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EC331: Research in Applied Economics

Child marriage
and female educational attainment:
an investigation into a complex relationship,
using Nigerian data

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Abstract

This paper investigates the relationship between child marriage and educational attainment. It confirms previous results by identifying a negative conditional correlation between years of child marriage and the probabilities of having some and a complete secondary education. However, it also demonstrates that the instruments used in previous studies may be invalid, casting doubt over the magnitude of the relationship. It thus provides a base for substantial further research.

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1 Introduction

Child marriage is defined as a marriage or union taking place before the age of 18 (UN General Assembly, 1989). Although both boys and girls are affected, girls form a higher share of those married early. This issue has recently seen a rise in the levels of political, public and research interest worldwide, due to its connections with the problems of gender equality and economic development. Ending child marriage is a target, under Goal 5 of “Achieve gender equality and empower all women and girls“, of the Sustainable Development Goals list, which outlines the global development priorities up to 2030 (Girls not Brides, 2017). And yet, levels of child marriage remain high: the share of women between 18 and 22 that were married before 18 in the 25 countries which account for the majority of child marriages is 36.7% (Wodon et al., 2017). Child marriage is a fundamental violation of human rights, which may lead to social isolation, loss of educational and life opportunities, as well as health problems due to early pregnancy (Nour, 2009). However, the effect is not limited to individuals solely. Research shows, that the individual effects lead to decreased per capita earnings, productivity and consumption, lower public and private expenditure, and, as a result, stall development and perpetuate poverty and inequality on country and regional level (Wodon et al., 2017). Despite this, investment in policies that would battle the issue of child marriage have remained limited (ibid.).

In light of this, it is key to provide research that proves the detrimental effect child marriage may have. This paper will focus on one of the main channels for this effect: the deprivation of child brides of education, which leads to serious economic costs. For example, Chaaban and Cunningham (2011) found that the cost as a percentage of GDP of Nigerian girls dropping out of school is equal to 8.18% for primary and 8.38% for secondary education. Although this paper does not specifically mention child marriage, it is still an insightful illustration of the magnitude of the economic effect it might have. Rabi (2014) finds that educational deprivation due to early marriage among girls aged 15-19 in Nepal leads to a loss of 3.87% of GDP. Providing an equal access to education for girls increases the efficiency of labour markets, boosts growth rates and reduces social disparities (Morrison, Raju and Sinha, 2007). Furthermore, the analysis of the relationship between child marriage and educational attainment may have key policy implications. Brown (2012) argues that there exists a “vicious circle“: gender inequality in educational opportunities results in girls dropping out as they make the transition from primary to higher levels of education, leaving them more likely to marry early. Meanwhile, economic pressure, delayed entry to school and social stigma mean that married girls become less likely to continue education. He suggests a tipping point solution: an attempt, through provision of finance, facilities and support, to keep girls of “school transition” ages in school. Simbine and Aluko (2015) examine a similar proposition and argue that it will drastically reduce the number of early marriages.

This paper will now proceed to investigate the relationship between child marriage and education in Nigeria. Given most research on the topic so far has been cross-country, and therefore tended to ignore socio-cultural differences, which may give rise to omitted variable bias, an intra-country study may provide more strength to the research. The main focus of the paper will be the unpacking the issue of endogeneity, further discussed in the literature review below. The conclusions reached show that it is indeed present in the relationship.

Moreover, the paper finds that most of the instrumental variable (IV)-estimation strategies available to date may be inadequate. A negative conditional correlation is nevertheless established between years of child marriage and both having some and completing secondary education. The paper's main contribution is to cast doubt over the existing research and thus open a gateway for further inquiry into the topic.

2 Literature Review

There is only a limited body of literature investigating the relationship between child marriage and educational attainment. Those works that exist face the problem of endogeneity: unobservable factors may be present in the error term that affect both child marriage and educational attainment, as the decision is often either to get married or continue with education (Wodon et al., 2017). These include a wide range of factors. The girl's individual ability may dictate the decision. Cultural beliefs about the value placed on a girl's education and the "proper behaviour" for a girl may also play a role (Khanna et al., 2013). Economic concerns may have some effect as well: marrying a girl off and receiving a dowry for her may seem as a good solution for parents facing poverty (Bates et al., 2004). Moreover, in some cultures, the dowry paid by a girl's family increases as the girl gets older (ibid.). There is a risk of bias where endogeneity is not controlled for.

