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Women 's education and fertility in Sub-Saharan Africa : channels and influence of education on fertility

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Women's education and fertility in Sub-Saharan Africa: Channels and influence of education on fertility

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Abstract

This paper seeks to contribute to the debate on the channels of influence of education on fertility in Sub-Saharan Africa (SSA). It uses a framework based on Bulato's model and individual level data from Demographic and Health Surveys of 14 countries of SSA to assess the extent to which some well-known determinants of fertility could be the channels of the effects of education. The paper argues that *exposure to media* and *contraceptive use* transmit better the effects of education on fertility than the *opportunity costs* of children and the bargaining power of women. This finding that was found robust with different measures of education and fertility suggests, therefore, a better design of schooling policies as well as curricula in SSA, so as to minimize drop-out and prepare young girls regarding fertility's concerns. In addition, contraceptive use should be promoted and the access to various media should be expanded with specific communication programs on fertility. The paper ends with a discussion on some caveats and particularly the causality issue and proposes for further studies, a better setting that could yield more consistent results.

Contents

1. INTRODUCTION

Since the 80s, a declining trend of the population is observed worldwide except in Sub-Sahara Africa which is still characterized by a high fertility rate of 5.1 children/woman along with a decreasing mortality rate (UN, 2013). Bongaarts (2013) even predicted that the future pace of the decline in fertility in Sub-Saharan Africa will be slower than the pace of developed countries at the same comparable time of evolution, suggesting that some special measures need to be taken. To that respect, many pieces of evidence have proved that education and particularly that of women is a successful and efficient mean for declining fertility (Drèze and Murthi, 2000; Meisenberg, 2008; Wang and Buffalo, 2004). Moreover, the International Institute for Applied Systems Analysis (IIASA, 2014) also argued that education of women is one of the best ways of dealing with population. Indeed, according to that Institution, education doesn't only induce a decline in fertility but also makes it possible to benefit from demographic dividend[1] through human capital formation.

In Sub-Saharan Africa (SSA), even though the evidence of the effect of women's education on fertility decline is also well-established (Ezeh et al., 2009), the question of the effectiveness of the transmission of its effects remains a concern. Indeed, the significant improvement in education observed in that region of the world over the last decades (United Nations, 2015a; Watkins, 2013), is only accompanied by a slight decrease in fertility. This highlights that there is still room for discussion on the mechanisms through which education affects fertility in Sub-Saharan Africa. As discussed by Cochrane (1979), the relationship between education and fertility is not direct but transits through many variables. Nevertheless, in the literature, it appears that most of the studies focussing on the relationship education-fertility usually attempted to measure the indirect effect of education on fertility without looking at the channelling mechanism in between. As a result, many actions using women's education as policy-variable to cause fertility to decline, have been found inefficient in many contexts and in SSA in particular (Bongaarts, 2013).

However, despite this knowledge gap on the dynamic between education and fertility, there is a huge number of studies that have provided empirical evidence to support the influential role of many factors on fertility[2]. It appears then interesting to investigate which of these well-established determinants of fertility could be important channels of the influence of education on fertility.

The objective of this study is, therefore, to look at the key channels through which education could bring about a consistent decline in fertility in Sub-Saharan Africa. More specifically, the study intends to discuss the extent to which some well-known determinants of fertility are affected by

[1] The demographic transition has been used to explain the evolution of the population in Europe prior to the industrial revolution. De Bruijn (2006) presents the gist of this theory as a three stages phenomenon: The first stage is characterised by high fertility and high mortality, the second stage occurs when mortality drops but fertility remains high owing inter alia to unintended fertility and resulting to an increase in population size. The third stage, known as fertility transition, appears when fertility drops inducing a steady state of the population at a lower level.

[2] Some authors have laid attention on exposure to media and contraception (Ainsworth et al., 1996; Cheng, 2011; Darroch and Singh, 2013; Westoff and Bankole, 2001), others emphasized on mothers and infants health (Arnold et al., 1998; Ben-Porath, 1976; Breierova and Duflo, 2004; McCrary and Royer, 2006), some others on opportunity cost of having numerous children, (Becker, 1960; Easterlin, 1975; Ribar, 1992) for others the focus should be women's empowerment (Suguna, 2011; Upadhyay et al., 2014; Upadhyay and Karasek, 2012)

education and how in turn these determinants influence fertility. To that end, two core questions will precisely help addressing this issue: What are the main channels through which women's education influences fertility? And what is the sensitivity of the influence of those channels with respect to a change in fertility's measures and/or a change in education's measures? The first question will be an attempt of looking at the channels that are relevant and strong enough to be considered either as a potential focus for fertility policies or a mean to improve educational policies so as to ensure a real impact on fertility. The second question basically aims at a methodological contribution and will enable to assess the robustness of the findings derived from the first question, by varying the measures of the variables of interest.

The rest of the document is organized into two main sections. The first one presents the theoretical framework based on the existing literature on fertility and education with a focus in Sub-Saharan Africa. The second section is allotted to an empirical analysis where the derived results are discussed. The document ends with a conclusive part including some policy implications.

2. THEORETICAL FRAMEWORK

2.1. Fertility and the channels of the influence of education

The common theories describing fertility patterns are from fields as various as anthropology, sociology, political science, psychology, demography, and economics (Leridon et al., 2015). In economics, the approaches used are initially derived from the theory of consumer behavior to conceptualize the demand and the supply of children and then the actual fertility (Becker, 1960). Furthering the works of Becker, Easterlin (1975) theorized fertility with a model that encompasses the contribution of many other disciplines. He ended up with a framework where the actual fertility is the result of the demand for children, the potential supply of children and the costs of fertility regulation. This theory is an equivalence of the consumer's choice under constraint which in the case of fertility are the opportunity cost of children and time allocated to childrearing. Similarly, Bulatao and Lee (1983) proposed a framework with various factors that should be considered while discussing the determinants of fertility. Bulatao's model also encompasses the three abovementioned main building blocks from which the actual fertility is derived: the demand, the supply and the regulation of fertility. In addition, this latter model includes many others variables that gravitate around these building blocks and influence them. These variables are social institutions, cultural norms, socioeconomic characteristics, environmental conditions, family structures, and reproductive history of the woman. According to Bulatao's framework, the demand for children or the intended fertility can be referred to as the number of children that a woman desired to have at the end of her childbearing life. This side of fertility is mainly driven by tastes, some constraints and the perception of children. However, for a couple, the desired fertility is also the result of the joint decision of wife and husband. Concerning the supply of children, it is basically given by the natural fertility which is the potential number of children that a woman can have during her childbearing life. In Bulatao's

model, it is determined by the same variables proposed earlier by Bongaarts (1978). Indeed, Bongaarts suggested that only biological and behavioural factors can have a direct effect on fertility. Thus, he proposed three main intermediates variables: the exposure factors (especially the marriage); the deliberate marital control (contraception and induced abortion) and the natural marital fertility factors (breastfeeding, frequencies of sexual intercourses, sterility, intrauterine mortality, duration of fertility period). Bongaarts concluded that the total fertility is a combination of all these components for married individuals. The regulation, third main component of fertility in the Bulatao's model, becomes crucial in the case of an inflated supply side that exceeds the demand side. This latter component of fertility acts, therefore, to cause the supply to meet the demand. It is worthwhile to notice that in some cases, some cultural behavior like abstinence during the childbearing or the breastfeeding may also act like "regulation". However, the regulation considered in economics models is more often the conscious one which is the result of a decisional process of reducing fertility. Finally, for the regulation of fertility to be effective, two elements need to be considered: the motivation and the cost related to birth control. These costs include psychological and income cost as proposed by Becker (1960).

