and economies of scale. We present results in Table 11 for both univariate probit which assumes exogenous fertility as well as the recursive bivariate probit. We have replicated the previous per capita

| Variable                  | Direct effect | Indirect effect | Total effect | Fertility equation |
|---------------------------|---------------|----------------|--------------|--------------------|
| Protestant                | 0.035**       | −0.000         | 0.035**      | 0.016              |
| Community                 |               |                |              |                    |
| Has clinic                | −0.029**      | −0.004*        | −0.031**     | 0.006              |
| Lives in trading centre   | −0.027        | −0.002         | −0.029       | −0.000             |
| Region                    |               |                |              |                    |
| North                     | 0.012         | 0.001          | 0.013        | −0.001             |
| Centre                    | −0.093***     | −0.013***      | −0.100***    | 0.023**            |
| Chi-square                | 725.23        |                |              |                    |
| Prob > Chi-square         | 0.00          |                |              |                    |
| Sample size               | 3402          |                |              |                    |

Notes: The coefficients are marginal effects. For variables which appear in both the poverty and fertility equations, the marginal effects are decomposed into two effects. The direct effect produced by its presence in the poverty equation, and an indirect effect which works through the fertility equation. The sum of the two makes the total effect. The total effect may not exactly equal the sum of the two effects due to rounding. Numbers in parentheses are standard errors. The poverty equation is based on annualized per capita real consumption expenditure. JCE is Junior Certificate of Education, and MSCE is Malawi School Certificate of Education.

\* \( p < 0.10 \).
\** \( p < 0.05 \).
\*** \( p < 0.01 \).
Table 9. Impact of endogenous fertility on poverty (World Bank).

| Variable                | Direct effect | Indirect effect | Total effect | Fertility equation Total effect |
|-------------------------|---------------|-----------------|--------------|---------------------------------|
| **Demographics**        |               |                 |              |                                 |
| Two children or more    | 0.167***      |                 | 0.167***     | 0.106***                        |
|                         | (0.020)       |                 | (0.020)      | (0.020)                         |
| Two girls first         |               | 0.010*          | 0.010*       | 0.098**                         |
|                         |               | (0.005)         | (0.005)      | (0.005)                         |
| Mother's age            | 0.003**       | -0.002          | 0.001        | 0.003**                         |
|                         | (0.001)       |                 | (0.001)      |                                 |
| Dependency ratio        | 0.080***      | -0.033***       | 0.150***     | 0.059***                        |
|                         | (0.010)       |                 | (0.010)      | (0.023)                         |
| Age at first birth      | -0.013***     | 0.004***        | -0.010***    | -0.020***                       |
|                         | (0.002)       |                 | (0.002)      | (0.005)                         |
| **Education**           |               |                 |              |                                 |
| Females with primary    | -0.040        | -0.002          | -0.042       | -0.03                           |
|                         | (0.034)       |                 | (0.035)      | (0.017)                         |
| Males with primary      | -0.008        | -0.008*         | -0.013       | 0.027                           |
|                         | (0.017)       |                 | (0.018)      | (0.016)                         |
| Females with JCE        | -0.018        | -0.007          | -0.023       | 0.036                           |
|                         | (0.036)       |                 | (0.038)      | (0.024)                         |
| Males with JCE          | 0.043         | -0.016***       | 0.033        | 0.075***                        |
|                         | (0.031)       |                 | (0.032)      | (0.021)                         |
| Males with MSCE         | -0.030        | -0.024***       | -0.046       | 0.086**                         |
|                         | (0.049)       |                 | (0.051)      | (0.029)                         |
| Father primary          | -0.012        | 0.006           | -0.008       | -0.028                          |
|                         | (0.025)       |                 | (0.027)      | (0.028)                         |
| Mother primary          | 0.017         | 0.003           | 0.019        | -0.007                          |
|                         | (0.046)       |                 | (0.048)      | (0.024)                         |
| Father secondary        | -0.099***     | 0.015           | -0.091***    | -0.147***                       |
|                         | (0.024)       |                 | (0.028)      | (0.054)                         |
| Mother secondary        | -0.064*       | 0.003           | -0.062*      | -0.046                          |
|                         | (0.035)       |                 | (0.038)      | (0.043)                         |
| **Employment**          |               |                 |              |                                 |
| Father works            | -0.035**      | -0.004*         | -0.038**     | 0.007                           |
|                         | (0.016)       |                 | (0.016)      | (0.008)                         |
| Mother works            | -0.036        | -0.006**        | -0.040       | 0.018                           |
|                         | (0.027)       |                 | (0.028)      | (0.011)                         |
| Children work at home   | 0.039**       | -0.024***       | 0.024        | 0.108***                        |
|                         | (0.017)       |                 | (0.017)      | (0.025)                         |
| Children work outside home | 0.053   | -0.006          | 0.050        | 0.029*                          |
|                         | (0.034)       |                 | (0.035)      | (0.016)                         |
| Number of enterprises   | -0.031**      | -0.002          | -0.033**     | -0.001                          |
|                         | (0.013)       |                 | (0.013)      | (0.006)                         |
| Loan                    | -0.026***     | -0.022**        | -0.046**     | 0.002                           |
|                         | (0.002)       |                 | (0.001)      | (0.002)                         |
| **Agriculture**         |               |                 |              |                                 |
| Grows tobacco           | -0.032*       | -0.005**        | -0.035*      | 0.010                           |
|                         | (0.017)       |                 | (0.018)      | (0.007)                         |
| Land                    | -0.002*       | -0.002          | -0.004       | -0.002                          |
|                         | (0.001)       |                 | (0.003)      | (0.002)                         |
| Livestock               | -0.038***     | -0.001*         | -0.039***    | -0.005*                         |
|                         | (0.005)       |                 | (0.006)      | (0.003)                         |
| **Religion**            |               |                 |              |                                 |
| Muslim                  | 0.025         | -0.003          | 0.023        | 0.017                           |
|                         | (0.033)       |                 | (0.034)      | (0.012)                         |
| Catholic                | 0.029         | 0.002           | 0.030        | -0.000                          |
|                         | (0.023)       |                 | (0.024)      | (0.011)                         |
results for comparison. For the univariate probit regression, the results indicate that the variables are jointly significant. The simple probit results indicate that when we account for economies of scale and household composition, fertility significantly increases the likelihood of being poor across the poverty lines. This effect is monotonic as before implying our results are robust to choice of poverty line, and that the first-order dominance assumption is not violated. As was the case with the per capita poverty regressions, we find that for the adjusted regressions the impact of fertility across the poverty lines increases as the poverty line increases, that is, moving from ultra-poor to poor. However, as expected AE scale adjustment reduces the impact of fertility on poverty. The reductions are economically substantial. For the ultra-poor poverty line, the reduction is about 83.4%, for the World Bank US $1 line the reduction is 77.8%, and finally for the poor poverty line the reduction is 37.8%. This implies that the higher the consumption the lower the reduction in the impact of fertility after AE adjustments.