The existing papers on the subject are thus separated into two broad groups by the methods they use. The first examines responses to survey questions regarding reasons for girls dropping out of school. The second uses regression techniques with instrumental variables. Lloyd and Mensch (2008) use the first method in their analysis. Demographic and Health Survey (DHS) data for five countries - Burkina Faso, Cameroon, Côte d'Ivoire, Guinea, and Togo - was used, where responses were collected for all women of reproductive age concerning age of leaving school and reasons for doing so. It is discovered that, depending on types of estimations, probability of school leaving due to marriage among women aged 15-24 ranges from 12% in Togo to 22.2% in Cameroon (most generous estimate). Nguyen and Wodon (2017), using similar data, find that early marriage (and pregnancy, but to a lower extent) account for 15 to 20% of secondary school level drop-outs. Moreover, they show that if child marriage and early pregnancies could be eliminated, the gender gap in education could be reduced by approximately 50%. However, this analysis does not account for endogeneity concerns.

Field and Ambrus (2008) use the instrumental variable approach, with age of first menarche as instruments, to estimate the effect of child marriage on educational attainment in Bangladesh, using the 1996 Matlab Health and Socio-Economic Survey (MHSS). Due to the cultural connection between menarche and marriage, and medical evidence of a large variation in age of puberty in healthy adolescents, age of menarche is seen as generating appropriate exogenous variation in girls' risk of marrying young. The two-stage model yields the following results: for each additional year of delaying marriage, years of schooling increase by 0.22 and literacy by 5.6%. The results seem robust, as the paper takes into account the possibility of endogenous instruments, selective mortality in those who reach puberty or marry early and recall bias, as well as the possibility of a direct effect of menarche on schooling. Furthermore, general equilibrium analysis of the market for brides shows that enforcing consent laws between ages 15 and 17 will be sustainable and result in a 5-8% improvement in average female schooling.

Delprato et al. (2015) also employ the IV estimation strategy, but use different instruments: past age of marriage, proportion of non-premarital sex and total fertility rate in the community. The first two instruments are likely to proxy socio-cultural views on early marriage and the value of virginity, and thus

be correlated with current age of marriage. The third instrument embodies the community survival strategy against poverty: early marriage leads to a larger number of pregnancies and surviving children, which increases future household income. The study is based on 36 DHS studies from Sub-Saharan Africa and South West Asia. It found that an enforcement of laws prohibiting marriage before the age of 18 would boost years of schooling by 39% in Sub-Saharan Africa and 15% for South West Asia, with significant heterogeneity across countries. Furthermore, the study notes that conflicts and undeveloped institutions are mediators in the effect of child marriage on educational attainment. However, the results for Sub-Saharan Africa are only significant for some regions. Moreover, the paper itself acknowledges that the instruments may not be valid due to endogeneity concerns.

Finally, Wodon, Nguyen and Tsimpo (2016) use several different approaches and data sources to estimate the effect of child marriage on secondary school enrolment in Uganda: both survey responses by different groups and regression techniques. Econometrically, an IV estimation strategy was again used, with Primary Sampling Unit-level variables measuring contemporaneous and past incidence of child marriage utilized as instruments. These are likely to be correlated with years of child marriage (for example as proxies of societal views on child marriage) but not with any measure of educational attainment. The same IV estimation strategy is used also by Nguyen and Wodon (2015). The main findings of the study can be summarised as follows: child marriage has a significant negative effect on educational attainment and the younger the age at which a girl marries, the larger the negative effects. For example, a girl who marries at 17 has 13.5% lower probability of enrolling in secondary school. These results may be regarded as robust, as several different strategies are used to confirm them.