Among the various determinants of fertility proposed in Bulatao's model, many could be potential channels of the effects of education. Indeed, on the supply side, education is likely to affect fertility through the probability of marriage, age at marriage, age at first childbirth as well as health (mother/infant health and mortality). The demand for children is likely to be affected by education through the perception of family size, the costs/benefits of children, the empowerment of woman as well as the wife's market wage and occupation. Education influences also the demand for children by inducing a change in attitude and via communication between wife and husband. The regulation acts on fertility when education enables women to have access and knowledge on contraception as well as information on opportunity costs of having numerous children. The focus in this paper will be on the factors that are more likely to be shaped by education; these are the opportunity cost of numerous children, women empowerment, contraceptive use and exposure to media.

- **Opportunity cost of numerous children**

With the development of the modern world and the globalization, there is more and more a change in behaviour worldwide and particularly regarding the value of children. Becker (1960) considered that having many children is costly in terms of opportunities so that there is a trade-off between the quality and quantity that leads people to choose fewer children that they can raise and educate well. This view has been supported indeed by many empirical studies. For example, Tadesse and Asefa (2001) investigated the determinants of demand for children in Ethiopia and found that education alters the economic value of children, resulting in a drop in children demand. In another case, Ribar (1992) studied the influence of childcare on the labor supply of married women and found that childcare negatively affects the labor opportunity of women. Since the labor supply is positively correlated to education, his findings suggest that education influences opportunity costs of children. In addition, educated women have more opportunities in the job market and income earning and find it, therefore, more costly to have many children.

On another side, educational achievement is also one of the opportunity costs that can influence fertility. According to Testa (2014), the desired number of children for highly educated people are higher than the desired of children of lower educated ones; but ultimately, educated people do not achieve their intention for many constraints related basically to the time devoted to school. Finally, the opportunity cost of having numerous children can also be assessed through the effect of income on fertility. Education is positively correlated with income, but the direction of the effect of education on fertility through the channel of income is not well established. Indeed, on the one hand, Muhoza et al.(2014) found that the main factor that sustains higher fertility is poverty. He argued that when income increases fertility should decrease. On the other hand, from the household theories of fertility, Baudin (2015) asserted that an increase in the income of men leads to an increase in fertility whereas an increase in the income of women induces a decrease in the demand for children. However, from the economic theories of fertility, it is established that when income increases there is a substitution from the quantity to the quality of children. Nevertheless, some will increase the quantity demanded whereas others will increase the quality demanded so that the overall effect on the number of children is not clear a priori (Becker, 1960).

- **Women's empowerment**

The role and place that women still have in Africa make it difficult for them to act on their fertility and particularly when they are married. Indeed, in SSA typically, women are devoted to childbearing, childcare, and all household related duties. Usually, they are not involved in decision making and they have almost no control over household orientations. Nevertheless, education is likely to change such things as it empowers women and changes their traditional role and status within the family (Suguna, 2011). Ultimately, women empowerment will influence fertility via gender equality and women's abilities derived from the various schooling virtues as discipline, self-restraint, patience, and routine that enhance them as family-planners (Basu and Jong, 2010). Empirically, in a study on four countries from SSA (Guinea, Mali, Namibia and Zambia) with DHS data, Upadhyaya and Karasek (2012) found a slight but negative correlation between a high desired number of children and women empowerment measured by the attitudes toward wife beating and refusing sex with the husband. In addition, while reviewing 60 studies among which one-fifth conducted in Sub-Saharan Africa, Upadhyaya et al. (2014) found in almost all the studies, a positive association between women's empowerment and lower fertility.

- **Contraceptive use**

A couple committed to manage their fertility will need contraception means to achieve their goal. Studying paths to lower fertility, Caldwell (1999) concluded that better contraception use has had a significant role in fertility decline after 1960 in developed and developing countries. Moreover, in a study conducted in 2001, with data from 200 surveys in sub-Saharan Africa and 251 surveys from other countries, contraception use is proved to be associated with a low fertility as it enables a good management of the spacing and the desired number of children (Westoff and Bankole, 2001).

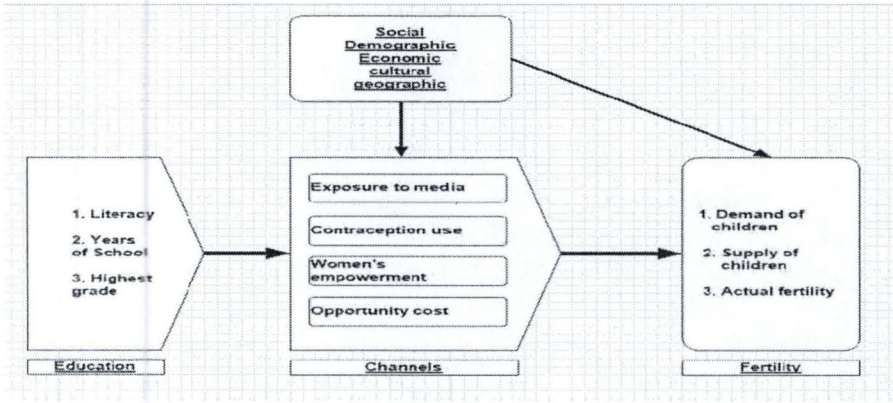
However, the study showed that for a comparable level of contraception use, the decline in trend was more visible for others regions than in SSA giving thus evidence of the necessity of improving contraceptive use in that part of the world, inter alia through education. As other evidence of the effect of contraception on fertility, Bongaarts and Casterline (2013) found that the stall in fertility decline in SSA is the result of a low level of contraceptive use due to the lack of knowledge, limited sources of supply, the low quality and the cost of contraceptives (see also Ezeh et al., 2009). Moreover, they also pointed out some side effects and objections from husbands or other family members. In addition, some concerns such as moral and social acceptability are other factors explaining the stalling of fertility in Africa. Similarly, Ndahindwa et al. (2014) found that in Rwanda, the high fertility level was associated with unmet need for contraception, meaning that efforts intending to improve the use of contraception could help in reducing fertility. In that way, education is a mean of improving access, use and knowledge of contraception as proved by Kirby (2008) who found that educational programs on sexuality affected positively the delaying of initiation of sex and increasing condom and contraceptive use among important youths. Moreover, education is typically the way through which couples and women, in particular, could acquire knowledge and abilities that could help them implementing family planning using contraceptive so as to adjust their desired number of children to a level that is convenient to their resources and expectations. This change in the desired number of children will then reflect on the final fertility. Finally, Mberu and Reed (2014) explained the differentials in fertility in Nigeria by a refusal to use contraceptive by some tribes, due to their religion.