For the bivariate probit regressions a similar pattern emerges. After accounting for the endogeneity of fertility as well as economies of scale and household composition, fertility significantly increases the likelihood of being poor across the poverty lines. Besides, the impact is not as economically significant as that for per capita models, as it ranges from 0.012 to 0.177, compared against a range of 0.139 to 0.304 for the unadjusted models. Our results are robust to choice of poverty line and the impact of fertility across the poverty lines increases as the poverty line increases, that is, moving from ultra-poor to poor. Compared with the results from the simple probit models which account for economies of scale and household composition, we note that the impact of fertility on poverty is underestimated in the simple probit models. However, compared with the per capita bivariate probit results, the results show that the impact is reduced. For the ultra-poor model the reduction is 91.4%, for the World Bank US $1 line the reduction is 77.8%, and finally for the poor poverty line the reduction is 35%. These are economically significant reductions. We also notice that these reductions are not very different from those found for univariate probit models. These findings suggest that it is quite possible that the impact of fertility would be economically insignificant with some values of the equivalent scale parameters.

The conclusion from these results is that accounting for economies of scale and household composition reduces the impact of fertility on poverty, and that these reductions are economically large. However, the impact of fertility is still statistically significant regardless of whether or not fertility is exogenous or endogenous. Thus far we have looked at the impact of fertility on poverty, where the objective measure of well-being has been defined as a dummy. We next investigate the robustness of our results to measuring objective poverty by using a continuous variable instead. We estimated Two Stage Least Squares (2SLS) regressions

| Variable          | Direct effect | Indirect effect | Total effect | Total effect |
|-------------------|---------------|----------------|--------------|--------------|
| Protestant        | 0.022         | −0.002         | 0.021        | 0.015        |
|                   | (0.021)       | (0.003)        | (0.022)      | (0.012)      |
| Community         |               |                |              |              |
| Has clinic        | −0.043**      | −0.005*        | −0.046**     | 0.007        |
|                   | (0.018)       | (0.002)        | (0.019)      | (0.007)      |
| Lives in trading centre | −0.040      | −0.003         | −0.042       | −0.001       |
|                   | (0.037)       | (0.005)        | (0.038)      | (0.020)      |
| Region            |               |                |              |              |
| North             | 0.007         | 0.001          | 0.008        | −0.001       |
|                   | (0.027)       | (0.004)        | (0.029)      | (0.013)      |
| Centre            | −0.130***     | −0.015***      | −0.141***    | 0.024**      |
|                   | (0.019)       | (0.005)        | (0.019)      | (0.009)      |
| Chi-square        | 828.37        |                |              |              |
| Prob > Chi-square | 0.00          |                |              |              |
| Sample size       | 3402          |                |              |              |

Notes: The coefficients are marginal effects. For variables which appear in both the poverty and fertility equations, the marginal effects are decomposed into two effects. The direct effect produced by its presence in the poverty equation, and an indirect effect which works through the fertility equation. The sum of the two makes the total effect. The total effect may not exactly equal the sum of the two effects due to rounding. Numbers in parentheses are standard errors. The poverty equation is based on annualized per capita real consumption expenditure. JCE is Junior Certificate of Education, and MSCE is Malawi School Certificate of Education.

*p < 0.10.

**p < 0.05.

***p < 0.01.
Table 10. Impact of endogenous fertility on poverty (poor).

| Variable                        | Direct effect | Indirect effect | Total effect | Fertility equation |
|---------------------------------|---------------|-----------------|--------------|--------------------|
|                                 |               |                 |              |                    |
| **Demographics**                |               |                 |              |                    |
| Two children or more            | 0.304***      |                 | 0.304***     |                    |
|                                 | (0.040)       |                 | (0.040)      |                    |
| Two girls first                 |               | 0.015**         | 0.015**      | 0.106***           |
|                                 |               | (0.008)         | (0.008)      | (0.020)            |
| Mother’s age                    | 0.006***      | −0.003          | 0.006***     | 0.001              |
|                                 | (0.002)       |                 | (0.002)      | (0.001)            |