Several conclusions can thus be made. Firstly, there is a noticeable scarcity of literature on the subject. Secondly, there exists a necessity for further study, as most of the methods used either failed to account for endogeneity or used instruments the validity of which may be questionable. Thirdly, although significant cross-country variations in the correlation between child marriage and educational attainment has been observed, few within-country studies have been produced. In line with these conclusions, the aim of this paper is to attempt to investigate, using a new dataset and a slightly different estimation strategy, whether the instruments used previously are valid. Through this strategy, an attempt at establishing a causal relationship between child marriage and educational attainment will be made.

3 Data Description and Methodology

3.1 A Note on Nigeria

The country chosen as the focus of this study is Nigeria. It was primarily selected due to data availability and the fact that it has a high rate of child marriage: a total of 39% of girls marry before the age of 18 (WLUML, 2013). There is also a significant geographical disparity in the incidence of child marriage: in the Northern states of Nigeria the percentage of girls married before 18 is approximately twice as high as the national average (Brown, 2012). Finally, it should be noted that in 2003 the Minimum Age of Marriage clause was added to the Nigerian Child Rights Act, which made it illegal for a parent to marry off his or her daughter if she is under the age of 18 (Toyo, 2006). However, it was met with a high degree of opposition, especially in the Northern states, which are predominantly Muslim. It was argued that it overlooked cultural-religious norms (ibid.). As a result, the clause was not ratified in many states. Where it has been ratified, it is often ineffectual (ibid.). A study of the relationship between child marriage and education, given its economic implications, may thus motivate more effective policy making.

3.2 Data Description

The data used is extracted solely from the 2013 Demographic and Health Survey for Nigeria (DHS-VI). The DHS is a national sample survey that provides information on fertility levels, marriage, fertility preferences, awareness and the use of family planning methods, child feeding practices, nutritional status of women and children, adult and childhood mortality, awareness and attitudes regarding HIV/AIDS, female genital mutilation, and domestic violence. The study covers 38,522 households and 38,948 females aged 15-49. The sample is cut down to 10,706 as the study is only looking at women between the ages of 25 and 34. The reason for this is to give enough time for the women to finish their education, but also have information on the previous cohort to allow for instrument construction, described in detail below.

Given the nature of the survey, and the specifics of the country it seems important to discuss how representative the sample is. The sampling strategy used by the DHS is designed to compile a highly representative survey, covering the entire population that resides in non-institutional dwelling units, and following a sampling frame prepared for the Population Census. The share of women living in the North is 63%. Approximately 50% of the sample are Christian, and 50% are Muslim, which is again in line with the national statistics (Pew Research Centre, 2011). 255 out of the country's over 500 ethnic groups are represented, however, since many of these are very small and there is no conclusive information as to the total number of ethnicities in Nigeria, and thus it seems infeasible that all groups could be represented (Findlay, 2017). Unfortunately, few sources detailing female educational attainment are available, thus not allowing comparison. In terms of child marriage, 42% of women were married before 18. Every woman has been married at least once. It may therefore be concluded that the sample is representative. A table with more detailed summary statistics may be seen in Appendix 1.

3.3 Primary Analysis

Table 1: Table detailing educational attainment by age of marriage

	All aged 25-34	Only Those Married After 18	Only Those Married Before 18
Average Years of Education	5.7	8.8	2.9
No Education	41.4%	17.8%	63.1%
At Least Some Primary	58.6%	82.2%	36.9%
At Least Complete Primary	53.1%	77.9%	30.4%
At Least Some Secondary	39.2%	64.1%	16.4%
At Least Complete Secondary	28.2%	49.1%	9%
Higher	9.8%	18.8%	1.6%
Literacy	41%	65.5%	18.2%

As can be seen from the above table, considerable differences between those married before and after 18 can be identified for all measures of educational attainment. However, this paper will focus on secondary education. The reason for this is threefold. Firstly, the transition between primary and secondary education has been identified by previous research as a key point at which individuals tend to leave school in order to marry (Brown, 2012). Moreover, secondary education seems to have the highest return in terms of employment and wages (Chaaban and Cunningham, 2011). Finally, the differences between those married before and after 18 seem to be of the greatest magnitude for secondary education. A test for the equality of shares of those with at least some secondary education between the two groups rejects the null hypothesis of equality with a p-value of approximately 0. The same result is obtained for those with a complete secondary education.