- **Exposure to media**

Exposure to media appears to be a priori a relevant variable associated to the desired number of children. Indeed, modern views of the ideal family size and the opportunity cost of having few children are many factors advertised through media. Such messages are likely to shape the behaviour of individuals and change their taste and hence induce a decrease in fertility. Moreover, knowledge of contraception, family programs, and population policies are commonly diffused through media. Cheng (2011) found that mass media and social networks play a key role in reducing fertility. The more a woman is educated, the more likely she is to actively seek information, understand and be open-minded to messages from media. In a study in Uganda, using data from Delivery of improved Services for Health evaluation Surveys 1997-1999, Gupta et al. (2003) found a positive association with a communication action called Behaviour Change Communication (BCC) and contraceptive use as well as intention to use. Others studies conducted in Nigeria (Bankole et al., 1996) and Kenya (Westoff and Rodriguez, 1995), provided further evidence of a strong association between the fact of having heard or seen a message about family planning through various media and the use of contraception. They also found a negative association with media and the number of desired children

From the above discussion, the model that will be used in the empirical analysis is derived from the framework of Bulatao and presented here below. In this model, education is isolated and the other potential factors are considered like variables to control for (socioeconomic, demographic, cultural and geographic). The model will enable to discuss empirically the importance of the channels of influence of education on fertility and the extent to which the measures matter.

Figure 1 : Diagram of the channels of the effects of education on fertility



***Source**: Based on Bulatao and Lee, 1983 and simplifying assumptions*

The underlying assumptions of the model are the followings:

1. No recursive effects so that there is no endogeneity
2. Education is completely exogenous
3. The fertility variables are considered separately
4. All the others potential determinants of the considered channels or fertility are exogenous

Hence, with such assumptions the framework of this paper will basically allow to capture only the correlations between the variables rather than the causal effects. The expected signs derived from the conceptual framework and discussed in section 2 are summarised in table 1 here below.

Table 1 : Hypothetical expected signs of relation

Education			***Channels***	***Fertility***		
Literacy	*Life time education*	*Highest degree*		*Number of Children even born*	*Ideal number of kids*	*Age at first marriage*
+	+	+	*Opportunity costs*	-/+	-	+
+	+	+	*Media*	-	-	+
+	+	+	*empowerment*	-	-	+
+	+	+	*contraception*	-	-	?

2.2. Measuring education and fertility

Measures have always been a challenge in studies of the relationship between education and fertility, leading in some cases to contrasted results (Cochrane, 1979). For example, in an evaluation of school entrance public policy, McCrary & Royer (2006) measured education by enrollment and found just a small and statistically insignificant effect of education on fertility. Conversely, Meisenberg (2008) found a much higher correlation between education and fertility while using the highest degree achieved to measure education. It turns out that some measures that capture the learning outcomes could be in certain case more appropriated for the analyses. Indeed, the change in behaviour that is likely to affect fertility may occur only if there are some learning outcomes from education.

For fertility, Total fertility Rate and Age-specific Total Fertility Rate are commonly used. Many others indicators are used in the literature to account for fertility,[3] but some of them are difficult to measure because they require sometimes constraining data collection like information on cohorts. In addition, the choice of fertility measures depends on the level of observation and the objective of the study. The Total Fertility Rate and the Age –specific Total Fertility Rate are suitable for cross-country comparisons whereas the number of children even born, the age at first birth, age at first marriage and the ideal number of children are mostly used for individual-level studies.

Finally, this discussion proves the importance of measures while studying the relationship education-fertility. It also raises the issue of comparability of studies provided that to be comparable, different studies need to use variables that have at least some overlap in the concepts that they measure.

3. EMPIRICAL ANALYSIS

3.1. Empirical approach

To analyse the dynamic between education and fertility, the strategy used in this paper is based on the proposed model of section 2. It will consist in looking at the influence of education on the channels and then the influence of the channels on fertility.

The first step of the analysis will focus on the influence of education on the channels. For each channel, a regression will be performed, with some additional discussion on the measures of education. The model is the following:

$$\boldsymbol{Channel_i = \alpha + \beta * Education_i + \theta * X_i + \varepsilon_i} \quad [1]$$

[3] Some others measures of fertility include the *childbirth intervals, Completed Fertility Rate* (Children Even Born for women over age 49); *achievement rate of fertility* (actual number divided by the desired number of children) etc.

The second step of the analysis will consider the influence of the channels on fertility through the following setting:

$$\boldsymbol{Fertility_i} = \boldsymbol{\alpha + \gamma_1 * Media_i + \gamma_2 * Empowerment_i + \gamma_3 * Opportunity_i + \gamma_4 * Regulation_i + \beta * Education_i + \theta * X_i + +\varepsilon_i} \quad [2]$$

To measure education three variables are used: literacy as a metric of the basic education, years of schooling to assess the time spent at school, the highest grade achieved to capture the learning outcome. The *"literacy"* is a multinomial variable with three modalities: *"illiterate"*, *"Able to read only part of a sentence"* and *"Able to read a whole sentence"*. The *"years of schooling"* is a continuous variable measuring the total time in years spent at school. The *"highest grade achieved"* is a multinomial variable with four modalities: *"uneducated"*, *"primary"*, *"secondary"* and *"higher"* representing the highest school grade achieved by the woman.

On the fertility side, three variables are also used to account for the demand for children, the supply of children and the final fertility. These variables are respectively the *"ideal number of children"*, the *"age at first marriage"* and the *"number of children even born"*. It is worthwhile to notice that the measure used for the supply side (*age at first marriage)* induces a bias as it excludes non-married women.

The four channels are the following, *"opportunity cost of children"*, *"exposure to media"*, *"women empowerment"* and *"regulation"*. The *"Opportunity cost of children"* is measured by the current working status of the woman. It is a dummy variable which is equal to 1 if the woman is currently working and 0 if not. However, a one-shot measure of the working status of the woman is not quite suitable to measure the extent to which job opportunities could affect fertility. But this is the best proxy for the "*opportunity cost of children"* available in the data set. The *"Exposure to media"* is measured by a dummy variable equal to 1 if the woman has a television or reads newspapers and 0 if not. The *"Women's empowerment"* which is also a dummy variable equals to 1 if the woman is involved in decisions regarding family planning issues or if she can refuse to have sex with her husband and 0 otherwise[4]. Notice that this variable is somehow tricky to conceptualize and the reality that is captured here is closer to the bargaining power of woman than the empowerment. The *"Regulation"* is a multinomial variable measured by the use of contraception with three categories: *"Not using contraception"*, *"using traditional methods"* and *"using modern methods"*.

For the others parameters, α stands for the intercept; X is a set of variables to control for (*age of the woman, household's size, religion, place of residence, country, and wealth. The number of other wives and the marital status are included in equation [2]*); β, θ and $\gamma_{j=1\ to\ 4}$ capture the magnitude of association between the outcome and the related variable. Finally, ε_i is the error term and *"i"* is the subscript for a given individual i.

[4] For the sake of simplicity, this variable is referred to as "decide for family planning" keeping in mind that it encompasses also the possibility of refusing having sex with husband.

In equation [1], since the dependent variable is either binomial or multinomial, a logistic regression or a multinomial regression will be performed for each measure of education and the level of association (β) will be derived and discussed.