| Dependency ratio                | 0.169***      | −0.081***       | 0.109***     | 0.148***           |
|                                 | (0.020)       |                 | (0.016)      | (0.023)            |
| Age at first birth              | −0.024***     | 0.010***        | −0.016***    | −0.019***          |
|                                 | (0.004)       |                 | (0.003)      | (0.005)            |
| **Education**                   |               |                 |              |                    |
| Females with primary            | −0.119***     | −0.005          | −0.124***    | −0.002             |
|                                 | (0.042)       |                 | (0.044)      | (0.017)            |
| Males with primary              | −0.001        | −0.017          | −0.014       | 0.028              |
|                                 | (0.038)       |                 | (0.041)      | (0.017)            |
| Females with JCE                | 0.048         | −0.011          | 0.041        | 0.022              |
|                                 | (0.055)       |                 | (0.014)      | (0.024)            |
| Males with JCE                  | 0.084*        | −0.041***       | 0.054        | 0.075***           |
|                                 | (0.047)       |                 | (0.014)      | (0.021)            |
| Males with MSCE                 | −0.074        | −0.055***       | −0.118       | 0.086***           |
|                                 | (0.070)       |                 | (0.019)      | (0.029)            |
| Father primary                  | −0.064        | 0.013           | −0.055       | −0.029             |
|                                 | (0.043)       |                 | (0.016)      | (0.028)            |
| Mother primary                  | 0.079         | 0.009           | 0.088        | −0.008             |
|                                 | (0.061)       |                 | (0.016)      | (0.064)            |
| Father secondary                | −0.228***     | 0.049*          | −0.195***    | −0.148***          |
|                                 | (0.043)       |                 | (0.025)      | (0.054)            |
| Mother secondary                | −0.185***     | 0.009           | −0.181***    | −0.047             |
|                                 | (0.057)       |                 | (0.018)      | (0.063)            |
| **Employment**                  |               |                 |              |                    |
| Father works                    | −0.055**      | −0.007          | −0.061***    | 0.007              |
|                                 | (0.024)       |                 | (0.004)      | (0.025)            |
| Mother works                    | −0.008        | −0.010          | −0.016       | 0.016              |
|                                 | (0.046)       |                 | (0.007)      | (0.047)            |
| Children work at home           | 0.062**       | −0.060***       | 0.016        | 0.107***           |
|                                 | (0.028)       |                 | (0.015)      | (0.027)            |
| Children work outside home      | 0.088*        | −0.015          | 0.077        | 0.029*             |
|                                 | (0.049)       |                 | (0.011)      | (0.050)            |
| Number of enterprises           | −0.091***     | −0.004          | −0.095***    | −0.001             |
|                                 | (0.020)       |                 | (0.004)      | (0.020)            |
| Loan                            | −0.028***     | −0.001          | −0.029***    | 0.003              |
|                                 | (0.002)       |                 | (0.004)      | (0.005)            |
| **Agriculture**                 |               |                 |              |                    |
| Grows tobacco                   | −0.087***     | −0.010**        | −0.096***    | 0.011              |
|                                 | (0.028)       |                 | (0.005)      | (0.029)            |
| Land                            | −0.002*       | 0.002           | −0.004       | −0.001             |
|                                 | (0.001)       |                 | (0.002)      | (0.004)            |
| Livestock                       | −0.060***     | −0.004          | −0.061***    | −0.005*            |
|                                 | (0.007)       |                 | (0.002)      | (0.007)            |
| **Religion**                    |               |                 |              |                    |
| Muslim                          | 0.039         | −0.008          | 0.033        | 0.016              |
|                                 | (0.044)       |                 | (0.007)      | (0.044)            |
| Catholic                        | 0.015         | 0.001           | 0.016        | −0.001             |
|                                 | (0.033)       |                 | (0.006)      | (0.035)            |
of the impact of fertility on poverty, where the dependent variables are the log of real annualized per capita and AE adjusted consumption expenditures. For the 2SLS regressions, all right-hand variables for the two regressions remain the same as in the bivariate probit. In this framework, we also estimated a naïve regression which