In line with these preliminary findings, the following hypotheses are proposed:

Hypothesis 1: *A one year postponement of marriage would be associated with an increase in the probability a girl has some secondary school education.*

Hypothesis 2: *A one year postponement of marriage would be associated with an increase in the probability a girl has completed secondary school education.*

3.4 Methodology

The first type of regression equation presented in this paper uses a probit specification, while two more use two different sets of instrumental variables in an IV-probit regression that uses maximum likelihood estimation. See Appendix 2 for further discussion of the theory behind the regressions.

In all cases, the dependent variable is first a binary variable that takes the value 1 where the woman has at least secondary education and 0 where she has not. The second dependent variable takes the value 1 where the woman has completed secondary education and 0 where she has not. The main independent variable of

interest are the years of child marriage, measured as a discrete variable. Thus, if the woman was married at exactly 16, the variable would take the value: $18-16=2$.

A number of individual-level control variables are introduced, which include whether the woman lives in the North or in the South, religion, type of residence (urban or rural), BMI as a measure of health, and the wealth quantile to which the woman belongs. Furthermore, Primary Sampling Unit-level controls are also introduced, measuring mean shares of individuals in the bottom two wealth quantiles, unemployment, and access to electricity.

The first set of instrumental variables used includes, mimicking Wodon, Nguyen and Tsimpo's (2016) study, Primary Sampling Unit (PSU)-level variables measuring contemporaneous and past (age group 34-49) leave-out-mean incidence of child marriage for each age of marriage. The second set of instrument uses past (age group 34-49) leave-out-mean incidence of child marriage for each age of marriage, proportion of non-premarital sex and the average total number of children in the Primary Sampling Unit, mimicking Delprato et al. (2015). The motivation for using these variables as instruments is given in the Literature Review, and discussed further in the Discussion subsection.

4 Results

Table 2: Regression results for years of child marriage and secondary education

Probit Estimates	At least Some Secondary Education	Complete Secondary Education
Years of Child Marriage:		
Probit Coefficient	-0.18***(0.011)	-0.205***(0.015)
Average Marginal Effect	-0.036***(0.002)	-0.04***(0.003)
Observations	10,706	10,706

Probit IV Estimates 1	At least Some Secondary Education	Complete Secondary Education
Years of Child Marriage:		
Probit Coefficient	-0.417***(0.036)	-0.468***(0.031)
Average Marginal Effect	-0.089***(0.009)	-0.101***(0.009)
First Stage F-statistic	148.57	148.57
Overidentification test	48.06***	33.33***
Wald test of exogeneity	32.37***	48.30***
Observations	10,706	10,706

Probit IV Estimates 2	At least Some Secondary Education	Complete Secondary Education
Years of Child Marriage:		
Probit Coefficient	-0.416***(0.035)	-0.501***(0.026)
Average Marginal Effect	-0.089***(0.09)	-0.113***(0.009)
First Stage F-statistic	185.39	185.39
Overidentification test	40.55***	47.61***
Wald test of exogeneity	34.4***	68.94***
Observations	10,706	10,706

Standard errors clustered at community level reported in parentheses. *Notes:* First stage F-statistic and overidentification result are obtained from a Newey's two-step probit regression with IV, rather than MLE (see Appendix 2). All specifications include the following controls: living in the North, religion, type of residence (urban or rural), BMI as a measure of health, and the wealth quantile to which the woman belongs, mean shares of individuals in the bottom two wealth quantiles, unemployment, and access to electricity on the Primary Sampling Unit-level. Years of Child Marriage are instrumented in the first specification by Primary Sampling Unit-level variables measuring contemporaneous and past (age group 34-49) incidence of child marriage for each age of marriage. In the second specification it is instrumented by past (age group 34-49) age of marriage, proportion of non-premarital sex and the average total number of children in the Primary Sampling Unit