For each measure of fertility and education in equation [2] an Ordinary Least Square (OLS) will be performed. The magnitude of the influence of the channels (coefficientsγ_i) and the coefficient of education (β) will be discussed for each OLS. Given that there are some women who didn't yet enter into the childbearing life[5] (basically those with zero child even born), a Tobit regression will be run also for that measure of fertility.

3.2. Data

The data used in this paper comprises of individual-level data from 14 SSA countries and has been obtained from Integrated Demographic Survey (IDHS).[6] For each country selected, the most recent DHS survey is used.

In the pooled sample, only 44% of the considered women can read properly a whole sentence. The others are either illiterate or can hardly read a whole sentence. Regarding education life time, the average time spent at school is 4.9 years. For the *"highest grade achieved"*, nearly 70% of the women have achieved at most the primary level and hardly 5% have reached high school.

On the fertility side, the average *"age at first marriage"* is estimated at 17.9 years. The *"ideal number of children"* averages 4.9 and the mean *"number of children even born"* is 2.8. The large values of the standard deviation of these two latter measures (respectively 2.2 and 2.4) inform on the heterogeneity of these variables across the women.

A fraction of 56% of women was working at the date of the survey. Globally, half of them are observed to be exposed to media. Regarding the process of decision-making for family planning, a large fraction of women is found empowered (78.4%). For regulation, less than 25% of women are using contraception. The modern and traditional methods are the ones commonly used by women implementing family planning.

[5] All the infecund women have been excluded from the data set such that women with 0 as number of children are basically those that have not yet started their fertility life.

[6] IDHS: Integrated Demographic and Health Series, version 2.0, Minnesota Population Center and ICF International. Accessed from http://idhsdata.org. Countries : *Benin 2011; Ethiopia 2011, Burkina Faso, Ghana 2008, Guinea 2012, Cote d'Ivoire 2011, Kenya 2008, Malawi 2010, Mali 2012, Mozambique 2011, Nigeria 2013, Zimbabwe 2010-11, Uganda 2011, Burkina Faso 2010.*

Table 2 **:** Descriptive statistics of the sample

	variable	mean or %	Median	Min	Max	Sd
Social, demographic and Economic characteristics	Age	26.9	26	15	49	8.34
	Live in urban Area	34.7%				
	Live in Rural Area	65.3%				0.48
	Muslim	34.7%				0.48
	Christian	60.1%				0.49
	Traditionalist	2.8%				0.16
	Others	2.5%				0.15
	Never been married	25.3%				0.43
	Formerly in couple	6.4%				0.24
	Currently in couple in the same house	59.8%				0.49
	Currently in couple not in the same	8.5%				0.28
	Household's size	6.4	6	1	49	3.5
Fertility Pattern	Number of children even born	2.8	2	0	18	2.67
	Ideal number of kids	4.9	4	0	18	2.37
	Age at first marriage	17.9	17	4	48	4.05
Education pattern	Total years of schooling	4.9	5	0	23	4.75
	Uneducated	37.0%				0.48
	Primary school	32.5%				0.47
	Secondary school	26.1%				0.44
	High school	4.5%				0.21
	Illiterate	48.5%				0.50
	Able to real only part of sentence	7.6%				0.26
	Able to read whole sentence	43.9%				0.50
Channels	Has television or read newspapers	43.7%				0.50
	Currently working	56.3%				0.50
	Women can have sex or decide for	99.0%				0.10
	Not using contraception	77.4%				0.42
	Tradition methods of contraception	3.5%				0.18
	Modern methods of contraception	19.1%				0.39

4. RESULTS AND DISCUSSION

4.1. Education and the channels

Table 3 displays the results for the correlation between each of the channels and education. Logit and multinomial-logit regression have been performed and Odd Ratios (OR) as well as Relative Risk Ratios (RRR) are provided respectively. Basically, it appears that the channels that are influenced by education are *"exposure to media"*, *"contraceptive use"* and to some extent the likelihood that the woman decides for family planning. Nevertheless, education does not seem to increase the likelihood of working as the Odd Ratios are near to 1 for all the measures of education.

Indeed, for the variable "decide for family planning", one additional year of schooling affects slightly the chance of the woman to be involved in decisions on family planning (1.04 times more). Using literacy, the chance (odd) to decide for family planning is 1.26 times more for women that can read a whole sentence than those that are illiterate. With the *"highest grade achieved"*, the influence of education is more visible for secondary and higher grades. Indeed, the likelihood of deciding for family planning is almost the same for uneducated women and for those of primary school, whereas women of secondary school have 1.4 times more chance to decide for family

planning than uneducated ones and those with higher grade have 2.7 times more chance to be involved in family planning decisions.

Table 3 **:** Results of the regression of the channels on education

	Outcome variable				
VARIABLES	**Opportunity cost (OR)**	**Empowerment (OR)**	**Media (OR)**	**Contraceptive use** (reference = Not using), **(RRR)**	
				Traditional method	Modern method
Education life time	0.98***	1.04***	1.27***	1.100***	1.071***
	(0.001)	(0.007)	(0.002)	(0.004)	(0.002)
Literacy= *Unable to read part of sentence*	*Reference*				
Literacy=*Able to read only part of sentence*	0.96*	0.92	3.07***	1.39***	1.80***
	(0.02)	(0.08)	(0.07)	(0.080)	(0.047)
Literacy= *Able to read whole sentence*	0.69***	1.26***	8.19***	1.82***	2.31***
	(0.01)	(0.08)	(0.11)	(0.0703)	(0.042)
Grade of education = *Uneducated*	*Reference*				
Grade of education = *Primary*	0.91***	1.01	2.89***	1.844***	2.36***
	(0.01)	(0.06)	(0.04)	(0.08)	(0.46)
Grade of education = *Secondary*	0.66***	1.4***	10.04***	2.64***	2.53***
	(0.01)	(0.12)	(0.17)	(0.128)	(0.057)
Grade of education = *Higher*	0.95	2.74***	48.25***	3.38***	2.444***
	(0.03)	(0.54)	(3.10)	(0.216)	(0.082)
Controlled variables	**YES**	**YES**	**YES**	**YES**	**YES**

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

For the exposure to media, the chance to be found exposed to media is 8 times more for women that can read properly a sentence than for illiterate ones. Women of secondary school have 10 times more chance to be exposed to media than uneducated ones and those with higher grade have nearly 50 times more chance to be exposed to media than uneducated women.

The channel contraceptive use is also strongly associated with education. Indeed, compared to women who do not use contraception, the risk of using traditional means is 1.1 times more for each additional year of schooling. This relative risk increases as education grade increases and is 3.4 times more for women of higher grade relatively to uneducated women. The same trend holds for modern methods of contraception. However, "Traditional method" seems to respond better to education than "modern methods" for higher levels of education. This could be due to the relatively low availability (in terms of cost and services) of "modern methods" compared to "traditional methods".

Globally, the effect of education on the working status of the woman is not visible at all and the possibility of deciding in family planning matters is only perceptible for higher levels of education.

For exposure to media and contraceptive use, the story is quite different. These variables rather exhibit a clear and strong association with education at all level.