Table 10. Continued.

| Variable                  | Direct effect | Poverty equation | Fertility equation |
|---------------------------|--------------|------------------|-------------------|
|                           |              | Indirect effect  | Total effect      |
| Protestant                | 0.006        | -0.008           | -0.001            | 0.014 |
|                           | (0.031)      | (0.007)          | (0.033)           | (0.012) |

Community

| Has clinic                | -0.064**     | -0.007           | -0.070**          | 0.007 |
|                           | (0.027)      | (0.004)          | (0.028)           | (0.007) |
| Lives in trading centre   | -0.089       | -0.005           | -0.094            | 0.001 |
|                           | (0.085)      | (0.010)          | (0.088)           | (0.019) |

Region

| North                     | 0.040        | 0.002            | 0.042             | -0.000 |
|                           | (0.045)      | (0.008)          | (0.046)           | (0.013) |
| Centre                    | -0.171***    | -0.022***        | -0.190***         | 0.024** |
|                           | (0.029)      | (0.007)          | (0.029)           | (0.009) |

Chi-square                 | 1076.35      |                  |                   |
Prob > Chi-square           | 0.00         |                  |                   |
Sample size                 | 3402         |                  |                   |

Notes: The coefficients are marginal effects. For variables which appear in both the poverty and fertility equations, the marginal effects are decomposed into two effects. The direct effect produced by its presence in the poverty equation, and an indirect effect which works through the fertility equation. The sum of the two makes the total effect. The total effect may not exactly equal the sum of the two effects due to rounding. Numbers in parentheses are standard errors. The poverty equation is based on annualized per capita real consumption expenditure. JCE is Junior Certificate of Education, and MSCE is Malawi School Certificate of Education.

*p<0.10.
**p<0.05.
***p<0.01.