* $p < 0.1$

** $p < 0.05$

*** $p < 0.01$

The table above shows the results of all three specifications. Starting with the simple probit results, they are significant even at the 1% level for both equations. Delaying marriage by one year is associated with a 3.6% point increase in the probability of having at least some secondary education. For completing secondary education, the probability would increase by 4% point. However, as was mentioned before, these results are prone to bias, as endogeneity is not accounted for. The existence of endogeneity is confirmed somewhat by the fact that the Wald test statistic in each of the IV specifications has a p value of approximately 0, rejecting the null hypothesis of the years of child marriage variable being exogenous.

The first IV specification uses Primary Sampling Unit-level variables measuring contemporaneous and past (age group 34-49) incidence of child marriage for each age of marriage. The results are again significant even at the 1% level. Delaying marriage by a year would be associated with an 8.9% point increase in the probability of having some secondary education. It would also be associated with a 10.1% point increase in the probability of completing secondary school. These estimates are markedly higher than those of the non-IV equations. The instruments used may be said to be strong, as the F-statistic, obtained from the first stage of an equation with Newey's minimum (two-step) chi-squared estimators (see Appendix 2), is greater than 10, as determined by Stock and Yogo (2005). However, the overidentification test (a version of the Sargan test suitable for a probit model) produces a statistic with a p-value of approximately 0. Thus, the null hypothesis of no overidentification is rejected. This indicates that at least one of the instruments is likely not valid, and there is a probable correlation between the instruments and the error term in the equations for both the probability of having some and having a complete secondary education.

The second IV specification uses past (age group 34-49) age of marriage, proportion of non-premarital sex and the average total number of children in the Primary Sampling Unit. The results are significant at the 1% level. Delaying marriage by a year would be associated with an 8.9% point increase in the probability of having some secondary education. It would also be associated with a 11.3% point increase in the probability of completing secondary school. The results are higher than in the non-IV specification, and very similar to the previous IV approach. In this case, again, the F-statistic from the first stage is higher than 10, thus the instruments may be seen as strong. However, the overidentification test produces a statistic with a p-value of approximately 0, thus rejecting the null hypothesis of no overidentification. This, again, indicates that at least one of the instruments is likely not valid.

Thus, given the data and theory available, valid instruments cannot be found. A preferred specification cannot be chosen. It may be suggested that there exists a negative conditional correlation between the dependant variables (probability of both having some secondary education and having a complete secondary education) and years of child marriage. It may also be suggested that the correlation is higher in absolute terms for completing secondary education than for having some secondary education. The hypotheses proposed above can be seen as somewhat confirmed. It should be noted that since a probit regression is a non-linear model, it would be preferable to report the effect on the probabilities of a specific number of years of marriage. This is not done because of the doubt over the validity of the instruments. No conclusions as to the magnitude of the relationship can be drawn as the endogeneity problem cannot be solved. A further discussion of the results is provided below.

5 Evaluation

5.1 Discussion

This paper has produced results that are in line with previous research on the subject, once again reaffirming that marrying as a child is associated with reduced educational attainment. It may be regarded as somewhat more robust than some previous studies as it limits itself to one country, thus avoiding some unobserved heterogeneity. It also confirms through testing that the variable for child marriage does indeed seem to be endogenous. It may also be argued that the unobserved factors driving this endogeneity lead to a downward bias of non-IV results, which would corroborate the findings of Delprato et al. (2015). However, perhaps the biggest contribution of this paper is to cast doubt over the relevance of two out of three IV-estimation strategies used in previous research. However, test results alone are not necessarily sufficient to discount the relevance of instruments. Thus, a more detailed discussion of the intuition behind the instrumental variable strategies is in order.