4.2. Fertility and the channels

i) Total children ever born and channels

Table 4 shows the results from the OLS regression along with Tobit regression with the *"total number of children even born"* as the outcome variable. Three different regressions are run to account each for one measure of education (years of schooling, literacy status and highest grade achieved).

Table 4 **: Regression of total number of children ever born and channels**

VARIABLES	Outcome variable: Total number of children ever born					
	Model 1		Model 2		Model 3	
	(OLS 1)	(Tobit 1)	(OLS 2)	(Tobit 2)	(OLS 3)	(Tobit 3)
Education life time	-0.109***	-0.124***				
	(0.00111)	(0.00144)				
Literacy= *Unable to read part of sentence*	*Reference*					
Literacy =*Able to read only part of sentence*			-0.224***	-0.242***		
			(0.0151)	(0.0190)		
Literacy= *Able to read whole sentence*			-0.598***	-0.744***		
			(0.0107)	(0.0136)		
Grade of education = *uneducated*	*Reference*					
Grade of education = *Primary*					-0.265***	-0.278***
					(0.0106)	(0.0131)
Grade of education = *Secondary*					-0.757***	-0.946***
					(0.0128)	(0.0167)
Grade of education = *Higher*					-1.856***	-2.239***
					(0.0209)	(0.0288)
Regulation de la fertility = *No regulation*	*Reference*					
Regulation de la fertility = *Traditional methods*	-0.0572***	0.0208	-0.156***	-0.0752***	-0.098***	-0.0169
	(0.0203)	(0.0249)	(0.0206)	(0.0253)	(0.0203)	(0.0249)
Regulation de la fertility = *Modern methods*	0.0306***	0.176***	-0.0227**	0.137***	0.00480	0.152***
	(0.0100)	(0.0125)	(0.0102)	(0.0127)	(0.0100)	(0.0125)
Woman is currently working=1	-0.110***	0.0292***	-0.119***	0.0155	-0.107***	0.0322***
	(0.00784)	(0.0101)	(0.00802)	(0.0103)	(0.00787)	(0.0101)
Has television or read newspapers=1	-0.0896***	-0.218***	-0.268***	-0.348***	-0.226***	-0.297***
	(0.00951)	(0.0125)	(0.00992)	(0.0128)	(0.00955)	(0.0123)
Woman can refuse sex or decide about family planning=1	-0.184***	-0.0688	-0.250***	-0.119***	-0.198***	-0.0760*
	(0.0374)	(0.0435)	(0.0382)	(0.0443)	(0.0375)	(0.0435)
Constant	-3.293***	-6.324***	-2.631***	-6.487***	-2.628***	-6.398***
	(0.0566)	(0.0684)	(0.0579)	(0.0698)	(0.0569)	(0.0685)
sigma		1.662***		1.691***		1.663***
		(0.00349)		(0.00356)		(0.00349)
Controlled variable	**YES**	**YES**	**YES**	**YES**	**YES**	**YES**
Number of observations	**159,243**	**159,243**	**158,050**	**158,050**	**159,283**	**159,283**
R-squared	**0.712**		**0.700**		**0.720**	

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

The results show that each additional year of schooling is associated with 0.11 fewer children (0.12 with Tobit). These results are in line with others findings in similar contexts. For example Ainsworth, (1989) also found in Côte d'Ivoire a 0.11 decrease in the number of children per additional year of education with OLS regression and 0.15 decrease with Tobit regression. Osili and Long (2008) even found a much higher magnitude of 0.26 fewer children per additional year of schooling in Nigeria.

With the variable "literacy", compared to illiterate women, those who are able to read only part of a sentence have 0.2 fewer children. Those who can read a whole sentence have also fewer children with a much higher magnitude (-0.60).

While using the "highest grade achieved", compared to uneducated women, those with primary grade have 0.3 fewer children, those with secondary grade have 0.7 fewer children and those with the high school grade have up to 1.8 fewer children. The Tobit model gives similar estimates with a systematic higher magnitude of effects (see table4). Globally, these results are consistent with the findings of Abadian (1996) who used country-level data from the 1992 World Demographic Report on 54 countries and found a negative correlation of magnitude 0.039 between secondary education and total fertility rate.

Regarding the job status, working women seem to have fewer children than those who was not found working. Indeed, the difference is significant and roughly 0.12 for all the measures of education. However, the Tobit regression displays different results as non-working women seem to have fewer children that working ones but this is not persistent in the setting using literacy. Nonetheless, given that the working status of the woman is a one shot measure, these results are to be taken with caution. Indeed, it is more consistent to expect only a long working period of the woman to be influential on the number of children even born. In a more robust setting, Bloom et al. (2009) worked on a panel of 97 countries (SSA included) with a span of 5 years and concluded to a loss of 1.9 years of woman's labor supply during her fertile years for each child born.

For exposure to media, women that are exposed to media have fewer children than those who are not. Indeed, the magnitude is nearly 0.10 fewer children while using *"total years of schooling"*, but higher with the *"highest grade achieved"* (-0.23) and much higher with the literacy status of the woman (-0.27). The magnitudes and the signs of the effects are consistent with those of the Tobit results.

Women that can decide in family planning have nearly 0.20 fewer children that those who cannot, in the models using years of schooling and highest grade achieved. With the variable *"literacy"* the effect is slightly higher (0.25). The Tobit models confirm the sign of the effects but have lower magnitudes. This result is in line with Upadhyaya et al. (2014) who reviewed up to 60 studies on the relationship between the number of children and many measures of women empowerment (refuse sex, household decision making, etc.). They concluded to a consistently negative relationship between empowerment and the total fertility of women.

ii) The Ideal number of children and the channels

Table 5 shows the results from the OLS regression for the demand for children measured by the ideal number of children. Three models are presented, each for one measure of education.

Table 5 : Regression of Ideal number of children, education and channels

	Outcome variable: Ideal number of children		
VARIABLES	**(OLS 1)**	**(OLS 2)**	**(OLS 3)**
Education life time	-0.112***		
	(0.00151)		
Literacy = *Unable to read part of sentence*	*Reference*		
Literacy = *Able to read only part of sentence*		-0.365***	
		(0.0202)	
Literacy = *Able to read whole sentence*		-0.733***	
		(0.0143)	
Grade of education = *Uneducated*	*Reference*		
Grade of education = *Primary*			-0.572***
			(0.0145)
Grade of education = *Secondary*			-1.083***
			(0.0174)
Grade of education = *Higher*			-1.589***
			(0.0281)
Regulation de la fertility = *No contraception*	*Reference*		
Regulation de la fertility = *Traditional methods*	-0.283***	-0.366***	-0.308***
	(0.0273)	(0.0276)	(0.0274)
Regulation de la fertility = *Modern methods*	-0.349***	-0.389***	-0.358***
	(0.0135)	(0.0137)	(0.0135)
Woman is currently working=1	-0.0452***	-0.0542***	-0.0465***
	(0.0106)	(0.0108)	(0.0107)
Has television or read newspapers=1	-0.284***	-0.383***	-0.344***
	(0.0131)	(0.0133)	(0.0130)
Woman can refuse sex or decide about family	-0.00698	-0.0678	-0.0172
	(0.0510)	(0.0515)	(0.0511)
Constant	4.111***	4.053***	4.181***
	(0.0769)	(0.0777)	(0.0772)
Controlled variables	**YES**	**YES**	**YES**
Number of observations	**151,993**	**150,907**	**152,032**
R-squared	**0.353**	**0.342**	**0.350**

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

From these results, one can see that each additional year of schooling tends to reduce the desired number of children by 0.11. Similar results were found in a study on the desired fertility and years of schooling in Ethiopia by Tadesse and Asefa (2001). Using a poison regression they found a negative, slight but significant marginal effect of magnitude 0.0531 of years of schooling on the desired number of children.