Table 11. Accounting for household composition and economies of scale (marginal effects).

| Variable                  | Ultra-poor | World Bank | Poor |
|---------------------------|------------|------------|------|
|                           | Per capita | AES        | Per capita | AES   | Per capita | AES |
| Univariate probit         |            |            |            |       |            |     |
| Two children or more      | 0.109***   | 0.018***   | 0.134***   | 0.030*** | 0.225***   | 0.147*** |
|                           | (0.013)    | (0.004)    | (0.016)    | (0.005) | (0.027)    | (0.015) |
| All covariates            | Yes        | Yes        | Yes        | Yes    | Yes        | Yes |
| Chi-square                | 511.47     | 208.69     | 624.9      | 263.63 | 892.5      | 542.73 |
| Prob > Chi-square          | 0.00       | 0.00       | 0.00       | 0.00   | 0.00       | 0.00 |
| Sample size^2             | 3402       | 3402       | 3402       | 3402   | 3402       | 3402 |
| McFadden R^2              | 0.167      | 0.18       | 0.175      | 0.176  | 0.19       | 0.153 |
| Bivariate probit          |            |            |            |       |            |     |
| Two children or more      | 0.139***   | 0.026***   | 0.167***   | 0.037*** | 0.304***   | 0.177*** |
|                           | (0.014)    | (0.002)    | (0.020)    | (0.006) | (0.040)    | (0.020) |
| Instrument                | Yes        | Yes        | Yes        | Yes    | Yes        | Yes |
| All covariates            | Yes        | Yes        | Yes        | Yes    | Yes        | Yes |
| Chi-square                | 725.23     | 4792.6     | 828.37     | 665.49 | 1076.35    | 779.68 |
| Prob > Chi-square          | 0.00       | 0.00       | 0.00       | 0.00   | 0.00       | 0.00 |
| Sample size               | 3402       | 3402       | 3402       | 3402   | 3402       | 3402 |

Notes: Numbers in parentheses are standard errors. The per capita poverty equations are based on annualized per capita real consumption expenditure, and AES poverty equations are based on annualized real consumption expenditure per AE scale and economies of scale. For the poverty equations in the bivariate probit we report the total marginal effects only. For brevity total marginal effects of the fertility equation for the bivariate probit are not reported. The per capita results are replicated from earlier regressions for comparison.

*p<0.10.
**p<0.05.
***p<0.01.
assumes that fertility is exogenous. This is done by using Ordinary Least Squares (OLS). All right-hand variables are the same as those for the univariate probit regressions. The results are presented in Table 12.

The results indicate that for the OLS regression, fertility is negatively related to both per capita and AE adjusted consumption. This implies that having more than two children lowers consumption, and hence increases poverty. This is similar to the finding earlier, where the objective measure of well-being is defined as a dummy. The impact of fertility on poverty is lower when we account for economies of scale and household composition. Again, this is similar to our earlier findings. The regression based Hausman test for endogeneity (see Wooldridge 2002 for details) shows that fertility is endogenous. This implies that our OLS results may be biased and inconsistent. The 2SLS results, which account for this endogeneity show that as is the case with the OLS results, fertility is significantly negatively related to both per capita and AE adjusted consumption. However, the impact of fertility on consumption is higher when we account for endogeneity of fertility. For example, the OLS results of the per capita regression underestimate the effect of fertility by about 2.3 times. The finding that accounting for endogeneity raises the impact of fertility on poverty is similar to the one before with a dummy dependent variable. Additionally, the impact of endogenous fertility is reduced when we account for economies of scale and household composition. The reduction after accounting for endogeneity of fertility (2SLS) is about 20%. We also note that this reduction though economically large, is smaller than the reductions found using the bivariate probit.

To conclude, these results suggest that our earlier findings are robust to a different conceptualization of objective poverty. Specifically, when the indicator of poverty is defined as a continuous variable fertility increases the likelihood of being poor, this effect is underestimated when the joint determination of the two is not accounted for, and accounting for household composition and economies of scale diminishes the effect. Our analysis so far has looked at poverty in the objective and monetary sense which is a narrower definition of poverty. In the next section, we present the econometric results of the impact of fertility on subjective poverty which is based on self-reported well-being.