The authors proposing the first instrumental variable strategy argue that the leave-out-mean contemporaneous and past incidence of child marriage capture social norms and other factors that may affect child marriage, but are unlikely to be associated with the decision to continue with education for a particular individual. However, as was indicated in the literature review, similar cultural beliefs may affect the decision to marry early and the decision to leave education. Thus, the instruments may be correlated with the unobservables in the equation for the probabilities of having or completing secondary school education. A further unobservable that may affect both the PSU-level of child marriage and the decision to continue with education is the poverty level in the community at the time the decision is made. The second IV-estimation strategy has similar arguments behind it: the instruments are seen as measuring the socio-cultural beliefs and the survival strategies of the community. The authors themselves note that the same factors may affect the decision to continue with education. They mention, for example, that high fertility levels tend to correlate with measures of poverty, which may also affect the supply of schooling. This paper's testing seems to confirm these endogeneity concerns.

It is thus established that it is highly difficult to produce an unbiased estimate for the effect of child marriage on educational attainment, as the decisions behind them are linked by factors that are often omitted in the available data. Cautious conclusions regarding the relationship should thus be drawn not only from this paper but from others on the subject. However, the results available at the moment do suggest the existence of a significant correlation between the decision to marry early and the decision to leave school. Policy efforts referred to in the introduction are needed. Moreover, the complexity of the relationship identified by this and other papers suggests that as the two problems (educational deprivation and child marriage) are so interlinked, the attempts to battle the two need to indeed be combined, as suggested by Brown. A combined effort is needed. Better supply of education is necessary to keep girls at school. Efforts are also required to battle community poverty and social misconceptions about the role of women in society, as well as empower all women and girls.

5.2 Limitations

Several limitations can be identified to this study. Firstly, although the sample has been shown to be representative, it relies on information provided during interviews, often with little to no documentary evidence, and thus can be prone to recollection bias. Furthermore, the second IV-estimation strategy was modified to include past leave-out-mean incidence of child marriage at each age of marriage rather than just past incidence of child marriage, and number of children rather than the total fertility rate. The first was done in order to allow for the test for overidentification. The second was done as the author of this paper was not able to run the program required to obtain the total fertility rate calculations using the means available. Thus, the second IV-estimation strategy may not be regarded as a complete replica of that used in the literature, but the variables used are likely to be highly correlated with those in the literature. Finally, Nigeria is perhaps not the best country to choose as a base for such a study, due to the above-mentioned heterogeneity within the country. However, this paper has attempted to control for this heterogeneity as far as possible, and the failure of policy methods aimed at battling child marriage mentioned above provide motivation for looking at Nigeria specifically.

5.3 Extensions

Given this paper has cast doubt over the validity of the instruments used in previous research, it provides ample opportunity for further research in the field. Further validity tests need to be carried out, using different methods and data sets, in order to confirm the findings on this paper. Research is needed to identify whether instruments exist that would not suffer from the same problems. However, identifying these will be difficult due to the above-discussed strong link between the marital and the educational decisions. Another important area of research is collecting data that provides more information about the time at which the decision to marry or continue with education was made. These could include variables that measure community-level poverty and cultural attitudes towards child marriage and the value assigned to female education.

This data itself provides space for extensions, once valid instruments are identified. Firstly, it could be useful to estimate the effect on the probabilities of having some and a complete secondary education of each specific year of child marriage, as mentioned above. Moreover, the difference in the effect of child marriage on educational attainment between the North and the South could be explored, with a deeper investigation into which specifics of the Northern states drive the heterogeneity. Furthermore, given the recent proliferation of the activity of the terrorist group Boko Haram, a time-series study could be carried out comparing years before and after it came to prominence, in an attempt to discover whether conflict amplifies the severity of the relationship. A time-series study may also allow to discover whether the Child Rights Act, although said to be of limited effectiveness, has had any influence on the relationship between child marriage and education in states where it was ratified. However, to the best knowledge of the author, time-series data of this sort is not available as of yet.

6 Conclusion

This paper has thus shown that further investigation into the complex relationship between child marriage and educational attainment is needed, due to the large opportunity costs child marriage has for both individuals and countries, as shown by previous research. Moreover, this need is further underlined by the lack of adequate policies that would combat the problem of child marriage, as has been shown using the example of Nigeria. The paper itself has made several contributions to existing literature. Firstly, it has confirmed somewhat the previous findings, by identifying a negative conditional correlation between years of child marriage and the probabilities of having some and completing secondary education. Secondly, and perhaps more importantly, this paper has cast doubt over the validity of the instruments used to combat the problem of endogeneity present in the relationship.