Using literacy to measure education yields 0.36 fewer children desired for women who can read part of a sentence, and a desire of 0.73 fewer children for those who can read a whole sentence, all

compared to illiterate women. With a paths analysis model on Africa data on a span of 12 years, Westoff (1992) found comparable results. Indeed, he reported a positive correlation of magnitude 0.47 between uneducated women and the desired for more children and a slight but positive correlation (0.192) between educated women and women wanting no more children.

The results with *"grade achieved"* give also the expected signs. Compared to uneducated women, those with primary level desire 0.57 fewer children, those with secondary level desire 1.08 fewer and those with high school grade desire 1.59 fewer children. A study on four countries from East Africa (Muhoza et al., 2014), showed that in Kenya higher educated people have a fertility preference close to the replacement rate of 2.1 children per woman, whereas uneducated people have an uncontrolled fertility. Conversely, from the same study, no significant difference between educated and uneducated people was found in Rwanda regarding fertility preferences.

For the contraceptive use, it is worthwhile noticing that this variable is conceptually unlikely to influence the desired number of children, but the reverse. However, in terms of correlations, women who use traditional means of contraception are associated with the desire of fewer children (respectively 0.28 with "years of schooling", 0.37 with "literacy" and 0.31 with "grade achieved") than women who are not using contraception. The results are the same for women using modern means of contraception with a higher magnitude (respectively 0.35 with "years of schooling", 0.39 with "literacy" and 0.0.36 with "grade achieved"). Westoff (1992) found also at the country level a 0.64 correlation between contraceptive prevalence and the desire for no more children.

Women that were found working at the survey time desire fewer children than those who were not working at all. However, the difference is hardly 0.05 fewer children. Tadesse and Asefa (2001) in Ethiopia found a 0.3 decrease in the desired number of children due to job opportunity, but the result was not significant.

For exposure to media, this variable has a high effect on lowering the desired number of children. Indeed, with all the three models, women exposed to media desire roughly 0.3 fewer children than women not exposed to media. The magnitude is nearly 0.4 in the setting using literacy to measure education. These results are similar to the findings of Westoff and Bankole (1997) who used DHS data from a survey conducted in 1992-1993 in six countries in SSA to study the determinants of the desired number of children. They found from OLS estimation that exposure to television reduces the desired number of children of married women of a magnitude ranging from 1.9 to 2.8 and reduce the desired number of children of "never married" women of a magnitude ranging from 0.7 to 1.6. The results for newspapers are also similarly conclusive. Indeed, they reported a reduction ranging from 1.1 to 2.1 of desired number children for married women and from 0.4 to 1.7 for never married women.

The desire of children is not significantly affected by the variable "can refuse to have sex or decide in family planning". The effect reaches hardly 0.01 with years of schooling, 0.02 with grade achieved and 0.07 with literacy. This result contrasts a little bit with Upadhyaya et al. (2014) who reviewed 60 studies on the relationship between the number of children and many measures of women empowerment. Indeed, the authors concluded to a consistently negative relationship between some measures of women empowerment (refuse sex, household decision making, etc.) and the desire of

children But the association was less strong with that latter than with the variable "number of children".

iii) The age at first marriage and the channels

Table 6 shows the results from the OLS regression for the supply of children as measured by the age at first marriage. Three models are equally presented, each for one measure of education.

Table 6 : Regression of the age at first marriage and the channels

	Outcome variable: Age at first marriage		
VARIABLES	**(OLS 1)**	**(OLS 2)**	**(OLS 3)**
Education life time	0.294***		
	(0.00331)		
Literacy = *Unable to read part of sentence*	*Reference*		
Literacy = *Able to read only part of sentence*		0.389***	
		(0.0431)	
Literacy = *Able to read whole sentence*		1.663***	
		(0.0312)	
Grade of education = *Uneducated*	*Reference*		
Grade of education = *Primary*			0.571***
			(0.0296)
Grade of education = *Secondary*			2.345***
			(0.0384)
Grade of education = *Higher*			5.286***
			(0.0670)
Regulation de la fertility = *No contraception*	*Reference*		
Regulation de la fertility = *Traditional methods*	-0.102*	0.142**	-0.0132
	(0.0561)	(0.0573)	(0.0560)
Regulation de la fertility = *Modern methods*	-0.499***	-0.410***	-0.446***
	(0.0284)	(0.0291)	(0.0284)
Woman is currently working=*1*	-0.0773***	-0.0361	-0.0831***
	(0.0231)	(0.0237)	(0.0231)
Has television or read newspapers=*1*	0.190***	0.538***	0.371***
	(0.0286)	(0.0294)	(0.0282)
Woman empowerment=*1*	0.336***	0.459***	0.349***
	(0.0944)	(0.0965)	(0.0944)
Constant	14.00***	14.15***	14.17***
	(0.152)	(0.156)	(0.152)
Controlled variables	**YES**	**YES**	**YES**
Number of observations	**118,246**	**117,327**	**118,271**
R-squared	**0.211**	**0.180**	**0.212**

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Each additional year of schooling results in a postponement of marriage for 0.29 years. While using literacy status to account for education, women who *"are able to read only part of sentence"* get married 0.40 year later than illiterate and those who *"can read a whole sentence"* get married 1.64

years later than illiterate. The results are similar while using the variable "grade achieved". Indeed, women with primary level get married 0.58 years later than uneducated one, those with secondary level get married 2.33 years later than uneducated women and those with high school grade married much more lately (5.22 years later). Equivalent results have been reported by Westoff (1992) who found that women who got married by 20 years old (i.e earlier) are positively correlated with low education (0.37) and negatively correlated with relatively high education (-0.34).

For the contraceptive use, this variable is conceptually unlikely to influence the age at first marriage, but the reverse. However, in terms of correlations women who got married earlier are likely to use contraception more than those who got married later. These results are somehow rational given that women that got married later tend to catch up with their fertility desired. Early marriage is associated with the unlikeness of using contraception as confirmed by Westoff (1992) who found a correlation of -0.213 between women that married before 20 and contraception use.

The correlation between the working status of the women and the age at first marriage do not have the expected sign and is found non-significant while using literacy status of the woman to measure education.

Women exposed to media are found with a later age at first marriage than those less exposed to media. The magnitude is 0.11 in the regression using the years of education, 0.46 while using literacy and 0.30 while using grade achieved. These results are supported by the findings of Westoff (1997) who used Demographic and Health Surveys from 1992-1993 and found significant effects of exposure to the mass media among women age 15-24, on age at first marriage. Indeed, the hazard ratio[7] estimates ranged from 0.3 to 0.9 for television and from 0.3 to 0.5 for newspapers.