### 5.3. Impact of fertility on subjective poverty

As before, we test for evidence of endogeneity between fertility and subjective poverty. The Chi-square value (p-value) of the Wald test for exogeneity of fertility is 0.17 (0.6766). We, therefore, find no evidence that fertility is endogenous with respect to subjective poverty. This is in stark contrast to the objective poverty analysis where we find that fertility is endogenous. We, therefore, present the results in Table 13 of a univariate probit regression. Fertility is found to significantly lower the likelihood that a household will be subjectively poor. We find that fertility lowers the probability of being poor by about 3%. This result is, however, different from the objective poverty analysis where we find that fertility increases the probability of being poor. This perhaps reflects rural Malawi’s social cultural context where those households with more children are treated with respect and those with few or no, children are looked at with some contempt (MHRC 2009). That is, having more children elevates your status in society and these intangible benefits feed into peoples’ sense of well-being. Another possible explanation is that

| Variable                  | OLS per capita | OLS AES per capita | 2SLS per capita | 2SLS AES per capita |
|---------------------------|----------------|-------------------|-----------------|---------------------|
| Two children or more      | −0.298***      | −0.172***         | −0.568***       | −0.456***           |
| Instrument                | −              | −                 | −               | −                   |
| All covariates            | Yes            | Yes               | Yes             | Yes                 |
| Hausman test              | −              | −                 | 0.281**         | 0.295**             |
| Mean of dep. variable     | 9.627          | 9.99              | 9.627           | 9.99                |
| F-stat                    | 59.75          | 43.45             | 53.86           | 40.18               |
| Prob> F-stat              | 0.00           | 0.00              | 0.00            | 0.00                |
| Sample size               | 3402           | 3402              | 3402            | 3402                |

Notes: Numbers in parentheses are standard errors. The dependent variables for the per capita models are log of the annualized per capita real consumption expenditure. The dependent variables for the AES regressions are the log of the annualized real consumption expenditure per AE and economies of scale. The Hausman test is a regression based test of endogeneity of fertility.

*p < 0.10.

**p < 0.05.

***p < 0.01.
there is discounting taking place in the sense that households with more children expect to have a higher future discounted income and therefore feel less poor. This finding can also be explained in terms of utility in the sense that couples get additional utility when they have additional children.

Interestingly, for all the other variables the results are similar in terms of the signs and statistical significance to those for monetary poverty. We included a dummy variable marital status to capture some of the characteristics of the household head. We have three classes: monogamous (mono), polygamous (poly), and the base category of those who are not married, that is, widowed, divorced, or separated. The results indicate that being married lowers the probability of feeling poor. We further note that the decrease in the likelihood of feeling poor is higher for polygamous households than it is for monogamous households. Specifically, relative to being widowed, divorced, or separated, being polygamous lowers the probability of being subjectively poor by 7.6% as against 5.9% for monogamous households. The same cultural explanation can be given here where being married raises your status, and having more wives further increases the respect that people may give you. The level of per capita annualized real consumption is also included to capture household income status. We find that household economic status as

| Variable                      | Two children or more | Dependency ratio | Monogamous | Polygamous |
|-------------------------------|----------------------|------------------|------------|------------|
|                               | −0.025**             | −0.016***        | −0.059***  | −0.076***  |
|                               | (0.012)              | (0.005)          | (0.011)    | (0.022)    |

| Variable                      | Females with primary | Males with primary | Females with JCE | Males with JCE |
|-------------------------------|----------------------|-------------------|------------------|---------------|
|                               | −0.046***            | −0.008            | −0.055***        | −0.012        |
|                               | (0.014)              | (0.013)           | (0.019)          | (0.014)       |

| Variable                      | Males with MSCE      | Father primary    | Mother primary  | Father secondary |
|-------------------------------|----------------------|------------------|-----------------|------------------|
|                               | −0.034               | −0.041*          | 0.038***        | −0.134***       |
|                               | (0.022)              | (0.022)          | (0.018)         | (0.029)         |

| Variable                      | Males with MSCE      | Father primary    | Mother primary  | Father secondary |
|-------------------------------|----------------------|------------------|-----------------|------------------|
|                               | −0.010               | −0.040           | 0.038***        | −0.134***       |
|                               | (0.012)              | (0.027)          | (0.018)         | (0.029)         |

| Variable                      | Children work at home | Children work outside home | Number of enterprises |
|-------------------------------|------------------------|--------------------------|-----------------------|
|                               | −0.048***              | 0.042***                 | −0.008                |
|                               | (0.011)                | (0.015)                  | (0.005)               |

| Variable                      | Agricultural Loan      | Grows tobacco          | Land                 | Livestock        |
|-------------------------------|------------------------|------------------------|---------------------|------------------|
|                               | −0.002*                | −0.040***              | −0.032***           | −0.024***        |
|                               | (0.001)                | (0.011)                | (0.003)             | (0.003)          |

| Variable                      | Consumption expenditure | Consumption expenditure |
|-------------------------------|-------------------------|-------------------------|
|                               | −0.099***               | (0.009)                 |