Thus, a base was provided for further action. More research is needed to identify valid instruments and, possibly, establish a causal relationship between being married as a child and educational deprivation. If such research is produced, it will hopefully motivate policy effort to combat this problem. The complexity of the relationship itself, as well as theoretical propositions indicate that this effort needs to be multidimensional. An increased and better supply of schooling is needed to provide an opportunity for girls to stay in education. Community-wide efforts are also necessary in order to combat social misconceptions and poverty, factors that have played an important theoretical role in this paper. Finally, efforts to empower women and girls are also in order.

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Appendix 1

Table 3: Summary statistics for main variables of interest

Variable	Mean/Share	Standard deviation
Age	28.81	2.78
Age at marriage	18.58	4.58
Years of child marriage	1.59	1.97
<u>Region:</u>		
North	63.43%	
South	36.57%	
<u>Religion:</u>		
Catholic	8.89%	
Other Christian	36.23%	
Muslim	53.95%	
Traditionalist	0.87%	
Other	0.07%	
<u>Wealth Index:</u>		
Poorest	19.46%	
Poorer	20.40%	
Middle	18.85%	
Richer	19.82%	
Richest	21.47%	
<u>Place of Residence:</u>		
Urban	37.59%	
Rural	62.41%	
BMI	2438.06	941.85
PSU-level mean share of individuals in the bottom 2 wealth quantiles	0.41	0.41
PSU-level mean share of unemployed individuals	0.24	0.19
PSU-level mean share of individuals with access to electricity	0.51	0.44

Appendix 2

The econometric model behind the IV regressions, taken from Wooldridge (2002), is as follows:

$$y_1^* = \gamma x_1 + \beta y_2 + u_1 \quad (1)$$

$$y_2 = \Pi_1 x_1 + \Pi_2 x_2 + v_1 = \Pi x + v_1 \quad (2)$$

$$y_1 = 1[y_1^* > 0] \quad (3)$$

where (u_1, v_1) has a zero mean, bivariate normal distribution. It is also assumed that the endogenous regressor is continuous. y_1 is the dependant variable (in our case having some and having a complete secondary education), y_1^* is the probability of a positive outcome for y_1 , y_2 is the endogenous regressor (years of child marriage in this case). x_1 is a vector of exogenous regressors, x_2 is a vector of additional instruments. γ and β are vectors of structural parameters, and Π_1 and Π_2 are matrices of reduced-form parameters.

The joint density is:

$$f(y_1, y_2 | x_1) = f(y_1 | y_2, x_1) f(y_2 | x_1) \quad (4)$$

The log likelihood for observation i is:

$$y_{i1} \log \Phi(w_i) + (1 - y_{i1}) \log [1 - \Phi(w_i)] - 1/2 \log(\tau_2^2) - 1/2 (y_{i2} - \Pi x)^2 / \tau_2^2 \quad (5)$$

where w_i depends on the parameters $(\Pi_1, \gamma, \rho_1, \Pi_2, \tau_2)$:

$$w_i \equiv [\gamma x_1 + \beta y_2 + (\rho_1 / \tau_2)(y_{i2} - \Pi x)] / (1 - \rho_1^2)^{1/2} \quad (6)$$

where ρ_1 is the correlation coefficient between u_1 and v_1 , τ_2 is the standard deviation of v_1 .

Summing expression (5) over all i and maximizing with respect to all parameters gives the maximum likelihood estimators for $(\Pi_1, \gamma, \rho_1, \Pi_2, \tau_2^2)$.

An econometric model with Newey's two-step estimators involves regressing the endogenous variable on a vector of the exogenous variables and instruments. The fitted values and residuals obtained from this regression are then used in a probit regression. A detailed description of the method is available in Newey (1987). Although coefficients from this method are not directly comparable with MLE, using it to test instruments is standard practice.