Women that can decide in family planning are found associated with a postponement of age at first marriage of 0.36 year in the setting with years of schooling, 0.48 with *"literacy"* and 0.37 with *"highest grade"*.

Further discussion on the relative importance of channels and the issue of measures

From the various regressions that have been discussed, table 7 summarises the relative importance of channels in terms of the magnitude of correlation with a level of significance $P<0.1$, in a setting using one specific measure of fertility in rows and one measure of education in columns.

Globally, contraceptive use and exposure to media appear to be potentially the most import channels as they exhibit relatively stronger and consistent correlations in all the settings. This is particularly visible while using *"ideal number of kids"* or *"age at first marriage"* as measures of fertility. The variable *"number of children even born"* that measures the actual or final fertility is basically the result of the demand (ideal number of kids) and the supply (age at first marriage) under the constraint of regulation as discussed in Becker (1960).

[7] Hazard Ratio lower that 1 here tells that there is a negative association between age at marriage and exposure to media.

Table 7 : Summarizing of the relative importance of the channels

	Years of schooling	Literacy	Degree
Children even born	Empower Opportunity cost Media regulation	Media Empower regulation	Media Empower Opportunity cost regulation
Ideal number of children	Regulation Media Opportunity cost	Regulation Media Opportunity cost	Regulation Media Opportunity cost
Age at first marriage	Regulation Empowerment Media Opportunity cost	Media empowerment Regulation	Regulation Media Empowerment Opportunity cost

In addition, the disparities observed in the results while using different measures of education and fertility as well as the accuracy of the results shows that measures matter (see table 8).

Indeed, the use of *"number of children even born"* gives a higher R^2 (71%) than all the other measures of fertility, but this measure only replicates the expected sign of correlation derived from the literature, in the setting using "literacy" to measure education. Moreover, it fails to give evidence of the well-established effects of contraceptive use on fertility. Finally, this measure is not consistent in its findings, given that it yields different conclusions while controlling education through different measures.

Table 8 : Summary of the sensitivity of measures

	Criteria of assessment	years	Literacy	degree
Actual fertility **Number of children even born**	▪ R^2	71.2%	70.0%	72.0%
	▪ *coeff. (p-val)*[8]	All significant	Not for Cost	All as expected
	▪ *Coefficient of variation*	1%	4.3%	2.3%
	▪ *Sign of the coefficient*	Except regulation	All as expected	Except regulation
Demand for children **Ideal number of children**	▪ R^2	35.3%	34.2%	35.0%
	▪ *coeff. (p-val)*	Except empowerment	Except empowerment	Except empowerment
	▪ *Coefficient of variation*	1.3%	3.7%	2.0%
	▪ *Sign of the coefficient*	All as expected	All as expected	All as expected
Supply for children **Age at first marriage**	▪ R^2	21.1%	18.0%	21.2.0%
	▪ *coeff. (p-val)*	All significant	Except Job	All as expected
	▪ *Coefficient of variation*	1.1%	6.5%	2.7%
	▪ *Sign of the coefficient*	All as expected	All as expected	All as expected

[8] Coefficient of variation is the average of the coefficient of variation of the main variable of the setting (channels and education)

The *"ideal number of kids"* exhibits a much lower R^2 (35%) than the previous measure but it has the merit of replicating perfectly the expected signs of the correlations admitted in the existing literature. In addition, the conclusion while using this variable to measure fertility is consistent in all the measures of education (Empowerment is not significant for all the measures of education). The main drawback of this measure is that it could change from a period to another for the same woman as illustrated by Kodzi et al. (2010). These authors used data from multiple surveys to assess the stability of intended fertility in a cohort of rural Ghanaian women over a period of five years and found that 20% of the surveyed women changed their fertility preference from one interview to another.

The *"age at first marriage"* yields a much lower R^2 (21%) than the other measures. It also replicates all the expected signs of the literature. However, this measure is somehow restrictive as it excludes the non-married women whose fertility is also part of the debate. Moreover, the consistency of the results is not strong enough (different conclusions with different measures of education).

Regarding specifically the measures of education, the *"years of schooling"* and the *"highest grade achieved"* should be preferred in this analysis as they yield lower values of coefficient of variation for the estimates, compared to literacy.

4.3. Robustness check and caveats

To check for robustness the study used different techniques of estimation (OLS and Tobit) as well as several measures for education, channels, and fertility. For education and fertility, as discussed, the results were found consistent and more robust with other pieces of research while using *"ideal number of children"*, *"age at first marriage"* on the fertility side and *"years of school"* as well as *"highest grade"* achieved on the education side. The change of measures of channels gives sometimes different results. For example, while introducing "radio" in addition to "newspapers" and "television" in the definition of the variable "exposure to media", the results were puzzling as *"exposure to media"* was positively correlated with fertility. The reason could be that television and newspaper as components of *"exposure to media"* are more influential on behavior than radio. The variable *"women empowerment"* also has been measured by different variables. While using only *"decision in family planning"* or *"woman can refuse to have sex"* the results were the same but less consistent. While combining the two measures, the results became more consistent.

While removing some outliers[9] with respect to the variables of interest (education, channels, and fertility), the results became slightly different, but the main findings were the same.

The non-linearity of the model was also checked as discussed for example by *Bongaarts* (2010, 2003); Bankole (1995) and Baudin et al. (2015). To that end, quadratic version of years to school(continuous variable) has been added in the models and the results were basically the same.

[9] For example, East Africa countries (Zimbabwe, Kenya) and Nigeria exhibits a much higher level of education compare to the others countries whereas Mali, Guinea, Malawi have a lower level.

Moreover, the use of grade of education which is not a continuous variable has also helped to sort out this issue.

The desire of children of the husband has also been controlled for. The magnitude of the results were slightly different but the findings remained unchanged.

Globally the robustness check confirmed the main findings that remained consistently unchanged despite some fluctuations in magnitudes.

However, it is important to acknowledge two main limits and constraints regarding this study. The first one is related to Data. The data from IDHS are known to be of good quality. Nevertheless, there were some limiting aspects for this study. The design of the DHS-surveys defines a "woman at childbearing age" a woman aged from 15 to 49, inducing thereby a selection bias for the women whose fertility could have appeared out of that conventional range. This fact is more and more common in SSA due to early marriage and adolescent pregnancy estimated at 1.8 million of girls giving birth before 15 years in SSA in 2010 (UNFPA, 2013). Another potential bias is due to the risks of non-independence between sampled women. Indeed, the sampling method used by DHS consisted in including all women of childbearing age within a selected household. Hence, in case of the presence of multiple women at childbearing age in the same household, many characteristics common to the household could have accounted for non-independence between individuals. However, the large size of the sample could have minimized the effects of these selection biases.