| Variable                      | Religion               |
|-------------------------------|------------------------|
|                               | −0.087***              |
|                               | (0.023)                |

| Variable                      | Protestant            |
|-------------------------------|-----------------------|
|                               | −0.001                |
|                               | (0.012)               |

| Variable                      | Community             |
|-------------------------------|-----------------------|
|                               | Has clinic            |
|                               | −0.111                |
|                               | (0.010)               |

| Variable                      | Community             |
|-------------------------------|-----------------------|
|                               | Lives in trading centre |
|                               | 0.045**               |
|                               | (0.018)               |

| Variable                      | Community             |
|-------------------------------|-----------------------|
|                               | Region                |
|                               | North                 |
|                               | −0.101***             |
|                               | (0.017)               |

| Variable                      | Community             |
|-------------------------------|-----------------------|
|                               | Centre                |
|                               | −0.039***             |
|                               | (0.011)               |

| Variable                      | Chi-square            |
|-------------------------------|-----------------------|
|                               | 857.003               |

| Variable                      | Prob > Chi-square     |
|-------------------------------|-----------------------|
|                               | 0.000                 |

| Variable                      | Sample size           |
|-------------------------------|-----------------------|
|                               | 3402                  |

| Variable                      | McFadden $R^2$        |
|-------------------------------|-----------------------|
|                               | 0.159                 |
measured by per capita consumption expenditure lowers the probability of feeling poor by about 10%.

6. Concluding comments

Using the IHS2, the paper sought to find the impact of fertility on poverty while recognizing the fact that the two variables are jointly determined. By using son preference as our IV, we are able to use exogenous variation in number of children to uncover the causal effect of fertility on poverty of rural households in Malawi. First, we have looked at poverty defined in the monetary sense. It has been found that fertility increases the likelihood of being poor; this effect is larger for endogenous fertility, implying that when fertility is treated as exogenous its effect on poverty is underestimated. Further to this, the significant impact of fertility has been found to be robust to choice of poverty line. This finding has been shown to hold when household composition, and economies of scale are accounted for, though, the effect tends to be reduced. Changing the conceptualization of poverty by capturing poverty using continuous variables does not change our finding that fertility increases poverty, and that its effect is higher when fertility is endogenous. Second, we have looked at poverty defined by using self-rated assessments of welfare. Interestingly, fertility has been found to have the opposite effect to that found under objective poverty. This contradiction in the impact of fertility on the narrower objective poverty and the broader subjective poverty might be a possible explanation for why families in rural Malawi have many children (in spite of this making them poor in the objective monetary sense) as it makes them feel less poor.

Though the study is able to suggest a causal relationship between fertility and poverty, it is worth pointing out that the study is static in nature and therefore cannot capture the dynamic aspects of the relationship between poverty and fertility. It should also be said that modernity can invalidate our IV in the sense that richer households may be less biased against female children for reasons related to modernity, and modernity (which is unobserved) can influence both poverty as well as their gender preferences. Since we cannot control for modernity, our conclusions from the paper should be taken with this caveat in mind.

Notes

1. As pointed out by one reviewer, the identification of number of children would be affected by the extent of remarriages, and the presence of multi-generational households. This is unlikely to be a problem, because the data show that polygamous marriages are very few with only 4% of the heads declaring to be polygamous. Further to this, multi-generational households are also limited in number; only 0.7% of the households have grandparents as co-residents.

2. To complement these results, we tested (using a t-test) whether or not there is a difference in the average number of children between households with two girls first and those with two boys first. We find that households with two girls first have a significantly higher number of children with a mean difference (standard error) of 0.3036 (0.054).

3. This can in a sense be viewed as direct evidence of son preference.

4. For the bivariate probit regression with adult equivalent adjustment we also find that fertility is endogenous, with the following Wald statistics (p-values) for the three poverty lines; Ultra-poor 8.1933 (0.0042), World Bank 4.2567 (0.0391), and Poor 4.392 (0.0361).

5. The F-statistic of the first stage regression on the excluded instrument (girlIV) is 247.18 with a p-value of 0.000. The partial $R^2$ of the excluded instrument is 0.0376. Together these statistics suggests our IV is not weak.

6. The coefficient for the instrument is 0.172 with a p-value of 0.000 suggesting that if the first two children are girls significantly increases the number of children.

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