The second problem is related to endogeneity which was omnipresent in this study. Indeed, the study made the "strong" assumption of non-recursive effects between education, channels and fertility while it is unlikely to be the case. For example, Lloyd and Mensch (2008) brought forth evidence on the fact that family formation and childbirth are factors that explain 5 to 10 percent of school dropout for young girls in SSA. Moreover, measuring education and fertility by indicators expressing the final fertility (number of children even born) or the final level of education (e.g total years of schooling) could be misleading (Rindfuss et al., 1980). In a more realistic view, it should be consistent to consider that education and fertility can affect one another during the life course. Indeed, the fertility and the education attainment of a woman can evolve alternately so that her actual fertility might not be the result of her actual level of education but that of an anterior level and iteratively.

To address this issue, some authors used the Structural Modeling Equations (SEM), but some others challenges are still remaining as these approaches also use strong assumptions like the absence of measurement errors. (see for example Graff et al (2010) and Ullman (2006) for SEM).

5. CONCLUSION

The well-known negative influence of education on fertility has been the starting point of this study which attempted to contribute to the research by discussing the channels through which education could consistently bring about a decline in fertility in Sub-Saharan Africa.

Two core questions have then oriented the discussion: what are the main factors through which education influences fertility and what are the sensitivity with respect to changes in measures usually used to capture fertility and education. A framework including four channels has been used to discuss these questions. Due to some serious issues of endogeneity, Logit, OLS and Tobit's regressions have been used to capture the correlations between education and channels in a first step, and the association between channels and fertility in a second step. In addition, the sensitivity of the results has been discussed using several measures of education and fertility.

The main contribution of this paper is to have shown that the channels *"contraceptive use"* and *"exposure to media"* are strongly associated with both education and fertility, giving thus evidence of the fact that they are potentially the main channels of the influence of fertility through education in SSA. The channels "decide for family planning" and the "working status" of woman are globally found weakly associated with education and fertility compared to the two first ones. However, it is worthwhile to notice that the measure "decide for family planning", used to capture "women empowerment" was much closer to a bargaining power than a real empowerment of women which by itself is quite tricky as concept. The current working status of the woman was also a weak proxy for the "opportunity cost" of having many children.

These results have been found globally consistent with previous findings in terms of the expected signs as well as the magnitudes of influence. This was the case, typically while using on the one hand "total years of schooling" and "highest grade achieved" to account for education and on the other hand "ideal number of children" and "age at first marriage" to account for fertility. The main other measures: literacy for education and "number of children even born" for fertility yield to less robust results.

Thereby, these results are compelling for both researchers and policymakers. For researchers, the issue of measures raised in this paper suggests that the demand side, measured by the ideal number of children is a best way to study fertility prospects, given that age at first marriage is somehow restrictive. However, data collection processes, as well as the econometric frames, should take into account the fact that this variable (ideal number of children) could change during the lifetime of a woman. For education, the total years of schooling and the highest grade achieved should be preferred to literacy, enrollment or school attainment provided that the former measures give a better insight of the learning outcomes.

For policymakers, the high association of contraceptive use and exposure to media with both education and fertility suggest that the authorities should:

1. Enhance educational programs and tackle in particular issues inducing early dropout so as to gain on the supply side of fertility. This gain will basically be the postponement of marriage and/or age at first birth for girls thanks to the time constraint related to school as discussed by Ferré (2009). They should also promote secondary and tertiary school, manage to reduce the gender gap and address the issue of the learning outcomes through an improvement of infrastructures and educational system including the training and the monitoring of teachers as proposed by Chaudhury et al. (2006).
2. Moreover, the educational curriculum in SSA should include fertility and sexuality related topics in order to educate young girls on fertility's issues. This will basically affect the demand side of fertility. A typical illustration of such policy is what was known as West African Youth Initiative (WAYI) peer education projects implemented from 1994-1997 to improve knowledge of sexuality and reproductive health and promote safer sex behaviors and contraceptive use among sexually active adolescents in Nigeria and Ghana. The post evaluation of these projects showed evidence of an improvement of knowledge and a change in behavior regarding sexual matters (Brieger et al., 2001).
3. SSA authorities should also promote exposure to media with particular programs that aim at advertising family planning, access and knowledge on contraceptive use as advocated by Bongaarts (2011).

Finally, this paper is only a basic contribution for the discussion on the channels of influence of education on fertility, due essentially to the limits imposed by endogeneity. For further studies, unlike the two-steps setting used here, a global frame might be used to assess the transmission mechanism of education on fertility, taking into account potential recursive-effects. This could be possible if using panel or cohort data or at least pseudo-panel and more consistent estimations techniques such as Instrumental Variable and/or Structural Equation Modelling.

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D.E.S. en Economie Internationale et du Développement

Nom du promoteur : Paul Reding Nom du tuteur : Timothée Demont

Nom de l'étudiant : NIBARUTA Pascal

- Démarche scientifique
  Les fondements théoriques sont-ils adéquats, suffisamment explicités et développés de manières rigoureuse ?

  Fondements théoriques peu présents
  Peu de référence aux arguments théoriques pour évaluer la pertinence de la réglementation proposée.

  Les techniques utilisées sont-elles bien choisies et mises en œuvre correctement ?

  Calcul des ratios effectué
  Pas de données de bilans exploitées
  Peu de détails sur méthodologie
  Peu de références.

  La cohérence d'ensemble du travail est-elle bien réalisée ?

  Plus ou moins.

- Autonomie
  De quel degré d'autonomie l'étudiant a-t-il fait preuve ?

  Assez faible. Beaucoup aidé. Bonne progression jusqu'à certaine limite...

- Applicabilité
  Le projet présente-t-il un intérêt pour la décision et l'application ?

  Faible

- Originalité
  Dans quelle mesure la démarche suivie par l'étudiant est-elle originale ?

  Originalité faible

- Forme
  Le projet est-il rédigé de manière claire, concise, agréable ; les différentes parties sont-elles bien articulées ?

  Moyen. Il reste un problème d'identification d'un point d'une source qui n'est mentionnée qui en bibliographie générale, alors que les feuillets annexes ont été exploités ! (2 passages de 5-6 lignes)

- Présentation orale
  Clarté de l'exposé, maîtrise du sujet ? Très faible

Résultat sur 20 = 11 ½ sans prendre en compte problème "sources"

D.E.S. en Economie Internationale et du Développement

Nom du promoteur : Paul Reding Nom du tuteur : Timothée Demont.

Nom de l'étudiant : Pascal Mbaruta

- Démarche scientifique
  Les fondements théoriques sont-ils adéquats, suffisamment explicités et développés de manières rigoureuse ?

  peu

  Les techniques utilisées sont-elles bien choisies et mises en œuvre correctement ?

  ratios, méthode précise ?

  La cohérence d'ensemble du travail est-elle bien réalisée ? Ok

- Autonomie
  De quel degré d'autonomie l'étudiant a-t-il fait preuve ?

  assez faible, progression

- Applicabilité
  Le projet présente-t-il un intérêt pour la décision et l'application ?

  faible

- Originalité
  Dans quelle mesure la démarche suivie par l'étudiant est-elle originale ?

- Forme
  Le projet est-il rédigé de manière claire, concise, agréable ; les différentes parties sont-elles bien articulées ?

  Moyen. :) prob. références

- Présentation orale
  Clarté de l'exposé, maîtrise du sujet ?

  faible

Résultat sur 20 = 11^5 (sans prendre en compte prob. sources)